Agricultural Pricing ~~Policies~~ in Developing Countries: Pakistan 1960-1988

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TO MY FAMILY

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Abstract

A substantial proportion of revenue in many developing countries comes from indirect taxes. It is also common for governments in developing countries to procure agricultural outputs through public agencies at prices below world prices and to sell at higher prices. In Pakistan over 80% of government revenue comes from (explicit) indirect taxes. Also, since the 1960s the nature and extent of government control of prices, particularly in agriculture, has changed dramatically. The theory of public finance can help to guide policy makers on the appropriate price and tax policies. In Chapter 1 we show how this theory can structure an analysis of the reform of taxes and prices.

The appropriate pricing policies depend sensitively on the policy instruments available to the government and on the nature of relationships between economic agents. A central topic of this thesis is the examination of how standard pricing policy analysis and prescriptions need to be adapted for developing countries where agriculture plays a dominant role and where government control over transactions is far from complete. Since the nature of transactions plays a crucial role, in Chapter 2 we give a brief discussion of the diversity of agricultural organization and practices in Pakistan, and highlight some of the important topics in the economics of agriculture in developing countries. We stress the importance of decision making in the presence of uncertainty and the existence of market imperfections in understanding agriculture in LDCs.

A characteristic of agriculture in developing countries is that households are both consumers and producers of foodgrains and that the pattern of marketed surplus varies across households. In Chapter 3 we show how cross-section data can be used to explain this variation in the marketed surplus for wheat. The need to allow for sample selection, influential observations and heteroskedasticity in analyses which use similar models and data is highlighted. The behaviour of marketed surplus is a crucial input into price and tax analysis.

In Chapter 4 we use a 'double hurdle' model to explain the variation in fertilizer levels applied to wheat in Pakistan. We show that attitudes to uncertainty and how these vary with wealth, along with varying productivity levels and credit constraints, can help to explain this variation.

The prevalence of distortions in developing countries is well documented. In Chapter 1 we show how the use of shadow prices in reform analysis can incorporate these distortions. Moreover, shadow prices have a number of further useful applications. Using input-output tables and data on revenue collections and price distortions we show, in Chapter 5, how one can calculate a set of shadow prices (accounting ratios) for Pakistan. These are then used to analyse how social profitability varies across industries and to comment on trade and industrialization policies.

In Chapter 6 we present a model which is intended to allow normative analysis of the policy instruments which were available to the government in Pakistan in the mid 1970s for raising revenue. Together with the theory presented in Chapter 1 this is then used to identify welfare-improving reforms of pricing policy and also to focus on the issues that need to be addressed when formulating pricing policy. We argue that there were large efficiency gains to be had from higher prices for major agricultural commodities. We also argue that in the absence of more direct income-transfer mechanisms subsidised rations and low procurement prices for foodgrains may be desirable when one is concerned with income distribution. Chapter 7 provides a summary and some conclusions. Although our analysis uses data for the mid 1970s our results also carry lessons for policies beyond this period and we use them to comment on policies followed in the 1980s and to set out recommendations for future policies.

Table of Contents

Addendum

The following corrections to the text are required: xx.yy.zz stand for page number (xx), paragraph number (yy) and line number (zz; a minus means 'from the end of the paragraph'). '—>' denotes 'should be'.

Chapter 1:

20.01 07	α —> -α
21.02.02	appeals —> appeal
21.02.04	household —> households
25.01.-3	openess —> openness
27.02.01	an —> on

Chapter 2:

34.04.02	milti —> multi
47.02.02	fertlizer —> fertilizer
51.03.-2	irrigations —> irrigation
53.01.02	draft —> draught
56.04.10	others —> others'
65.02.18	then —> than
73.02.09	assymetric —> assymmetric
80.01.06	'total farm output' should be deleted
81.02.-3	crops —> crop
81.03.06	adaquacy —> adequacy
94.04.08	procucers —> producers
96.01.11	'input, i.e. the price of one kg of' —> 'input.'
102.01.-1	varation —> variation

Chapter 3:

105.01.03	detain —> detail
105.02.10	unlikely —> is unlikely
112.02.04	being —> been
127.03.04	tobit —> Tobit
127.03.08	stocastic —> stochastic
131.	Table 3.3 Last line of 'Notes': ha —> has
145.04.-3	semed —> seemed
146.02.05	producers —> consumers

Chapter 4:

150.03.04	profitably —> profitability
152.02.08	prominant —> prominent
163.01.01	the the —> the
165.02.-4	thise —> these
166.01.-2	foe —> for
166.02.-2	liklihood —> likelihood

Chapter 5:

193.02.-2	liscencing —> licensing
194.02.-2	liscences —> licenses
198.03.-7	whould —> should
241.03.02	quantative —> quantitative

Chapter 6:

244.02.03	coside —> coincide
271.03.04	argues —> argue
272.04.07	an —> a

Chapter 7:

291.01.10	emphaises —> emphasises

References:

294 Amemyia —> Amemiya
296 Boiteux, 1971 —> Boiteux, 1956
298 Hazell, R. —> Hazell, P.
299 Kusro —> Khusro
299 In Maddala (1983): Qualative —> Qualitative
299 In Matur and Ezekel (1961): Ezekel —> Ezekiel
300 In Pakistan Institute of Development Studies (1985): Studies —> Economics
In Newbery (1987a): Newbry —> Newbery
In Newbery (1987b): Newbwey —> Newbery

The following references should be included:

Deaton, A., and M. Irish (1984): 'A Statistical Model for Zero Expenditures in Household Budgets', Journal of Public Economics, 23, pp59-80.

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List of Tables

Chapter Four:

Chapter Five:

Chapter Six:

List of Figures

Appendices to Chapters

List of Appendix Tables

Chapter One

Introduction

§1.1 Background

In this thesis we examine issues which influence the appropriate agricultural pricing and indirect taxation policies in developing countries. For this purpose we concentrate on the policies followed in Pakistan in the mid 1970s. Our choice of country and time period reflects the wide range of policy instruments employed during this period and also the availability of adequate data. However, we also use our analysis both to comment on policy since the mid 1970s and to make recommendations for future pricing policy. Because the basic economic principles underlying pricing policy and indirect taxation policy are essentially the same, we will often use the general term 'pricing policy' to refer to both.

Our focus on agricultural pricing policy suggests two questions: 'Why pricing policy?' and 'Why agriculture?'. The answer in each case is that both are central to public policy in developing countries. A common characteristic of many developing countries is the extent of government intervention in the economy by way of manipulating prices, either directly through price controls or indirectly through indirect taxes. While there may be a number of reasons or objectives behind such intervention the need to raise revenue to finance various government expenditures is often central. Although economic theory suggests that the most efficient way to raise revenue is to do so directly via lump-sum taxes, the absence or political unacceptability of such instruments in developing countries necessitates a reliance on more indirect instruments such as the manipulation of prices. This is particularly so when it comes to the taxation of agriculture where the number of households and their geographical dispersion removes many of the more direct instruments from the menu of feasible instruments.

Pakistan is no different in this respect. Since the mid 1970s indirect taxes have accounted for around 80-85% of total tax revenue, which in turn accounted for around 70% of total revenue. As in many other developing countries, trade taxes and excises raise most of the indirect tax revenue. In 1976/7 customs and excises accounted for around 37% and 32%, respectively, of indirect tax revenue. However, while tax revenue has remained at around 13% of GDP during the 1970s and 1980s, current expenditures have increased from 16% in 1975 to 23% in 1985. Within indirect taxes there has been a shift towards customs and surcharges and away from excises. Both have concentrated on a narrow base in terms of commodities covered, and on the taxation of intermediate commodities with the consequent cascading and efficiency problems. Between 1976 and 1986 customs and surcharges increased (as a percentage of total indirect tax revenue) from 37% to 42% and 7% to 13%, respectively, while excises fell from 32% to 23%. The shift towards customs reflects the pressure to raise more revenue to finance increasing current expenditures, the convenience of foreign trade as a source of revenue (especially in the short run) and the small base for excises in terms of the number of commodities covered.

While one can argue that there is an over-reliance on commodity taxation as a source of revenue and that one needs to develop a more effective direct tax system, in the short to medium term at least, it is likely that the extra revenue requirement must come from indirect taxation. However, we shall argue that there is much room for improvement in the existing combination of indirect taxes and subsidies in terms of both their efficiency and distributional impact. We also argue that our ultimate concern should be for the present and future well-being of individuals rather than sectors.

The main contribution of the thesis is in the area of applied economics, in particular in relation to agricultural pricing policy. We take a specific model for the analysis of policy in Pakistan and our results highlight issues which are central to the understanding of what constitutes appropriate pricing policy. We focus particularly on agricultural inputs and outputs and show how empirical analysis can be used to explain the patterns of agricultural outputs and input use across farms. We also show how these patterns are affected by various household characteristics (such as composition, farm size and prices), some of which can be influenced by government policy, and their consequences for other variables of interest to government (e.g. revenues, expenditures, foreign exchange, and the pattern of foreign trade). We also show how the existing pattern of outputs and inputs and their responsiveness to government policy instruments influence the equity and efficiency consequences of price reforms and thus determine appropriate pricing policy. Our analysis also brings out the strong relationship between investment, trade and pricing policies. In all these respects the level of detail and the scope of the thesis mean that the work presented should be seen as complementary to recent works in the area of agricultural pricing policy in general (see Newbery and Stern, 1987) and pricing policy in Pakistan in particular (see Ahmad and Stern, 1991).

In this chapter we describe our approach to the analysis of pricing policy. In §1.2 we give a brief account of the main features of standard optimal commodity taxation models. These models provide some very useful insights into the desirable characteristics of a system of commodity taxes and help to highlight the efficiency and equity issues which underpin most of the results. However, the system of indirect taxes which exists in many developing countries often bears little resemblance to that suggested by these models and governments are understandably wary of making substantial changes, not least because of the uncertainty about revenues needed to finance politically sensitive expenditures. One therefore needs a theory for the reform of prices and in §1.3 we describe a theory of price reform which helps to identify welfare-improving changes when there already exist many other distortions in the system. Then in §1.4 we describe how such a theory can be applied in practice and identify the data requirements for such an analysis. In §1.5 we highlight some of the special features of the agricultural sector which need to be incorporated into standard theoretical models and any analysis of the impact of reforms on social welfare. Finally, in §1.6, we describe the layout of the thesis and indicate some of the policy implications of our analysis.

§1.2 The Theory of Optimum Pricing and Indirect Taxation

The issue of how to raise the revenue necessary to finance the various government expenditures is an important one for all developing countries. When formulating and appraising the policy instruments employed one needs to combine basic economic principles with an understanding of the political, legal and administrative environment of the country in question. One needs to recognise that without an effective legal system any form of taxation is open to manipulation or abuse and may be rendered totally ineffective. Likewise, when advocating policies one must be aware of both the political and administrative constraints facing governments which determine the eventual success or failure of policies pursued. Therefore, the appropriate policies from an economic viewpoint need to be set against legal, political and administrative criteria and experience has shown that these often lead to contradictory choices or conclusions. Although we focus primarily on economic criteria, i.e. equity and efficiency considerations, we try to heed our own advice and use these other non-economic criteria when making final recommendations. The advantage of the approach described below is that while it helps to identify the trade-off between equity and efficiency when choosing between competing 'distortionary' revenue-raising instruments it does so in a way which also helps to identify the types of policy instruments required and the consequent gainers and losers (i.e. the incidence of the taxes). One can then consider the legal and administrative requirements necessary for implementing such policies and consider their political acceptability.

The theory of public finance has long been concerned with the most efficient and equitable ways of raising a given revenue requirement. For our purposes the two fundamental theorems of public economics provide a useful starting point. These state that:

(a) If we assume that all markets exist and that there are no externalities then a competitive equilibrium is Pareto efficient.

(b) If we further assume that production and preferences are convex and that revenue can be raised and distributed in a lump-sum manner, then any Pareto efficient allocation can be decentralized as a competitive equilibrium.

The term 'lump-sum' refers to the fact that agents are unable to change the level of taxes paid or transfers received by changing their behaviour. These theorems suggest that governments wishing to raise revenue, either to finance the provision of public services or to redistribute income to other households, should do so using lump-sum taxes and transfers. Under these circumstances (relative) consumer and producer prices are equal and reflect social opportunity costs in terms of a social welfare function which depends on the welfare of households in the economy. Resource allocation decisions by economic agents, e.g. consumers and producers, based on market prices will be socially optimal in the sense of (a) and (b) above.

Much of the literature in public finance is concerned with optimal policy when some of the above assumptions are relaxed. For example, many governments, particularly in developing countries, are either unwilling or unable to raise some or all of their revenue requirement using lump-sum taxes. Also, the identification and use of certain household characteristics to enable the effective lump-sum transfer of income to deserving (e.g. poor) households is not always desirable from a political viewpoint or feasible from an administrative viewpoint. The process of identifying or constructing lump-sum tax instruments is more difficult when one considers the problem of incentives where households understand that there is, say, a 'wealth' or income basis for the level of tax paid. Therefore, governments are generally forced to rely on 'distortionary' taxes which drive a wedge between market prices and social costs and benefits. Distortionary taxes can be divided into 'direct' and 'indirect' taxes. Direct taxes usually take income and wealth as their base whereas indirect taxation refers to the taxation of commodities. Because of the political and administrative implications of many direct forms of taxation it is often left to the indirect tax system to raise the bulk of the funds required. This leads us to ask what commodities should be taxed and how should these rates of taxes vary over commodities, if at all?

The theory of optimal indirect (i.e. commodity) taxation asks how commodity taxes should be set so as to raise a given revenue requirement [see, for example, Ramsey (1927), Samuelson (1951 and 1988), Boiteux (1956) and Diamond and Mirrlees (1971)]. Generally speaking, from an efficiency point of view, taxes should be higher on goods with lower (compensated) price elasticities of demand. However, when we introduce income distribution considerations into the model the theory suggests that commodities which account for a higher proportion of the budgets of more deserving households should have relatively lower taxes. Since, in practice, those commodities are often necessities with low demand elasticities there is often a trade-off or conflict between efficiency and distributional considerations when setting commodity taxes.

The general results described here suggest that we should have a differentiated tax system with rates varying across commodities according to the pattern of own- and cross price demand elasticities and the pattern of their budget shares across income groups. However, if we introduce the possibility of lump-sum transfers to households related to demographic structure and if consumer preferences satisfy certain conditions, e.g. common and constant marginal propensities to spend across households and separability of labour from goods, then uniform commodity taxes are optimal in the presence of optimal lump-sum transfers of the type described (see, for example, Deaton and Stern, 1986, and Stern, 1990, for a more detailed discussion). We can then view indirect taxes as purely revenue-raising instruments with income distribution considerations taken care of through lump-sum taxes financed by the indirect tax revenue. In general, the more comprehensive the system of lump-sum transfers available the stronger the argument for uniform commodity taxes.

So far we have been concerned only with ways of raising revenue where there are limitations on tax instruments. The implicit assumption (see, for example, Drèze and Stern, 1987) is that producer prices are proportional to shadow prices, defined as social opportunity costs. If there are market imperfections then (relative) shadow prices may not equal (relative) producer prices. Fortunately, many of the principles discussed follow through by simply replacing producer prices with shadow prices, and interpreting taxes as shadow taxes. Then taxes can be seen as having a dual purpose: the raising of revenue and the correction of market imperfections.

The standard models (see, for example, Diamond and Mirrlees, 1971) usually assume that either all production is in the public sector or, where some private production exists, that technology exhibits constant returns and markets are perfectly competitive. Alternatively, in the presence of pure profits in the private sector, we can assume that profits can be optimally taxed so that the effects of any changes in profits on income distribution can be ignored. In such circumstances production efficiency is desirable in the public and private sectors taken together so that all producers (public and private) should face the same prices (and, thus, marginal rates of transformation in production) and there should not be any taxation of intermediate goods.

In the model presented by Diamond and Mirrlees (1971) to analyse optimal commodity taxation (which also assumes all goods can be taxed) the assumptions imply not only that production efficiency is desirable but also that the model can be formulated as if producer prices are constant, i.e. as if taxes are totally shifted forward onto the consumer. However, for developing countries where a large proportion of the population usually rely directly on agriculture as their main source of income the assumptions above cannot be realistically applied. For example, it is widely accepted that taxation of profits from agricultural production is very difficult so that the assumption of 100% (or optimal) profits taxation would be hard to accept. Also, since most farm households consume from their own produce before marketing their surplus, it is not possible to tax all goods (total household consumption), i.e. we cannot confront producers and consumers with different prices. However, if there are no agricultural profit taxes, one can include the agricultural sector along with the consumer sector. In this case production efficiency is desirable in the remaining 'limited' production sector, and the relevant derivatives in the tax rules relate to marketed surplus rather than consumption. Notice that because the agricultural sector is now taken as part of the consumer sector we will in general require inputs to be taxed or subsidized at the optimum - production efficiency is desirable only for the limited production sector (assuming the Diamond-Mirrlees assumptions apply to the 'remainder' of the model).

The above discussion suggests that where possible we should tax final consumption only. Intermediate taxation is desirable only if some output cannot be taxed (or for income distribution reasons where alternative redistribution measures are unavailable). Often output and input prices are distorted as a means of encouraging or discouraging certain industries. Broadly speaking economic theory suggests that if we wish to encourage or discourage certain industries (say, for 'infant industry' or 'learning by doing' reasons) then we should try to do so directly, i.e. go directly to the source of the distortion. If there are externalities in production which are not reflected in output prices then taxes or subsidies should be used to correct the relevant prices. Distorting input prices in an attempt to influence investment decisions is not desirable unless more direct instruments (e.g. direct subsidies or output taxes) are not available. The theory of the second best also emphasises that the presence of irremovable distortions or market imperfections elsewhere affects the types of policies we should implement. In such cases, where shadow and producer prices are not proportional, indirect taxes take on a corrective role as well as their revenue raising function.

An attractive feature of the optimum tax models discussed is that they give guidance on the design of the overall tax and transfer system and emphasise the trade-off between equity and efficiency which exists when one does not have access to non-distortionary or lump-sum instruments. However, more often than not, the tax and transfer systems in place in many developing countries bear little resemblance to those suggested by optimal tax models, even when we think in terms of a second-best optimum situation. A risk-averse government with politically sensitive expenditures to finance will be understandably wary of policies which require a major redesign of the existing system. However, it will probably be more receptive to 'welfare-improving' policy recommendations which involve small or gradual movements away from the status quo even when these are presented within a framework which involves a longer-term redesign of the existing system. It is therefore helpful to have a theory of tax (or price) reform. We have focused here on indirect taxation policy. However, the principles highlighted above also apply directly to pricing policy since we can interpret the differences between output prices and (marginal) costs as a tax. Many important industries, e.g electricity, gas, transport and fertilizers, are often in the public sector or under strict government control. The pricing of these outputs are therefore also under the control of government and should be guided by the principles outlined. In the rest of the thesis we use the terms 'indirect tax policy' and 'pricing policy' interchangably.

§1.3 The Theory of Price Reform

The model presented here is taken from Drèze and Stern (1987). In this model we see the government as examining a group of policy variables. Some of these policy variables will be taken as fixed or predetermined and others as chosen optimally subject to the scarcity constraints that demands do not exceed supplies. Let $\boldsymbol{\omega}$ be a vector describing the former and $\boldsymbol{\kappa}$ the vector describing the latter (bold type indicates vectors). Social welfare $V(\boldsymbol{\kappa},\boldsymbol{\omega})$ and excess private sector demands $\mathbf{E}(\boldsymbol{\kappa},\boldsymbol{\omega})$ are both functions of these policy variables. The optimal value for $\boldsymbol{\kappa}$ is derived from the solution to the following problem:

$$\begin{aligned} &\max_{\boldsymbol{\kappa}} \quad V(\boldsymbol{\kappa},\boldsymbol{\omega}) \\ &\text{s.t.} \quad \mathbf{E}(\boldsymbol{\kappa},\boldsymbol{\omega}) = \mathbf{z} \end{aligned} \qquad (1.3.1)$$

where $\mathbf{z}$ is a vector of public sector supplies (which may be zero). We are assuming that the above problem is feasible so that we shall usually require the dimension of $\boldsymbol{\kappa}$ to be greater than or equal to those of $\mathbf{E}$ and $\mathbf{z}$ (i.e. there are at least as many policy variables to be chosen as there are constraints). If the two dimensions are exactly equal then, if the function $\mathbf{E}$ is invertible, $\boldsymbol{\kappa}$ will be defined as a function of $\mathbf{z}$ and there will essentially be no choice. Thus the case where policies are determined entirely by constraints is included. Further constraints in addition to those arising through $\mathbf{E}(\boldsymbol{\kappa},\boldsymbol{\omega})=\mathbf{z}$ may be added to the analysis although they will add extra terms to the Lagrangian of the problem. The Lagrangian for (1.3.1) is:

$$L(\boldsymbol{\kappa},\boldsymbol{\omega}) = V(\boldsymbol{\kappa},\boldsymbol{\omega}) - \mathbf{v}' \, [\mathbf{E}(\boldsymbol{\kappa},\boldsymbol{\omega}) - \mathbf{z}] \qquad (1.3.2)$$

where $\mathbf{v}$ is the vector of shadow prices (prime superscripts denote row vectors). The shadow price of a good is here defined as the increase in social welfare when an extra unit of public supply is made available [or $\partial V^*/\partial \mathbf{z}$ where $V^*(\boldsymbol{\omega},\mathbf{z})$ is the maximum-value function for (1.3.1)]. Given that we have set up the problem as in (1.3.2) above, shadow prices will coincide with the Lagrangian multipliers for (1.3.2) when the $\boldsymbol{\kappa}$ are chosen optimally.

Taking a reform viewpoint we may regard some indirect taxes and government controlled prices as elements of $\boldsymbol{\omega}$, the vector of predetermined variables. We may then consider the reform issue as an evaluation of a shift in a variable previously seen as fixed from its pre-reform position. It can be shown (see Ahmad and Stern, 1990, pp136-139) that the effect on welfare of a change in a predetermined variable, here a change in the indirect tax or government controlled price of the i'th commodity, dt_i, is:

$$dV = \left\{ \frac{\partial V}{\partial t_i} + \frac{\partial R_v}{\partial t_i} \right\} dt_i \qquad (1.3.3)$$

where R_V is shadow government revenue (its derivative taken at constant shadow prices) and is derived as follows. If **y**, **p** and **q** are vectors of private sector output, producer prices and consumer prices respectively then:

$$\mathbf{E} = \mathbf{x} - \mathbf{y}$$

and we can write

$$-\mathbf{v}'\mathbf{E} = \mathbf{v}'(\mathbf{y} - \mathbf{x}) = (\mathbf{v} - \mathbf{p})'\mathbf{y} + (\mathbf{q} - \mathbf{v})'\mathbf{x} + \mathbf{p}'\mathbf{y} - \mathbf{q}'\mathbf{x}$$
$$= R_V$$

where $(\mathbf{p}'\mathbf{y} - \mathbf{q}'\mathbf{x})$ is government direct tax revenue, and $(\mathbf{q} - \mathbf{v})$ and $(\mathbf{v} - \mathbf{q})$ can be thought of as 'shadow consumption taxes' and 'shadow producer taxes' respectively. So, from (1.3.3) we see that the effect of the reform on welfare is the direct change in welfare plus the change in shadow revenue representing the general equilibrium adjustments to the reform. The change in shadow revenue will be composed of two elements: the change in actual revenue and an adjustment to take into account the divergence between shadow and market prices. We can then define the marginal cost in terms of social welfare of raising one extra unit of revenue by taxing good i as:

$$\lambda_i = \frac{\partial V}{\partial t_i} \Big/ \frac{\partial R_V}{\partial t_i} \qquad (1.3.4)$$

Away from the optimum there will be as many marginal costs of funds raised as there are tax instruments. If we think of another commodity, j, where $\lambda_i > \lambda_j$, i.e. the marginal social cost of raising one unit of revenue by taxing i is greater than that from taxing j, then we can increase social welfare, at constant shadow revenue, by switching a unit of shadow revenue on the margin from good i to good j.

We link social welfare to household welfare using a Bergson-Samuelson welfare function such that:

$$W = W(V^1, V^2, \ldots V^h, \ldots, V^H)$$

where V^h, the utility of household h. We think of it as a function of consumer prices and lump-sum income, i.e. via the indirect utility function. For the most part we assume lump-sum incomes are fixed. We assume there are H households and index them using h=1,...,H. Then the 'direct effect' on household welfare of a tax change is:

$$\frac{\partial W}{\partial t_i} = \Sigma_h \frac{\partial W}{\partial V^h} \frac{\partial V^h}{\partial t_i}$$

$$= - \Sigma_h \beta^h x_i^h$$

where $\beta^h = (\partial W/\partial V^h)\alpha^h$ is the social marginal utility of income to household h, α^h is its private marginal utility of income, x_i^h is the consumption of commodity i by household h and $q_i=p_i+t_i$ and we think of p_i as being amongst the other elements of $\boldsymbol{\omega}$ and $\boldsymbol{\kappa}$ so that $\partial t_i \equiv \partial q_i$. It is clear that $\partial V/\partial t_i=\alpha^h x_i^h$ with or without rationing in the system. Here q_i and p_i are the consumer and producer prices of the i'th commodity respectively. From (1.3.3) we have that the indirect effect is given by the effect on shadow revenue, R_V, so that

$$\frac{\partial R_V}{\partial t_i} = x_i + \Sigma_j (q_j - v_j) \frac{\partial x_j}{\partial t_i}$$

The marginal social cost of raising an extra unit of shadow revenue by taxing good i is simply the direct effect on welfare of the change divided by the indirect effect:

$$\lambda_i = \frac{- \Sigma_h \beta^h x_i^h}{x_i + \Sigma_j (q_j - v_j) \frac{\partial x_j}{\partial q_i}} \qquad (1.3.5)$$

where $x_i = \Sigma_h x_i^h$ The set of λs which emerge from a reform analysis provide a menu of possible tax reforms. By comparing the marginal social cost of varying each tax rate (price) we can focus on welfare-improving reforms which keep shadow revenue constant. If $\lambda_i>\lambda_j$, i.e. the marginal social cost of raising an extra unit of shadow revenue by taxing good i exceeds that from taxing good j, then we can increase welfare by switching shadow revenue from i to j in such a manner that shadow revenue is constant. Alternatively we can use the results to decide on the least damaging way of raising extra revenue.

The direct distributional consequences of a (marginal) reform are captured by the extent of consumption by household h of the commodity in question, multiplied by the social marginal utility of income to this household. This is summed across all households. Notice that the indirect effect depends on the response to the reform (say, a change in price) of the aggregate consumption of each commodity and also the divergence between consumer and shadow prices for these commodities. In response to a change in q_i the demand for and prices of other commodities will change to restore equilibrium. The elasticities capture the demand changes while shadow prices depend on the way in which equilibrium is restored to the system so that the scarcity constraints are met. The shadow price of a commodity was defined, from (1.3.2), as the net effect on social welfare of a change in its net supply. If, for example, an increase in supply leads to a change in the foreign trade flow of a commodity then its shadow price is its world price, or if it leads to a change in domestic production then it is the marginal social cost of production. Likewise, the shadow price of another commodity j will depend on how its market clears in response to a change in the net demand for j due to a change in q_i. If the price of j changes so as to restore equilibrium then this must be reflected in the shadow price. If, for example, an increase in q_i leads to a fall in demand for i and a fall in demand for labour then equilibrium in the labour market may be restored by a fall in the wage rate. The distributional consequences of this are captured through the shadow wage rate which is an element of the shadow price vector which is used to calculate R_V.

The results of a reform analysis can be translated into policy guidelines in a way which can be constructed so as to appeals to the intuition of policy makers. The data requirements are also less demanding than those required by optimal taxation models. One needs information on present consumption patterns by household and also *local* aggregate elasticities. As with optimality analysis one can experiment with welfare weights which reflect varying degrees of aversion to inequality.

§1.4 Empirical Applications

As mentioned above, one of the attractions of focusing on price *reform* (as opposed to optimal pricing) is the less stringent data requirements. To focus on these we rewrite (1.3.5) in a form more convenient for empirical application. Multiplying numerator and denominator by q_i we get:

$$\lambda_i = \frac{-\Sigma_h \beta^h q_i x_i^h}{q_i x_i + \Sigma_j \tau_j q_j x_j \epsilon_{ji}} \qquad (1.4.1)$$

where $q_i x_i$ is the expenditure on good i (summed over all households), τ_j is the shadow tax on good j, i.e. $(q_j - v_j)$, as a proportion of its consumer price, and ϵ_{ji} is the uncompensated elasticity of demand for good j with respect to the price of good i. This formula is more useful because household expenditure surveys usually contain expenditures by each household on each commodity and demand responses often come in the form of elasticities. Also, we show in Chapter 5 that using an input-output table and revenue collections it is relatively straightforward to calculate accounting ratios defined as the shadow price divided by the consumer price for a commodity (see Ahmad, Coady and Stern, 1988). Since

$$\tau_j = (q_j - v_j) / q_j$$
$$= 1 - (v_j/q_j)$$

these can easily be applied in our analysis using (1.4.1).

By focusing on the reciprocal of λ_i we can arrive at an informative decomposition involving a distributional characteristic of the commodity and a tax elasticity (see Stern, 1988). From (1.4.1):

$$\frac{1}{\lambda_i} = \frac{1}{D_i}\left\{ 1 + \frac{1}{x_i} (\mathbf{q} - \mathbf{v})' \frac{\partial \mathbf{x}}{\partial t_i} \right\} \qquad (1.4.2)$$

where $D_i = [\Sigma_h \beta^h x_i^h / x_i]$ and other variables are as earlier. The term D_i involves only household demands and welfare weights but not demand derivatives and it is often termed the distributional characteristic of a good - see, for example, Feldstein (1972). This characteristic often plays a dominant role in determining the ranking of λs over commodities, especially when one has a high aversion to inequality (reflected in β^h declining strongly with real income).

Above we expressed the formulas for calculating the marginal social cost of raising extra revenue using the consumption vector, **x**. Implicit in this is the assumption that all consumption can be taxed so that consumers and producers face different prices. However, agricultural households are both producers and consumers for certain commodities thus imposing a restriction on the tax instruments available to the government. We have seen that in such a situation we can include the agricultural sector along with the consumer sector and the efficiency and equity effects of price changes then depend on the price elasticity of net trade (or marketed surplus) and its pattern across households.

To show how marketed surplus enters the formulas we can consider the agricultural sector in isolation and remember that it is now classified along with the consumer sector. The indirect utility for the farmer is given by:

$$V = V\ (q,\ m)$$

where m is lump-sum income or profits from production, $\pi(q)$, and q are now the prices faced by the farmer (e.g. output and input prices, or the prices of purchased final goods). Differentiating with respect to a particular q_j we have:

$$\frac{dV}{dq_j} = \frac{\partial V}{\partial q_j} + \frac{\partial V}{\partial m}\frac{\partial \pi}{\partial q_j}$$

which, using Roy's Identity (i.e. $\partial V/\partial q_j=-\alpha x_j$, where $\alpha=\partial V/\partial m$) and Hotelling's Lemma (i.e. $\partial\pi/\partial q_j=y_j$), reduces to:

$$\frac{dV}{dq_j} = \frac{\partial V}{\partial m}(y_j - x_j)$$

$$= \frac{\partial V}{\partial m} s_j \qquad (1.4.3)$$

where x_j is consumption and y_j production, $\partial V/\partial m$ is the marginal utility of income and s is the marketed surplus. So when measuring the direct effect on households of a change in price we focus on net trade. Non-producing households can be introduced by setting $s_j=-x_j$.

The indirect effect of a reform is captured by the change in government revenue at shadow prices, R (from here on we drop the subscript for convenience), where:

$$R = \Sigma_j(q_j - v_j)s_j$$

where s reflects the degree of government intervention in the economy. Then, the denominator of (1.4.1) is:

$$q_i \frac{\partial R}{\partial q_i} = q_i s_i + \Sigma_j \tau_j q_j s_j \epsilon_{ji} \qquad j=1,\ldots,N \qquad (1.4.4)$$

where $s_j = \Sigma_h s_j^h$ is the net surplus of j summed over all households, τ_j is one minus the accounting ratio for good j, $q_j s_j$ is the value of total net trade in j and ϵ_{ji} is now the elasticity of total net trade in j with respect to the price of good i.

We can see that the direct and indirect effects of any reform depend on the pattern of marketed surplus across households and how the aggregate surplus responds to price changes. For some commodities the net trade of agricultural households can be negative, positive or zero (e.g. foodgrains, labour), positive or zero (e.g. cash crops), or negative or zero (e.g. purchased inputs).

§1.5 The Importance of Agriculture

It is instructive to consider why we focus particularly on the agricultural sector and not just see it as one production sector among many. A common feature in developing countries is that agriculture accounts for both a large proportion of total output (25-50%) and of total employment (50-75%) in the economy. Therefore, agricultural policies can affect the incomes of a substantial number of households and these effects in turn can have implications throughout the economy. For example, changes in agricultural incomes affect demand for both agricultural and industrial outputs; changes in agricultural foodgrain prices directly affect most urban and rural households while changes in cash crop prices affect industrial users; changes in foodgrain prices can have substantial effects on rural marketed surplus, government procurement and foreign trade earnings; changes in rural incomes affect the level of migration to urban areas, urban unemployment and wages; and the dominant contribution of agriculture to GDP means that changes in its growth rate have a large impact on the growth rate of the economy as a whole. Also the political sensitivity of food security means that most governments in developing countries pay particular attention to the total availability of food, and its distribution, pricing and quality.

In the 1950s a common view of the role of agriculture in development was as a declining sector which should provide food, labour and finance for a growing industrial sector. Surplus labour could be drawn from the agricultural sector without adverse effects on food supply, and the consequent increasing per capita incomes of those remaining could be tapped to provide finance for modern industry. Although this 'extractive' approach towards agriculture was challenged in the 1960s (see, for example, Johnston and Mellor, 1961), with greater emphasis being placed on agriculture as a source of *increasing* food supplies and essential foreign exchange earnings, and expansion of demand for industrial outputs, it still appears to have dominated development strategies followed in many developing countries (see, for example, Government of India, 1956). While it has been recognized that the importance of domestic food supply in growth strategies depends on the openess of the economy, it is the case that important stimuli to economic growth in developing countries have come from increased productivity (through technical progress) in agriculture.

The view of agriculture as a resource reservoir has naturally been reflected in the taxation and pricing policies formulated by governments. Since agriculture accounts for such a high proportion of total incomes in developing countries it must be included in the tax base if sufficient revenue is to be raised to finance growing government expenditures. However, the presentation of the question as one of agricultural versus industrial taxation is not very fruitful and ignores the diversity in patterns of production, consumption and income within each sector. One should recognize that there exist projects in both sectors which show high social returns and that 'poor' households are to be found in both rural and urban areas. In rural areas households possess a diverse range of characteristics as regards sources of income (e.g. labour or land), size and quality of landholdings, cropping patterns, production technologies, access to knowledge and credit, attitudes to risk, and influence over government policies. Urban areas are not only made up of those employed in the formal or modern industrial sector, but also include those employed in the informal sector and the unemployed. While both sectors have their share of wealth and poverty, the policy instruments available to the government to raise revenue or transfer resources between households may differ in each sector. For example, direct transfer mechanisms (such as rationing schemes) may be more prevalent in urban compared to rural areas. When deciding on appropriate tax and pricing policies the government must take account of this diversity of characteristics within each sector and the different constraints on policy instruments since both of these determine the efficiency and distributional implications of taxes.

Economic theory tells us that where possible revenue should be raised and distributed using 'lump-sum' instruments or with as 'little distortion' as possible. It is for this reason that land taxation is often seen as an attractive way of taxing rural households. In principle land provides a relatively easy base to measure since it has fixed location and owners have an incentive to register property rights. These factors should ensure that administration costs are low relative to potential revenue, at least compared with other taxes. Land taxation may be seen as attractive from both efficiency and equity viewpoints since it is in inelastic supply and is unequally distributed. One could argue that land taxation based on land quality might deter investments to improve land quality and output and thus have adverse efficiency effects. But it may be possible to base valuations for land tax on such exogenous characteristics as rainfall, soil quality or access to a canal network. However, in spite of these apparent economic advantages and although historically important (see Ahmad and Stern, 1991, Chapter 8, for a discussion for India and Pakistan) land taxes presently raise very little revenue in most developing countries and attempts to impose them have been strenuously opposed, possibly reflecting the visibility of such taxes and the political influence wielded by those with large landholdings. It should also be noted though that complete reliance on land taxes to the exclusion of output taxes may not be desirable when output and incomes are uncertain and complete insurance markets do not exist (see Hoff, 1991).

The inability or unwillingness of governments in developing countries to use 'lump-sum' or more direct policy instruments to raise and redistribute revenue has meant that they have had to rely predominantly on more indirect methods by manipulating the prices facing consumers and producers. Economists have therefore focused on minimizing the excess burden and distributive impact associated with 'distorted' prices. Unfortunately, the question has often been presented as a choice between agricultural and industrial taxation. Proponents of a greater reliance on agricultural taxation have pointed to the low price elasticity of aggregate supply in this sector. Some empirical studies do support such claims (see, for example, Binswanger *et al*, 1985) when concerned with aggregate agricultural output. However, empirical studies also show that individual elasticities can be quite high (see Askari and Cummings, 1976, and Timmer *et al*, 1983). One can also argue that although the direct effect of the taxation of agricultural output (more precisely, marketed surplus) is to decrease the income of relatively wealthy farmers the indirect effects on labour markets may imply a fall in the incomes of rural labourers whose standard of living may already be quite low. This in turn may decrease wages and prices in the modern industrial sector thus increasing the welfare of urban consumers who often enjoy a much higher standard of living than their rural counterparts. Obviously the conclusions we come to in relation to all of these arguments will ultimately depend on empirical analysis (as well as the theoretical structuring of the problem).

Traditionally, governments in developing countries have relied an manipulating the prices of agricultural outputs and inputs in order to tax or subsidise farmers. These include (with examples for Pakistan):

(i) The imposition of export taxes, e.g. export duties on cotton and rice with the sole right to export often invested in publically controlled marketing boards.

(ii) The procurement of agricultural outputs at prices below world prices, e.g. wheat procurement and the ban on inter-provincial trade.

(iii) The subsidization or taxation of imports, e.g. subsidies to imported wheat and sugar distributed through ration shops, and import taxes on private imports of sugar.

(iv) Price support to farmers, e.g. sugarcane.

(v) Subsidized agricultural inputs, e.g. prices for electricity and water fixed below costs of production or fertilizer prices fixed below world prices.

(vi) Taxes on final consumer goods consumed by rural households.

The central objective of this thesis is to analyse the impact of reforms of this system of taxes on social welfare (in terms of equity and efficiency) and to identify possible welfare- improving reforms with particular emphasis on agricultural pricing policies.

§1.6 The Layout of the Thesis

We have argued that both the manner in which governments can raise revenue effectively by manipulating prices and the implications of these policy instruments for efficiency and equity depend on the nature of the relationships between economic agents, the organization of markets, and the decision-making framework of households. Therefore, in Chapter 2 we describe the organization of agriculture in Pakistan using country-wide data on farm households for 1976/7 (the Indus Basin Survey) and we comment briefly on preliminary results from more recent surveys. We discuss the system of land tenure, the operation of factor markets and their implication for the economic behaviour of farm households, and use this analysis of the data to suggest possible reasons for the substantial variability in farm practices and yields across farms and individual crops. We argue that behaviour under uncertainty and the imperfect operation of many markets can help to explain this observed diversity in agricultural organization. It is therefore important that these aspects be incorporated into any analysis of the behaviour of agricultural households or the implications of various policies for farm household decisions.

In §1.4 we showed that when the government cannot tax total consumption, as is the case for foodgrains in Pakistan where a substantial proportion is consumed on-farm, then the agricultural sector can be viewed as part of the consumer sector and we should focus on marketed surplus when analysing the consequences of price changes. The implications of price changes for equity will depend on the pattern of marketed surplus across households (with differing welfare weights) while the implications for efficiency depend on how aggregate marketed surplus responds to these price changes. In Chapter 3 we focus mainly on the marketed surplus of wheat, the major foodgrain in Pakistan, and show how we can gain useful insights into the determinants of household marketed surplus using cross-section data from household surveys. We further argue that agricultural household models are useful in deciding how our empirical analysis should be formulated, what variables should be included and how the model should be specified. The constraints imposed by the nature of the available data (e.g. the presence of influential observations, endogeneity and sample selection) are also highlighted and we show how they can be overcome. Our results confirm the belief that much of the marketed surplus (i.e. government procurement and rural consumption by rural non-producers) originates on large farms with small farms being self-sufficient or net consumers. This pattern reflects the unequal distribution of land in Pakistan and suggests that high procurement prices will have adverse effects on equity (ignoring wage effects) since many small farms and the landless are net consumers. However, it is also the case that the elasticity of marketed surplus is high so that low procurement prices may lead to substantial efficiency losses. This trade-off between equity and efficiency is analysed in more detail in Chapter 6. The high price elasticity suggests that small changes in prices may have substantial effects on government procurement, the level of rural food surpluses to be transferred to urban areas, and foreign exchange earnings. These effects should all be taken into account when formulating pricing policy.

When we include the agricultural sector in the consumer sector for the purposes of analysing pricing policy it is no longer the case that economic efficiency is necessarily desirable for this sector. Thus, it may be appropriate to tax or subsidise some agricultural (purchased) inputs and the levels of tax or subsidy should depend on the pattern and responsiveness of use across farms. In Chapter 4 we analyse the pattern of chemical fertilizer use across farm households using the Indus Basin Survey. We argue that in empirical analyses it is important to treat separately households which do not apply fertilizer because they are constrained, say, in the credit market, and those who do not apply fertilizer because at current relative prices it is not profitable for them to do so. We therefore use a 'double-hurdle' model, which enables us to take account of zeros which can arise in more than one way, to explain the variation in fertilizer use across farms. We use a simple model of behaviour under uncertainty as the basis of our empirical investigation and our interpretation of the results. These results suggest that, although the productivity of fertilizer may be higher on larger farms because of a greater endowment or access to complementary inputs and technical knowledge, the presence of uncertainty and increasing relative risk aversion dominates and we observe lower fertilizer intensities on larger farms. We also find that lack of access to credit to finance fertilizer purchases is more constraining on smaller farms. One policy implication of the results is that if one assumes that markets for risk are unlikely to emerge in the short to medium run then this should influence the choice of policy instruments used to, say, raise revenue from the agricultural sector.

It is generally agreed that in developing countries, because of the imperfect operation or absence of many markets (in particular factor and risk markets) and the nature of government involvement in the economy, market prices of commodities may not reflect their true social value to the economy. When evaluating government policies and investment decisions it is necessary to take account of this divergence between social and market prices. Fortunately, from the point of view of pricing policy, much of the standard tax analysis goes through as before but with producer prices being replaced by shadow prices and by viewing the difference between shadow and consumer prices as a shadow tax. In Chapter 5 we show how data which are often available for many developing countries can be used to calculate a set of economy-wide shadow prices and how these can be used to evaluate possible reforms of trade and industrialization policies. The model presented is based on the well-known Little-Mirrlees procedure for calculating shadow prices and it is easy to manipulate for the purposes of sensitivity analysis. Our discussion of industrialization and trade policies in Pakistan since Independence shows that there has been a gradual movement away from quantitative restrictions on domestic production and foreign trade in favour of manipualting price incentives for investment in various industries. The complexity of the price and tax system has also been such that there have been unintended consequences, in particular the effective taxation of exporting industries. We also argue that when there already exists industries in which there are large fixed investments the appropriate short-run policies appear inconsistent with those suggested by longer-term objectives, reflecting the low short-run marginal social cost of production.

In §1.2 and §1.3 we discussed the standard models for tax analysis, showed how these can be adapted to incorporate the special features of the agricultural sector and the limitations on the policy instruments available to the government, and described how the theory of tax reform can be used to identify welfare-improving marginal reforms in the tax and price system. We further argued that risk averse governments with politically sensitive expenditures to finance may be more willing to undertake piecemeal reforms. In Chapter 6 we present a model specific to Pakistan which is intended to allow normative analysis of the instruments available to the government in the mid 1970s. Using data for this period we calculate and compare the marginal social costs of raising additional revenue across the various price and tax instruments available to the government. We use these to identify possible welfare-improving reforms in the existing system for the mid 1970s. However, our results also carry lessons for policies beyond this period and we use these to comment on policies followed in the 1980s and to set out recommendations for future policy. From the policy viewpoint we found that there was substantial scope for agricultural price reforms which provided large efficiency gains. However, we emphasise that there is a strong trade-off between equity and efficiency and one should examine the possibilities for providing subsidized rationed commodities or income support schemes. Since such schemes in rural areas may be administratively burdensome it might be that low procurement prices for commodities for which poorer households are net consumers may be desirable. We also highlight the importance of analysing price reforms in a general equilibrium framework especially when there exist 'distortions' in other commodity and factor markets so that individual price changes can have substantial efficiency and equity effects which arise through the net demand responses in these markets. We show that such considerations are particularly important when considering reforms in the system of agricultural prices.

Chapter Two: The Organization of Agriculture in Pakistan

§2.1 Introduction

Policy makers in Pakistan in the late 1950s and early 1960s placed great emphasis on the importance of increasing agricultural output, especially foodgrains. This reflected, in part, the desire to create a surplus in the agricultural sector which could then be used to finance investment in the industrial sector. Higher agricultural output would also relax the foreign exchange constraint enabling the import of capital required by modern industry. Further, larger food supplies could be used to keep food prices down in urban areas (especially in the face of an increasing population) and wages low, thus increasing the profitability of investment in the industrial sector.

In order to create a surplus in the agricultural sector it was deemed necessary to invest in agriculture to stimulate output growth and rural incomes. Therefore, the early 1960s saw increased goverment investment in improving irrigation facilities, especially the provision of tubewells, and also in the production and distribution of chemical fertilizers (Bose, 1972). This in turn laid the basis for the introduction of the new high-yielding variety (HYV) seeds in the late 1960s. Yields from these 'improved' seeds were substantially higher than those from the 'traditional' varieties if used in conjunction with chemical fertilizers, regular irrigation and the appropriate farm practices.

The central objective of this chapter is to present a description of the organization of agricultural production and the nature of agricultural practices in Pakistan. The data set at our disposal is that of the Indus Basin Survey (IBS) which covered the 1976/7 summer (kharif) and winter (rabi) seasons. This survey concentrated mainly on agricultural households in and around the Indus Basin, an area well endowed with water resources. We are not aware of any other work which has attempted to use the IBS for analyses similar to that presented here.

The Indus river stretches from the far north of Pakistan to the far south where it enters the sea. Although the focus of the survey on the Indus Basin means that other areas not as well endowed with water resources, i.e. the rainfed or 'barani' areas of

Baluchistan and NWFP, are under-represented or excluded altogether (as with Baluchistan) it is nevertheless the case that a very high percentage of farms are located in the Indus Basin area and an even higher percentage of agricultural output originates here.

In §2.2 we discuss the relevant characteristics of households in the IBS. We briefly examine, in turn, land tenure, the labour market, the use of draught animals and tractor services, irrigation practices, access to and use of credit, the role of land leasing and the cropping pattern. Specific constraints perceived by farmers are also highlighted.

It is often argued that while the new production technology was essentially scale neutral government policy created an environment where it was more profitably employed, and therefore more quickly adopted, on larger farms, leading to a more unequal distribution of income than that which already existed (see Griffin, 1974). In §2.3 we test the relationship between productivity, i.e. physical output per acre for each crop, and farm size. However, we also argue that such simple regressions do not throw much light on the issues which theory suggests may influence productivity levels. More useful approaches are discussed and we suggest a research agenda which we think is more appropriate from a policy viewpoint. In §2.4 we apply production function analysis in an attempt to identify the factors which explain the variation in output levels across farms. We find that these results reinforce our findings in §2.2 that credit and irrigation constraints lead to a wide variation in input levels and farm practices across farms, reduce the use and productivity of crucial inputs such as fertilizer, and lower yields. Unavailability of credit is seen to be an important constraint on smaller farms.

The use of data for the mid 1970s, although somewhat dated, has a certain attraction. The Green Revolution began to take effect in Pakistan around the mid 1960s. Government policy was geared towards increasing the use of HYV seeds and in disseminating knowledge of the appropriate farm practices, e.g. the use of chemical fertilizers and efficient water management. An analysis of the situation in the mid 1970s will therefore contribute to an evaluation of the effectiveness of government policy in achieving its objectives. We are also very fortunate to have access to preliminary results from a very comprehensive study of agricultural practices in the early

1980s. This covers households throughout the four provinces of Pakistan, i.e. Punjab, Sind, NWFP and Baluchistan, and enables us to present a more up-to-date picture of agriculture in Pakistan in §2.5.

In the conclusions to this chapter we argue that behaviour under uncertainty and the imperfect operation of many markets can help us to understand the observed diversity in agricultural behaviour and the variability in input levels, farm practices and yields. In order to formulate welfare improving policy reforms one needs to identify the factors which constrain yields and to incorporate those features into our economic models.

§2.2 The Indus Basin Survey (IBS)

In this section we examine data from the IBS in an attempt to get some picture of the nature of agricultural organization and practices in Pakistan in the mid 1970s. However, it should be kept in mind that the survey data relate to households located in and around the Indus Basin. It is therefore probable that households located in barani (i.e. rain fed) areas are under-represented. For instance, there are no households in the sample located in Baluchistan, an area not very well endowed with irrigation facilities. Such sample bias must be allowed for when interpreting the description of the data which follows, especially when focusing on constraints facing farmers and the importance of these constraints across farms with various characteristics. It must be remembered though that most of the farms in Pakistan are located around the Indus river and an even larger percentage of output originates here. In 1972, for example, Baluchistan accounted for only 4% of the total rural population of Pakistan.

In all, 2002 households were surveyed using, according to informal discussion, a milti-stage cluster sampling technique. Nearly 60% were located in the Punjab with 37% and 3% located in Sind and NWFP respectively (see Table 2.1). Focusing on total cropped acreage, 78% of farms were less than 12.5 acres, but this percentage varied across provinces with the corresponding figures being 74%, 85% and 70% for Punjab, Sind and NWFP respectively. For most heads of household (90%) agriculture is their sole occupation.

Table 2.1

Distribution of Farms According to Acreage and Location

Farm Acreage	All Pakistan	Punjab	Sind	NWFP
Less than 5	681 (0.34)	334 (0.28)	322 (0.43)	21 (0.35)
5-12.5	880 (0.44)	543 (0.46)	316 (0.42)	21 (0.35)
12.5-25.0	315 (0.16)	210 (0.18)	91 (0.12)	14 (0.23)
25 and over	126 (0.06)	103 (0.08)	19 (0.03)	4 (0.07)
Total	2002	1190	748	60

Note: Acreage refers to cropped acreage. Province figures do not include four households categorized as milk producers which did not have a province code. Percentages are given in brackets.

Source: Indus Basin Survey (1976).

Table 2.2

Distribution of Farms According to Land Tenure

Tenure	All Pakistan	Punjab	Sind	NWFP
Pure Owner	1115 (0.56)	804 (0.67)	271 (0.36)	36 (0.60)
Pure Tenant	592 (0.30)	197 (0.17)	379 (0.51)	16 (0.27)
Owner-Landlord	75 (0.04)	38 (0.03)	34 (0.04)	3 (0.05)
Owner-Tenant	220 (0.11)	151 (0.13)	64 (0.09)	5 (0.08)
Total	2002	1190	748	60

Note: Owner-landlords and owner-tenants are those who own land but also hire-out and hire-in land respectively.

Source: Indus Basin Survey (1976).

§2.2.1 *Land Tenure*

The sample is predominantly made up of pure owners which constitute 56% of total households (see Table 2.2). Pure tenants are the next most important group accounting for 30% of farm households. The rest of the sample is made up by owner-landlords (4%), i.e. those that own and hire-out land, and owner-tenants (11%), i.e. those that own and hire-in land. The relative importance of tenure categories varies across provinces. Tenancy is much more prevalent in Sind than in Punjab or NWFP. Of those who own their land nearly 70% inherited it, 20% purchased it in the market and 10% both inherited and purchased their land. In Pakistan, as in many developing countries, the sale of land is quite uncommon and is usually undertaken only as a last resort. Therefore most land exchanged is on a contractual (i.e. tenancy) basis.

In the sample, land hired-in is subdivided into sharecropped-in, rented-in and contracted-in. We do not have detailed information on the exact definitions of such transactions. However, we can speculate as follows. Sharecropping involves the sharing of outputs and possibly inputs whereas renting and contracting involves only the payment of cash for securing the use of land. Renting is usually undertaken on a yearly basis while contracting can cover periods of more than one year.

Households contracting-in, renting-in or sharecropping-in some part of operated land accounted for 3.5%, 4.5% and 37% of total households respectively. Households usually undertook only one mode of land transaction, although 12 households which rented-in land also contracted-in. Also the hiring-in and hiring-out of land simultaneously was not common. Over 55% of households owned all the land they operated.

Sharecroppers were asked who made certain sharecropping decisions. Over 50% said that decisions regarding which crops were planted and when and where they were planted were taken both by landlord and tenant (see Table 2.3). Over 60% said that decisions as regards chemical fertilizers (henceforth referred to just as fertilizer) were taken mutually and 60% also said decisions regarding seeds were taken mutually. It is clear that in most cases landlords have a strong influence on sharecropping decisions.

Table 2.4 presents data on the share of total fertilizer inputs provided by the landlord. Since owner-tenants have their own land total fertilizer use includes both

Table 2.3

Sharecropping Decision Making (%)

Decision On	Decision taken by: Sharecropper	Landlord	Mutual
Crops Planted:			
- which	28	22	50
- where	28	20	52
- when	35	10	55
Fertilizers	17	19	64
Seeds	24	16	60

Source: Indus Basin Survey (1976).

Table 2.4

Landlord-Tenant Fertilizer Shares (%)

	All Sharecroppers	Owner-Tenants	Pure Tenants
Nitrogen Share			
Landlord = 1	11	5	16
50:50	56	17	67
Tenant = 1	19	40	12
No. of Hslds.	739	173	564
% Users	80	83	79
Phosphate Share			
Landlord = 1	13	4	15
50:50	63	19	75
Tenant = 1	14	44	6
No. of Hslds.	739	175	564
% Users	39	35	40

Source: Indus Basin Survey (1976).

fertilizer for own land and for sharecropped land. We therefore focus on pure tenants. The most common situation is where landlord and tenant each provide half of the fertilizer applied. This is so for both nitrogen and phosphate applications. For both nitrogen and phosphate around 15% of sharecroppers have the landlord providing all of the nitrogen. The percentage of households where the tenant provides all of the nitrogen or phosphate is 12% and 6% respectively. Note also that with owner tenants this percentage is much higher at around 40%. This may reflect the absence of input constraints, e.g. credit availability.

The picture for output shares is very similar. For wheat, rice and cotton around 90% of pure tenants retain half of their output. With sugarcane only 57% of pure tenants retain a 50% share of output while 36% retain all their output (it may be the case that these latter tenants pay in cash or have hired land from the sugar refining industry and that payment is deducted from sales value when sold to the refinery). It does appear, however, that for the main crops a 50:50 share agreement dominates.

The fact that sharecropping is widespread suggests that it helps those who enter into such agreements to achieve something which otherwise could not be achieved or that other forms of contract are less effective in some respect. In developing countries markets for draught power and labour are often non-existent or, where they exist, are imperfect. Binswanger and Rosenzweig (1986) explain this phenomenon through the difficulty of monitoring the operation of such market transactions. For instance, households who own draught animals are often reluctant to hire-out animals to others (except possibly to relatives) and will only do so if they are accompanied by a member of their own family. This reflects the fear of overuse and/or underfeeding of animals and the high costs of monitoring such practices. Problems with synchronic timing of farm operations reinforce these difficulties since farmers will prefer to have an assured access to such services. The labour market suffers from similar difficulties. For certain tasks it is nearly impossible to measure output (and thus link pay to the performance of well-defined tasks), especially when the quality of the task is important, e.g. weeding tasks. The costs of monitoring these activities are very high so farmers prefer to allocate them to family labour. So the synchronic timing of agricultural activities and the search costs involved attach a premium to the ownership of, or assured access to, labour or other factors of production at peak periods.

The imperfect nature of markets for draught power, tractor power and labour may mean that households who own such factors will transact on the land market so as to match land to their 'fixed' (or imperfectly mobile) factors. We use this argument in our attempt to explain land transactions below (see §2.2.6). Alternatively, farmers will interlink transactions in various markets in order to alleviate such difficulties. For example, landlords may provide credit to tenants (or to farm labourers) in return for their labour at planting and harvesting. If the labourer receives a proportion of final output then there is an incentive to be diligent at planting. A higher wage may be paid at harvesting to give the labourer an incentive to return at harvest time. After harvest, credit and other contracts can be honoured simultaneously. Such interlinking of transactions reduces search cost for both parties, provides tenants or labourers with access to credit and overcomes the problems associated with information acquisition and default in the credit market. We discuss credit transactions in more detail below (see §2.2.5). For a detailed survey of issues concerning the interlinking of transactions in agriculture see Bell (1988).

§2.2.2 *Labour*

The preference for family labour, especially for certain agricultural tasks, has already been mentioned above. The IBS contains data on the number of days worked on and off the farm for each household and, within each household, for various categories of household members (i.e. head of household, men over 15, women over 15 and children under 15). These data are also disaggregated by month. Whereas all household members contribute to on-farm work the extent of the supply of off-farm work varies across household categories. The percentage of households with positive off-farm work ranges from 10-17%, 6-9%, 2-3% and 1.5-3% for heads of household, males over 15, women over 15 and children under 15 respectively (see Table 2.5). So off-farm work is not very common especially among females and children.

Unfortunately we do not have detailed data on method of payment or level of

Table 2.5

Households with Off-Farm Labour Supply (%)

Month	Head of Households	Male Over 15 Years	Female Over 15 Years	Child Under 15 Years
1976				
April	13.4	8.1	2.6	2.7
May	10.2	6.5	2.2	1.6
June	15.1	7.9	2.7	1.9
July	12.6	8.2	2.4	1.9
August	16.5	9.0	3.0	2.0
September	15.5	8.5	2.8	1.8
October	12.5	8.1	2.9	1.9
November	11.7	8.0	2.6	1.8
December	17.1	9.1	2.8	2.5
1977				
January	14.0	8.8	2.9	1.6
February	13.2	8.2	2.5	1.7
March	13.2	8.6	3.0	2.2

Source: Indus Basin Survey (1976).

Table 2.6

Ownership of Draught Animals and Tractors (%)

Number of Animals/ Tractors	Buffalo (Mature)	Buffalo (< 4 yrs)	Bullock (Mature)	Bullock (< 3 yrs)	Tractor
0	26.2	38.2	13.2	78.7	95.5
1	24.0	24.5	3.0	11.7	4.4
2	21.2	19.4	60.4	6.6	0
3	10.4	7.6	4.5	1.9	0.1
4	7.7	5.0	14.5	0.4	0
5 - 10	8.8	4.7	3.8	0.6	0
>10	1.7	0.3	0.6	0	0

Source: Indus Basin Survey (1976).

wages. We are therefore not in a position to analyse important features of labour contracts, e.g. the labour contracts on tenant farms and the extent of interlinking involving labour. Such data are often available from village-level studies and the analysis and interpretation of the data are made easier by the intimate knowledge researchers may have of the village (see, for example, Bliss and Stern, 1982).

§2.2.3 *Draught Animals and Tractors*

Ownership of, or at least access to, either draught animals or a tractor is crucial for the cultivation of land. Markets for the hire of draught animals are often not well developed in developing countries. Therefore, transactions in the land market may reflect ownership of these factors of production (see §2.6).

From Table 2.6 we can see that the majority of households own some draught animals. Those who do not own any must have access to their services for ploughing and other agricultural activities. The hire of tractor services is of course an alternative. Also, a household with only one draught animal may enter into an arrangement which involves the mutual exchange of draught animals with another farmer, possibly a brother or a close relative. Less than 5% of farmers in the sample owned a tractor.

§2.2.4 *Irrigation*

The main sources of irrigation were canals and public and private tubewells (see Table 2.7). Just over 9% of households said they owned a private tubewell and 50% of these had one or more partners. Of farmers with a private tubewell (or access to a private tubewell), 70% had diesel-run tubewells, while others were run on electricity. Below we present results which indicate that variations in irrigation practices account for a large proportion of the variation in per acre yields across crops. Also, our analysis of answers to questions concerning constraints facing farmers will suggest that lack of, or inadequate, irrigation facilities is a common complaint.

§2.2.5 *Credit*

Along with the increased use of HYV seeds there has been an increase in the purchase of crucial inputs, e.g. fertilizers, from the market. Whereas the expenditure on many of these inputs is incurred at the start of the production cycle the revenue from output sales is not received until the end of the cropping season. This introduces the need for credit for many farmers.

Before creditors are willing to provide loans they will require information on the individual characteristics of potential debtors and their intended uses of credit. The acquisition of such information is often costly to obtain and asymmetrically held. Debtors will have an incentive to provide misleading information or to hide information that might adversely affect their chances of securing credit or the terms on which credit is obtained. Access to the required information is often less costly the greater the number of transactions between the parties involved. It is for these reasons that either or both of the parties may attempt to interlink credit transactions with those in other markets. Large landholders may give credit to labourers or tenants in return for a pledge of labour at peak periods. Such interlinking also saves on search costs for both parties. Similarly, traders or commission agents may provide credit (or inputs on credit) in return for the sole right to the marketed surplus of farmers.

Because information acquisition is less costly on a local basis (reflecting the greater incidence of interaction at village level) credit markets are usually fragmented (see Aleem, 1990). This, combined with a lack of interaction with areas outside the village can act as a barrier to entry and possibly present local money lenders with monopoly positions. However, when analysing credit transactions one must take account of, *inter alia*, the presence of collateral and its level, the potential for securing collateral in the event of default, the ease of liquidation of the collateral, features of the environment which deter strategic default, the interest rate and other terms of interlinked transactions (e.g. the price paid to labour at peak periods or the price paid for marketed surplus). Transactions are also often interlinked in a manner which attracts 'good' debtors or encourages debtors to provide useful information. Unfortunately we do not have enough detailed information to examine the terms on which credit is provided and other details of credit transactions. Neither do we have sufficient detail to analyse the extent and nature of interlinking in land, labour and credit markets. The collection of such

Table 2.7

Source of Irrigation (%)

Source	February	March	June	July	November	December
	Month					
C	52.0	51.2	68.2	68.6	56.6	16.9
PuT	4.3	4.3	0.2	0.4	3.9	47.2
PrT	9.2	9.7	0.6	1.0	8.4	5.8
C+PuT	8.4	8.3	11.7	11.0	9.0	10.4
C+PrT	9.3	9.2	16.1	15.2	11.2	7.6
C+PuT+PrT	0.3	0.3	0.4	0.5	0.3	10.3
C+PW	0.4	0.3	1.2	1.2	0.9	0.3
C+T+PW	0	0	0.2	0.2	0.1	0.5
T+PW	0.7	0.7	0.1	0.1	0.5	0.1
No Source	15.2	15.7	1.0	1.5	8.9	0.7

Note: C = Canal, PuT = Public Tubewell, PrT = Private Tubewell and PW = Persian Wheel.

Source: Indus Basin Survey (1976).

Table 2.8

Households Using Credit for Production Purposes (%)

Farm Acreage	All Households	Pure Owners	Pure Tenants	Owner-Landlords	Owner-Tenants
Less than 5	15.1	13.6	20.8	0	18.2
5-12.5	25.7	15.0	39.7	38.1	23.4
12.5-25.0	29.1	20.1	44.3	20.0	27.8
Over 25	26.9	26.4	27.8	37.5	22.6
All	25.9	19.1	38.3	32.0	24.6

Source: Indus Basin Survey (1976).

information is costly and more easily undertaken on a village level. We do, however, have data which indicate the source of credit and the constraints facing farmers.

Households were asked if they had used credit for production purposes in the previous year and over 25% replied that they had. It is possible that credit is not explicitly given but is implicit in interlinked transactions, e.g. as part of sharecropping contracts, and not included here. The percentage using credit was lowest among pure owners and owner-tenants and also increased over the farm size categories (see Table 2.8). The main reasons given for not using credit (see Table 2.9) were, in order of importance, 'too much trouble' (47%), 'no need' (22%), and 'did not know how' (18%). The responses 'too much trouble' and 'no need' were most common among owner-landlords and also on larger farms - whereas the response 'did not know how' was least common among owner-landlords, and more common on smaller farms. These replies reinforce the view that small farms do not have access to credit markets even though these are the farms most likely to need credit due to lack of their own cash balances.

Where households had used credit they were asked the source of credit (see Table 2.10). Among pure owners the main sources were agricultural banks and relatives, with commercial banks and money lenders acting as secondary sources. With pure-tenants, landlords and relatives were the main sources with agricultural banks, commercial banks and market lenders being secondary sources. Owner-landlords relied mainly on agricultural banks and relatives as main sources of credit using commercial banks and money lenders as secondary sources. Among owner tenants the main sources of credit were agricultural banks, relatives and landlords, with commercial banks and market lenders acting as secondary sources. The importance of relatives as a main source of credit decreases with farm size while the importance of agricultural banks as a main source of credit increases with farm size. Among households which said they used credit it appears that 41% relied on one source of credit only and 58% on two sources, so that 50% of those using credit obtained it from three sources. Unfortunately we do not have any information on the terms of credit, i.e. collateral, loan amount or interest rates. Access to banks as a source of credit is seen as desirable by farmers probably

Table 2.9

Why Households Did Not Use Credit (%)

Reason	All Households	Tenure: Pure Owners	Pure Tenants	Owner-Landlords	Owner-Tenants	Farm Size: 1	2	3	4
No need	21.9	22.8	18.9	28.8	21.6	21.6	18.5	20.9	0.29
Not Know How	18.4	18.0	22.2	9.6	15.0	22.7	20.0	19.8	0.11
Too Much Trouble	47.2	46.4	47.7	53.9	48.5	40.5	48.3	46.3	0.51
No One to Guarantee	2.7	2.1	4.7	0	2.4	3.8	2.6	3.1	2.0
Other	2.2	2.4	1.6	3.8	1.8	2.2	2.8	2.4	1.0
Interest too High	7.5	8.2	4.9	3.9	10.8	9.2	7.8	7.4	6.4
No. of Obs.	1488	904	365	52	167	185	540	449	314

Note: Farm size is divided into farms (1) Less than 5, (2) 5-12.5, (3) 12.5-25.0 and (4) Over 25 - all in acres.
Source: Indus Basin Survey (1976).

Table 2.10

Main Source of Credit by Tenure and Farm Size

Reason	All Households	Farm Tenure: Pure Owners	Pure Tenants	Owner-Landlords	Owner-Tenants	Farm Size: 1	2	3	4	Source 2	Source 3
Relatives	19.8	27.5	11.4	17.4	26.4	46.9	24.7	14.6	12.9	31.2	20.4
Landlord	40.2	-	82.5	-	22.6	21.9	53.8	44.9	16.4	10.2	5.0
Money Lender	3.1	7.1	0.9	4.3	9.4	6.2	0.5	4.9	3.4	9.2	15.0
Agricultural Bank	25.2	46.9	2.6	43.5	28.5	18.7	13.2	23.2	49.1	28.7	22.7
Commercial Bank	5.4	9.5	0.9	8.7	7.5	3.1	1.1	8.1	8.6	14.5	32.7
Other	6.2	9.0	1.7	26.1	5.6	3.1	6.6	4.3	9.5	5.9	4.2
No. of Obs.	515	211	228	23	53	32	182	185	116	303	260

Note: The breakdown over farm tenure and size is given for the main source of credit only. See also note to to Table 2.9

Source: Indus Basin Survey (1976).

because of the availability of loans at low interest rates. However, smaller farms are often excluded from these sources (usually because of lack of collateral) and, if credit from relatives is not forthcoming, they are pushed into using money lenders and the informal credit market where interest rates are probably much higher.

Households were also asked how they would allocate additional credit (see Table 2.11). Use of extra credit 'to purchase more fertlizer' (27%) was the most common response, the percentage giving this response decreasing with farm size and being lowest among owner-landlords. The second most common response was 'to purchase bullocks' (24%), the percentage giving this reply being highest among the smaller farms and among pure tenants. The percentage who would use extra credit to purchase a tractor (21%) or thresher (2%) increased with farm size and was highest among owner-landlords. This is consistent with the view that large farms lease out land because of the constraints on fixed assets such as family labour and draught power. Similar patterns applied to the use of extra credit to purchase a tubewell.

The percentage of households applying chemical fertilizer increased with farm size and was highest among owner-landlords and owner-tenants (see Table 2.12). Those who did not apply fertilizer were asked their reason for not doing so. The most common response was 'shortage of money' (63%), followed by 'no need' (18%) and by 'not available' (12%). The percentage quoting 'shortage of money' as the main reason decreased with farm size and was substantially lower in the largest farm size category and among owner-landlords. The percentage replying 'not available' is not much different over farm-size categories.

Households were asked whether or not they thought they were getting optimum yields. Although the exact interpretation of this question is unclear the answers do throw light on constraints as perceived by farmers. Over 97% of farms said that they did not think they were getting optimum yields (see Table 2.13). The main reason given was 'insufficient irrigation' (45%), but 'insects and disease' (21%), 'monsoon flooding' (13%) and 'lack of fertilizer' (9%) were also common responses. Lack of fertilizer seemed to be a more important reason on smaller farms and on pure owner and pure tenant farms, while 'monsoon flooding' was a more common response on pure

Table 2.11

Use of Additional Credit

	Farm Tenure				Farm Size				All Households		
	Pure Owner	Pure Tenant	Owner Landlord	Owner Tenant	1	2	3	4	Use 1	Use 2	Use 3
Purchase Bullocks	18.3	38.7	8.2	15.6	34.4	27.4	24.1	11.6	23.7	5.4	4.6
Purchase Tractor	27.0	7.8	52.1	20.3	6.1	13.2	22.8	41.0	21.5	4.4	1.9
Purchase Thresher	3.0	0.3	6.9	1.4	0	1.0	0.5	0.2	0.8	6.1	2.3
Wedding	0.6	1.2	0	0.5	1.9	1.0	0.5	0.2	0.8	1.9	2.3
Purchase Tubewell	11.2	2.2	11.0	13.2	3.8	8.4	9.7	10.4	8.7	5.6	2.7
Children's Education	2.9	5.3	0	1.4	5.2	4.7	2.6	1.4	3.4	8.5	9.2
Purchase Fertilizer	26.1	28.5	11.0	31.1	34.0	28.9	27.1	19.1	26.8	34.2	19.0
Level Fields	5.4	6.3	8.2	6.1	4.7	7.4	5.9	3.8	5.8	9.3	9.6
Improve Watercourse	1.6	2.0	0	0.5	3.3	1.8	0.6	1.4	1.5	2.5	4.0
Purchase Imported Seed	2.3	4.3	0	3.8	4.3	2.8	3.0	2.4	2.0	17.8	25.3
Other Prodn. Purposes	1.2	2.7	2.7	3.3	0.9	3.0	1.7	0.9	1.9	3.0	15.4
Other Consumpn Purposes	0.2	0.7	0	2.8	1.4	0.6	0.8	0.9	0.8	0.6	3.6

Note: Households gave three uses for additional credit in order of importance. The breakdown over farm tenure and size is for use one only. See also note to Table 2.9.

Source: Indus Basin Survey (1976).

Table 2.12

Use of Chemical Fertilizers

	Farm Tenure				Farm Size				
Response	Pure Owner	Pure Tenant	Owner Landlord	Owner Tenant	1	2	3	4	All Households
Not Available	8.4	16.8	33.3	15.6	9.1	13.2	12.6	10.9	12.2
Shortage of Money	67.4	56.0	33.3	71.9	68.2	63.2	65.4	56.4	63.5
Do Not Need	16.3	16.8	33.3	3.1	20.5	14.5	11.8	23.6	15.6
Not Know How	1.4	0.8	0	0	2.3	0.7	1.6	0	1.7
Other	5.6	8.0	0	6.2	0	6.6	7.9	7.3	6.3
Price too High	0.9	1.6	0	3.1	0	2.0	0.8	1.8	1.3
% of Users:									
by tenure	79.6	78.6	93.3	85.5	-	-	-	-	80.5
by farm size	-	-	-	-	78.0	78.6	79.2	86.8	80.5

Note: The response is in answer to the question 'If you don't use chemical fertilizers, why not?'
See also note to Table 2.9

Source: Indus Basin Survey (1976).

Table 2.13

Reasons Given for Non-Optimum Yields[1]

Response	Farm Tenure: Pure Owner	Pure Tenant	Owner Landlord	Owner Tenant	Farm Size[2]: 1	2	3	4	All Households: Reason One	Reason[3] Two	Reason[4] Three
Insects/Disease	18.8	23.3	27.8	20.1	19.1	20.4	21.3	20.5	20.6	29.1	19.2
Lack of Fertilizer	9.0	11.1	5.6	6.4	12.0	10.5	9.3	5.7	9.2	23.5	19.7
Monsoon Flooding	10.4	21.7	5.6	9.6	11.0	14.4	14.4	11.6	13.5	12.8	6.5
Lack of Good Seed	1.3	1.4	1.4	1.0	2.4	1.3	0.5	1.9	1.3	6.6	12.4
Shortage of Power	0.9	0.5	0	1.8	2.4	1.0	0.3	0.5	0.8	2.1	2.7
Lack of Credit	1.0	0.2	1.4	1.8	1.0	0.7	1.0	0.7	0.8	4.3	8.6
Insuff. Irrigation	50.4	32.6	48.6	49.3	44.0	42.6	45.1	49.3	45.0	12.8	13.2
Labour Shortage	0.2	0	0	0	0	0	0	0.5	0.1	0.7	2.1
Other	8.1	9.2	9.7	10.1	8.1	9.1	8.0	9.4	8.7	5.9	12.1
% without optm. yields	97.3	96.5	96.0	99.6	95.0	97.5	97.9	97.0	97.3		

Note: (1) See note to Table 2.9
(2) The breakdown according to farm size and farm tenure is for the first reason only.
(3) 2.3% of households with non-optimum yields didnot give a second reason.
(4) 3.4% of households with non-optimum yields did not give a third reason.
Source: Indus Basin Survey (1976).

tenant farms. Insufficient irrigation was a less common constraint on pure tenant farms. The fact that inadequate supply of irrigation leads to lower levels of fertilizer use was further highlighted by the responses to the question 'with adequate supply of irrigation at all times what would you do as regards your use of fertilizer? Nearly 90% replied that they would increase their levels of application.

Households were also asked if they had fallow land and, if so, why? Nearly 77% had fallow land in kharif with 80% having fallow land in rabi (see Table 2.14). The percentage having some fallow land increased with farm size and was lowest among pure tenants. Again 'shortage of irrigation' (69%) was the main reason for having fallow land and seemed more important for pure owners and owner-tenants. Others said that land was left fallow mainly 'to increase fertility' (16%), this being a less common reason among the smallest farms. 'Shortage of money' was quoted by 3% of households this answer being more common among very small farms, and also among pure tenants and owner tenants. 'Shortage of labour' seemed to be a problem (although minor) among the largest farms and for owner-landlords, while 'lack of equipment' was a constraint on very small and very large farms and among pure owners and owner-landlords. The figures quoted pertain to the rabi season but the answers for the kharif season were very similar.

The answers to the above questions suggest that the main constraints facing farmers were insufficient irrigation, lack of credit and lack of fertilizer. The three constraints are closely linked. Access to credit would help farmers purchase and apply more fertilizers while improved irrigation would make it profitable to apply more fertilizer. If access to public irrigation, i.e. canals and public tubewells, is restricted then credit will also be necessary to finance the installation of private tubewells. Inability to secure credit, especially institutional credit, was more of a problem on smaller farms probably reflecting lack of collateral and influence. It is common, however, to see groups of small farms band together to purchase a tubewell. Later we present results from our production function estimates which indicate that variations in the level and standard of irrigations and in the level of fertilizer applied are statistically significant in explaining the variation in the output levels of the four major crops.

Table 2.14

Reasons for Fallow Land

Reason	Farm Tenure				Farm Size				All Households	
	Pure Owner	Pure Tenant	Owner Landlord	Owner Tenant	1	2	3	4	Rabi	Kharif
Shortage of Irrigation	74.3	60.7	58.3	67.2	71.2	68.6	70.8	68.5	64.2	69.5
Shortage of Labour	0.3	0.3	3.3	0.5	0	0.2	0	1.5	0.4	0.5
Shortage of Money	1.8	4.6	0	4.2	5.3	2.0	2.7	2.8	2.8	2.7
Lack of Equipment	1.2	0.5	5.0	0.5	2.3	1.0	0.4	1.8	1.1	1.1
To Increase Fertility	13.2	25.1	20.0	12.7	11.4	19.1	16.2	14.4	16.8	16.3
Other	9.2	8.9	13.3	14.8	9.9	9.1	9.9	11.1	14.7	9.9
% with Fallow Land										
- Kharif	86.7	62.2	80.0	86.4	60.1	69.7	81.0	90.4	-	76.9
- Rabi	81.7	73.8	80.0	86.4	51.8	76.3	86.6	90.0	79.8	-

Note: The breakdown according to farm tenure and size is for rabi season only. See also note to Table 2.9.

Source: Indus Basin Survey (1976).

§2.2.6 *Land Leasing*

Because of the problems associated with the hiring of some factor services, especially labour and draft power, households are often unable to adjust factor services to land owned by hiring these services in or out. So households may adjust land cultivated to match factor endowments when markets for these factor services are imperfect or non-existent. In this section we test this hypothesis. For our purpose we use a simple model developed by Bliss and Stern (1982, pp141-166 - henceforth, BS). We assume that households have a 'desired cultivated acreage' (DCA) which is an increasing function of family labour supplies and draught or motive power. With perfect adjustment the net amount of land leased-in would be the difference between DCA and the amount of land owned. We assume, however, that for various reasons households are unable to perfectly adjust so as to cultivate their exact DCA. We suppose that the actual net amount leased in (NLI) is related to the difference between DCA and land owned.

In our model we use a quadratic approximation for DCA so that focusing solely on draught power (V) and man-power (M), ignoring interaction terms, we would have:

$$DCA = c + \beta_1 V + \beta_2 V^2 + \beta_3 M + \beta_4 M^2 \qquad (2.1)$$

In our regressions we will also include a number of other variables which may also determine DCA (see Table 2.15). Net land leased-in (NLI) is then defined as:

$$NLI = \alpha[DCA - L] \qquad (2.2)$$

where L is land owned by the household and α is a constant. If $\alpha<1$ then households are unable to adjust land cultivated to exactly match their DCA. We could of course make α an increasing function of, say, land owned, if we thought that a household's ability to adjust towards its DCA increased with land owned possibly reflecting the relaxation of some constraints (e.g. willingness of others to lease to the household or credit constraints). However, this is not undertaken here. Substituting (2.1) into (2.2):

$$NLI = \alpha c + \alpha\beta_1 V + \alpha\beta_2 V^2 + \alpha\beta_3 M + \alpha\beta_4 M^2 - \alpha L \quad (2.3)$$

From equation (2.2) we see that:

$$\frac{\partial NLI}{\partial DCA} = -\frac{\partial NLI}{\partial L} = \alpha \quad (2.4)$$

Also from equation (2.1) we have:

$$\frac{\partial DCA}{\partial V} = \beta_1 + 2\beta_2 V \quad (2.5)$$

and

$$\frac{\partial DCA}{\partial M} = \beta_3 + 2\beta_4 M \quad (2.6)$$

By estimating equation (2.3) using regression analysis we can obtain values for α and β_i (i=1 to 4). We can therefore estimate values for equations (2.5) and (2.6) which describe how much more land households would see themselves able to cultivate as V and M increased respectively. However, it must be borne in mind that this model is very simple and we use it for exploratory purposes only. We first present some results and then comment on some empirical problems that emerge.

The results of our regressions are presented in Table 2.16 and a definition of all the independent variables given in Table 2.15. Various interaction terms for factor services were experimented with but none of these emerged as significant. From Table 2.16 we see that estimated coefficients had the expected signs. We estimate that α=0.59 which is much lower than the value of 0.78 estimated by BS. Using (2.5) we can calculate the change in a household's DCA when it obtains an extra unit of draught or tractor power as 0.61 acres and 3.95 acres respectively (remember that draught power is in units of Rs1,000 and tractor power in Rs10,000). For the former, BS calculated a value of about 3 acres.

In our sample the average price for a pair of mature bullocks was about Rs2,750. This implies an increase in DCA for an extra pair of bullocks of 1.66 acres. Using (2.6), with β_4=0, we see that an extra male adult increases DCA by 1.72 acres. In our sample the average cultivated acreage per Rs1,000 draught power and per adult male were 1.55 and 6.25 respectively. These values are much greater than the marginal

Table 2.15

Definition of Variables in Leasing Regression

Variable	Definition
L	Acreage owned by household
V	Value of draught power (Rs1,000). Its square is VSQ.
T	Value of tractors (Rs10,000). Its square is TSQ.
MEN	No. of men over 15 years.
WOMEN	No. of women over 15 years.
BOYS	No. of boys between 10-15 years.
GIRLS	No. of girls between 10-15 years.
CHILD	No. of children (male and female).
PTUBE	Dummy for access of tubewell.
EDUC	Years of formal education for head of household.
JOB	Dummy for head with another occupation.
SIND	Dummy for location in Sind.
NWFP	Dummy for location in NWFP.
IMMP	Dummy for immigrant from within Pakistan
IMMI	Dummy for immigrant from India.

Table 2.16

Leasing Model: Quadratic Approximation

Variable	Co-efficient	t-statistic
Intercept	2.348	2.99
L	-0.588	-52.26
V	0.358	7.79
VSQ	-0.001	-3.86
T	2.403	5.95
TSQ	-0.040	-2.31
MEN	1.014	4.34
WOMEN	0.422	1.61
BOY	-0.062	-0.24
GIRL	0.127	0.48
CHILD	0.072	0.61
PTUBE	3.617	2.99
EDUC	0.279	2.72
JOB	-1.277	-1.14
SIND	2.572	3.65
NWFP	-3.383	-1.75
IMMP	1.408	1.13
IMMI	-2.012	-1.91

No. of Obs. = 2002
R^2 = 0.61

effect of an extra unit of each factor on DCA, a result consistent with those of BS.

Comparing our results with those for the village of Palanpur in BS we find that an average household in Pakistan with an extra pair of bullocks would want to cultivate an extra 1.66 acres but would only be able to lease in 59% of this, i.e. 0.98 acres. In Palanpur an average household with an extra pair of bullocks wanted to cultivate an extra 3 acres but was able to lease in only 78% of this, i.e. 2.34 acres. There could be many reasons for these differences (for example, non-equivalence of bullock units or a greater amount of draught power required to plough an extra acre in Pakistan) so we do not speculate any further here. Also, an average household in Pakistan with an extra adult male would wish to cultivate an extra 1.72 acres but would only be able to lease in an extra 1.01 acres while a household in Palanpur would wish to cultivate an extra acre but could only lease in 0.78 acres. Possible reasons for this difference may include a greater availability of outside jobs for a household in Palanpur compared to the average rural household in Pakistan.

The significance of variables PTUBE and EDUC may be capturing greater initiatives or planning in households which own a private tubewell or have more years of formal education. Also the positive coefficient on the dummy for Sind suggests that the extent of leasing-in is greater in this province. We saw earlier that tenancy was also more common in Sind than in other provinces. A poorer quality of land on average in Sind may also be a factor.

Although our results coincide with *a priori* expectations we should point out some problems with our model. Firstly, we assume that the ability to adjust land cultivated to factor endowments is similar for both those who lease-out and those who lease-in. Secondly, we interpret zeros as a decision that land owned already equals a household's DCA. It may be the case that some of these zeros reflect an inability or unwillingness to hire in land, in which case the model is not appropriate and we should us a model such as the 'double-hurdle' model presented in Chapter 4. However, given the exploratory nature of our analysis we refrain from undertaking such a task.. Thirdly, the value of draught power or motive power may not be capturing the important characteristics and some households may have access to others draught power from, say, a brother.

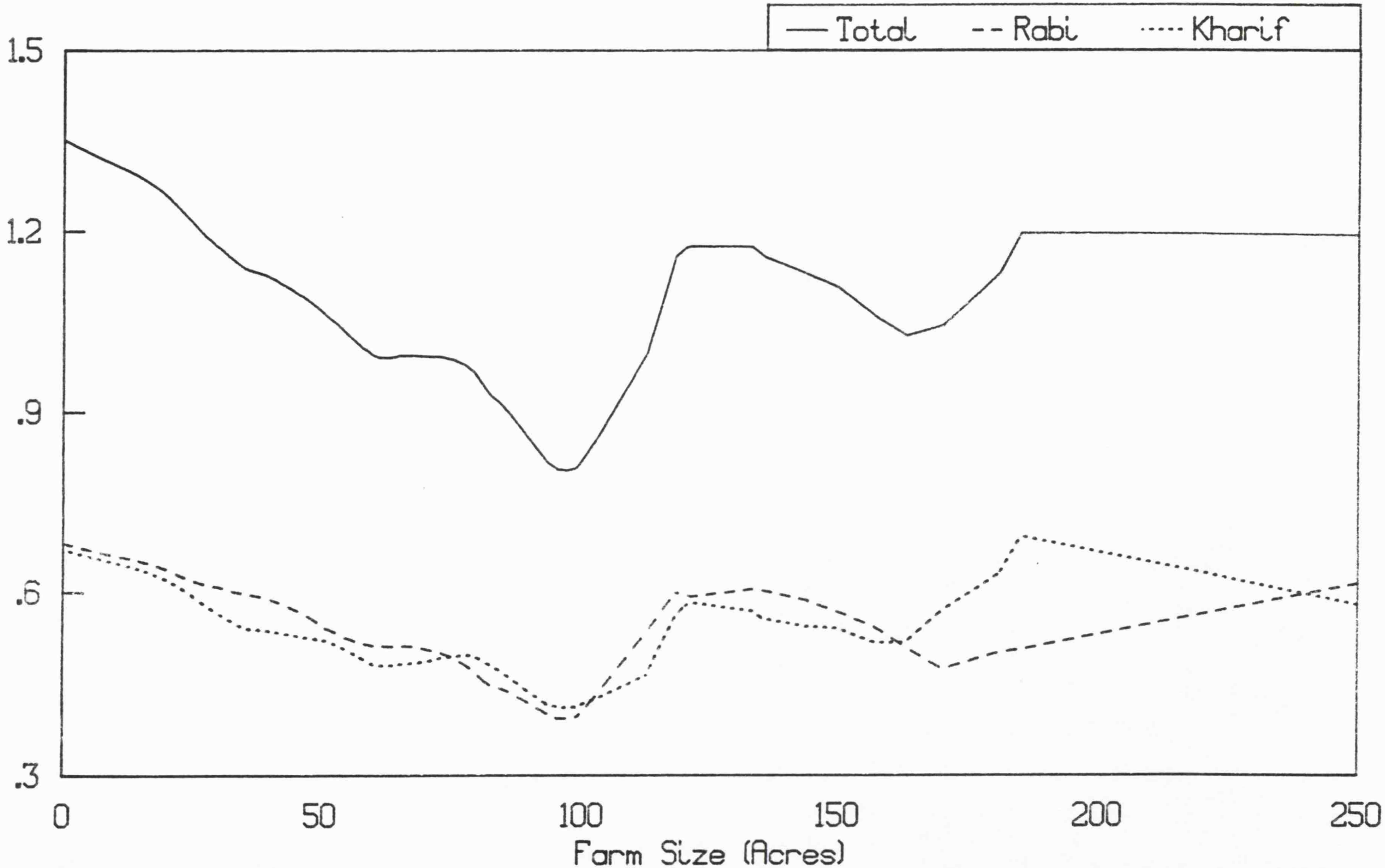
Finally, the nature of the data is such that influential observations greatly affect the coefficient estimates. For instance, the largest value for LOWN is 750 acres whereas the next largest value is just above 400 acres. The inclusion of the former observation greatly affects the estimates of α, the coefficient on LOWN, reducing it from 0.59 to 0.45. Fortunately, however, it does not appear to affect the marginal effect on DCA of an extra unit of factor services. But the exclusion of this observation did reduce our R^2 from 0.60 to 0.46. The presence of such observations is always a problem in such data sets as the one used for our analysis. One method of reducing the impact of extreme observations is to express the variable in log form but with the presence of many zeros this option is not available to us. A more detailed discussion of the effect and detection of influential observations is given in the Appendix B (to Chapter 3).

§2.2.7 *Cropping Pattern*

When analysing cropping patterns we use a kernel smoothing technique to describe the relationship between cropping behaviour and farm size. For any given landholding (i.e. the x-variable) we calculate a smoothed y-value (say, for cropping intensity) as the weighted average of the y-values of all the x's lying within the kernel, with the weights decreasing the further the x's are from the particular landholding in question (see Deaton, 1989, Appendix, for a more detailed discussion). The larger the kernel the smoother the curve. In all our calculations we used a kernel of 20 acres. Since there are very few very large farms, for the largest landholdings there will also be very few other observations within the kernel chosen. In this case the weighted y-value for these observations will not be very smoothed. In the extreme there will only be one observation in the kernel and the calculated y-value will be the actual or observed y-value. This explains the lack of smoothness to the right of most of the diagrams. When using the diagrams to capture the *general* pattern of the data we therefore concentrate our comments on the left side of each diagram.

In Figure 2.1 we have plotted the relationship between cropping intensity and farm size. Cropping intensity in the rabi and kharif seasons are defined as the ratio of total

Figure 2.1: Cropping Intensity



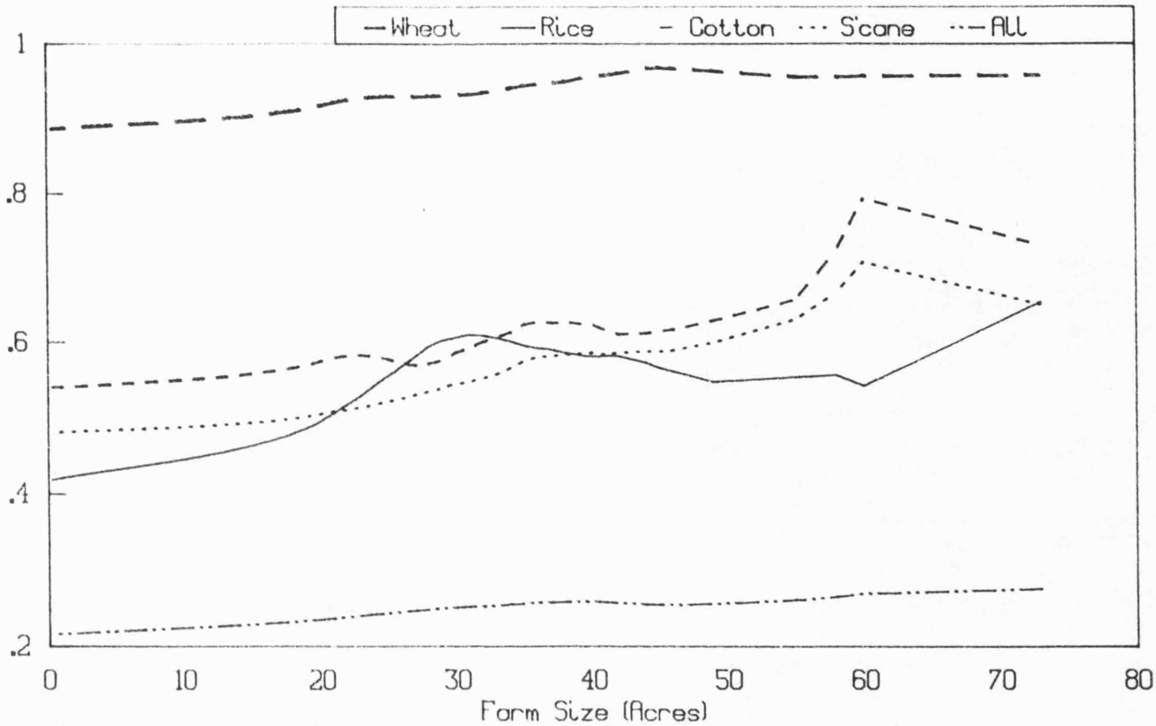
Note: Rabi and Kharif are the proportion of cultivated land cropped in each season. Total is the sum of both. The lack of smoothness for farms over 100 acres reflects the small number of large farms.

cropped acreage to total cultivated acreage in rabi and kharif respectively. The difference is accounted for by fallow land. Total cropping intensity is the sum of rabi and kharif cropped acreage divided by total cultivated acreage. We can see that cropping intensity decreases with farm size, being roughly 70% on the smallest farms in both seasons but falling to 40% on farms of 100 acres.

The four major crops grown in Pakistan are wheat, rice, cotton and sugarcane which in 1976/7 accounted for 35%, 10%, 10% and 5% respectively of total cropped area (Pakistan Statistical Yearbook, 1985). Wheat is by far the most important rabi crop. Rice and cotton are the main kharif crops while sugarcane is planted in kharif and harvested at the end of the rabi season. For all crops improved varieties dominated. Out of the 2002 sampled households, 1472 (73%) planted improved wheat and 202 planted traditional wheat, two of the latter also planting improved wheat. The mixing of wheat with other crops was not common. The number of farms planting improved rice was 787 (39%), while 102 planted traditional rice with 8 planting both. Improved cotton was planted by 911 (45%) farms, while 166 planted traditional cotton with only 4 planting both. Improved sugarcane was planted by 776 (39%) farms and traditional sugarcane was planted by only 32 farms (over both seasons). No farms planted both improved and traditional sugarcane. It is common for sugarcane stumps left over from the fresh sugarcane harvest to be left in the ground to produce a crop in the following year. This practice is called ratooning.

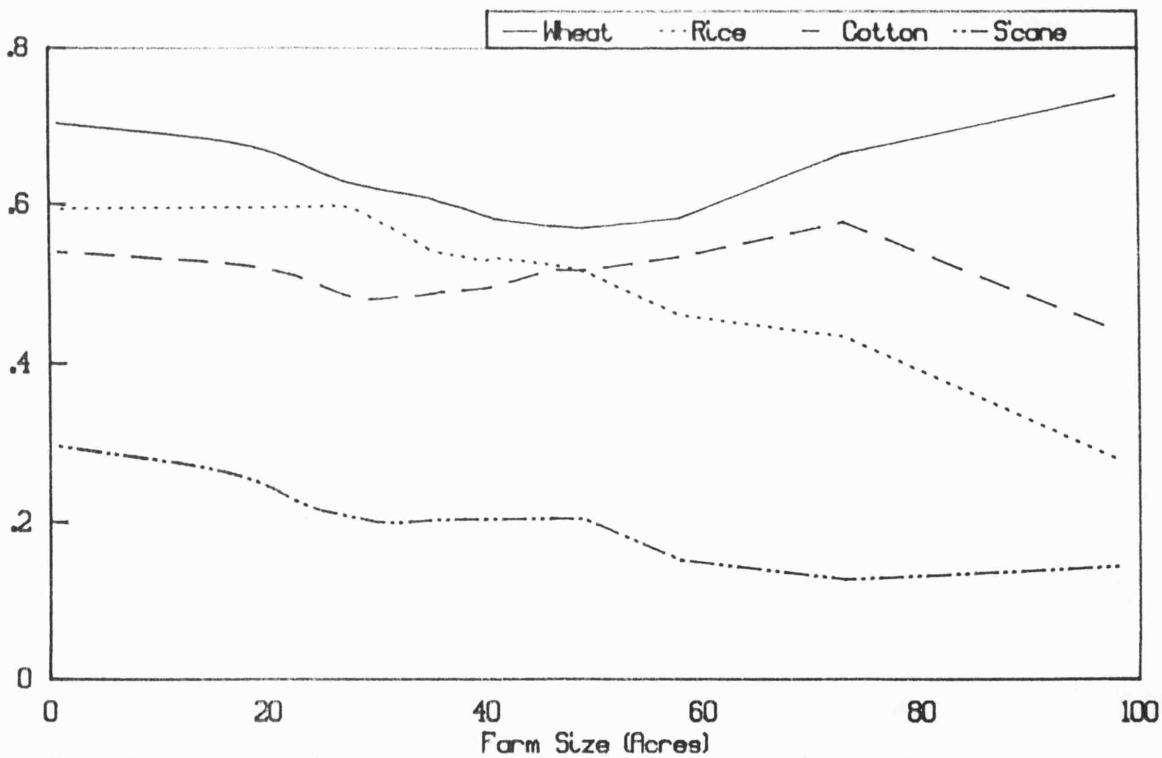
Figures 2.2 and 2.3 describe the allocation of land between the four major crops (improved and traditional varieties combined). In Figure 2.2 a household is given a y-value of one if it planted the various crops, zero otherwise. The y-axis can be interpreted as the proportion of households allocating some land to each crop. This proportion increases with farm size for all the major crops. Although the four major crops have higher mean returns they also require adequate and timely applications of water and fertilizer. This implies an initial outlay of funds for the purchase of these crucial inputs. If larger farms have more reliable water supplies and access to credit then they may be more willing to allocate land to these crops. We therefore observe more small farms allocating all their land to such crops as maize and sorghum (in

Figure 2.2: Crop Allocation



Note: Curves show the proportion allocating some land to each crop. 'All' reflects the level of involvement in all four crops (x0.1) taking the value one if only one was planted and four if all were planted.

Figure 2.3: Land Allocation



Note: Curves show the proportion of cropped acreage allocated to each crop, for those with positive allocated acreage.

kharif) or pulses (in rabi). In constructing the curve for *all* crops we sum the zero-one y-values for each crop for each household. So if a household planted all four crops it will have a value of four. This curve reconfirms that larger farms are more involved with the major crops.

Figure 2.3 focuses on households with positive allocations for each crop. It shows that for each crop, among households with positive allocated acreage, the percentage allocated to that crop decreases with farm size. We can focus on each season separately. In rabi we can combine wheat and sugarcane and view them as high-yielding but purchased-input-intensive crops. We find that the percentage of cropped area allocated to this group also decreases with farm size: decreasing from over 80% for farms less than 10 acres to less than 70% for farms around 55 acres. The fact that large farms allocate a smaller *proportion* of cropped acreage to high mean-yielding but more risky crops is consistent with increasing relative risk aversion. When we focused only on 'improved' varieties the same pattern emerged. Given the high proportion of cropped acreage allocated to wheat in rabi it would dictate the slope of the combined curve (i.e. for both wheat and sugarcane) in Figure 2.3. It is often argued (see, for example, Hazell, 1988) that, because of uncertainty in production and the possible ineffectiveness in transporting grains from surplus to deficit areas in the event of regionalized crop disasters, small farms will allocate a larger percentage of farm area to these crops in order to ensure adequate food supplies in bad years.

Focusing on the kharif season and the combined group of rice, cotton and sugarcane, a different pattern emerges. All farms less than 70 acres allocate between 74-77% of cropped acreage to this group of crops, this being slightly higher on larger farms. It may be that this reflects a greater availability of scarce water on larger farms in kharif and this could counteract any effect from increasing relative risk aversion. Unreliable water supplies increase the risk associated with high-yielding crops.

§2.3 Output Levels and Farm Size

There is much debate in the development literature concerning the relationship between farm size and output per acre [for studies relating to Pakistan, see Salam

(1978, 1981a), Khan (1979), Khan and Maki (1980), and Mahmood and Nadeem-Ul-Haque (1981)]. Many of the early studies were carried out on Indian data relating to the 1960s (see Bhalla and Roy, 1988, for references). These studies suggested an inverse relationship between productivity and farm size thus, some argued, reinforcing distributional arguments for land reform with efficiency considerations. For example, Cornia (1985, p532) argues that land reform '......would bring about a resource use more in line with the factor endowment of developing countries by increasing labour absorption (especially self-employment), while forestalling premature labour-displacing mechanization......(Also, it) would likely be more beneficial in countries where land concentration is high.' (bracketed words added). For governments who see the level of agricultural output (more specifically, the level of marketed surplus) as a bottleneck to economic development such arguments might be persuasive.

Various reasons may be advanced to explain why output per acre may be related to farm size (or other agricultural characteristics). These include:

(a) Credit: An important characteristic of the new HYV seeds is the need to use purchased inputs such as fertilizers or pesticides if one is to avail of their potentially high yields. This in turn requires an outlay of funds prior to revenue receipts from output sales. For most farmers this implies a need for credit. Small landholders often find it difficult to gain access to the formal credit market usually because they cannot provide the collateral required to secure a loan. Where they do have access, the risk of default and the higher transaction costs of small loans make it less likely that they will receive the credit they would demand in the market at the 'going' price. Therefore, small landholders frequently find themselves pushed into the informal credit market, i.e. village moneylenders, local shopkeepers or large land-owners, where interest rates are much higher than in the formal market reflecting the higher risks and transactions costs and possibly monopoly elements.

On the other hand, large landholders can supplement their own savings with credit from agricultural or commercial banks which in many cases is subsidized by the government. Differences in cost of credit imply differences in input costs leading to lower level of inputs and lower output on small farms. For example, subsidized credit for the purchase of tractors makes it more profitable for large landholders to use them, and farms with access to tractors may have better preparation of the soil and be in a position to sow at a more timely date thus increasing the productivity of all inputs. If the above arguments are valid then large farms should have greater access to, and be able to secure a greater amount of, cheaper credit thus enabling them to apply more inputs per acre and achieve higher yields.

(b) Technology: To capture the higher yields from HYV seeds farmers must not only apply the right amount of inputs but must do so at the right time and in the right way. These skills need to be acquired. If large farms have greater access to knowledge, e.g. formal education or agricultural advisers, then their practices are likely to be more efficient and output levels consequently higher. Government programmes aimed at diffusing new technologies may be concentrated on larger farms, reflecting a desire to increase total output and marketed surplus, and the cost effectiveness of policies which focus on a smaller number of larger farms units.

Larger landholders are in a stronger position to exert influence on politicians and the bureaucracy. In fact politicians are often from the ranks of large landholders. Political influence can ensure that government schemes are tailored to meet the needs of large landholders, e.g. access to HYV seeds, irrigation facilities, credit or electricity. This enables large landholders to have better farm practices and, consequently, higher output per acre.

(c) Nature of tenure agreement: It is often suggested that, due to insecurity of tenure or output sharing (but not cost sharing), tenant farmers will apply inputs less intensively than others and have lower output as a result. However, tenancy agreements often involve output and cost sharing and can act as a means of spreading risks (see Bliss and Stern, 1982, pp53-65) so that one may find that output per acre is higher on tenant farms. Also tenant farms may have access to credit despite insecurity of tenure and lack of collateral since credit can be provided by landlords. Alternatively, if credit- or asset-constrained farms lease out land to others who are not constrained then one may observe tenant farms having higher inputs and yields.

(d) Uncertainty: Where returns are uncertain risk averse farmers may apply inputs less intensively. If the degree of risk aversion (appropriately measured) is negatively correlated with farm size then inputs and output per acre may be positively correlated with farm size. The effect of uncertainty and risk aversion on input and output levels may also depend on the ability of farmers to allocate land between risky and less risky crops.

(e) Irrigation: Public irrigation schemes involve decisions on where public tubewells and canals are located. Those who are fortunate enough to be located near public tubewells or canals can have access to a reliable and regular source of irrigation which increases yields substantially. To the extent that large landholders can exert greater influence on the location of public irrigation facilities this can increase yields on larger farms. Also private tubewells are probably only profitably installed on farms over 10 acres. However, efficient rental markets or farmer co-operatives can overcome this problem and make water use more divisible (see Chaudhry, 1978, and Kaneda and Ghaffar, 19**, for a discussion of irrigation in Pakistan).

(f) Opportunity cost of labour: Subsistence farmers who have little land and very few employment opportunities are likely to attach a low marginal value to time, both their own and that of other family members. One should then observe high labour-land ratios and higher yields on small farms. This is reinforced by the tendency of large farms to make greater use of hired labour which may have additional costs in the form of a requirement to monitor their efforts (see Binswanger and Rosenzweig, 1986).

(g) Land Quality: Sen (1975) argued that population density would be higher in areas with good land so that small farms may have higher quality land. Therefore, while the relationship between farm size and productivity may be found to be negative when analysing countrywide data, this relationship within villages (with presumably similar land quailty) would disappear.

During the agricultural year farm households must decide, *inter alia*, how much land to cultivate (and lease in or out), how much land to allocate to individual crops, and when to plant and harvest each crop. These decisions will depend on many things including the household endowment of factors, the workings of factor and output markets, and the factor intensities of the various crops. The amount of land allocated to each crop will be influenced by the uncertainty of yields and the households attitude to -risk. For example, one expects risk averse households to allocate a smaller acreage to risky crops and more to less risky but lower mean-yielding crops. Alternatively, households with a large land endowment may, in the presence of imperfectly functioning labour markets, allocate more land to labour-intensive crops. Therefore, it is possible that the presence of uncertainty or imperfectly functioning markets affects the crop allocation decision as well as the allocation of factors to each crop.

Analyses of the relationship between farm size and productivity usually regress (the log of) the total value of farm output on (the log of) operated holdings. According to Cornia (1985, p514):

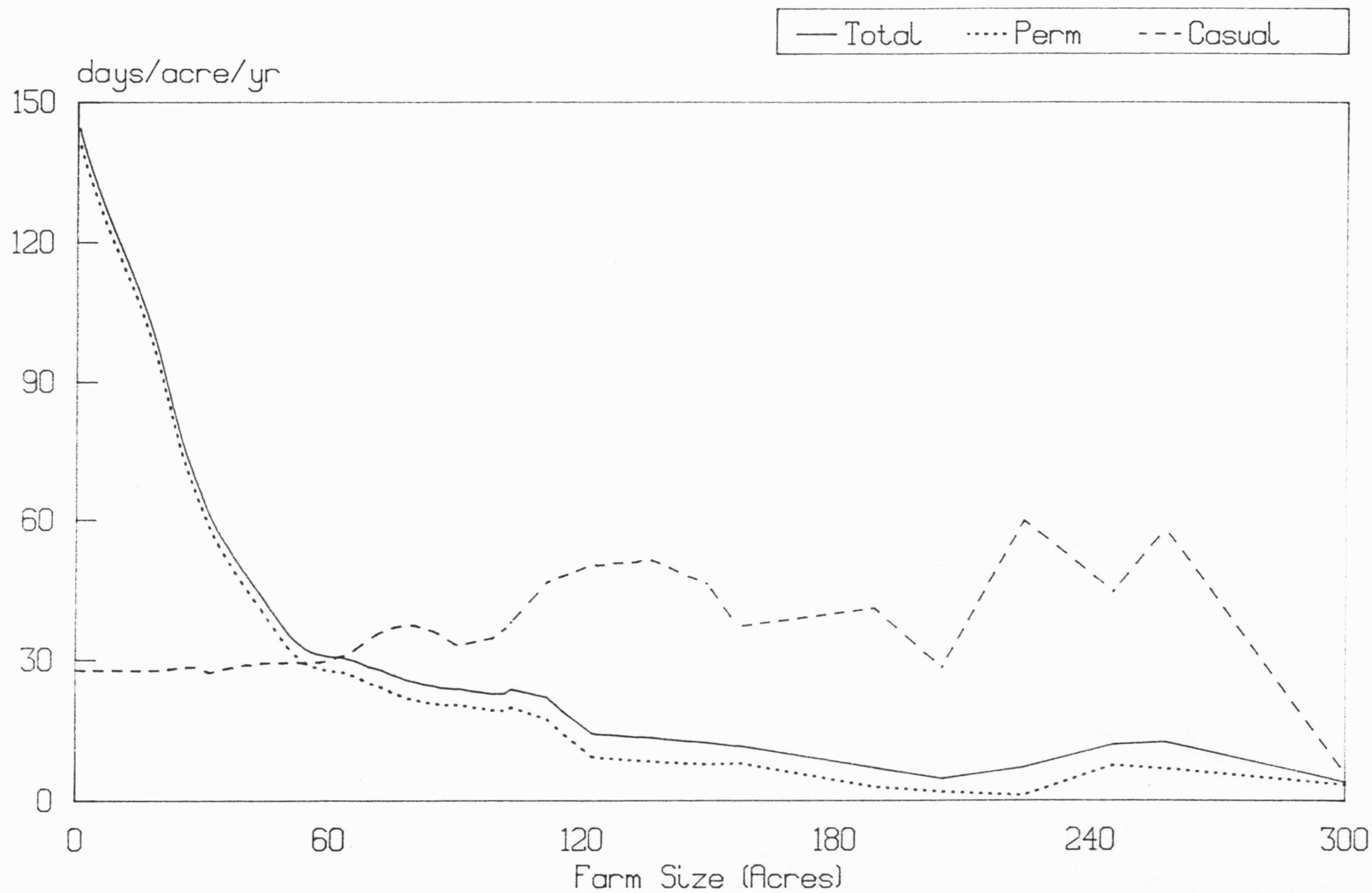
> The modern version of the controversy on the size effect started with the publication in the 1950s of the results of the Indian Farm Management Studies, which showed that there was an inverse relationship between farm size and land productivity. Subsequent empirical investigation leaves little doubt about the validity and generality of this phenomenon observed in many developing countries of Asia and Latin America characterized by widely different natural and climatic conditions, types of soils, agrarian structures and cropping patterns'

Explanations of this relationship have focused on the findings that small farms have a more intensive use of labour in each crop activity, cultivate a higher proportion of available land on the farm in each season, and have a more intensive use of land during the year. The studies by Carter (1984) and Cornia (1985) confirm these findings. Carter (1984) used data from the Farm Management Surveys of Haryana, an Indian state, for the agricultural years 1969-72. His estimates:

> ......indicate (after correcting for sample selection bias) that small farms would produce 15% less output then large farms given the same inputs. This result may reflect better access of large farms to yield increasing green revolution technology. Certainly no explanation of the inverse relationship is to be found in terms of technical efficiency. The inverse farm size productivity relationship, which exists despite the technical efficiency of small farms, must therefore be the result of greater input intensitiy per hectare on small farms' (pp141-2, bracketed words added)

His results also suggested that, contrary to the findings of Sen (1975), the within village inverse relationship was not significantly different from the relationship between villages. This finding is consistent with that in Bhalla and Roy (1988) who, using Indian data for the mid 1970s, found that the inverse relationship between farm size and productivity, although diluted, persisted when they controlled for various land quality characteristics (e.g. soil texture, colour and depth, and surface drainage and the rate of

Figure 2.4: Labour Use



Note: Permanent labour (Perm) includes family and non-family members.
Casual has been multiplied by ten.

percolation). Likewise Cornia (1985), analysing farm-level data from the Farm Management Surveys for 15 countries for the years 1973-79, found that both land use and resource use intensity (e.g. labour, capital and intermediate goods) both decreased with farm size, as did land productivity.

These results suggest that a higher ratio of operated to total farm size, a higher cropping intensity, and a more intensive use of labour and other inputs (all on small farms) combine to produce higher productivity on small farms. In §2.2.7 we also saw that in Pakistan small farmers had both a higher proportion of landholdings under cultivation and a higher proportion of cultivated land under crops (i.e. less fallow land) in each season, implying a higher cropping intensity over the whole year. Using the kernel smoothing technique described in §2.2.7, we also find that total labour use per acre decreases with farm size, reflecting the reliance of smaller farms on the labour of permanent household members (see Figure 2.4). The focus of most studies has been on the *value* of total farm output but we abstract from land use intensity and cropping patterns and focus on individual crop yields.

The results presented in Table 2.17 are based on regressions with the log of physical output per acre (individually for each crop) as the dependent variable. For each crop two regressions are run: (a) has the log of total cropped acreage (summed over all crops), LANDL, as the only independent variable along with a constant term, while (b) also includes the log of the proportion of total cropped acreage allocated to the crop in question (CROPL). In §2.2.7 we showed that, on average, small farms allocate a higher percentage of land to more risky crops in rabi (i.e. to wheat and sugarcane) but that this relationship disappeared in kharif, and was even slightly reversed. One might expect that the greater the percentage of land allocated to risky crops the higher the risk and therefore the lower the input levels and yields. We hope that the coefficient of CROPL in regression (b) will pick up this effect. In this case the coefficient on LANDL can be interpreted as a 'pure farm-size effect', i.e. after controlling for risk levels.

Focusing on the (a) results we see that for both wheat and sugarcane there is a positive relationship between physical output per acre and farm size, with a doubling of farm size consistent with a 6% increase in yields. For both rice and cotton there is a negative relationship with a doubling of farm size consistent with a 141% and 9% decrease in yields respectively. The large negative coefficient for rice may reflect the labour intensity of the production process, the lower cost of monitoring family labour and the high level of husbandry skills involved. The positive relationship for sugarcane may reflect the importance of reliable water supplies and liquidity over a longer period. The positive relationship for wheat may also reflect the higher yields on well-irrigated larger farms. Since cotton requires less water and its harvest is labour intensive this may explain the negative relationship.

Table 2.17

Land Productivity, Farm Size and Land Allocation

	LANDL	CROPL	$\bar{R}^2$	No. of Obs.
Wheat:				
(a)	0.06***	-	0.01	1456
(b)	0.03	-0.66***	0.05	
Rice:				
(a)	-1.41***	-	0.01	711
(b)	-0.01	-0.41***	0.04	
Cotton:				
(a)	-0.09**	-	0.01	772
(b)	0.10*	1.53***	0.05	
Sugarcane:				
(a)	0.06***	-	0.01	748
(b)	0.06**	-0.01	0.01	

Note: The dependent variable in all regressions is the log of physical output per acre for each crop. The results under (a) are based on regressions with the log of total cropped acreage (LANDL), i.e. for all crops, as the independent variable; (b) has both LANDL and the log of proportion of total cropped acreage under the crop (CROPL) as independent variables. All regressions were run with an intercept term. '***', '**' and '*' indicate significance at the 1%, 2% and 10% levels respectively; all other variables are insignificant at the 10% level. Where necessary the results have been corrected for sample selection bias using the Heckman (1979) technique.

Turning to the (b) regressions we find that for wheat, rice and sugarcane the coefficient on CROPL is negative, although statistically insignificant for sugarcane. These suggest that farms allocating a higher percentage of land to risky crops could be compensating for the greater risk by applying lower inputs per acre with consequent lower yields. For wheat this explains some of the positive relationship in (a) since we have seen that large farms allocate a lower proportion of land to wheat (see Figure 2.3). This is also the case with sugarcane, although the coefficient on CROPL is insignificant, possibly due to multicollinearity. With rice the negative relationship between farm size and the percentage of land allocated to rice was not as pronounced. The greater labour use on smaller farms may account for the negative relationship in (a), since rice is very labour-intensive. The positive coefficient for CROPL among cotton producers is harder to explain but could be due to economies of scale for cotton. Since small farms allocate a larger proportion of land to cotton this helps to explain some of the negative relationship between farm size and yields in (a). In fact, the 'pure farm-size effect' is positive, although statistically significant only at the 10% level.

Our results therefore suggest that the relationship between physical yields and farm size is crop specific. The large proportion of land allocated to wheat may dilute the negative relationships for rice and cotton so that our earlier findings that cropping intensity is higher on small farms may dominate any analysis of the relationship between the *value* of total farm output and farm size, i.e. one might expect to find a negative relationship. Above we argued that a higher level of risk on farms which allocate a higher percentage of land to risky crops leads to such farms applying less inputs. We now give a brief description of fertilizer use which, in the following section, is shown to be statistically significant in explaining the variation in crop yields.

The regressions run are the same as for Table 2.17 except that the dependent variable is now the log of total (nitrogenous) fertilizer use per acre. Table A2.1 shows that the proportion of farms applying fertilizer increases with farm-size category. However, Table 2.18 shows that, among farms with positive levels of fertilizer use, for wheat, rice and sugarcane there is a negative relationship between per acre application levels and farm size, although it is not statistically significant for wheat. For cotton the coefficient of LANDL is insignificantly positive. These results are consistent with the findings of Salam (1978) for the Punjab region. So it appears that although the proportion of farms applying fertilizer increases with farm size, among users the per acre levels decrease with farm size. This latter finding is consistent with the presence of increasing relative risk aversion, since one would expect that, if anything, fertilizer productivity (and therefore input) levels were higher on larger farms reflecting better water availability and, possibly, information on good practices.

Table 2.18

Nitrogen Use, Farm Size and Land Allocation

	LANDL	CROPL	$\bar{R}^2$	No. of Obs.
Wheat:				
(a)	-0.03	-	0.001	1126
(b)	-0.03	-0.18*	0.020	
Rice:				
(a)	-0.26*	-	0.05	529
(b)	-0.09*	-0.25*	0.04	
Cotton:				
(a)	0.02	-	0.04	625
(b)	-0.02	-0.01	0.05	
Sugarcane:				
(a)	-0.08*	-	0.02	568
(b)	-0.14*	-0.13	0.04	

Note: The dependent variable in all regressions is the log of nitrogen applied per acre for each crop. The results under (a) are based on regressions with the log of total cropped acreage (LANDL), i.e. for all crops, as the independent variable; (b) has both LANDL and the log of proportion of total cropped acreage under the crop (CROPL) as independent variables. All regressions were run with an intercept term. '*' indicates significance at the 1% level; all other variables are insignificant at the 10% level. Where necessary the results have been corrected for sample selection bias using the Heckman (1979) technique.

In all cases, except for cotton, the introduction of CROPL into the regressions does not change the sign of the coefficient on LANDL. The negative coefficients for CROPL are consistent with the argument that the greater percentage of land allocated to risky crops the higher the risk level, and farms compensate for this by applying lower inputs (i.e. fertilizer) per acre. The fact that we find a negative coefficient for LANDL in (a), in spite of higher risk on smaller farms is consistent with the presence of increasing relative risk aversion.

Binswanger and Rosenzweig (1986, p531) point out that when testing for a relationship between productivity and farm size one should introduce a distinction between acreage owned by an operator and operational scale. Their model has three independent variables, i.e. land operated, land owned and family size. Output per acre operated is the dependent variable. Controlling for land operated and family size, an increase in land owned should increase output per acre if tenanted land is less productive (possibly reflecting higher credit costs). Controlling for land owned and family size, an increase in land operated should decrease output per acre mainly because of increased labour costs, reflecting a greater use of more costly hired labour. Similarly, controlling for land owned and land operated, an increase in family size implies lower labour costs and higher output per acre.

The results from our estimation of the BR model are presented in Table 2.19. In most cases the variables have the expected signs though not always statistically significant. The coefficient for LOWN, although small, is significantly positive for wheat and rice, but is not significantly different from zero for cotton or sugarcane. In all cases the coefficient of LOPRL is significantly negative with elasticities in the range 1-2.3%. Only for rice is the coefficient for MENL significantly different from zero (and positive, with an elasticity of 1.3%). When other variables representing the number of women, boys, girls and children were included they were highly insignificant as were the squared terms for all variables when the quadratic form was fitted. The absence of any significant relationship for cotton or sugarcane may reflect the existence of contracts between producers and ginners/refiners which may alleviate problems regarding access to credit or technical knowledge.

The results indicate a somewhat mixed picture as regards the relationship between physical output levels and farm size across crops. However, one can speculate somewhat as to the likely reasons for the relationships which have emerged. For example, rice is a relatively labour- and husbandry-intensive crop and small farms apply more family labour per acre. This is reinforced by the positive coefficient for adult males (and negative coefficient for LOPRL) in Table 2.19. We also found that among rice producers who applied fertilizer the per acre level applied decreased with farm size. The negative relationship for cotton could also be due to lower labour costs on small farms and the fact that cotton is not a particularly water-intensive crop. Wheat and sugarcane yields do respond sensitively to good water availability and management. Also, sugarcane has high liquidity requirements given its relatively long growing season. These factors seem to dominate or eliminate any inverse relationship which may arise from greater fertilizer application (for sugarcane) and cheaper labour costs on small farms. In all cases a lower percentage of land allocated to risky crops operates to reduce risk (and increase input levels), although (in the case of fertilizer at least) increasing relative risk aversion may explain why we still observe a negative relationship between resource use and farm size.

Table 2.19

Productivity, Land Tenure and Family Labour

	Wheat	Rice	Cotton	Sugarcane
Intercept	2.06**	6.53**	5.48**	5.13**
LOWN	0.001**	0.004**	0.00	0.001
LOPR	-0.23**	-0.13**	-0.10*	-0.19**
MEN	0.00	0.13**	0.00	-0.02
No. of obs.	1456	711	772	748
R^2	0.03	0.02	0.01	0.03

Note: Dependent variable is the log of output per acre for each crop. Independent variables are land owned (LOWN;in acres), land operated (LOPR;in log acres) and the number adult males in the family (MEN;in logs). The use of 'acres' instead of 'log acres' for land owned reflects the presence of zeroes for this variable. '**' and '*' indicate significance at the 1% and 5% levels respectively, all other variables being insignificant at the 10% level. Where appropriate results have been corrected for sample selection bias using the Heckman (1979) technique.

Studies undertaken using data for the Punjab for the years 1972-74 also give mixed results. Salam (1978) found that only for improved wheat were yields significantly different across farms being significantly higher (at a 10% level) on larger farms. Khan (1979) also found that output was higher on larger farms, but output here referred to the total value of farm output. Khan and Maki (1980) found no relationship between physical output and farm size for improved varieties of wheat and rice. Mahmood and

Nadeem-Ul-Haque (1981) found a u-shaped relationship. However, not only were they focusing on the total value of farm output, but they were also using grouped data.

We began this section by highlighting the fact that physical output per acre for each crop varies widely across farms. We then went on to suggest reasons why output levels might differ. If larger farms have greater access to credit or technical knowledge then we expect productivity to be positively correlated with farm size. On the other hand, small landholders have a greater (per acre) supply of cheaper family labour which can operate to increase yields on smaller farms. The important point is that there exist many reasons which can explain the variations in productivity across farms, some which tip the balance in favour of higher productivity on small farms others which suggest that large farms will exhibit higher productivity levels.

An appropriate agenda for economic analyses in this area is as follows. One must first try to explain why yields vary across farms. The analysis at this stage should identify variations in input levels and farm practices. One then asks why input levels and farming techniques differ. For instance, one may find that extension services and access to and the terms of credit are biased in favour of larger farms and these in turn imply higher applications of purchased inputs and more effective farm practices. The final step is to ask if government policy can influence this situation and, if so, whether and how to do so. Again the market for credit is instructive. Greater access to cheaper credit for large farms may reflect problems of assymetric information. It is doubtful if state banks can overcome such problems and are probably less able to do so than the fragmented private market. The experience of state banks in developing countries is often one of high default rates with cheaper credit being allocated mainly to large farms (see Bell, 1988, for a detailed survey of the issues involved, and Aleem, 1990, for an analysis of credit policy in Pakistan).

From the perspective of the above agenda simply regressing output per acre on total cropped acreage in itself is not very useful. What these regressions capture is the net result of the various forces at work and their relationship to farm size. They do not identify the precise reasons for the variation in productivity levels. Also, higher output per acre is an appropriate measure of greater efficiency only if land is the sole scarce factor. At best, one can say that an inverse relationship implies that efficiency considerations reinforce distributional arguments for land reforms which redistribute large landholdings among the landless or among small holdings. Such results can therefore be used to ensure that land reform remains an issue when it comes to government policy making. However, it is also important to recognize that higher yields on small farms may not reflect greater 'efficiency' if it arises from higher input levels.

If one accepts that land redistribution is not really on the agenda, at least for the forseeable future, then one should focus on why productivity levels vary and how government policy can and should influence the determining factors. This approach is valid whether the relationship is negative, positive or non-existent. Whether or not variations in productivity levels are related to farm size is not *per se* the important question from a policy viewpoint, although if we do find such a relationship then this may help to explain the existence of wide variations in productivity levels. Broadly speaking governments wish to use appropriate policy instruments to encourage the spread of 'best practice' techniques and to raise productivity levels. The appropriate choice of policy instruments will require a comparison of the social costs and benefits of reforms. The objective of empirical work should be to concentrate on identifying the factors which explain the variation in productivity levels (and these may or may not be correlated with farm size) and the role of government in affecting these factors.

Separating land into acreage operated and acreage owned and also including family size as an independent variable does go some way in focusing on particular household characteristics which theory suggests may influence productivity levels. In this respect these results are more useful. In the next section we estimate production functions for each crop with input levels and farm practices as independent variables. Such an approach enables us to identify the particular inputs and practices which help to explain variations in output levels. The use of fertilizers is a good example. Above we found that although the percentage of households using fertilizers increases with farm-size categories, among those that do apply fertilizers the level applied per acre decreases with farm size. Anticipating the results of the next section we also find that the level of nitrogenous fertilizer applied per acre significantly affects productivity levels for each crop. These results beg the question: What determines whether or not households apply fertilizers and the levels applied? Output prices, fertilizer prices and access to credit and fertilizer supplies will obviously play a role in the answer. One should also incorporate uncertainty into any analysis of this kind. In Chapter 4 we analyse fertilizer use in more detail.

§2.4 Farm Practices and Crop Production Functions

In this section we analyse the variation in input and output levels and in farm practices for the major crops in Pakistan in an attempt to identify the factors which explain output variations. The crops analysed are improved varieties of wheat, rice, cotton and sugarcane. Production functions are estimated for each crop and the model is described in Appendix A (to this chapter). In our sample of 2002 farms, 1472 planted improved wheat, 787 improved rice, 911 improved cotton and 776 inproved sugarcane. We have already discussed cropping patterns in §2.2.7. For all crops it was necessary to delete observations, mainly due to missing values for output or fertilizer. A crude examination of the percentage deletions by farm-size category suggested that while the deletions for missing output values were not correlated with farm size, those for missing fertilizer values were. The latter is to be expected since the missing values were for large farms that had fertilizer use above a certain level so that the value did not fit into the number of spaces allocated when coding the data. In our analysis we test for sample selection bias arising from these deletions. The deletions reduce our samples to 1352, 688, 728 and 729 observations for wheat, rice, cotton and sugarcane respectively. Fertilizer deletions accounted for 87%, 23%, 12% and 23% for each crop respectively. A crude examination of the data suggests that only for wheat do *total* deletions appear to be correlated (positively) with farm size.

We now discuss the explanatory variables used in our regression analyses. The definitions of all variables are collected in Table 2.20 and a statistical summary is presented in Table A2.2. We can divide variables into 'direct' and 'proxy' variables where the former refer to inputs and practices which affect outputs directly (e.g. the level of fertilizer or ploughings, or the quailty of farm practices such as the manner in which fertilizer is applied) and the latter are only correlated with such variables and act as their proxies. If we had detailed information on all direct variables then we would not expect the proxy variables to emerge statistically significant from our regressions. However, to the extent that we do not, these variables may be statistically significant in explaining variations in output levels.

§2.4.1 *Chemical Fertilizers*

It is their responsiveness to high doses of nitrogenous fertilizer that has been treated as the hallmark of new seed varieties. However, it is not the level of fertilizers alone which leads to higher per acre yields but also the timing and sequence of inputs. The productivity of fertilizers depends greatly on the use of other inputs such as irrigation, weeding and ploughing. Good agricultural practice involves the use of the correct levels of inputs and the correct timing of their applications.

Salam (1975) refers to the recommended (presumably by a national agricultural research institute/station) level of nitrogen for Mexi-Pak wheat, local rice, cotton and sugarcane as 57, 27, 32 and 79 (all kg/acre) respectively. For phosphate the recommended levels quoted for these crops were 34, 34, 23, and 34 (all kg/acre) respectively. In the case of rice the nitrogen level recommended for improved varieties would probably be higher. Research stations recommend that half of the nitrogen and all of the phosphorous and potash should be applied as a basal dressing at the time of sowing. The remainder of the nitrogen should be applied as a top-dressing at the time of the first irrigation. The irrigation immediately following this top-dressing is crucial to fertilizer productivity. If wheat is grown unirrigated then all the fertilizer should be applied as a basal dressing at the time of sowing. Without irrigation the productivity (marginal and average) of fertilizer is lower. The yield-maximizing level of nitrogen without irrigation is suggested to be around 28 kg/acre. Therefore, profit-maximizing levels will also be much lower without irrigation. The optimal level of fertilizer also depends on whether or not the seeds were sown at the appropriate time. With late sowing (e.g. December for wheat) recommended nitrogen levels are reduced by around 20% compared to sowing at the appropriate time (e.g. mid November for wheat).

Table 2.20

Definition of Variables Used in Regressions

Dependent Variable

YPA:	Output per acre (kgs)

Independent Variables

NPA:	Nitrogen per acre (kgs)
PPA:	Phosphate per acre (kgs)
NTOPD:	Nitrogen applied as a top dressing (Dummy)
FMPA:	Farmyard manure per acre (kgs)
SPA:	Seed per acre (kgs)
PLANT:	Planting before critical planting date(Dummy)
IRRN:	Number of irrigations
IRRS:	Level of water supply (Dummy)
RAUN:	Irrigation prior to planting (Dummy). A dummy, RAUN5, for irrigation within five weeks of planting is also included
NRAUN4:	Irrigation within four weeks following planting (Dummy). A dummy, NRAUNO, for both NRAUN4=1 and PLANT=1 is also included
PLOUGH:	No. of ploughings
PLANK:	No. of plankings
HARROW:	No. of harrowings
HOE:	No. of hoeings
WEED:	No. of weedings
AGE:	Age of head of household
EDUC:	Years of formal education of head of household
TRAC:	Ownership of tractor (Dummy)
BVAL:	Value of draught power (Rs 10000/acre)
CROPR:	Percentage of cultivated land cropped in rabi
CROPK:	Percentage of cultivated land cropped in kharif
PARCEL:	Number of parcels into which land is divided
JOB:	Household head having another occupation (Dummy)
SLSAL:	Land defined as slightly saline (Dummy)
GSAL:	Land defined as generally saline (Dummy)
SVSAL:	Land defined as severely saline (Dummy)
PTEN:	Household defined as pure tenant (Dummy)
OTEN:	Household defined as owner-tenant (Dummy)
MCON:	Household defined as mixed consolidator (Dummy)
OWNL:	Household defined as owner-landlord (Dummy)
OWNT:	Household defined as owner-tenant (Dummy)
CRACRE:	Cropped acreage
SIND:	Household located in Sind
NWFP:	Household located in NWFP

Note: Where squared terms are included the number '2' is added to the end of the relevant variable above, e.g. EDUC and EDUC2.

Control of weeds is also important since weeds compete with wheat for nutrients. Pre-sowing ploughings and weedings can help control weeds. More will be said of these activities below.

It is important to remember that 'optimum' fertilizer levels from a profit-maximizing viewpoint are probably lower at farm level reflecting inappropriate farm practices, constraints on credit and the use of complementary inputs, and different relative prices due to varying credit, transport and labour costs. Also, the presence of risk operates to reduce input levels when risk averse farmers maximize their expected utility of wealth.

The IBS contains information on the amount of nitrogen, phosphorous, farmyard manure and green manure applied. Earlier we saw that there was a negative relationship between farm size and the per acre level of nitrogen applied (for those applying some fertilizer) but that a higher proportion of larger farms applied some fertilizer. This is consistent with some earlier studies for Pakistan for the early seventies. Salam (1978) and Mahmood and Nadeem-Ul-Haque (1981) found that smaller farms used more fertilizers but the latter study used the total level of fertilizer used on-farm and also grouped data. However, Khan (1979) found that larger farms used more 'non-traditional' inputs such as fertilizers, hired labour and farm machinery than smaller farms, but he also analysed the total value of fertilizer used on-farm.

The average level of nitrogen applied is lower than the recommended levels given earlier for all crops, particularly so for wheat, rice and sugarcane. However, as pointed out earlier, actual farm practices and conditions are substantially inferior to those in research stations. If farm tasks and practices, complementary to fertilizer use, are inferior then the average and marginal productivity of fertilizer will be lower and the profit-maximizing level of fertilizer use below recommended levels. Even taking this into account actual application levels appear very low. One can interpret this as sub-optimal use of fertilizer on farms, evidence of inefficient farm practices, the presence of credit and other input costs or a behavioural response to uncertainty. Alternatively, one might think that households have some other objective. A more detailed analysis of fertilizer use is presented in Chapter 4.

The number of fertilizer applications is also provided in the survey (FERTN) and is concentrated around 1-2 with between 45-60% applying more than once. In the absence of data on the timing of fertilizer applications (relative to planting of seeds) we assume that those who had two or more applications applied fertilizer as a basal dressing and as a top dressing. So we use a dummy variable to represent whether or not fertilizer was applied as a top dressing (NTOPD). We also use a zero-one variable, PHOS, which takes the value one if phosphate was applied, zero otherwise. For wheat and rice around 20% apply phosphate with a corresponding figure of 32% for cotton and sugarcane 32%. For wheat, rice and cotton around 25-30% applied farmyard manure but for sugarcane the percentages were 66% and 43% respectively.

§2.4.2 *Seeds*

The main sources for improved seed were 'own-farm' and 'neighbours' for wheat, rice and sugarcane with 'village market' and 'government' acting as minor sources. For cotton the main source of seed was the 'government' followed by the 'market dealer', 'on-farm' and 'village market'. The average level of seed applied per acre (SPA) did not vary significantly over farm size except for sugarcane and rice where the level was significantly lower on the largest farms when compared to the smallest.

The IBS also gives data on the completion date for planting. For wheat we take the critical planting date (CPD) as 1st December with 71% of farms finishing planting before this date. We use a dummy variable to represent this in our regressions (PLANT12; 1 if planted before 1st December, zero otherwise). The CPD for rice and cotton was taken as 1st July (PLANT7) with 38% and 98% finishing planting before this date respectively. For cotton 61% finishing planting before 1st June. The CPD for sugarcane was taken as 1st April (PLANT4) with 70% finishing planting before this date. This is a very simple way of capturing the returns to sowing at the appropriate time and the CPDs are based on discussions with agricultural economists in Pakistan.

Salam (1976), analysing agricultural practices in the Punjab, found that many farmers continued to sow wheat after the normal sowing time was over, many sowing as late as January. This is consistent with our data. It is often found that the harvesting time for cotton leaves inadequate time for seed-bed preparation. This is often also the case with rice harvesting, especially basmati rice which takes a longer time to mature than other varieties. Although sowing after the CPD does not improve output for a crop (for given seed and other inputs), taken in isolation it may do so when all seasons and crops are taken together, i.e. it may be consistent with greater total farm output total farm output. Salam also observed that farmers try to compensate for late sowing by applying more nitrogeneous fertilizer, something which was also found in the BS study of Palanpur in northern India. This is inconsistent with the recommendations for late sowers where the recommended level of nitrogen is roughly half that for timely sowers. However, it may be due to an 'income' or 'relaxed constraint' effect since by leaving the previous crop longer yields and income increase thus providing more own-funds to finance the purchase of inputs.

§2.4.3 *Ploughing, Weeding and Hoeing*

Pre-sowing ploughings help control the spread of weeds which compete with crops for soil nutrients. They also provide a good seedbed. Hand-weeding and hoeing also reduce the spread of weeds. Many observers think that an improvement in these activities would increase yields substantially. The number of ploughings on land sown with each crop is available from the survey (PLOUGH). The level of ploughing is quite high; the percentage of farms with zero ploughings was less than 3% for all crops. The average number of ploughings is about 5 but this is a bit higher for sugarcane.

The level of hand-weeding (WEED) is very low for wheat with less than 3% undertaking any hand-weeding and 6% any hoeing (HOE). However, for other crops the number undertaking hoeing increases to 50-75% of farms for rice, cotton and sugarcane (the percentage being higher for cotton and sugarcane). It was most common for those undertaking hoeing to do so 1-2 times for each crop. The extent of ploughing may be one reason for the low level of weeding and hoeing. The number of harrowings is also available (HARROW). Less than 3% of farmers carried out any harrowing.

§2.4.4 *Irrigation*

Both the level and timing of irrigation affect output. We do not have precise data on the level of irrigation, i.e. water applied. The number of irrigations, however, is available in the survey (IRRN). Almost all farmers carry out some irrigation with most irrigating between 5 and 15 times. The average number of irrigations is higher for rice and sugarcane than for wheat and cotton. The timing of irrigation relative to the time of planting is very important, and proper practices can significantly increase the productivity of fertilizers and other inputs. Irrigation just prior to sowing and just subsequent to sowing increase productivity substantially. Also wheat must be irrigated regularly, ideally at around three week intervals.

We use a zero-one variable to reflect whether or not the farmer irrigated prior to sowing (RAUN), or (alternatively) within five weeks prior to sowing (RAUN5). Similarly we use a zero-one variable to capture whether or not the crop was irrigated within four weeks of sowing (NRAUN4). We also introduce another zero-one variable (NRAUNO), which takes on the value 1 if there was an irrigation within four weeks of sowing and if seeds were planted before the critical planting date. For wheat and rice over 95% of farmers irrigated prior to sowing, for cotton 72% and for sugarcane 44%. The percentage of farms irrigating within five weeks prior to sowing was 70%, 67%, 91%, and 40% for wheat, rice, cotton and sugarcane respectively. Also 53%, 27%, 67% and 50% both irrigated within five weeks prior to sowing and planted before the CPD. For each crops around 60% irrigated within five weeks of sowing. Unfortunately, we have no way of adjusting for the quality of irrigations, e.g. efficient channels or sufficient water.

Farmers were also asked, for each month, whether irrigation conditions were 'adequate', 'in short supply' or 'too much'. The zero-one variable IRRS was set equal to 1 if supply was 'adequate' or 'too much' during the few months prior to CPD, otherwise it was set equal to zero. The percentage with adequate irrigation supply was between 30-40% for each crops. The fact that the irrigation practices are so good, as measured by the number and adaquacy of irrigations, reflects the nature of the sample.

§2.4.5 *Other Variables*

The IBS provides information on other variables which may be of use in explaining some of the variation in YPA over farms. These variables are explained briefly below and fall mostly under the heading of 'proxy' variables. As mentioned earlier, to the extent that input levels and other farm practices are already captured by the variables described above one expects that many of the following variables will emerge as insignificant in our regressions with YPA as the dependent variable.

(a) CROPR: This variable represents the percentage of cultivated land which was cropped in rabi. One can argue that a higher cropped level reflects a diligent farmer. However there may be reasons other than laziness for some land being left fallow, e.g. lack of access to certain inputs, liquidity constraints or bad land. A similar variable for the kharif season is also included (CROPK). In this case a lower value may also mean that nutrients in the soil are more plentiful than if the land was cropped and these are available for absorption by the rabi crop. Alternatively, cropping in kharif can act as a control on weeds and this increases the productivity of inputs in rabi. This may be reinforced if fertilizers are also applied in kharif. Given the extent of ploughing in the sample it is likely that the additional effect of kharif cropping on weed control is minimal.

(b) AGE: This is the age of the farm operator. One might think that the older the farmer the more farming experience he possesses and is therefore more productive. Alternatively one may think that old farmers tend not to be up to date with modern methods and less productive as a result. A noticeable feature of the replies is that they cluster around multiples of five.

(c) EDUC: This is the number of formal years of education received by the head of the household. It is often argued that educated farmers are more likely to be aware of good practices and also more receptive to them. Educated farmers can read leaflets and instructions on how to apply inputs and are therefore not solely reliant on physical instruction. For the whole sample about 75% of farmers had no formal education. Salam (1981a), using 1972-73 data for Pakistan, found that farmers with a higher level of education applied more fertilizer per acre.

(d) PARCEL: Land holdings may be in one unit or several disjoint parcels. This variable represents the number of parcels of land. 55% of farms had land in more than one parcel.

(e) JOB: Operators were asked whether they had another occupation or profession. If they had then JOB was set equal to 1, zero otherwise. Farmers with other occupations to fall back on in difficult agricultural periods may be less careful with their practices and less productive. Alternatively, another occupation may mean less aversion to risk and a higher level of inputs being applied as a result or may provide more liquidity for purchasing inputs. However, less than 7% had another occupation. Unfortunately, we do not have information on whether or not other members of the family had a job outside agriculture.

(f) SAL: Land is divided into four categories, namely, non-saline, NSAL; slightly saline, SLSAL; generally saline, GSAL; and severely saline, SVSAL. This is obviously a crude measure of soil quality but the best available. The variables SLSAL, GSAL and SVSAL are included as explanatory variables, so their coefficients are relative to households with non-saline land.

(g) POWN: Tenure status is given as either pure owner, POWN; pure tenant, PTEN; mixed consolidator, MCON; mixed owner-landlord, OWNL; and mixed owner-tenant, OWNT. The dummies PTEN, MCON, OWNL and OWNT are included as explanatory variables with their coefficients interpreted as relative to pure owners.

(h) BVAL: This represents the value of draught power (Rs10000) owned by the household. Greater draught power enables better land preparation and higher standards for other activities thus increasing output levels.

(i) TRAC: Less than 4% of operators own a tractor. Where the operator owns a tractor TRAC is set equal to 1, zero otherwise. As with draught power access to a reliable supply of tractor services may balance the effect of ownership. Salam (1981a), using Pakistani data for 1972-73, found that tractor farms had higher output per acre and higher fertilizer input per acre.

(j) SIND,NWFP: Land and practices are thought to be of superior quality in the Punjab. The dummy variable SIND takes the value 1 if the farm is located in SIND, zero otherwise. Just over 25% of farmers are in Sind. A zero-one variable for NWFP is also included. Less than 4% of households were located in NWFP. The variables SIND and NWFP will therefore indicate whether or not the level of output per acre is on average significantly different in Sind or NWFP than in the Punjab.

(k) LANDCR: We have already discussed the effect of land size on productivity. This variable is the amount of land cropped in the relevant season.

§2.4.6 *Results*

In this section we present the results of our production function analyses for each crop. A description of the function employed in the analyses is presented in Appendix A and the definitions of the variables used are given in Table 2.20. Two sets of results are presented for each crop: labelled RUN1 and RUN2. In RUN1 only households using fertilizers are included whereas RUN2 includes all producers of the relevant crop.

To enable the use of logs for fertilizer (NPA) and irrigation (IRRN) variables we add a constant to each variable. In RUN1 this applies only to IRRN since this variable has some zero observations. We use the log of (I+c) as an explanatory variable where I is the number of irrigations and we choose a value for c so as to maximise R^2. The range of values over which we searched was c=1,2,..,10. A similar procedure was used in RUN2 for fertilizers. We use the log of (N+g) as an explanatory variable and choose g to maximize R^2. The range of values over which we search is g=5,10,15,20,25 and 30. In RUN2 we choose the combination of g and c which maximizes R^2. This procedure may be justified by noting that the soil already contains some nitrogen and moisture.

Tables 21 to 24 present the results for each crop. The coefficients, their t-statistics, the elasticity of output with respect to each variable and their marginal products (MP) are all presented (for statistically significant variables). Elasticities and MPs are calculated as described in Appendix A. Where variables enter in log form elasticities and MPs are taken at the geometric means and where variables enter in a linear form, along with their square, elasticities and MPs are taken at the arithmetic

Table 2.21

Determinants of Variation in Output Per Acre (Wheat)[1]

Variable	RUN1 B	RUN1 E	RUN1 MP	RUN2 B	RUN2 E	RUN2 MP
Intercept	3.861	-	-	3.083	-	-
	(11.24)			(10.11)		
NPAL	0.173	0.173	4.13	-	-	-
	(5.50)					
NPAL7	-	-	-	0.199	0.199	4.24
				(7.27)		
PPA	0.008			0.008		
	(2.63)	0.047	2.60	(2.62)	0.044	2.73
PPA2[2]	-0.016			-0.016		
	(-2.37)			(-2.28)		
NTOPD	0.076	7.9%		0.094	9.8%	
	(1.84)			(2.25)		
FMPA[2]	0.003			0.004		
	(1.71)			(1.98)	0.030	0.02
FMPA2[3]	-0.002			-0.003		
	(-0.68)			(-1.07)		
SPAL	0.208	0.208	3.07	0.243	0.243	3.30
	(3.12)			(3.83)		
IRRN3	0.368	0.368	22.18	-	-	-
	(4.98)					
IRRN4	-	-	-	0.478	0.478	24.30
				(7.05)		
IRRS	0.070	7.2%		0.063	6.5%	
	(2.08)			(2.01)		
RAUN5	0.025			-		
	(0.58)					
NRAUNO	0.012			0.031		
	(0.32)			(1.02)		
BVAL	0.160			0.190		
	(1.22)			(1.59)		
BVAL2	-0.002			-0.004		
	(-0.18)			(-0.41)		
TRAC	0.111			0.133		
	(1.25)			(1.56)		
PLOUGH	0.038			0.041		
	(1.02)			(1.24)		
PLOUGH2	-0.002			-0.002		
	(-0.49)			(-0.58)		
PLANK	-0.036			-0.027		
	(-0.97)			(-0.82)		
PLANK2	0.004			0.003		
	(1.11)			(0.93)		
HARROW	0.239			0.203		
	(2.09)	0.008	127	(1.91)		
HARROW2	-0.047			-0.041		
	(-1.76)			(-1.57)		
WEED	0.009			-0.001		
	(0.15)			(-0.02)		
WEED2	-0.008			-0.005		
	(-0.41)			(-0.24)		

contd.

HOE	0.129			0.219		
	(1.05)			(1.87)		
HOE2	-0.018			-0.048		
	(-0.27)			(-0.71)		
AGE	0.004			0.010		
	(0.70)			(1.65)		
AGE2[2]	-0.005			-0.009		
	(-0.74)			(-1.58)		
EDUC	-0.020			-0.017		
	(-1.43)			(-1.33)		
EDUC2	0.003			0.003		
	(2.34)			(2.16)		
PARL	0.008			0.006		
	(0.23)			(0.21)		
JOB	-0.005			-0.061		
	(-0.84)			(-1.02)		
SLSAL	-			0.077		
				(1.14)		
GSAL	-0.095	-9.0%		-0.082	-7.9%	
	(-2.12)			(-1.98)		
SVSAL	-0.180	-16.5%		-0.129	-12.0%	
	(-4.43)			(-2.94)		
MCON	0.560			0.549		
	(1.52)			(1.45)		
OWNL	0.051			0.025		
	(0.58)			(0.29)		
OTEN	0.098			0.093		
	(1.88)			(1.93)		
PTEN	0.042			-0.001		
	(0.98)			(-0.002)		
SIND	-0.234	-21.0%		-0.273	-24.0%	
	(-4.71)			(-4.33)		
NWFP	0.035			-0.035		
	(0.38)			(-0.34)		
CRPRL	0.105	0.105	86.2	0.101	0.101	75.7
	(2.30)			(2.51)		
CRPK	0.580			0.818		
	(2.09)	-0.029	-26.1	(3.37)	-0.036	-30.1
CRPK2	-0.527			-0.747		
	(-2.13)			(-3.67)		
LANDCR	-0.028			-0.034		
	(-1.03)			(-1.37)		
N		1100			1352	
R^2		0.26			0.35	

Note: (1) B is the estimated coefficient, E the elasticity of output with respect to the relevant variable (or simply the percentage shift if a dummy variable) and MP is the marginal product of the relevant variable.
(2) Multiply coefficient by 10^{-2}.
(3) Multiply coefficient by 10^{-6}.
(4) See Table 2.20 for definition of variables.

Table 2.22

Determinants of Variation in Output Per Acre (Rice)[1]

Variable	RUN1 B	RUN1 E	RUN1 MP	RUN2 B	RUN2 E	RUN2 MP
Intercept	3.856			2.732		
	(6.68)			(4.89)		
NPAL	0.282	0.282	8.73	-	-	-
	(5.35)					
NPAL25	-	-	-	0.416	0.416	6.15
				(5.37)		
PPA	0.001			0.001		
	(0.22)			(0.19)		
PPA2[2]	-0.001			-0.002		
	(-0.36)			(-0.70)		
NTOPD	0.168	18.0%		0.193	21.3%	
	(2.23)			(2.69)		
FMPA[2]	0.003			0.002		
	(1.15)			(0.82)		
FMPA2[3]	-0.004			-0.003		
	(-2.17)			(-1.46)		
IPA[2]	0.105			0.020		
	(0.10)			(0.03)		
IPA2[2]	-0.001			0.002		
	(-0.11)			(0.25)		
PLANT7	0.091			0.087		
	(0.84)			(1.53)		
SPAL	-			0.013		
				(0.25)		
IRRN10	0.466	0.466	13.7	0.530	0.530	14.1
	(3.07)			(4.05)		
IRRS	0.034			0.061		
	(0.56)			(1.16)		
NRAUN4	0.036			0.082		
	(0.46)			(1.43)		
NRAUNO	0.044			-		
	(0.33)					
BVAL	0.595			0.717		
	(2.03)	0.100	349	(3.05)	0.120	378
BVAL2	-0.146			-0.192		
	(-1.67)			(-2.48)		
TRAC	0.029			0.077		
	(0.20)			(0.57)		
PLOUGH	0.063			0.020		
	(0.98)			(0.37)		
PLOUGH2[2]	-0.500			-0.071		
	(-0.79)			(-0.14)		
PLANK	-0.064			-0.009		
	(-1.17)			(-0.19)		
PLANK2[2]	0.600			-0.046		
	(0.91)			(-0.08)		
HARROW	-0.610			-0.408		
	(-1.71)			(-1.42)		
HARROW2	0.124			0.086		
	(1.60)			(1.30)		

contd.

WEED	-0.042			-0.073		
	(-0.80)			(-1.59)		
WEED2	0.008			0.017		
	(0.80)			(1.27)		
HOE	-			-0.032		
				(-0.08)		
HOE2	-			-0.356		
				(-1.03)		
AGE	-0.011			-0.005		
	(-0.96)			(-0.49)		
AGE2[2]	0.015			0.008		
	(1.21)			(0.71)		
EDUC	-0.008			0.015		
	(-0.33)			(1.52)		
EDUC2[2]	0.300			-0.001		
	(1.340			(-0.08)		
PARL	0.088			0.086	0.086	33.3
	(1.42)			(1.68)		
JOB	-0.098			-0.001		
	(-0.80)			(-0.01)		
SLSAL	0.066			0.048		
	(0.49)			(0.45)		
GSAL	-0.055			-0.047		
	(-0.63)			(-0.64)		
SVSAL	-0.043			-0.139	-13.0%	
	(-0.46)			(-1.74)		
OWNL	-0.047			-0.028		
	(-0.031)			(-0.021)		
OTEN	0.197	21.8%		0.183	20.0%	
	(2.09)			(2.24)		
PTEN	0.209	23.0%		0.165	17.9%	
	(2.70)			(2.55)		
SIND	-0.321	-27.0%		-0.311	-27.0%	
	(-2.48)			(-2.55)		
NWFP	-0.960	-62.0%		-1.151	-68.0%	
	(-2.38)			(-3.30)		
CRPKL	0.196	0.196	186	0.147	0.147	130
	(2.35)			(2.09)		
CRPR	0.847			1.215		
	(1.78)	0.050	44.8	(3.31)	0.086	73.4
CRPR2	-0.540			-0.793		
	(-1.39)			(-2.55)		
LANDCR	-0.007			-0.043		
	(-0.14)			(-1.00)		
N		488			688	
R^2		0.25			0.26	

Note: (1) B is the estimated coefficient, E the elasticity of output with respect to the relevant variable (or simply the percentage shift if a dummy variable) and MP is the marginal product of the relevant variable.
(2) Multiply coefficient by 10^{-2}.
(3) Multiply coefficient by 10^{-6}.

Table 2.23

Determinants of Variation in Output Per Acre (Cotton)[1]

Variable	RUN1 B	RUN1 E	RUN1 MP	RUN2 B	RUN2 E	RUN2 MP
Intercept	2.707			3.809		
	(2.78)			(7.48)		
NPAL	0.232	0.232	1.95	-	-	-
	(3.17)					
NPAL15	-	-	-	0.275	0.275	1.57
				(3.64)		
PPA[2]	-0.030			0.202		
	(-0.06)			(0.38)		
PPA2[2]	0.005			0.003		
	(0.43)			(0.24)		
IPA	0.012			0.013		
	(1.75)	0.036	2.49	(1.87)	0.030	2.38
IPA2[2]	-0.008			-0.009		
	(-1.08)			(-1.23)		
FMPA[3]	0.005			0.029		
	(0.14)			(0.95)		
FMPA2[4]	-0.001			-0.086		
	(-0.01)			(-0.37)		
IRRN10	0.743	0.743	8.97	-	-	-
	(2.50)					
IRRN2	-	-	-	0.539	0.539	11.91
				(4.28)		
IRRS	-	-	-	-0.002		
				(-0.04)		
BVAL	-0.062			-0.139		
	(-0.12)			(-0.31)		
BVAL2	-0.159			-0.027		
	(-0.35)			(-0.06)		
TRAC	0.054			0.164		
	(0.26)			(0.092)		
PLOUGH	-0.035			0.018		
	(-0.38)			(0.23)		
PLOUGH2[2]	0.600			-0.011		
	(0.72)			(-0.01)		
PLANK	-0.049			-0.086		
	(-0.57)			(-1.22)		
PLANK2[2]	-0.090			0.005		
	(-0.08)			(0.48)		
HARROW	-0.037			0.056		
	(-0.26)			(0.48)		
HARROW2	0.035			-0.003		
	(0.70)			(-0.13)		
WEED	-0.002			-0.001		
	(-0.02)			(-0.01)		
WEED2	0.001			0.002		
	(0.03)			(0.08)		

contd.

HOE	0.120			0.073		
	(1.93)	0.126	24.3	(1.32)		
HOE2	-0.008			-0.003		
	(-0.59)			(-0.22)		
AGE	-0.004			-0.019		
	(-0.24)			(-1.42)		
AGE2[2]	0.900			0.023		
	(0.61)			(1.63)		
EDUC	0.030			0.005		
	(0.86)			(0.17)		
EDUC2	0.001			0.002		
	(0.41)			(0.84)		
PARL	-0.006			-0.020		
	(-0.09)			(-0.32)		
JOB	-0.337	-28.6%		-0.300	-26.0%	
	(-2.29)			(-2.31)		
SVSAL	-0.084			-0.102		
	(-0.90)			(-1.24)		
OWNL	-0.113			-0.126		
	(-0.63)			(-0.74)		
OTEN	0.058			0.033		
	(0.51)			(0.33)		
PTEN	0.071			0.022		
	(0.78)			(0.27)		
SIND	0.282	32.0%		0.314	37.0%	
	(3.02)			(3.72)		
CRPKL	0.137			0.108		
	(1.31)			(1.20)		
CRPR	0.239			0.244		
	(0.36)			(0.41)		
CRPR2	-0.339			-0.358		
	(-0.64)			(-0.77)		
LANDCR	-0.199	-0.199	5.51	-0.214	-0.214	5.62
	(-3.35)			(-4.08)		
N		558			728	
R^2		0.17			0.20	

Note: (1) B is the estimated coefficient, E the elasticity of output with respect to the relevant variable (or simply the percentage shift if a dummy variable) and MP is the marginal product of the relevant variable.
(2) Multiply coefficient by 10^{-2}.
(3) Multiply coefficient by 10^{-3}.
(4) Multiply coefficient by 10^{-8}.

Table 2.24

Determinants of Variation in Output Per Acre (S'cane)[1]

Variable	RUN1 B	RUN1 E	RUN1 MP	RUN2 B	RUN2 E	RUN2 MP
Intercept	8.141			7.820		
	(15.98)			(19.19)		
NPAL	0.118	0.118	40.98	-	-	-
	(2.43)					
NPAL6	-	-	-	0.094	0.094	40.64
				(3.62)		
PPA	-0.002			-0.002		
	(-0.70)			(-0.60)		
PPA2[2]	0.003			0.003		
	(0.47)			(0.53)		
NTOPD	0.015			0.100		
	(0.27)			(0.17)		
FMPA[3]	-0.006			-0.003		
	(-0.50)			(-0.32)		
FMPA2[4]	0.001			0.001		
	(1.41)			(1.36)		
SPAL	0.072	0.072	0.56	0.066	0.066	0.50
	(2.08)			(2.12)		
IRRN2	0.222	0.222	180.6	-	-	-
	(2.91)					
IRRN1	-	-	-	0.184	0.184	160.4
				(3.10)		
IRRS	0.051			0.095		
	(1.07)			(2.20)	10.0%	
IPA	0.002			0.003		
	(0.55)			(0.62)		
IPA2[2]	-0.002			-0.002		
	(-0.35)			(-0.42)		
BVAL	0.268			0.360		
	(1.31)			(2.07)	0.060	3193
BVAL2	-0.138			-0.148		
	(-2.30)			(-2.66)		
TRAC	0.048			0.035		
	(0.51)			(0.38)		
PLOUGH	-1.182			-0.122		
	(-3.11)	0.370	577.9	(-2.45)	0.280	416.2
PLOUGH2	0.016			0.011		
	(3.24)			(2.72)		
PLANK	0.075			0.098		
	(1.77)	0.039	92.91	(2.52)	0.100	235.9
PLANK2	-0.007			-0.008		
	(-1.83)			(-2.25)		
HARROW	0.015			0.100		
	(0.15)			(1.11)		
HARROW2	0.004			-0.005		
	(0.29)			(-0.40)		
WEED	0.207			0.159		
	(2.48)	0.045	2158	(2.12)	0.035	1704
WEED2	-0.044			-0.033		
	(-1.59)			(-1.43)		

contd.

HOE	0.126			0.116		
	(2.74)	0.050	596	(2.74)	0.056	600.4
HOE2	-0.036			-0.031		
	(-2.80)			(-2.59)		
AGE	-0.005			0.003		
	(-0.56)			(0.34)		
AGE2[2]	0.004			-0.004		
	(0.44)			(-0.50)		
EDUC	-0.003			0.014		
	(-0.16)			(0.75)		
EDUC2[2]	0.089			-0.069		
	(0.43)			(-0.36)		
PARL	0.022			0.013		
	(0.49)			(0.32)		
JOB	0.016			-0.056		
	(0.16)			(-0.61)		
SLSAL	-0.027			-0.035		
	(-0.20)			(-0.30)		
GSAL	-0.084			-0.095		
	(-1.50)			(-1.86)	-9.0%	
SVSAL	-0.042			-0.021		
	(-0.65)			(-0.37)		
MCON	0.671			0.871		
	(1.29)			(1.60)		
OWNL	0.058			0.120		
	(0.49)			(1.03)		
OTEN	0.040			-0.007		
	(0.58)			(-0.11)		
PTEN	0.154	16.6%		0.169	18.4%	
	(2.53)			(3.08)		
SIND	0.151			0.188		
	(1.07)			(1.55)		
NWFP	0.168			0.202		
	(0.94)			(1.25)		
CRPKL	0.124	0.124	2592	0.115	0.115	2292
	(1.88)			(2.03)		
CRPR	-0.398			-0.016		
	(-0.61)			(-0.03)		
CRPR2	0.312			-0.006		
	(0.67)			(-0.01)		
LANDCR	0.039			0.023		
	(1.02)			(0.67)		
N		547			729	
R^2		0.22			0.22	

Note: (1) B is the estimated coefficient, E the elasticity of output with respect to the relevant variable (or simply the percentage shift if a dummy variable) and MP is the marginal product of the relevant variable.
(2) Multiply coefficient by 10^{-2}.
(3) Multiply coefficient by 10^{-3}.
(4) Multiply coefficient by 10^{-4}.

means.

The analysis presented here focuses on RUN2 which included both households which applied fertilizers and those that did not. However, these results are very similar to those from RUN1. In both runs observations with missing values for outputs, inputs and (in RUN1) with nitrogen use equal to zero were deleted. We have therefore tested for sample selection bias using the technique of Heckman (1979), but in all cases there was no evidence of such a bias. We now summarize the results presented in Tables 21 to 24.

For all crops the level of fertilizer applied and the number of irrigations are statistically significant at the 5% level. The elasticities of output with respect to the level of nitrogen applied were 0.20, 0.42, 0.27 and 0.09 for wheat, rice, cotton and sugarcane respectively. So, for example, a 10% increase in the level of nitrogen applied to wheat increases wheat output by 2%. Only in the case of wheat did variations in phosphate levels explain any variations in output - the elasticity was 0.04. Households applying nitrogen as a top-dressing had 10% and 21% larger outputs for wheat and rice respectively. The elasticity of output with respect to farmyard manure was 0.03 for wheat but this variable was insignificant for other crops.

The elasticities of output with respect to the number of irrigations were 0.48, 0.53, 0.54 and 0.18 for wheat, rice, cotton and sugarcane respectively. In the cases of wheat and sugarcane households which felt they had 'adequate' or better water supplies (IRRS=1) had a 6.5% and 10% higher output levels respectively. Only for wheat and sugarcane did variations in seed levels significantly explain variations in output levels, the elasticities being 0.24 and 0.07 respectively. The elasticity of cotton output with respect to pesticide and insecticide expenditure (IPA) was 0.03 - only cotton producers applied pesticides and insecticides to any noticeable extent.

For wheat the elasticity of output with respect to the number of harrowings was less than 0.01, while the elasticity of cotton output with respect to the number of hoeings was 0.13. For sugarcane the elasticities of output with respect to the number of ploughings, plankings, weedings and hoeings were 0.28, 0.10, 0.03 and 0.06 respectively. For rice and sugarcane the elasticities of output with respect to the value of draught power (Rs10,000/acre) owned was 0.12 and 0.06 respectively. Ownership of draught power may enable more timely and higher quality farm practices and better quality ploughings before sowing which gives a better prepared seed-bed.

The elasticities of output with respect to the percentage of total landholdings cropped in the same season (CRPR/K) were 0.10, 0.15 and 0.12 for wheat, rice and sugarcane respectively. The positive sign may reflect less constraints on inputs, greater effort or higher quality of land. The elasticities with respect to the percentage of land cropped in the previous season were -0.04 and 0.09 for wheat and rice respectively. The negative sign for wheat may reflect the depletion of soil or time constraints, e.g. inadequate time to prepare soil. The positive coefficient for rice may reflect the nutrients left over from rabi or the benefits from good soil preparation for wheat.

The elasticity of rice output with respect to the number of parcels into which land holdings are divided was 0.09. This may reflect higher quality land or hard-working dynamic farmers who lease in parcels of land. Among cotton producers, households whose head had another profession had 26% higher output possibly reflecting a higher educational level and knowledge of efficient farm practices.

Variations in the quality of land help explain variations in output for wheat, rice and sugarcane. Among wheat producers those with 'generally saline' or 'severely saline' land have significantly lower output levels compared to households with non-saline land: 8% and 12% lower outputs respectively. For rice, households with 'severely saline' land have 13% lower output levels compared to those with non-saline land. Sugarcane producers with 'generally saline' land had 9% lower output. The effect of tenure status also varies across crops. For wheat and rice owner-tenants have 9% and 20% higher outputs respectively, compared to pure owners. For both rice and sugarcane procucers pure tenants have 18% higher outputs respectively, again when compared to pure owners.

The effects of location are captured in the variables SIND and NWFP. In Sind producers have 24% and 27% lower output levels for wheat and rice respectively, but cotton producers have 37% higher output levels (all compared to Punjab). Only for rice do producers in NWFP have systematically lower output levels than for Punjab, output levels being 68% lower in NWFP.

In §2.3 we examined the relationship between land size and output levels and our results suggested a relationship which varied across crops. In this section we have tried to explain variations in output levels for each crop through variations in input levels and farm practices. For all crops the level of nitrogen applied and the number of irrigations carried out help to explain a substantial amount of the variation. However, it is important to note that only in the case of cotton has land size (i.e. total cultivated acreage) been significantly correlated with output level, after we controlled for input levels and farm practices - cotton a 10% increase in the total area cultivated leading to a 2% lower output level.

We argued earlier that it is input levels and the standard of farm practices (in conjunction with some other factors, e.g. weather conditions) which determine output levels and not land size *per se*. When we regress output levels on land size without controlling for input levels etc. we must interpret any significant relationships in this light. For example, a positive relationship is explained by the fact that input levels, the standard of farm practices or land quality are positively correlated with land size and this is what is being captured by the regression. However, in our production function analyses we have tried to control for variations in these variables. Our results then indicate that keeping input levels etc. constant we find that only in the case of cotton are there lower output yields on larger farms. It could, of course, be the case that we have not included some important variables or that some of the variables which we have included do not adequately capture the relevant characteristic of an input and that these are correlated with land size. For instance, if the quality of irrigations varies a lot then the number of irrigations (IRRN) may not be an adequate variable. This type of argument is to be preferred here when explaining such relationships between land size and per acre yields.

Table 2.25 presents the marginal products (MPs) of the various inputs for individual crops. The calculation of MPs is described in Appendix A. Since the level of inputs and the standard of farm practices vary across farms, so too will the MPs of the various inputs. To give some idea of the average standard of agricultural practices we present marginal products at some average (or representative) value. For inputs which enter our regressions in log form (e.g. nitrogen) the MPs are calculated at their geometric means while for variables which enter in linear form (along with their square) MPs are calculated at the arithmetic mean. It is common to ask whether inputs are applied at levels which are economically efficient in the absence of uncertainty, i.e. up to a level where the value marginal product (VMP) of an input equals its price. If the ratio (ER) of the VMP of an input to its price exceeds one then the input is being applied at a level below its profit-maximizing level (assuming fixed prices and MPs decreasing with input levels). We present these ratios for nitrogen in Table 2.25 for the various crops. The choice of nitrogen reflects the fact that it is relatively easy to calculate the cost of an extra unit of nitrogen input, i.e. the price of one kg of

Table 25

Ratio of Value Marginal Product to Output Price for Nitrogen

Crop	q	MP	ER
Wheat	0.94	4.24	1.23
Rice	0.80,1.20	6.15	1.51,2.27
Cotton	2.67,3.21	1.57	1.29,1.55
Sugarcane	0.12,0.16	40.64	1.50,2.00

Note: q is the output price (Rs/kg), MP is the marginal product of one kg of fertilizer and ER is the ratio of the value marginal product of fertilizer to the price of fertilizer (Rs. 3.25/kg), p. Therefore, ER=q.MP/p. Results use RUN2 estimates of marginal products. For rice, cotton, and sugarcane (for which output prices vary considerably) we choose two representative prices and thus have a range of ERs.

The average price of nitrogen quoted in the sample is Rs2.96/kg with little variation around this value. Of course, the cost of an extra application (kg) of nitrogen will be higher since we must allow for extra trade and transport, labour costs and credit costs. So calculations of ER use Rs3.25/kg as the price of nitrogen input which is just less than 1.1 times the average price in the sample. The average price of wheat quoted in the survey was Rs0.94/kg with little variation around this value. The prices quoted for rice varied widely with 94% of producers quoting a price in the range Rs0.6-1.4/kg and 50% quoting a price in the range Rs0.8-1.2/kg. The price of cotton also varied widely with 74% quoting a price in the range Rs2.67-3.21/kg and 98% quoting a price in the range Rs2.67-3.35/kg. For sugarcane 41% of households quoted a price of Rs0.12/kg and 39% quoted a price of Rs0.16/kg. The prices used when calculating ER for each crop are included in Table 2.25.

Given that the prices for any particular crop vary across households and that input levels and agricultural practices (and, as a result, MPs) also vary, so too will the value for ER for each household. The values for ER presented in Table 2.25 should therefore be interpreted as average values. These exceed one for all crops: ER is around 1.3 for wheat and lies in the ranges 1.51-2.27, 1.29-1.55 and 1.50-2.00 for rice, cotton and sugarcane respectively. The value of 1.3 for wheat is substantially lower than the value of 3.5 calculated by Bliss and Stern (1982) for Palanpur, a village in northern India. However, it should be borne in mind that the sample used here is taken from the irrigated areas around the Indus Basin river. This affects the productivity of inputs and may mean that farmers in the sample may not face the same constraints as those in areas less well endowed with irrigation facilities, e.g. barani areas. It is also the case that access to irrigation reduces farmers' dependence on an uncertain event, namely, rainfall. Therefore, the risks facing farmers in our sample are possibly not as great. Unfortunately, we do not have any comparisons with other studies for Pakistan for any of the crops. It is possible to show (see Chapter 4) that when uncertainty is allowed for in our models of farmer behaviour then optimal behaviour can involve values of ER greater than one. Indeed we would be surprised to find empirical studies which calculate a value of ER=1 given the uncertainty associated with agriculture.

The results from our production function analysis highlight the importance of two crucial inputs in determining output levels, namely, irrigation and fertilizers. This is consistent with the results of our analysis of the data in §2.2 which identified irrigation, fertilizers and credit as the major constraints facing farmers. Also, these constraints were more restricting on smaller farms, although we did also find that among users of fertilizer the per acre level applied decreased with farm size. We now present findings from a more recent set of studies of agricultural practices in Pakistan.

§2.5 Agricultural Practices in the 1980s

A major element in the 6th Five-Year Plan for 1983-88 (Governmant of Pakistan, 1983) was the recognition of the need to acknowledge the various constraints facing small farmers and to incorporate these into policy initiatives. The large increase in the provision of credit, targeted at smaller farmers, for the purchase of crucial inputs was a central part of the new strategy. In an effort to identify the constraints facing small farmers the government commissioned a study which was undertaken for the country as a whole (see Ahmad *et al*, 1986a and 1986b, and Sharif *et al*, 1986). In all, for the agricultural year 1984-85, around 1600 farms were surveyed. In this section we give a summary of some of the 'premilinary findings' of this study. However, it is important to understand that these findings are based on crude analysis (mainly cross tabulations) with no detailed theoretical or empirical modelling involved. This section should therefore be viewed as a summary of the suggestions from the preliminary findings.

The statistical characteristics of the sample were very similar to those of the IBS. However, one additional feature was the addition of barani (i.e. unirrigated or rain fed areas) in the sample. The distribution of farms according to farm size and tenure were similar to the IBS. Farms located in unirrigated areas tended to be larger than elsewhere reflecting the lower productivity of such land. The predominant form of tenancy was sharecropping with equal sharing of output and purchased inputs being most common.

As with the IBS there was substantial variation in input practices and output levels. Awareness of recommended practices was quite low except concerning the application of seeds and the numbers of ploughings. It appears that those farmers who were aware of recommended practices showed a high rate of adoption of these practices. The most prominent reason for non-adoption, after unawareness, was lack of funds often due to lack of access to sufficient credit. Overall the standard of extension services was very poor, in particular as regards the knowledge of recommended farm practices held by field assistants. Also, field assistants tended to focus on larger farms. In Baluchistan and NWFP the coverage of extension services was minimal. Households which exhibited an awareness of recommended practices quoted radio as the main source of information, followed by newspapers and agricultural literature.

Very few households owned tractors (less than 1.5%) but smaller farms did not appear to experience any difficulty in hiring tractor services if required. The hiring-out of labour was more common in unirrigated areas where labourers would immigrate to irrigated areas in search of employment. In general there was no systematic variation in per acre yields with respect to farm size. However, there was substantial variations in yields across households with yields apparently higher on tenant farms. The reports suggested that this latter trend was explained by the access of tenants to information concerning farm practices and inputs via landlords. The higher yields on tenant farms was more pronounced among smaller farms.

The results pertaining to access and use of credit reinforced those from earlier studies (see, for example, Amjad, 1972; Gotsch, 1973; and Khan, 1975) which showed that smaller farms had difficulty in securing loans for production purposes. The 1970s witnessed a substantial increase in agricultural credit initially channeled through the Agricultural Development Bank of Pakistan, with commercial banks eventually becoming the dominant institutional source. In 1979 the federal government directed commercial banks to provided interest free credit to small farmers (i.e. those with less than 12.5 acres). However, the awareness of such a scheme was very limited, especially among smaller farmers. The survey shows that in Sind less than 20% of farmers were aware of the scheme. Large farms continued to have privileged access to institutional sources. The results of the survey suggest that only 15% and 7.6% of farms in Punjab and Sind respectively had access to institutional credit. This figure was much lower among farms with less than 12.5 acres.

The insistence by credit institutions on collateral was a major reason for the exclusion of small landholders from the formal credit market. Other studies (for example, Khan *et al*, 1986) have also highlighted the fact that larger farmers have been able to gain access to the cheap institutional credit, meant for smallholders, by falsely fragmenting landholdings. The main reasons given by respondents for not using credit were non-availability, complicated procedures, lack of information and the need for illegal gratification. Among households who managed to secure institutional credit larger farms received higher levels in per acre terms. The results suggest that the low use made by tenants of institutional credit was explained by their lack of land which could be used as collateral and their access to credit via their landlord. The use of institutional credit was virtually non-existent where relatives were the dominant source.

With restricted access to institutional forms of credit smaller farms turned to non-institutional sources of credit, e.g. moneylenders, commission agents or friends/relatives. In Punjab 32% used non-institutional credit with 70% using this source in Sind. Again, small farms tended to get lower loan amounts per acre. Non-institutional loans were on average smaller than institutional loans. Whereas institutional credit was used almost exclusively for production purposes, in particular the purchase of fertilizers, households using non-institutional credit often used it to fund consumption.

The continued inability of credit schemes to reach their targeted group has created a deep suspicion, both within Pakistan and elsewhere, about the effectiveness of such a strategy. In economics there has been a growth in the theoretical and empirical discussion of credit markets, their operation and the appropriate government policies (see Bell, 1988,for a detailed survey). The use of credit and its interlinking with other markets is an important areas of study in developing countries. While the survey discussed here did not analyse these issues in detail it does seem that the data collected are sufficiently detailed for such purposes and such an analysis promises to be very fruitful.

In general the results of the survey were consistent with our suggestions in §2.2 and §2.3. Small farms tended to be constrained by access to credit, having to rely mainly on non-institutional sources. Although output yields were not systematically related to farm size, there was substantial variation across households. Awareness of best practices was positively correlated with farm size. However, adoption of recommended practices, given awareness, was not necessarily significantly correlated with farm size. This result is similar to those for fertilizer use described earlier using the IBS data and highlights the need for a more detailed analysis of variations in input use. This task is undertaken for fertilizer use in Chapter 4.

§2.5 **Conclusions**

One of the features of agriculture in many developing countries is the existence of a wide range of production techniques and household characteristics. It is common for the use, level and method of application of various inputs to vary substantially across farms. Some households have access to irrigation or credit and some do not. Some farmers use bullocks while others use tractor services. Not all farmers use fertilizers and, among those who do, the levels applied vary. In these respects Pakistani agriculture is no different. A central objective of this chapter is to describe, and try to explain, the organization of agriculture in Pakistan. Broadly speaking, we find that behaviour under uncertainty and the presence of market imperfections, especially for agricultural inputs, can help us in understanding agricultural decisions and the variation in agricultural practices observed in Pakistan.

The level of husbandry skills required by modern agricultural technology, combined with the imperfect operation (or even non-existence) of some crucial input markets has important implications for the decisions of agricultural households and the nature of their contracts in other markets. In §2.2 we use this approach to explain the decision making of agricultural households in Pakistan. For example, we provide evidence to show that the combination of the synchronic timing of many farm operations, the need for reliable access to crucial factor inputs and the imperfect operation of the markets for draught animals, credit and labour, leads farmers to transact in the land market so as to match land operated to these imperfectly mobile factors. The higher cost of hired labour, reflecting the need to monitor certain tasks carefully, can help to understand cropping decisions and the greater use of labour on smaller farms. Also, sharecropping appears to play a role in overcoming some of the informational problems associated with credit provision and in ensuring a reliable labour supply. Landlords and tenants may interlink transactions in markets through this share tenancy arrangement with, for example, the former providing credit and land for the latter in return for guaranteed labour at crucial times.

An ongoing debate in development economics concerns the relationship between productivity and farm size and its explanation. Previous analyses of this relationship suggest that it is negative and that it reflects the greater proportion of landholdings under cultivation, the higher cropping intensity, and the higher resource (e.g. labour and fertilizer) intensity on smaller farms. Our results confirm this reasoning for Pakistan. Focusing on individual crop physical yields our results suggest that, although the relationship between farm size and yields is crop specific, in all cases a smaller percentage of land allocated to risky crops operates to decrease risk and to increase input levels and yields on larger farms. The observed negative relationship between yields and farm size for rice and cotton is consistent with the presence of increasing relative risk aversion. Further evidence of increasing relative risk aversion is provided by the fact that, although the percentage of farms applying fertilizer increased with farm-size category, among users the per acre level applied is negatively correlated with farm size, yet also negatively correlated with risk level in spite of the fact that small farms seem to allocate a higher proportion of landholdings to risky crops. We argue that the negative yield relationships for rice and cotton will counteract the positive relationships for wheat and sugarcane so that it is likely that the higher cultivating and cropping intensities on smaller farms will dominate, producing an overall negative relationship between farm size and the *total value* of annual output per acre. So the uncertainty of agricultural production, the absence of adequate insurance markets, and the greater ability of larger farms to diversify among crops (reflecting greater resources) can help to understand the varation in cropping patterns, input levels and yields across farms.

In §2.3 we argue that testing for a relationship between land size and productivity is only a first step in testing some of the relationships suggested by economic theory. From a policy viewpoint what is more interesting is the identification of the factors which underlie the variation in productivity levels. One can then focus on the operation of the relevant markets and institutions and highlight reforms which would improve farm practices, the availability of important inputs, and increase output. For instance, if credit is found to be the main factor curtailing the use of crucial inputs (such as fertilizers) then one must analyse the credit market in more detail and decide whether government policy has any role in improving the operation of this market.

We also discussed the factors constraining productivity levels, as perceived by farmers. The availability of credit and adequate irrigation were seen as the main constraints. Without access to credit many farmers are unable to purchase crucial inputs such as fertilizers. Households without own-funds are forced to rely on non-institutional credit from the informal credit sector (i.e. moneylenders, friends or relatives) where interest rates are often much higher. Inadequate irrigation facilities reduces the productivity of inputs such as fertilizers and increases uncertainty in yields. A greater percentage of smaller farms perceived credit availability as a constraint.

In §2.4 we use production function analysis in an attempt to identify the inputs and practices which would explain the variation in crop yields. Variations in fertilizer and irrigation levels were statistically significant in explaining the variation in yields. This reinforces our earlier findings that these inputs were perceived as major factors constraining yields. Our finding that the ratio of the value marginal product of fertilizer to its price exceeded unity for all crops reinforces the importance of allowing for uncertainty and risk aversion when analysing agricultural household behaviour.

The results from more recent surveys for the mid 1980s suggest that these constraints still persist despite a substantial increase in institutional credit and tubewell finance. Larger farms still appear to have a disproportionate claim on subsidized institutional credit channelled through agricultural banks, despite evidence of a higher probability of default. The insistence by agricultural banks on collateral is a major reason for this bias. Many smaller farms were unaware of the possibility of cheaper credit and some complained of the need to provide 'illegal gratification' in order to even be considered for loans. Also, the concentration of government extension services on larger farms also meant that smaller farms were often unaware of recommended practices. This suggests that an understanding of behaviour under uncertainty and the imperfect nature of markets for inputs and factors of production is still important if an economic analysis of the organisation of agriculture in Pakistan is to contribute to the formulation of welfare-improving policy recommendations.

Chapter Three

Marketed Surplus of Foodgrains in Pakistan

§3.1 Introduction

From the perspective of economic development and growth the agricultural sector in developing countries has been seen as both a source of government revenue to finance the modern industrial sector and as a provider of crucial inputs to the latter. While governments in developing countries have been keen to exploit the revenue potential of agriculture (as witnessed by the procurement of agricultural produce at prices below world prices) they have also been aware of the importance of agriculture in providing inputs into major industries, many of which are important earners of foreign exchange, as a supplier of essential wage goods (i.e. food), and as an important earner of foreign exchange directly.

When setting procurement prices for agricultural outputs governments have therefore had to be concerned with the consequences of low agricultural prices for the level of marketed surpluses, especially for staple foods. Since it is commonplace for governments to procure only a small percentage of total foodgrain production, reflecting the high level of consumption on farm, small changes in production can have substantial effects on market surplus and procurement as well as foreign trade and earnings. From a revenue-raising point of view, the efficiency effects of price changes depend on individual crop own- and cross-price elasticities. One must also take account of the proportion of total production which is consumed on-farm and the proportion sold or bought in the market, i.e. the marketed surplus (henceforth denoted MS). The consequences for income distribution of price changes depend on the pattern of net purchases or sales of foodgrains across households.

While there have been some studies which analyse the factors determining the level of government procurement of food over time (see Pinckney, 1989, for Pakistan) there are very few which study the level of MS. This reflects, in part, the absence of time-series data on levels of marketed surplus. The central purpose of this paper is to show how we can gain useful insights into the determinants of the level of MS using cross-section data from farm-household surveys. Our results have implications for agricultural policy in Pakistan and we analyse the implications for pricing policy in more detain in Chapter 6. Here we concentrate mainly on wheat, the major staple food in Pakistan.

In §3.2 we describe the operation of the wheat marketing system in Pakistan. The use of agricultural household models to show how one can analyse the MS of foodgrains is the subject of §3.3. There we indicate the characteristics which are important for a household when it comes to deciding on the level of on-farm consumption of foodgrains and market purchases or sales. The discussion of these models helps to decide how our empirical analysis should be formulated, what variables should be included and how the model should be specified. We give simple examples to show the likely direction and magnitude of household responses to various variables of interest. Then §3.4 focuses on the price elasticity of MS. We discuss the likely determinants of this elasticity and calculate a value for Pakistan, showing that it unlikely ever to be negative. In §3.5 we give a general description of the pattern of MS according to farm size, tenure and location. We analyse the determinants of MS across households using the Indus Basin Survey (IBS) of agricultural households in Pakistan for the agricultural year 1976/77. We also try to trace the determinants of MS back to their effects on consumption and production. Some of the problems that commonly present themselves with data of this nature are highlighted and incorporated into our analysis. §3.6 contains our conclusions and summary.

§3.2 Government Procurement and Market Structure

In this section we give a brief description of the wheat marketing system in Pakistan. Much of the information is drawn from Cornelisse and Naqvi (1987) and Turvey and Cook (1976). We concentrate mostly on the procurement stage which is more relevant to farmers' decisions regarding the level of their marketed surplus.

State support prices were introduced into Pakistan in 1959-60 together with a ban on the movement of wheat by private traders across provincial boundaries. The latter restriction ensures that market-clearing prices in surplus areas are lower than otherwise would be the case thus enabling the government to attain given procurement targets at relatively low procurement prices. Usually wheat is planted around November and harvested in April or May - this is the rabi season. Government procurement is concentrated between May and August. Procurement levels increased substantially after 1972 with the introduction of procurement centres in rural areas (see Table 3.1). In the early seventies the government procured between 16-18% of production but this has increased since 1976 to between 20-30%. Higher levels of procurement have been reflected in reduced imports and an increase in government stocks.

About 60% of the total production of wheat is consumed on-farm and the government procures around 70% of wheat sold in the market. Between 75-80% of the marketed surplus of wheat originates on farms greater than 12.5 acres. The central government sets the procurement (support) price for wheat and also procurement targets at the provincial level. It then decides how much wheat it needs to import. Each province is responsible for the collection of wheat and its allocation to the mills. Transfers to other provinces need to be agreed by central government. Deficit provinces pay all costs, i.e. procurement price plus handling, storage, and transport costs. The Punjab is the major surplus producer, Sind is more or less self-sufficient while both NWFP and Baluchistan are deficit areas. There is thus a substantial transfer of wheat from the Punjab to the latter two provinces: around 60% of total procured wheat or over 20% of the punjab harvest, which in 1976 would have been equivalent to 1.6 times the combined wheat harvests of NWFP and Baluchistan.

Wheat traders can be divided into village shopkeepers (beoparis), commission agents, wholesalers and procurement centres. Village shopkeepers buy mainly from small farmers surrounding a village, then resell to other traders in larger quantities. *Beoparis* purchase from both small and large farmers and sell in larger quantities to procurement centres or to mills. Often village shopkeepers, *beoparis* or large farmers will employ commission agents to find buyers. These agents sell mainly to procurement centres. Wholesalers, on the other hand, deal only with other traders and not with farmers. The fact that government procurement prices are widely advertised and wheat traders are numerous ensures that the market for the purchase of wheat from farmers is

Table 3.1

Wheat Supply in Pakistan, 1970-1983[1]

Year	Y[2]	M[3]	TA[4]	PR[5]	ST[6]	POP[7]
1970-71	6476	285	7579	1017	n.a.	60449
1971-72	6890	690	7166	841	n.a.	62640
1972-73	7442	1359	8249	208	n.a.	64911
1973-74	7629	1229	8671	1342	n.a.	66841
1974-75	7673	1344	8973	1253	n.a.	68829
1975-76	8691	1186	8859	1236	417	70876
1976-77	9144	499	9190	2339	728	72984
1977-78	8367	1052	10196	1842	255	75154
1978-79	9950	2236	10603	1086	347	77389
1979-80	10857	602	10552	2376	685	79691
1980-81	11475	305	11162	2955	1021	82061
1981-82	11304	360	11835	2989	1572	84501
1982-83	12414	353	11657	3131	2097	87125

Source: Pakistan Economic Survey 1982-83 (reproduced from Cornelisse and Naqvi, 1987, Table 1, p5).

Notes: (1) All values are in '000 tons.
(2) Production: Sown in October, harvested in April.
(3) Imports: from July to June.
(4) Total availability: Production of previous year plus imports.
(5) Procurement: from May to April.
(6) Stocks: measured in April at end of harvest year, just before harvest
(7) Population: in millions.
n.a. = not available.

very competitive. So we expect that the variation in prices received by farmers reflects trade and transport margins. Also, although some wholesalers carry stocks in order to enable regular supplies to mills, it is unlikely that they can exert much control over prices since they must compete with sales from government stocks.

The marketing system described thus far applies mainly to Punjab and Sind. The level of government procurement in NWFP is minimal as is the level of marketed surplus. Using data for 1982, Cornelisse and Naqvi (1987) found that 79% of total procured wheat came from Punjab with 20% procured in Sind. Marketed surplus as a percentage of total production was 43%, 40% and 37% in Punjab, Sind and NWFP respectively. This is consistent with our results using the Indus Basin Survey (1976). Of this surplus the government procures 74%, 72% and 5% respectively. Due to the fact that government involvement in the wheat market is much lower in NWFP, prices received by farmers tend to deviate more from the procurement price. Since NWFP is a deficit area the open market price of wheat is usually substantially higher than the procurement price.

§3.3 Agricultural Household Models and Marketed Surplus

In most developing countries the agricultural sector dominates both in terms of the proportion of total output originating from this sector and the numbers finding employment within the sector. Thus the majority of households rely on agriculture as a major source of income. The agricultural sector is also often responsible for a large proportion of exports and foreign exchange earnings. It is therefore of great importance to policy-makers to be able to predict the likely impact of government policies on agricultural households and their behaviour. To do so one must appreciate that the characteristics of the agricultural sector differ substantially from those of other sectors. For example, households both produce and consume certain commodities, and markets are often not as developed as in, say, the industrial sector. One needs to be careful to incorporate these characteristics when predicting the impact on household behaviour of changes in government policies, e.g. changes in procurement prices. In recent years much more emphasis has been placed on developing detailed agricultural household models when analysing the effect of policy changes or when explaining the observed behaviour of agricultural households (see Singh *et al*, 1986).

In this section we set out a very basic model which enables us to discuss some of the issues involved. Much of the analysis is based on Singh *et al* (1986). Consider a household which maximizes utility, U, where:

$$U = U\ (X_a, X_m, X_\ell) \qquad (3.3.1)$$

with X_a and X_m representing the consumption of an agricultural staple and market-purchased commodity, respectively. X_ℓ is the consumption of leisure. The budget constraint facing households is:

$$p_a(Y_a - X_a) - w(L - F) - p_m X_m = 0 \qquad (3.3.2)$$

where p_a, p_m and w are the market prices of the staple, the market-purchased commodity and leisure (i.e. the wage rate) respectively. The term (Y_a - X_a) is the marketed surplus (MS) of the staple good, the difference between a household's production (Y_a) and its consumption. L is total labour input into household production and F is labour supplied by family members, so that (L-F) is the amount of hired labour, if positive, or off-family labour supply, if negative. The household also faces a time constraint:

$$X_\ell + F = T \qquad (3.3.3)$$

where T is the total amount of time available to the household to be allocated between leisure and either on-farm or off-farm labour. The production technology for the staple produced by the household is given by:

$$Y_a = Y_a\ (L, A) \qquad (3.3.4)$$

where A is the fixed amount of land available to the household. This implicitly assumes that households will transact in other factor markets in order to meet the input requirements of a fixed land supply, rather than the other way round.

Substituting into (3.3.2) for F and Y_a we can rewrite the budget constraint as:

$$p_m X_m + p_a X_a + w X_\ell = w T + \pi \qquad (3.3.5)$$

where $\pi = p_a Y_a(L, A) - wL$, i.e. profits from the household's production activities.

The right-hand side of this equation is often referred to as 'full-income'. The model presented here, although obviously over-simplified, is adequate for the purposes at hand. In reality households may grow many crops (e.g. cash crops) and use many inputs (e.g. fertilizer). Also we have ignored uncertainty, which one would expect to be of importance to agricultural households when making decisions such as the amount of land to allocate to certain crops and the level of various inputs to apply.

We assume here that prices are fixed. Households choose X_a, X_m, X_ℓ and L so as to maximize utility. To focus on the choice of L (labour input) we present the relevant first-order condition:

$$p_a \frac{\partial Y_a}{\partial L} = w \qquad (3.3.6)$$

This tells us that households should allocate labour to production up to the point where its marginal revenue product equals the wage rate. Notice that this equation contains only one endogenous variable, L, which can be solved for as a function of prices (p_a and w), the technological parameters of the production function and the fixed land area. The choice of L (and consequently of Y_a) does not depend on consumption decisions.

Let the optimum choice of L be:

$$L^* = L^* (w, p_a, A) \qquad (3.3.7)$$

which gives a profit-maximizing level, π^*, which can be substituted into (3.3.5). Households can now choose X_a, X_m and X_ℓ to maximize utility subject to this new budget constraint:

$$p_m X_m + p_a X_a + w X_\ell = I^* \qquad (3.3.8)$$

where I^* is the full income associated with profit-maximizing production decisions, i.e. $I^* = \bar{I} + \pi^*$ and $\bar{I}$ is exogenous income. The first-order conditions for utility maximizing decisions are:

$$\frac{\partial u}{\partial X_m} = \lambda p_m$$
$$\frac{\partial u}{\partial X_a} = \lambda p_a \qquad (3.3.9)$$
$$\frac{\partial u}{\partial X_\ell} = \lambda w$$

and the budget constraint as given by (3.3.8). λ is the marginal utility of income. The solutions to these equations gives us the standard demand curves for the various consumption goods, i.e.

$$X_i = X_i\ (p_m,\ p_a,\ w,\ I^*) \qquad \text{for } i = m,\ a,\ \ell \qquad (3.3.10)$$

Additional household characteristics, e.g. the number of household members, can be included as extra variables if these affect consumption. However, as long as these are viewed as fixed then this will not change the analysis. Notice that consumption is a function of I^* so that profit-maximizing production decisions affect consumption decisions. We can therefore treat production and consumption decisions as being sequential even though they may be taken simultaneously. Household decision-making can be modeled *as if* households first maximize profits from production and then choose consumption bundles subject to profit-maximizing full-income. Although production decisions can be taken independently of consumption decisions the reverse is not true since consumption is a function of π^*.

The recursive nature of the model presented here depends crucially on some of our assumptions. For example, the amount of the staple produced is determined independently of the amount consumed because the household can always buy or sell wheat at the fixed market price. But if a market for a commodity does not exist or if production or consumption decisions affect market prices then the recursive nature of the model no longer applies. In both cases the relevant price is endogenous to the model and production and consumption decisions must be solved simultaneously.

It is often the case in developing countries that markets do not exist for certain commodities so that production must equal consumption for these commodities. In such cases it is useful to focus on the concept of the virtual (or shadow) price for the relevant commodity when analysing household decisions. The virtual price of a commodity can be defined as the price that would lead the household to make the same consumption and production decisions for the commodity if markets did exist as they do when such markets are absent.

It may be plausible to assume that markets do not exist for certain produced-commodities, e.g. maize or other home-grown foodstuffs. For such commodities it is helpful to focus on the virtual price when analysing the consequences of various policy changes or in explaining observed behaviour. Take, for instance, the example where the price of a cash-crop increases. This increases household income which increases the demand for, say, maize. The virtual price must then increase so as to equate the household demand for maize with its production of maize. The increase in the virtual price of maize leads to a substitution away from maize in consumption (if maize is not a Giffen good) and a substitition towards maize in production.

In this paper we are concerned with explaining the variation of MS across households. In our data set we observe, for each household, the outputs of various crops and the distribution of these outputs over various claims. For the purpose of our analysis we assume that the production decisions have already being made so as to maximize (expected) household utility subject to various constraints, and we observe the outcome of these decisions. Households now make decisions about the distribution of these outputs between, say, domestic consumption and market sales. Note that we do not necessarily assume that the household model is recursive. We assume that when the household makes decisions about the distribution of various outputs it does so knowing the outcome of its production decisions and the prevailing market conditions, e.g. prices. The resulting distribution decisions do not necessarily have to coincide with those expected (or intended) at the beginning of the season (e.g. at planting) but will do so if expectations formed at this time actually materialize.

This approach is essentially one of households making decisions in light of known endowments (i.e. outputs) and market conditions (e.g. prices or the existence, or otherwise, of certain markets) so as to maximize household utility. Thus our model can be viewed as an exchange model. Such an approach is plausible given the uncertainty in agriculture and the distinct time division between production and consumption decisions. For instance, at the beginning of the season a household decides how much land to allocate to wheat and the appropriate level of inputs, given actual input prices, expected outputs and expected output prices at harvesting. If, at harvesting, actual results (e.g. outputs or prices) do not coincide with expectations then there is no reason why the household should stick with its planned decisions unless it has entered into fixed contracts or something of this nature. It can reassess the situation and decide, say, how much wheat to retain for domestic consumption and how much to sell in the market.

The particular objective of this paper is to explain the variation in the MS of foodgrains (e.g. wheat and rice) across households. Let the MS of, say, wheat be:

$$MS_w = Y_w - X_w (p, I, Z) \tag{3.3.11}$$

where Y_w is the actual output of wheat and X_w is the amount of wheat retained by households for domestic consumption. Prices of consumption goods are denoted by p (a vector) and I is full-income or wealth. Notice that although, post harvest, input costs have already been incurred and other incomes received (e.g. income from off-farm labour supply) we still use the term full-income. Whether or not we include these factor incomes or input costs in 'exogenous income/wealth' or along with profits (as we do below) makes no difference to the analysis which follows. Here we can think as if income from off-farm labour supply is included in exogenous income, and profits as being net of input costs, since this is the most common way of presenting the analysis.

We assume that the household can consume three commodities, namely wheat (w), other farm products (f) and market-purchased goods (m). Therefore the vector p consists of three prices: p_w, p_f and p_m. We can interpret Z as household characteristics which affect consumption, e.g. the number of household members. We assume that households produce wheat, other farm-products and a cash-crop (c), and that the total cost of production is C.

With the above assumptions full-income, I, can be written as:

$$I = \bar{I} + \pi$$

where

$$\pi = p_w Y_w + p_f Y_f + p_c Y_c - C \tag{3.3.12}$$

$\bar{I}$ is fixed exogenous income and π is profits from production. Households choose consumption bundles to maximize utility given prices and a full-income constraint. We can analyse the variation in MS across households by examining (3.3.11).

We interpret (3.3.11) as applying to a particular household (say, h). Consider now another household, k, where the only difference between k and h is that k has a larger endowment of wheat (possibly because it had an extra acre which was allocated to wheat). The effect of this larger endowment of wheat can be gauged by differentiating (3.3.11) with respect to $Y_{W.}$ Thus, dropping the subscript for convenience,

$$\frac{\partial MS}{\partial Y} = 1 - \frac{\partial X}{\partial I}\frac{\partial \Pi}{\partial Y}$$

Rearranging we get:

$$e_{ms} = 1 + \theta\ [1 - e_I\ e_\pi] \qquad (3.3.13)$$

where e_{ms} is the elasticity of MS of wheat, e_I is the income elasticity of demand for wheat and e_π the elasticity of profits, all with respect to Y_W. The term $\theta = X/MS$ is the ratio of household consumption of wheat to its sales of wheat.

To get some idea of the sign and possible magntitude of e_{ms} we can impose some plausible values on (3.3.13). Immediately we can see that $e_{ms}>1$ if $e_I e_\pi<1$. Assume that the household retains 60% of output for domestic consumption, so that $\theta_W=1.5$, and that the income elasticity of demand for wheat is 0.35. To select a value for the elasticity of profits, e_π, we assume two outputs (i = 1,2) with constant per unit profit margin, π_i. The elasticity of profits with respect to Y_1 is then:

$$e_\pi = \frac{\pi_1\ Y_1}{\pi_1\ Y_1 + \pi_2\ Y_2}$$

In this example we see that the more important is wheat (commodity 1) in terms of total farm output the nearer is e_π to unity. If, at the optimum, per acre profits are equalized across crops and 70% of land is allocated to wheat then $e_\pi = 0.70$. Imposing these values on (3.3.13) implies a value of $e_{ms} = 2.13$. Alternatively, if 50% of output is retained for domestic consumption then $\theta_1 = 1$ and $e_{ms} = 1.75$. Here we have assumed that per acre profits are constant over all ranges of Y_1. However, it is easy to see that e_{ms} is a decreasing function of π_1. These examples are fairly crude but seem to indicate that we would expect e_{ms} to exceed unity.

Equation (3.3.13) represents the elasticity of household MS of wheat to an increase in the household endowment of wheat, holding all other household characteristics (e.g. other endowments) constant. If the price of wheat varies across households then this will also affect the level of MS. Differentiating (3.3.11) with respect to the price of wheat (remembering that we are keeping <u>all</u> endowments constant) we get:

$$\eta^m(\bar{y}) = -\epsilon^c \frac{X}{MS} - b \qquad (3.3.14)$$

where ϵ^c is the compensated own-price elasticity of demand for wheat (a negative number) and b is the marginal propensity to spend on wheat. In the next section we present plausible values for these parameters. Imposing these values on (3.3.14) we have:

Wheat: $\eta^m(\bar{y}) = 0.35\ (1.5) - 0.054 = 0.471$

Rice: $\eta^m(\bar{y}) = 0.49\ (0.25) - 0.05 = 0.072$

These are relatively crude estimates but indicate that we might expect this elasticity, the constant output price elasticity of MS, to be positive. In the next section we discuss the elasticity of MS as it is usually defined in the literature. The difference with this elasticity here, $\eta^m(\bar{y})$, is that we keep output (or endowments) constant.

Consider now the situation where the only difference between household k and household h is that k has a larger endowment (output) of a cash crop. This increases the full-income of k leading to an increase in consumption of wheat (a normal commodity). Thus, from (3.3.11), we expect household k to have a lower MS of wheat. The same applies to a higher endowment of other farm products.

We can use the concept of the virtual price of a commodity to analyse the effect of a larger endowment of a commodity for which no market exists, i.e. households produce the amount they wish to consume. A larger endowment will imply a lower virtual price (so as to equate demand and supply) which in turn implies a lower full-income, a lower consumption of wheat and a larger MS of wheat. So if a particular farm product is non-traded we expect a larger endowment to lead to a higher level of MS of wheat. Compared to the case where we assumed it to be traded, the sign of the effect has changed from negative to positive. This highlights the importance of modeling markets correctly.

Notice that any difference between the household characteristics of h and k which increases the full-income of k will lead k to have a higher consumption of wheat and a lower MS. Also, if k has a greater preference for other commodities then it will consume more of these leaving less income to be spent on wheat and a consequent increase in its MS. The analysis here is partial in the sense that we are focusing on differences between h and k keeping all other characteristics constant. So the directional impact on the MS of wheat coincides with the sign of the relevant variable on the right-hand side of a regression with MS as the dependent variable.

In §3.5 below we present the results of an empirical analysis of the MS of wheat and its variation across households. The model and discussion presented here give some indication as to which variables should be included as explanatory variables in our regressions which have MS as the dependent variable. Equations (3.3.11) and (3.3.12) suggest that variables which reflect variations in household endowments of various commodities or household characteristics which capture household consumption preferences should be included. Notice, however, that we assumed that unit production costs and unit profit margins were constant across farms for each crop. If this is not the case then we must include some variable to capture variations in cost. For example, if we thought that unit costs were a decreasing function of farm size then we could include a farm-size variable as an explanatory variable (which would be expected to exhibit a negative coefficient reflecting the higher full-income on larger farms). Alternatively, if costs varied systematically across provinces then we could interpret locational dummies in this light. Lack of data on the cost side may mean that we must rely on such proxies in our regressions. However, one should appreciate that such dummies can pick up a variety of effects in practice (e.g. income effects or variations in the standard of infrastructural services). Before presenting our empirical results we discuss some of the factors which determine the price elasticity of MS, in particular the aggregate response for the economy as a whole.

§3.4 The Price Elasticity of Marketed Surplus

Agricultural household models provide a very useful framework in which we can discuss household reaction to various policy changes. We focus here on how household production and consumption decisions change when faced with an increase in output prices. We are particularly interested in the factors which determine the own price elasticity of MS for the two major foodgrains in Pakistan, i.e. wheat and rice. Work with agricultural household models has highlighted the need to incorporate an additional profit effect alongside the traditional income and substitution effects of a price change. The positive profit effect on consumption of a price increase introduces the possibility of a fall in the MS of a foodgrain in response to an increase in its price. In this section we examine the various arguments concerning the sign and magnitude of the elasticity of MS and are particularly interested in the elasticity for the economy as a whole.

The marketed surplus of a household for any commodity is defined as the difference between household production and household consumption, i.e.

$$MS = Y(p) - X(p,I) \qquad (3.4.1)$$

where MS is marketed surplus, Y household production and X household consumption. Production is a function of output prices - we assume constant input prices to simplify the analysis. Consumption is a function of prices and total income, I. Total income can be divided into income from non-agricultural sources, $\bar{I}$, and profits from agriculture, Π:

$$I = \bar{I} - \Pi(p) \qquad (3.4.2)$$

where profits are a function of output prices. Differentiating (3.4.1) with respect to p, applying the Slutsky decomposition of a price change and Hotelling's Lemma we get:

$$\eta^m = \eta^y \frac{Y}{MS} - \epsilon^c \frac{X}{MS} - b \qquad (3.4.3)$$

where η^m and η^y are the price elasticities of MS and production respectively, ϵ^c is the compensated elasticity of demand and b is the marginal propensity to spend on the commodity in question. It can be easily shown that these aggregate elasticities are weighted averages of individual farm household elasticities. For market surplus and the marginal budget share the weights are household MS as a proportion of total MS while for output and consumption the weights are household output and consumption respectively as a proportion of total MS. We now use this equation to discuss the various arguments forwarded regarding the size of η^m relative to the elasticity of production, η^y, and also the sign of the former. We then analyse the data for Pakistan in order to get a rough idea of the elasticities that are likely to emerge.

As a starting point we examine a paper by Mathur and Ezekel (1961) - henceforth M-E. The basic argument in this paper concerns the sign of η^m. From (3.4.3) we see that for η^m to be negative η^y must be less than a weighted average of the compensated elasticity of demand for the commodity and its marginal budget share, with the shares of consumption and MS in production, respectively, as weights, i.e.

$$\eta^m < 0 \quad \text{iff} \quad \eta^y < r_x \, \epsilon^c + r_m \, b \qquad (3.4.4a)$$

where $r_x = X/Y$ and $r_m = MS/Y$ are, respectively, the shares of consumption and MS in output, ϵ^c is the compensated elasticity of demand (a negative number), b is the marginal budget share and other variables are as before. Also:

$$\eta^m > \eta^y \quad \text{iff} \quad \eta^y > \epsilon^c + \frac{r_m}{r_x} b \qquad (3.4.4b)$$

M-E argue that in less developed countries, where there exists a large number of 'subsistence' farmers, η^m is likely to be negative. They explain the basis of their proposition as follows. 'Subsistence' farmers do not produce enough foodgrains to meet 'basic consumption' needs yet we observe them selling a 'surplus' in the market. The purpose of these sales is to raise cash to pay for 'fixed' cash expenditures, e.g. cash payments for land rent. The effect of a rise in price of foodgrains (relative to all other prices) is that the farmer can now sell less wheat and still meet these fixed cash requirements and can also increase his own consumption of foodgrains. So it appears that what M-E had in mind was a farm household which has a cash rent to pay and its only source of cash liquidity (at least on the margin) is the sale of foodgrain in the market. For such households this constraint is assumed binding (in the sense that given their income and other household characteristics they would like to sell less food and consume more on-farm) and therefore determines the level of home consumption of food. By definition then an increase in price will always lead to a fall in market sales of foodgrain.

With the above assumptions the M-E hypothesis is quite valid. However, Dandekar (1964) refutes the validity of these assumptions for many less developed countries. He argues that the 'subsistence farmer' as portrayed by M-E, while he does exist, is not representative of many farmers in less developed countries. For our purposes we can divide farmers into four categories:

i) Small farmers whose output of foodgrains does not meet their basic requirements. These supplement their consumption of foodgrain output with purchases of food from the market. They also purchase other goods from the market. The cash necessary to purchase from the market comes from providing casual labour to other farmers, sales of other output produced on the farm (if such exists) or remittances from family members working in the urban sector or abroad.

ii) Small farmers who neither buy nor sell foodgrains from the market. These farmers produce just enough foodgrains to satisfy their requirements. The consumption of other necessities is financed as in (i) above.

iii) Small farmers who, while they have not retained as much foodgrains as they would have liked, still sell a small amount of foodgrains in the market to finance the consumption of other necessities. This category corresponds to M-E's subsistence farmer. It is more useful to think of these as having no income other than that from the production of foodgrains and therefore being poorer than farmers in category (i) above.

iv) Medium and large farmers who sell a relatively substantial proportion of their output in the market and whose consumption of other necessities easily covers basic requirements.

Dandekar argues that even though the final category of farmers typically account for a smaller proportion of farm units they nevertheless usually account for a relatively large proportion of acreage and an even larger proportion of the MS of foodgrains. Therefore, they carry a larger weight in the calculation of η^m in (3.4.4) above. So it is the behaviour of these farmers in response to a change in the output price of foodgrains that is relevant. The characteristics of these farmers are as follows:

a) Their output is responsive to price changes (i.e. $\eta^y > 0$). This is especially true of very large farms which are run on a commercial basis. Use of modern inputs and access to credit is not a problem for many of these farmers. Indeed, Dandekar thinks that even for subsistence farmers $\eta^y > 0$ since higher prices raise income levels, consumption and health. Some of the extra income may also be allocated to improvements in farm utensils, better draught power and improved feeding of existing draught animals, which in turn increases output.

b) The cash received from market sales is used to finance the consumption of a wide range of other commodities, including food. Some of the extra income is allocated to farm improvements and increases in the level of inputs, thus raising output levels. Since basic food requirements have been covered the marginal budget share of food is much lower than unity (i.e. $b < 1$).

c) Market sales as a proportion of output can be 0.5 or higher, i.e. $r_m = 1-r_x > 0.5$.

These three factors all combine to make it very unlikely that $\eta^y < 0$.

We now examine the data for Pakistan to get some idea as to the likely magnitude of the aggregate elasticities of MS for wheat and rice, the most important foodgrains in Pakistan. The breakdown of output over that procured by government, consumed on-farm and sold to other consumers is presented in Table 3.2a. The elasticities are aggregate elasticities for the economy as a whole so we are concerned here with the overall elasticity of MS for the economy.

We can apply the values presented in Table 3.2 to (3.4.3) to calculate the elasticities of MS for wheat and rice as:

$$\text{Wheat: } \eta^m = (2.50 \times 0.15) - (1.50 \times -0.35) - 0.054 = 0.864$$
$$\text{Rice : } \eta^m = (1.25 \times 0.15) - (0.25 \times -0.49) - 0.050 = 0.260$$

Table 3.2

(a) Procurement, Marketed Surplus and Output Elasticities

Sector	Procured	On-Farm	Open Mkt.	r	s	η^y
Wheat	0.25	0.60	0.15	2.50	1.60	0.15
Rice	0.30	0.20	0.50	-	-	0.15
S'Cane	0.30	0.70	-	3.33	-	0.50
Cotton	1.00	-	-	1.00	-	0.40

(b) Elasticities, Output and Marginal Budget Shares

	η^y	r	r_s	r_x	ϵ^c	b
Wheat	0.15	2.50	0.40	0.60	-0.35	0.054
Rice	0.15	1.25	0.36	0.63	-0.49	0.050

Sources: Agricultural Statistics of Pakistan (1985), Pakistan Statistical Survey (1985), Micro-Nutrient Survey (1976), Ahmad and Ludlow (1987) and Askari and Cummings (1976).

Note: η^y is the own-price elasticity of output, r is the ratio of output to marketed surplus, s is the ratio of surplus to government procurement, r_s is the ratio of surplus to output, r_x is the share of consumption in output, ϵ^c is the compensated elasticity of demand and b the marginal budget share.

Ali (1988, p21) derives alternative higher estimates for the price elasticities of output for wheat (0.327) and rice (1.92). These imply an η^m for wheat and rice of 1.29 and 2.47 respectively. The values from Table 3.2 also indicate that the output elasticities for wheat and rice would have to be less than -0.19 and -0.29 respectively for the corresponding surplus elasticities to be negative (see equation 3.4a). Since these figures are highly unlikely so too is a negative surplus elasticity for either commodity. Finally, the surplus elasticities will exceed their corresponding output elasticities where the latter exceed -0.31 and -0.46 for wheat and rice respectively (see equation 3.4b). Therefore, if the chosen values are representative, it is very unlikely that the surplus elasticity of wheat or rice for the economy as a whole will ever be lower than the relevant output elasticity for the economy.

We now turn to the household characteristics which determine whether or not households sell in the market and analyse the determinants of the level of MS across households.

§3.5 Determinants of Marketed Surplus of Wheat

In this section we analyse the MS of foodgrain in Pakistan for 1975/6. We focus mainly on wheat for which we have the relevant data. However, we also make some references to rice in passing. We are interested in identifying the characteristics of those households which sell wheat in the market and the factors which determine the level of their marketed surplus. Initially for the purpose of analysing the distribution of MS over households we divide farms into four categories according to total acreage: (1) less than 5.0 acres, (2) 5.0 - 12.5 acres, (3) 12.5 - 25.0 acreas and (4) over 25 acres. From Table A3.1a we see that the percentage of farms with zero MS of wheat decreases over farm size category, is highest in NWFP and lowest in Punjab. It is also substantially higher for pure tenants. Among households with positive MS the percentage of the operator's share sold in the market increases over farm-size category. Of the total sample MS, 80% originates on farms with acreage greater than or equal to 12.5 acres.

For rice the story is much the same (see Table A3.1b). The percentage of households with zero MS decreases with farm-size. Also, among households with MS>0 the percentage of output sold increases with farm-size, being especially high for households with farm-size exceeding 25 acres. In our sample very few households in NWFP grow rice and those that do have MS≤0. The percentage of households with MS>0 is similar in both Punjab and Sind, both just less than 50%. Also, a greater percentage of owner-landlords appear to have zero surplus. Of the total sample surplus 70% originates on farms with acreage greater than or equal to 12.5 acres.

Some idea of the distribution of landholdings across households in Pakistan for 1972 and 1980 can be obtained from Table A3.2. The picture is much the same in both years. Focusing on 1980 we see that although 76% of farms are less than 5 hectares (12.35 acres) these account for only 36% of total farm area and only 39% of total cultivated area. So land in Pakistan is very unequally distributed.

The above analysis supports the view that even though larger farms constitute only a small percentage of total farm units they account for a relatively large proportion of farm area and an even larger proportion of the MS of foodgrains. We now describe a model which can be used as the basis for an empirical analysis of the variation of MS across households.

§3.5.1 The Model

In our model we think of a farm household post harvest. For each household the level of various outputs are known, as are market prices. The household now has to decide how much of each commodity to consume and how much to buy or sell in the market. We focus here on wheat and can set out a simple model as follows:

$$MS_W = Q_W - C_W \tag{3.5.1}$$

$$C_W = \beta_0 + \beta_1 Y + \beta_2 P_W + \beta_3 N + \beta_4 Z \tag{3.5.2}$$

$$Y = P_W Q_W + P_O Q_O - P_V V + wL \tag{3.5.3}$$

where M_W, Q_W and C_W are the household's MS, production (or endowment) and consumption respectively. Household consumption is a function of income (Y), prices

(P), the number (and composition) of household members (N), and other household characteristics (Z). Wheat, 'other' outputs and variable inputs are denoted by subscripts w, o amd v respectively. Here we have used a specific function where consumption is linearly related to the relevant variables, but this is just for the purposes of discussion, and we argue below that there are important difficulties when it comes to estimating such models in practice. Income is defined as the value of outputs (endowments) minus input costs plus any other sources of income such as off-farm labour income.

Since we view endowments and income as fixed the only decision remaining for the household is its level of wheat consumption. The level of MS is derived as the difference between the fixed wheat endowment and the desired level of consumption, and can be positive, negative or zero. Substituting income into the consumption equation we can estimate the βs using household data. Substituting back into the equation for MS we can calculate the response of MS to various parameters, say, prices and income. So, for example, dropping the subscript w for convenience,

$$\frac{\partial M}{\partial Q} = 1-\beta_1 P; \quad \frac{\partial M}{\partial Y} = -\beta_1 ; \quad \frac{\partial M}{\partial P} = \beta_2 \; - \; \beta_1 Q$$

Often it is difficult to calculate input costs but one could assume these to be a function of, say, farm size or farm tenure, and interpret the coefficients accordingly.

Although the structure of the above model adequately captures the decision making of agricultural households there are problems when it comes to estimation. Consider the simple consumption model where:

$$C = \beta' X + u$$

where C is consumption, X is a vector of explanatory variables (which will include those in the reduced-form consumption function from the system described by equations 3.5.1 to 3.5.3), β is a vector of parameters to be estimated and u is a stochastic error term. The estimation problems arise from (a) the correlation of some explanatory variables, X, with the error term, u, so that $E(X'u)\neq 0$, (b) sample selection, (c) influential observations, and (d) heteroskedasticity. We discuss these in turn.

There are many reasons why *E(X'u)≠0* when estimating the consumption function described above. For example, the error term may capture the fact that certain households may have a preference bias towards wheat consumption and this is not allowed for in our X variables. If there is a preference for home-grown wheat then one might expect that households with a bias towards wheat will have a higher level of wheat production so that $E(Q_W'u)>0$. Therefore, estimated coefficients are biased and inconsistent.

More generally, if any of the explanatory variables are measured with error then their coefficient estimates are biased and inconsistent. These errors may be due to substantive measurement problems such as those arising from difficulties in specifying an appropriate definition of income to use in the consumption function, or just ordinary measurement problems in data collecting and processing. It is quite possible that the measurement of income we use (calculated from our data) may not include income from all sources or that we are unable to capture the cost side adequately. If any of these measurement errors are systematically correlated with another explanatory variable (e.g. farm size) then its coefficient estimate is also biased and inconsistent. To circumvent this problem we fall back on a reduced-form MS equation which includes only fixed or quasi-fixed household characteristics as explanatory variables (e.g. farm size, household composition, land tenure, location or market prices).

Because of the way that the data are collected we also have problems with *sample selection bias*. The Indus Basin Survey contains data on the level of output and the distribution of output over various claims, e.g. landlord, family consumption and market sales. Households can have positive, zero or negative MS. However, for both households with zero MS and negative MS we observe zeros, i.e. we do not have any information on purchases from the market. It is therefore necessary to focus on households with MS>0. An analysis of this truncated sample must then take into account its non-random nature. Applying classical regression techniques (i.e. OLS) to non-randomly selected samples gives biased and inconsistent estimates This results from the fact that population values of u are excluded from the sample in a way that systematically depends on X. Then the conditional expectation of u is not equal to zero and u is likely to be correlated with X, so that $E(X'u)\neq 0$. It can be shown that in such selected samples:

$$E(u_i) = \alpha\lambda_i$$

where λ_i is the inverse of Mill's ratio and α is a constant. To enable us to get consistent estimates of population parameters from a selected distribution we use the Heckman (1979) technique. This interprets the problems which arise when applying OLS to non-randomly selected samples as one of specification error or omitted variables. First we get a consistent estimate of λ_i by applying a probit analysis to the full sample and use this estimate as an explanatory variable in an OLS regression. If the coefficient on λ_i is significantly different from zero then we can reject the null hypothesis that sample censoring for the model is an unimportant phenomenon. However, although the coefficient estimates emerging from this technique have desirable large sample properties (i.e. consistency) they are inefficient compared to maximum likelihood estimates.

A preliminary analysis of the data highlighted the presence of *influential observations*, i.e. those which lie outside the pattern set by the majority of the data. Influential observations are usually located far from the centre (i.e. majority) of the data and are referred to as 'leverage points'. Such points can have an unreasonable influence on regression estimates when we use OLS. One way of reducing the impact of such observations (and the one adopted here) is to use the logs of the relevant explanatory variable (see Appendix B to this chapter for a more detailed discussion).

A central assumption in OLS regressions is that all error terms have the same variance, i.e. the assumption of homoskedasticity of the error terms. If households with higher levels of income (e.g. those with large farms) have more flexibility over their choice of how much to sell in the market and how much to retain for own-consumption then this assumption may be invalid, i.e. we may have *heteroskedastic* errors. It is reasonable to expect that households at or near subsistence levels of consumption are unable to change the amount they sell in the market by very much if they are to meet minimum household requirements. We may therefore observe that the consumption and MS levels of households with higher incomes exhibit higher variances, i.e. some rich households consume relatively high levels of wheat while others consume relatively low levels possibly reflecting ability to purchase or an acquired taste for more expensive wheat substitutes. In such circumstances estimated coefficients are inefficient, i.e. they no longer have the property of minimum variance. The estimates are still, however, unbiased and consistent.

It is a common approach in the presence of heteroskedasticity to transform the data so as to reduce the dispersion in the tails of the distributions of variables. One such transformation is to express the data in log form. Since the use of logs for the relevant variables also reduces the impact on the estimates of observations which lie a long distance from the centre of the data we decided to transform the relevant data in this manner. However, we keep in mind throughout that this is imposing a functional form on the data and where possible experiment with other functional forms.

Finally, we say a few words about the use of the Heckman (1979) technique in our truncated sample. Notice that if we have data on all the explanatory variables for the observations deleted from the sample (i.e. where observed MS=0) then we could run a tobit regression. However, since we do not have wheat prices for these observations we would have to estimate prices using the Heckman technique. For example, let

$$MS = \beta_0 + \beta_1 X_1 + \beta_2 P + u$$

and $$P = \alpha_1 + \alpha_2 X_2 + \varepsilon$$

where X_i are explanatory variables, the variables X_2 form a subset of X_1, P is the price of wheat, and u and ε are stocastic error terms. We do not observe prices for households with $MS \leq 0$. However, we can calculate the appropriate inverse of Mill's ratio, λ, by substituting for P in the MS equation. We then use λ as an extra explanatory variable when estimating the price equation using the truncated sample. The predicted prices (for the full sample) can then be used in a tobit regression run on the full sample to estimate the MS equation. Such a technique was experimented with and we found that only provincial location variables were significant in the price equation. Also, the results from the tobit are suspect: for example the price elasticity of MS was negative. This may reflect the presence of heteroskedasticity which in limited-dependent variable models leads to inconsistent estimates. In fact modest heteroskedasticity can cause parameters to be misestimated by a substantial amount (see Maddala, 1983, pp178-182). We therefore do not present the results from the tobit regressions.

§*3.5.2* ***The Data***

We now discuss the data used in our empirical analysis. The Indus Basin Survey (IBS) provides data on total cropped acreage (LAND). The data show that the percentage of land allocated to wheat decreases with farm size but that absolute wheat acreage increases with farm size. We may therefore expect an increase in LAND to increase wheat production and MS, i.e. the production effect dominates the negative effect of increased income on MS. We also have data on the prices received by farmers for their wheat output (WHPR). Higher prices have a production effect as well as an income and substitution effect in consumption. The sign of the income effect on consumption depends on whether a household is a net buyer or seller of wheat, being negative for the former and positive for the latter. Therefore, the net consumption effect of a price change can be positive or negative. In §3.4 we argued that we expect, on average, the price elasticity of MS to be positive.

Data are also available on the method used to transport wheat to the market. Wheat was usually transported using a bullock or donkey and cart (70%) but was sometimes man-carried (12%). We include zero-one variables representing modes of transport as explanatory variables. We distinguish between five modes of transport: tractor and trolly (TRAC), bullock and cart (BULL), donkey (DONK), man-carried (MAN) and various other methods (OTHTR). Each variable is set equal to one if the household used this method of transport, zero otherwise. If per unit costs vary according to transport method then these dummies should emerge as statistically significant from our regressions. For instance, if 'bullock and cart' is a more costly mode of transport than other methods then this will reduce income for households relying on this mode and lower consumption with a consequent increase in MS. However, if per unit costs are equalized across modes of transport then these dummies should be insignificant in our regressions. Information is also available on the distance wheat is transported to the market (DIST).

Other variables used as independent variables are: whether or not the household used credit for production purposes (CREDIT), whether or not the head of the household had an outside job (JOB), the nature of the tenure agreement (where PTEN is 1 if the household is a pure tenant, OTEN is 1 if it is classified as an owner-tenant and OLRD is 1 if it is classified as an owner-landlord - otherwise the relevant variable is set equal to zero), and location in the Punjab (PUNJ) or in NWFP. All these variables are introduced as zero-one variables. It is possible that households which rely on credit do so because at the beginning of the season they do not have the funds required to finance the purchase of necessary inputs. We can interpret this as such households having lower exogenous income and therefore expect them to have a higher MS. However, one must be aware that answers to such questions may not be very revealing since credit may be replacing decreased consumption as a source of input finance. Also, access to credit may enable the purchase of agricultural inputs such as fertilizer and thus increase production and MS. In contrast, income from an outside job increases consumption and decreases MS. Alternatively, if an outside job entails more frequent contact with urban areas then this enables the household to purchase flour, especially cheaper rationed flour. This preference for urban flour reduces consumption of home-grown wheat leaving more for sale in the market.

The number of household members is disaggregated into: (i) men over 15 - MEN, (ii) women over 15 - WOMEN, (iii) boys 10-15 - BOYS, (iv) girls 10-15 - GIRLS, and (v) male and female children - CHILD. Literature on the extent of poverty and inequality often distinguishes between the total number of household members and this number translated into 'equivalent units'. This use of 'equivalent scales' in meant to capture the differing food requirements of households with different age and gender characteristics. For instance, a household with five members made up of five adults will have a greater food requirement than another with two adults and three children. This approach can be contrasted with the view that household endowments (particularly of food) are distributed unequally or unfairly among its members (say, in comparison to individual requirements). It is often suggested that females fare badly when it comes to the intra-household allocation of food, sometimes referred to as 'gender bias' (see, for example, Deaton, 1989).

When the head of a household decides how much of home-produced food to retain for consumption (given endowments) his decision will reflect the number of household members, their classification according to age and sex, and any 'gender bias' which may be present. For our analysis therefore the 'equivalent scales' may have to be augmented by the 'gender bias'. Also it must be true that all these factors are taken into account by the head of the household when making the relevant decisions. While equivalent scales are frequently available this is not true of any measurement of gender bias. However, if the equivalent scales are measured from demand analysis then they will include this gender bias effect. Rather than experiment with equivalent scales we disaggregate household members according to age and gender and examine their effect on consumption, production and marketed surplus.

We now move on to discuss the results of our empirical analysis. First of all we concentrate on the results from our probit regressions which are useful and interesting in their own right. We then turn to the results from our analysis of the truncated sample using the Heckman (1979) method to correct for sample selection bias.

§3.5.3 ***Probit Results***

An analysis of the IBS data shows that a greater percentage of smaller farms do not sell wheat in the market. For farms less than 5 acres 87% have zero MS whereas only 22% of farms over 25 acres do not sell wheat (see Table A3.1a). This also applies to rice growers where 67% of households with holdings less than 5 acres do not sell rice whereas for households with over 25 acres only 18% do not have a positive MS (see Table A3.1b). In this section we are interested in identifying the household characteristics which determine whether or not a household sells foodgrains in the market. We run probit regressions for the full sample of wheat producers. However, we leave the interpretation of coefficients until our discussion of the results of the OLS regression run on the truncated sample.

The definitions of variables used in our empirical analyses are given in Table 3.3 and data statistics in Table A3.3. Our probit results are presented in Table A3.4. As

Table 3.3

Summary of Variables used in Regression Analyses

Dependent Variable:

MS : Level of marketed surplus (kgs).
FC : Family consumption of wheat (kgs).
Y: Wheat output (kgs).
MSD : Dummy for whether or not household has surplus.

Independent Variables:

LAND	Total cropped acreage.
WHPR	Price of wheat (Rs/kg).
NUMTOT	Number of household members.
MEN	Number of adult males in family.
WOMEN	Number of adult females in family.
BOYS	Number of boys (<15 years) in family.
GIRLS	Number of girls (<15 years) in family.
CHILD	Number of children (<10 years) in family.
NUMOTH	Number of women, boys, girls and children.
DIST	Distance grain has to be transported (miles).
BULL	Dummy for transport of grain by bullock and cart.
DONK	Dummy for transport of grain by donkey and cart.
MAN	Dummy for transport of grain by man-carried.
TRAC	Dummy for transport of grain by tractor and trolly.
CREDIT	Dummy for use of credit for production purposes.
JOB	Dummy for head of household having an outside job.
PTEN	Dummy variable which equals 1 if pure tenant.
OTEN	Dummy variable which equals 1 if owner-tenant.
OLRD	Dummy variable which equals 1 if owner-landlord.
SLSAL	Dummy for 'slightly saline' land.
GSAL	Dummy for 'generally saline' land.
SVSAL	Dummy for 'severely saline' land.
PUNJ	Dummy variable which equals 1 if located in Punjab.
NWFP	Dummy variable which equals 1 if located in NWFP.
λ	Inverse of Mill's ratio.

Notes: Farm tenure dummies are measured relative to 'pure owners', transport dummies relative to 'man-carried', salinity dummies relative to 'non-saline' land, and locational dummies relative to location in Sind. Variables entered in squared levels have SQ added to end of variable name while those entered in logs have L added. When presenting results ††, †, ** and * denote statistical significance at the 1%, 2%, 5% and 10% levels. The test statistics are calculated as in Heckman (1979) and Greene (1981). The full sample has 1437 wheat producers and the truncated sample ha 529 households.

expected the coefficients of LANDL and NUMTOT are highly significant suggesting that an important determinant of whether or not a household sells wheat in the market is the per capita level of its endowment. We use LANDL in place of LAND as an explanatory variable because when the latter was used we had problems with heteroskedasticity (the classical and robust t-statistics were very different) which in limited-dependent models gives inconsistent estimates.

Since the wheat price is not included as an explanatory variable the model is to be interpreted as reduced form. We mentioned earlier that an analysis of prices (after correcting for sample selection bias) suggested that locational factors determined prices with households located in Punjab and NWFP facing lower prices. In the reduced form probit the coefficient of PUNJ was not statistically different from zero but that for NWFP was statistically negative at the 10% level. When we allocated regional average prices to households without marketed surplus and included these in the probit the coefficient on NWFP was still significantly negative (at 10% when prices were included in Rs/kg and at 5% when the log of this value was included) probably reflecting the fact that markets there are less developed with little government involvement by way of procurement.

Using the non-parametric (kernel smoothing) regression technique discussed in §2.7 we plot the relationship between both the average predicted and actual probabilities against farm size. The predicted uses the probabilities predicted by the probit model while the actual uses the zero-one values as the variable on the y-axis, and the smoothing technique (kernel=20 acres) helps to smooth out any individual household idiosyncracies which are not captured in our model. We see that both curves track each other closely and this gives us added confidence in our model (see Figure 3.1). Using 0.5 as the cut-off point and treating all predicted probabilities at or above this point as having positive MS, we compared this with the actual zero-one values. The model gave correct predictions for 73% of households: 18% of the sample were predicted as not having sales when they actually had, while 8% were predicted as having when they had not.

Figure 3.1
Actual and Predicted Probabilities

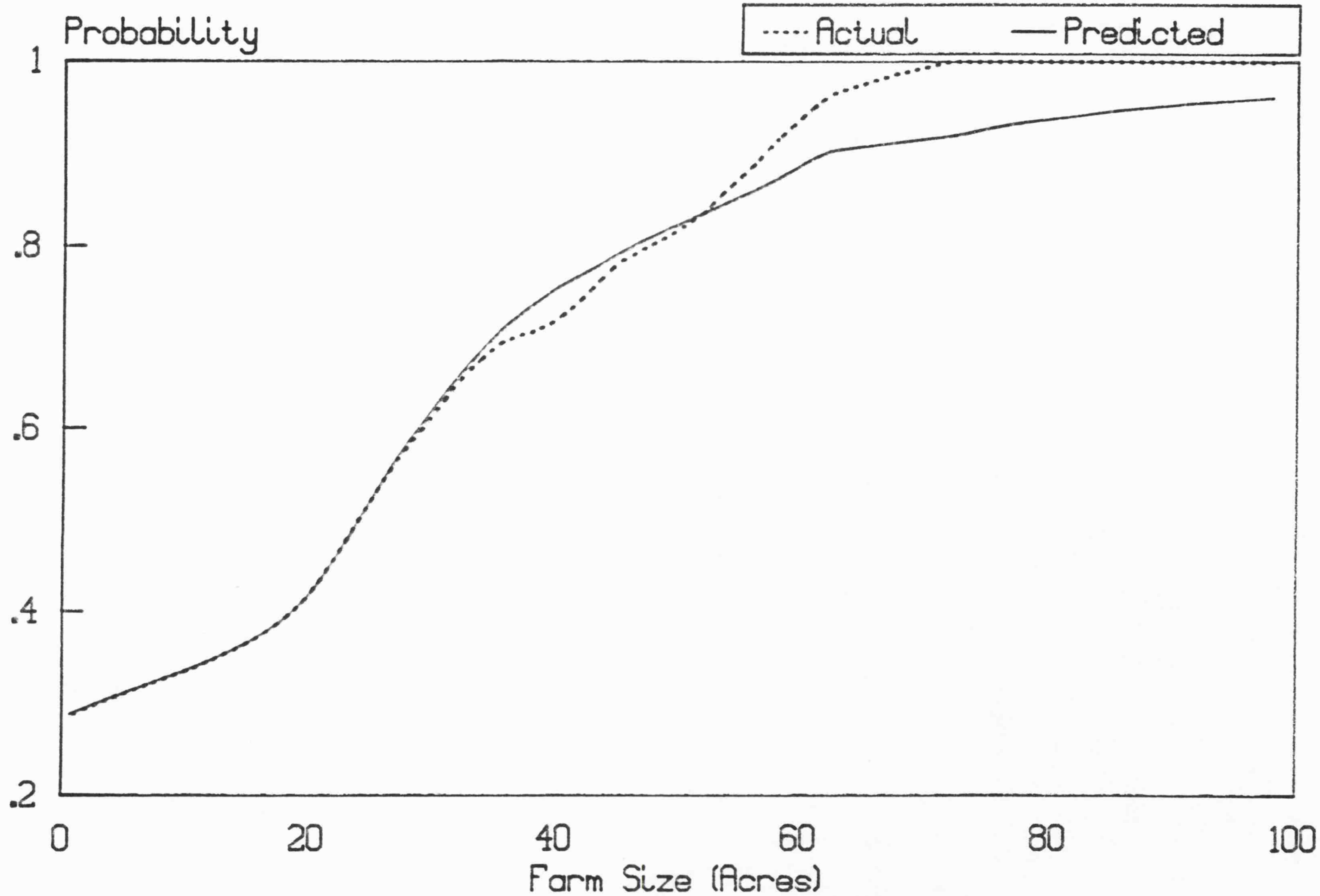
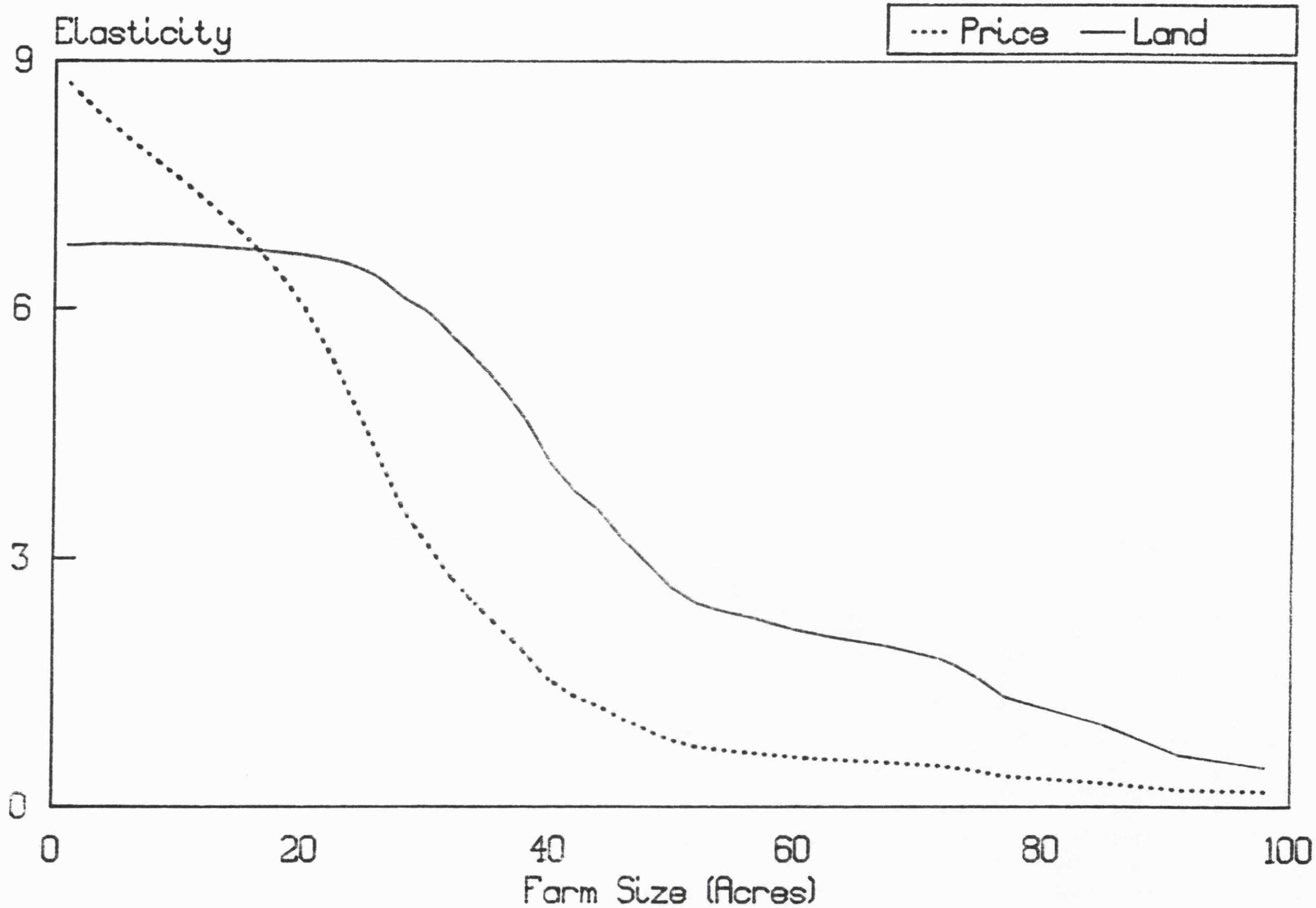


Figure 3.2
Land and Price Elasticities



§3.5.4 Marketed Surplus Results

In this section we present the results of regressions which use the truncated sample and include the inverse of Mill's ratio, λ, as an extra explanatory variable. We also try to identify the source of the effects, i.e. whether they work through production or consumption or both, and discuss the pattern of the land and price elasticities of MS across farm size.

- Farm Size: The coefficient of total cultivated land (LAND) indicates that a 10% increase in cultivated land leads to an 13% increase in MS (see Table 3.4). Extra land has both output and income effects. If some of the extra land is allocated to wheat then output of wheat should increase. However, the land that is not allocated to wheat may absorb more of a fixed family labour supply, especially if extra hired labour is not used or if hired labour is more expensive thus decreasing wheat output and MS. In Chapter 2 (see §2.7 and Figure 2.2) we saw that the proportion of total cropped acreage allocated to wheat decreases with farm size. Extra land also brings more income which increases consumption of wheat and possibly leads to a fall in labour supply, thus decreasing the MS of wheat on both counts. The estimated elasticity incorporates all these effects and reinforces our earlier result that most of the total MS of wheat originates on large farms.

Notice that the functional form imposes the restriction that the elasticity is constant whereas the observation that the proportion of extra land allocated to wheat decreases with farm size suggests that the output elasticity may vary across farm size. Combined with the possibility that the marginal budget share for wheat decreases with income, this suggests that the land elasticity of MS should vary with farm size. We therefore also experiment with a quadratic approximation. However, it must be remembered that the results are suspect because of the presence of influential observations for the farm size variable. Moving to this functional form the adjusted-R^2 increases from 0.55 to 0.58 (see Table 3.5). Using the non-parametric regression technique we plot the fitted land elasticity against farm size and find it decreases as expected (see Figure 3.2).

Focusing on family consumption and production (see Tables 3.6 and 3.7) we find that a 10% increase in LAND implies a 6% increase in wheat consumption and a 11%

Table 3.4

Marketed Surplus: Log-linear model

Intercept	3.24††	2.11*	2.11*
LANDL	1.34††	1.57††	1.57††
WHPRL	1.46††	1.46††	1.43††
NUMTOTL	-0.15**	-	
MEN	-	-0.02	-0.02
WOMEN	-	-0.03	-
BOYS	-	-0.02	-
GIRLS	-	-0.05*	-
CHILD	-	-0.004	-
NUMOTH	-	-	-0.02*
DIST	0.05	0.04	0.04††
TRAC	0.73††	0.81††	0.83††
BULL	0.38*	0.51**	0.52**
DONK	0.26	0.38	0.39*
OTHTR	0.07	0.12	0.13
PTEN	-0.93††	-1.11††	-1.10††
OTEN	-0.18	-0.23	-0.22
OLRD	-0.34*	-0.40*	-0.41*
CREDIT	0.17*	0.21*	0.21*
JOB	0.15	0.12	0.13
SLSAL	0.43**	0.45*	0.44*
GSAL	-0.59*	-0.67*	-0.67*
SVSAL	-0.17	-0.16	-0.16
PUNJ	0.40**	0.39*	0.38*
NWFP	-0.25	-0.56	-0.54
λ	0.83**	1.27**	1.26**
$\bar{R}^2$	0.55	0.56	0.56

Note: See notes to Table 3.3.

Table 3.5

Marketed Surplus: Quadratic model

Intercept	-18385††	-17916††	-18039††
LAND	596††	603††	596††
LANDSQ	-2.34††	-2.40††	-2.35††
WHPR	10609	10607	10455
WHPRSQ	-2723	-2815	-2649
NUMTOT	-137††	-	-
MEN	-	-296**	-324††
WOMEN	-	-255	-
BOYS	-	160	-
GIRLS	-	59.8	-
CHILD	-	-166**	-
NUMOTH	-	-	-85.8
DIST	920*	902*	900*
TRAC	2885*	2966**	2871*
BULL	1445	1550	1510
DONK	1218	1280	1218
OTHTR	-44.07	-14.2	63.4
PTEN	-3173††	-3038††	-3123††
OTEN	-983	-766	-918
OLRD	-1289	-1320	-1308
CREDIT	932	956*	880
JOB	-609	-734	-776
SLSAL	249	179	312
GSAL	-1793	-1786	-1864
SVSAL	-406	-481	-389
PUNJ	325	365	402
NWFP	-4137	-3347	-3715
λ	7129††	6904††	6994††
$\bar{R}^2$	0.58	0.58	0.58

Note: See notes to Table 3.3.

Table 3.6

Consumption: Log-linear and quadratic models

Intercept	4.55††	4.66††	331	223
LANDL	0.63††	0.63††	-	-
LAND	-	-	102††	102††
LANDSQ	-	-	-0.13	-0.13
WHPRL	0.26	0.23	-	-
WHPR	-	-	-1511	-1472
WHPRSQ	-	-	606	587
NUMTOT	-	-	32.71†	-
NUMTOTL	0.18††	-	-	-
MENL	-	0.11**	-	-
MEN	-	-	-	80.21
NUMOTH	-	-	-	19.72
NUMOTHL	-	0.09*	-	-
DIST	0.004	-0.004	-171	-166
TRAC	0.41††	0.42††	771	777
BULL	0.28**	0.28**	332	315
DONK	0.19	0.20	227	227
OTHTR	0.25**	0.26**	421	395
PTEN	-0.44††	-0.47††	-544*	-557*
OTEN	-0.12	-0.13*	-212	-229
OLRD	0.15	0.14	642	647
CREDIT	0.06	0.06	113	127
JOB	-0.30**	-0.30**	-593	-551
SLSAL	0.60††	0.58††	828*	813*
GSAL	-0.15	-0.15	-491	-473
SVSAL	-0.08	-0.07	-106	-111
PUNJ	0.66††	0.65††	859**	839**
NWFP	0.97**	0.91**	2505*	2398*
λ	0.29	0.32	168	215
$\bar{R}^2$	0.50	0.50	0.44	0.44

Note: See notes to Table 3.3.

Table 3.7

Production: Log-linear and quadratic models

Intercept	4.42††	4.36††	-23373††	-23022††
LANDL	1.09††	1.11††	-	-
LAND	-	-	928††	928††
LANDSQ	-	-	-3.60††	-3.60††
WHPRL	0.79††	0.78††	-	-
WHPR	-	-	10089	9933
WHPRSQ	-	-	-2153	-2078
NUMTOT	-	-	-104**	-
NUMTOTL	-0.003	-	-	-
MEN	-	-	-	-293*
MENL	-	-0.05	-	-
NUMOTH	-	-	-	-52.5
NUMOTHL	-	0.03	-	-
DIST	0.03	0.01	576	556
TRAC	0.59††	0.60††	4159**	4145**
BULL	0.38††	0.39††	2497*	2562*
DONK	0.33††	0.35††	2450*	2450*
OTHTR	0.18	0.21*	543	651
PTEN	-0.13	-0.15	-1939*	-1889*
OTEN	0.07	0.06	17.8	83.2
OLRD	0.003	-0.01	-350	-370
CREDIT	0.15†	0.15**	1223	1170
JOB	-0.15	-0.16	-1776	-1945
SLSAL	0.63††	0.61††	1781	1844
GSAL	-0.44**	-0.46**	-2923	-2995
SVSAL	-0.06	-0.06	-553	-535
PUNJ	0.63††	0.63††	1942	2019
NWFP	0.45	0.46	-1515	-1088
λ	0.67†	0.68†	9032††	8845††
$\bar{R}^2$	0.70	0.70	0.68	0.68

Note: See notes to Table 3.3.

increase in wheat production. The consumption effect reflects higher incomes and the production effect is consistent with our findings in §2.3 that wheat yields increase with farm size.

- Wheat Price: A higher price (WHPR) can have both output and consumption effects. The output effect arises from the allocation of a greater amount of total cultivated land to wheat as well as due to increased per acre yields because of higher input levels. This acts to increase wheat surplus. The negative pure substitution effect in consumption also leads to an increase in MS. This is reinforced by a negative income effect for households who are net consumers of wheat in the market. Households with a positive MS have a positive income effect on consumption which acts to decrease their MS of wheat. Our estimate, that a 10% increase in price leads to a 14% increase in MS, suggests that any increased consumption effect from higher income is swamped by the other effects. This contrasts with our earlier calculations (using aggregate values), at the end of §3.4, which suggest a corresponding 8.6% rise in MS. However, if we replace the price elasticity of output of 0.15 with the estimate of Ali (1988, p21) of 0.327 we get a price elasticity of MS at nearly 1.3 which is similar to our estimate here. As with the land elasticity we expect that price elasticities vary according to farm size reflecting varying responses in terms of land allocation, agricultural input use and consumption. The quadratic approximation does not give a statistically significant price response and using the F-test we are unable to reject the null hypothesis that both the coefficients for price and its square are equal to zero. In spite of this we plot the price elasticity against farm size using the non-parametric technique and find that it decreases with farm size (see Figure 3.2). The very high price elasticities on small farms reflects, in part, their low MS levels.

When family consumption is taken as the dependent variable we find that its price elasticity is not significantly different from zero, i.e. we are not able to reject the null hypothesis that the income and pure substitution effects cancel out (see Table 3.6). However, on the production side we do find that a 10% increase in prices implies an 8% increase in wheat production. This figure is much higher than other estimates and may be due to the fact that we may not have controlled for some crucial factors which are correlated with prices. For example, households with higher prices may be located in areas which have efficient trade networks due to the concentration of government procurement. Alternatively, these households may also have higher rice prices so that the wheat-rice rotation is more profitable than wheat/cotton or sugarcane so that these households allocate a greater proportion of total cultivated acreage to wheat.

- Family Size: Extra family members can increase both the production and consumption of wheat, the net effect on MS depending on their relative contributions to each. The results suggest that a 10% increase in the number of family members leads to a 1.5% fall in MS, equivalent (at the geometric mean) to a 23.6kg of wheat per extra family member. However, one expects that the effect on MS can vary according to the age and gender composition of the change. When NUMTOT was disaggregated according to age and gender we found for all categories, except girls, we could not reject the null hypothesis (at the 10% level) that their output and consumption effects cancelled out. For girls the coefficient was significantly negative at the 10% level, suggesting a fall in MS of 77kg per extra girl possibly reflecting that while extra girls increase wheat consumption they do not contribute to wheat production. Since we expect that children have minimal contribution to output, but presumably do increase consumption, the sign of the coefficient suggests that the consequent fall in per capita income induces an increase in labour supply from other household members. This sort of income effect may also be present for women, boys and girls so that an increase in their number induces an increased labour supply from adult male members of the household. It is also useful to keep in mind another possible general equilibrium response to increased labour supply: households with more labour may allocate more of total cultivated land to more labour intensive crops. However, whether or not crops competing with wheat in rabi are more or less labour intensive is a moot point.

We also categorized household members into 'males over 15' and 'others' (NUMOTH). All households had at least one male over 15 and less than 1% of households had zero 'others'. Eliminating the latter the coefficient of NUMOTH was significantly negative at the 10% level. However, we still could not reject the null hypothesis that for adult males the consumption and production effects cancelled out.

When both MEN and NUMOTH were entered in logs they were both insignificantly different from zero. The results changed when we used the quadratic model (see Table 3.5) where we also found a significantly negative effect on MS for an extra family member, but when we disaggregated NUMTOT we found that this negative effect was attributable to adult males and children, an extra family member from each category leading to a fall in MS of 296kg and 166kg respectively. The negative effect of males was reinforced when we grouped other family categories into one group (NUMOTH).

Using family consumption and wheat output as the dependent variables we can trace the origin of the effect of family size and composition on MS (see Tables 3.6 and 3.7). Focusing on consumption and the log-linear model we find that a 10% increase in the number of family members leads to a 1.8% increase in wheat consumption, equivalent to an increase of nearly 34kg for an extra family member. When we disaggrated NUMTOT according to age and gender none of the categories were significantly different from zero. However, when non-adult-male family members were grouped into NUMOTH, we got consumption elasticities of 0.11 and 0.09 for adult males and 'other family members' respectively, equivalent to 72kg and 25kg extra consumption per extra member respectively. With the quadratic model the coefficient of NUMTOT was significantly positive and indicated an increase of 33kg in wheat consumption for an extra family member. However, when we disaggregated NUMTOT none of the component parts were significantly different from zero.

On the production side the results from the log-linear model do not suggest a significant relationship between output and the number or composition of family members. This may be because households with, say, an extra adult male allocate a higher proportion of land to other crops and this cancels out any output effect resulting from higher labour input per acre. Alternatively, one might take this as evidence of a well functioning labour market with households hiring in or out labour according to landholdings. However, in Chapter 2 we saw that per acre labour use decreases with farm size and we interpreted this as resulting from imperfectly functioning labour markets. Results from the quadratic model suggest that households with an extra adult male actually produce 293kg less wheat which suggests that the land allocation argument may be important.

- Other Variables: The negative coefficients on PTEN and OTEN reflect rent payments, and therefore lower income, by tenants in the form of wheat - tenants share output with landlords before allocating the remainder between family consumption and marketed surplus. As expected, the coefficient is greater, in absolute terms, for pure tenants who on average have a 60% lower surplus compared to a 20% lower surplus for owner tenants, both relative to pure owners. The insignificant coefficients for these variables when output is the dependent variable suggest that the lower MS for tenants comes from the consumption effect only, i.e. it does not reflect lower wheat output. Likewise, the negative coefficient for owner-landlords appears to also come from a consumption effect, higher consumption levels reflecting extra income from leased-out land.

The signs and relative values of the salinity variables suggest that these are not adequately capturing variations in land quality - we expect all to be negative and increasing (in absolute terms) as salinity increases. Households using tractor and trolly, bullock and cart, or donkey to transport grain appear to have higher MS levels than those who man-carried the wheat or used other methods. These households seem to have both higher consumption and higher production, the former probably reflecting higher income and the latter higher productivity because of ownership of tractors or draught power. The insignificant coefficient for DIST may mean that our price variable already incorporates transport costs.

Households using credit for production purposes also have higher levels of MS and higher production seems to be the source. Also, households located in Punjab have both higher wheat consumption and higher wheat output. The former reflects the taste preference for wheat in this province (households in Sind consume more rice), while the latter may reflect a greater land allocation to wheat for similar reasons or even higher yields. The higher MS in Punjab may also arise due to its higher level of government activity in terms of procurement.

- Sample Selection Bias: Finally, there is evidence of sample selection bias in both the marketed surplus and production equations, this being more pronounced in the quadratic models. Focusing on the MS equation we can explain the sign of the coefficient of λ (say, α) and the effect of sample selection bias as follows. The sign of α is the the same as that for the covariance between the error terms in the probit and MS equations, say σ. Since factors which increase the probability of being included in the truncated sample also operate to increase the level of MS, σ is positive. Therefore, α will also be positive. It can also be shown that $d\lambda/dx$, where x is an explanatory variable, is negative (positive) if the coefficient of x in the probit equation is positive (negative). Standard omitted variable analysis then tells us that that, since $\sigma>0$, omitting λ from our MS regression using the truncated sample would negatively (positively) bias the estimated coefficient of x in such a regression if the coefficient of x in the probit equation is positive (negative) so that $d\lambda/dx$ is negative (positive). So when λ was omitted the coefficients corresponding to those in Table 3.4 were lower in absolute terms.

§3.6 Summary and Conclusions

In this section we summarize our results and indicate the lessons that can be taken from our analysis. Our discussion of agricultural household models (AHMs) highlighted the need for care when modelling the behaviour of agricultural households and analysing the likely impact of government policies. When formulating models one must try to incorporate the heterogenous characteristics of rural households. An example of this is the existence of a profit effect for agricultural producers and the different direction of this effect over small and large producers.

The framework of AHMs is a useful basis for the formulation of more specific and simpler models. We showed how they can be used to indicate the important variables which should be included in our model of MS and how the model should be set up. With simple examples we were able to show the likely direction and magnitude of household responses to various parameters of interest. In §3.4 we focused on the household characteristics which determine the size of the price elasticity of MS. Using parameters for Pakistan for the mid 1970s and 'low' estimates of production elasticities, we calculated an aggregate elasticity of 0.86 for wheat and 0.26 for rice. We also argued that these elasticities are unlikely to be negative and are likely to exceed their output elasticities.

Our analysis of the pattern of MS across households according to farm size, tenure and location reinforced our initial belief that MS was much higher on large farms, reflecting the highly skewed nature of per capita landholdings. Using a simple model of MS we pointed out the estimation problems likely to be encountered, their origins and possible solutions. The problems of measurement error, sample selection, heteroskedasticity and influential observations are likely to be common to many agricultural household data sets because of the way they are collected and given the highly skewed distribution of landholdings in many developing countries. Therefore, one should be careful to take account of these problems when selecting models and data to estimate household behaviour. We have shown here how many of these can be overcome for our particular analysis.

The results from our probit analysis confirm that there is a strong positive correlation between the probability of having MS and farm size. We also found that households located in NWFP have a lower probability of having market sales reflecting the fact that markets there are less developed with little government involvement by way of procurement.

Using the inverse of Mills' ratio as an explanatory variable in our regression of MS on household characteristics for our selected sample we derived consistent estimates of reduced-form parameters. We interpreted our results with arguments to explain their sign and magnitude and tried to trace their origins back to their effects on production and consumption. We found evidence that both the land and price elasticities of MS decreased with farm size. Also, as expected, the price elasticity of MS was substantially greater than one. Extra land increases both wheat output and wheat consumption (reflecting higher income), with the output effect dominating. The origin of the positive price effect on MS semed to be on the production side, suggesting that the positive income effect from higher prices (for those with market sales) cancelled out the negative pure substitution effect in consumption.

Extra family members led to lower MS levels reflecting higher consumption of wheat. However, wheat production levels were not correlated with the number of adult males or other members in the family. Rather than interpreting this as evidence of a well- functioning labour market, we suggest that the negligible effect of household numbers on wheat production may reflect the reallocation of land away from wheat which cancels out the higher wheat yields per acre due to extra labour supply. We also found evidence of a consumption preference for wheat in both Punjab and NWFP. Our results confirm the need to allow for sample selection bias when dealing with truncated samples as we do here. We explain the origin of the positive sign on the inverse of Mill's ratio, λ, and the sign of the bias when λ was not included as an extra explanatory variable.

Although the analysis is not specifically focused on policy there are some implications for pricing policy. These relate to the pattern of MS across households and how levels of MS change in response to price changes. The data show that MS decreases with farm size with large farms being net producers and smaller farms having low or zero MS or even being net producers. Landless labourers will also be net consumers and these are often among the poorest social groups. Therefore, low wheat procurement prices are attractive from a distributional viewpoint. However, the high price elasticity suggests that there will be large efficiency losses connected with low wheat prices. We return to this trade-off between equity and efficiency in Chapter 6.

Chapter Four

An Empirical Analysis of Fertilizer Use in Pakistan

§4.1 Introduction

The introduction of high-yielding varieties (HYVs) of wheat and rice in Pakistan in the mid 1960s was heralded as a major breakthrough in the problem of food supply. A crucial characteristic of these new HYVs was their high yields when used in conjunction with chemical fertilizer (henceforth just fertilizer) and controlled irrigation. Great emphasis was placed on increasing the supply and use of fertilizer. Fertilizers were still regarded as of crucial importance by the mid 1980s - of the total increase in agricultural output envisaged by the Sixth Five Year Plan (Government of Pakistan, 1983), 48% of it was expected to come from increased use of fertilizer.

Although the technology associated with HYVs is essentially regarded as being neutral to scale, constraints such as those arising from inadequate irrigation, an inability to secure (or secure terms for) credit, and access to extension services, can bias the technology towards larger farms. These issues are discussed in more detail in Chapter 2. In this chapter we focus on the use of fertilizer. The data presented in Chapter 2 show that just over 80% of the sample applied fertilizer, this percentage being highest on farms of 25 acres and over. However, our simple analysis of fertilizer use did not indicate any systematic relationship between land size and per acre levels applied. In most studies of fertilizer use, as in that of Chapter 2, zero observations are dropped. This approach has serious drawbacks since the application of classical OLS regression techniques to such truncated samples leads to inconsistent estimates and fails to analyse the process by which these zeros are generated. In empirical analyses it is important to treat separately households which do not apply fertilizer because they are constrained, say, in the credit market (and would not apply fertilizer no matter what relative prices they faced) and those who do not apply fertilizer because at current input and output prices it is not profitable for them to do so. We can think of the former group as not having 'access' to fertilizer (or to other purchased inputs). Here we present a double-hurdle model which incorporates these zeros into the analysis and examines whether or not fertilizer is used and, if so, how much is used.

The issues relevant in explaining the wide variation in fertilizer use across households are also relevant for other crucial inputs. Also, although our analysis uses data for the mid 1970s, preliminary results of a more recent survey for Pakistan also seem to support much of what we find here. Therefore, the policy implications of our results may be pertinent both to other purchased inputs and the present.

In §4.2 we give a general description of the important characteristics of the HYV technology and of the evolution of agricultural policy in Pakistan. In §4.3 we give a brief outline of the theoretical models used to analyse the variation in inputs across households, with particular emphasis on the role of uncertainty. The data are described in §4.4 and the double-hurdle model used in our empirical analysis in §4.5. Results are presented in §4.6 followed, in §4.7, by conclusions.

§4.2 The Green Revolution

The introduction of HYVs in developing countries has been seen as a substantial step towards satisfying the large increases in food demand concomitant with rapidly growing populations in these countries. However, the use of HYV seeds is only one aspect of a complex technology which involves the use of other crucial inputs and farm practices. The potential returns from this new technology can only be realised if the appropriate combination, level and timing of inputs and farm practices are adopted. The response of yields to fertilizer, especially in the presence of irrigation, was seen as the hallmark of the new varieties. However, high levels of fertilizer and irrigation alone do not achieve these yields. Also important are the timing and method of their application and the presence of the appropriate farming techniques, e.g. sowing and weeding practices. As Hussain(1989, p235) put it:

> As suggested by its name, 'seed engineering' consists in embodying in a new variety a menu of characteristics picked from a population of extant varieties left behind by human and natural selection. The central feature of the HYV seed is that it is but one component in an interdependent network of inputs (such as fertilizer and water) and farm practices (such as weeding and controlling diseases and pests).

This technical modernization of agriculture in developing countries has been labelled the *green revolution.* The major technological advances have been for cereals such as wheat and rice, especially for the former. Therefore, in much of the discussion that follows we focus on these grains.

The exploitation of the advantages of HYV seeds requires knowledge of the appropriate inputs and farm practices. The acquisition of this knowledge and skills takes time and governments can play a central role in dissemination. To accelerate the diffusion of this modern technology governments have taken an active role and emphasised investment in extension services. At the initial stages of adoption, imported HYV seeds do not necessarily possess the characteristics appropriate for the domestic climatic and soil conditions. Whereas traditional varieties are robust to variations in natural conditions, HYVs need to be fitted to the particular local biochemical environment. Investment in basic research is necessary to improve on the initial stock and to develop varieties more suitable to local conditions. Also, because HYVs often have an inbuilt obsolescence (i.e. the yields from seeds retained from output decreases over time), new stocks need to be continually developed to maintain both their high yields and resistance against disease. Investment in extension services must be maintained if improved farm practices and new knowledge are to be adopted as they become available.

Because the increased use and productivity of fertilizer is related to the introduction of HYV seeds it is common to view the use of HYV seeds, fertilizer and irrigation as a single innovation. However, the use of fertilizer can also be treated as a separate component (as can irrigation) which enhances productivity even without the adoption of the complete HYV package. Indeed, the use of fertilizer had started to increase prior to the introduction of HYV seeds, mainly due to improved supply and increased irrigation. The popular view is that the subsidization of fertilizer consumption was an effort to overcome the initial resistance of farmers to adopting fertilizer by making its application more profitable. Prior to any judgement on the effectiveness or desirability of such a policy one must understand the process of diffusion and the various obstacles and constraints facing farmers which restrain the adoption and increased use of fertilizer.

A conventional approach to an innovation is to view its diffusion as a sigmoid time path with consumption (adoption) taking-off slowly at first, increasing rapidly and then tapering off towards total adoption. At the early stages there are farmers who have adopted and those who have not. Lack of complementary inputs such as irrigation, or inefficient farm practices because of lack of familiarity with the new technology, may make it unprofitable to adopt. Credit difficulties also restrict demand by farmers. If farmers originally produced much of their own inputs then adequate credit markets may not have emerged to finance the movement to market transactions. The credit that is available may be channeled towards larger farms. However, in response to difficulties the nature of farming contracts may change.

After the initial stages two forces will be driving demand: the increase in demand due to an increase in the number of adopters (i.e. fertilizer widening) and the increase in demand arising from those who have adopted applying more fertilizer to their crops (i.e. fertilizer deepening). Increases in the expected profitability of the new technology increase adoption and application levels. As farm practices improve and the supply and use of complementary inputs increase, the profitability of the new technology increases and more farmers adopt or apply fertilizer at higher levels. Because of the high returns to appropriate timing of applications, improvements in the supply of fertilizer at the right time and place will also increase demand.

The inability of some farmers to secure any or enough credit may prevent them from applying as much fertilizer as they would wish. Further, inadequate irrigation decreases yields. One would expect that in such circumstances the role of price in stimulating increased demand by increasing expected profitably to be somewhat diminished. This follows from the LeChatelier-Samuelson Principle which shows that in the presence of any rigidity (here constrained irrigation and credit) the responsiveness to prices in other markets is reduced. For example, if the relative price of fertilizer (to output prices) is reduced then even with fixed irrigation the returns to additional fertilizer are increased and demand also increases. Since irrigation is a complement to fertilizer the removal or relaxation of this constraint allows farmers to also increase irrigation thus leading to an additional increase in the productivity of fertilizer. This leads to a further increase in fertilizer demand. Therefore, the responsiveness of fertilizer demand to relative input-output prices is higher when farmers can vary their use of irrigation.

One of the main reasons for subsidizing fertilizer since the early days of the Green Revolution was the desire to induce farmers to apply it and at higher levels. This raises the question of the effectiveness and desirability of low prices in this regard compared to extension services. In Chapter 2 we saw that the reasons given by farmers for not applying fertilizer were 'lack of access to credit' and 'no need' (the latter may reflect lack of knowledge of the productivity of fertilizer). It seems unlikely that lower fertilizer prices would improve access to credit, and the inducement to non-users to start using may be weak. To maintain higher application levels amongst those who are using subsidies must be continued.

Compare this to extension services. These increase the awareness of farmers as to the productivity of fertilizer and also help to increase total factor productivity through the spread of improved farm practices. When extension services also incorporate improved knowledge of complementary inputs, such as irrigation and credit, they shift the production function further upwards. Therefore, there is a lasting effect in terms of higher levels of fertilizer applied. Focusing on the design of these services also makes policy makers more aware of other important requirements such as the availability of fertilizer at the right time and place.

A crucial element in a cost-benefit comparison of extension services expenditure with price subsidies will be the effectiveness of the services in increasing the awareness of the potential productivity of fertilizer. Increasing awareness also involves improving knowledge of best farm practices. We do not review here the vast literature on the most effective form of extension services but point out that important constraints include adequate training of field staff and proper remuneration, as well as the need to incorporate the resources and constraints of farmers when designing such services (see, for example, Gamser, 1988).

The increasing cost of fertilizer subsidies, especially when the total amount of fertilizer applied increases over time, has been a continuing burden on government finances. For example, by 1979/80 (1980/81) fertilizer subsidies accounted for 77% (84%) of 'development subsidies', which in turn accounted for nearly 46% (55%) of total subsidies (i.e. current plus development), which in turn were 3% (1.9%) of GDP. By 1985/6, although total subsidies had fallen to 1.5% of GDP and development subsidies to less than 30% of total subsidies, fertilizer subsidies accounted for nearly all of the development subsidies. Subsidies to irrigation, pesticides, wheat seeds and petroleum products (together these constitute the whole of development subsidies) had either been reduced drastically or eliminated altogether (see Pakistan Economic Survey, 1986/7, pp 44-45). The size of these subsidies has been a major factor in their withdrawal since 1980. Also, in spite of the size of these subsidies, there is no reason to believe that they have a lasting effect in terms of higher productivity.

Preliminary results from a more recent survey in Pakistan for the mid 1980s (see Sharif *et al*, 1986, and Ahmad *et al*, 1986) suggests that the inability to secure any or enough credit is still the most important reason cited by farmers for not applying inputs at recommended levels. In spite of the substantial increase in availability through formal institutions (i.e. Agricultural Development Banks, Commercial Banks and Cooperatives) smaller farms, in particular, experience problems in securing these loans. The main reasons cited for not using credit were 'non availability', 'complicated procedure' and the need for 'illegal gratification'. These problems were more prominant among smaller farms and tenants, the latter reflecting the requirement of land as collateral. When the government directed formal institutions to provide subsidized credit to smaller farms, often interest free, they were reluctant to do so given their unwillingness or inability in the event of bankruptcy to secure land given as collateral. Many of the loans were given to larger farms which split their holdings into smaller units using the names of relatives. The surveys found that many smaller farms were not even aware of the existence of such loans. For example, in the Sind survey they found that only 19% of all households were aware. A study by Khan and Sarwar (1986) for the Punjab found that only 44% of 'targeted' loans went to smaller farms (less than 12.5 acres). Small farms have therefore had to resort to the informal credit market where interest rates are substantially higher. These findings led to calls for a major overhaul of the distribution mechanism of subsidized credit so that it reaches its targeted group more effectively.

The surveys also indicate that problems with extension services still exist. Field assistants are very often unaware of recommended practices and seem to concentrate on larger farms. While the overall level of knowledge of recommended agricultural practices was found to be very poor this absence was more pronounced among smaller farms. This suggests that there is a lot of room for improvement in the effectiveness of the 'training and visit' agricultural extension scheme operating in Pakistan.

When using time-series data to estimate the price responsiveness of fertilizer demand one needs to allow for improvements in farm practices (from, say, increased or improved extension services or from familiarity with new techniques), supply and use of complementary inputs (e.g. irrigation), the supply of fertilizer (which may lead to improvements in the availibility of fertilizer at the right place and time), and availability of credit. Improvements in all of these factors have undoubtedly taken place in Pakistan. In the early 1960s there was a substantial increase in irrigated acreage reflecting improved availability of canal water and a large increase in the number of private tubewells installed (see Figure 4.1). The main beneficiary was sugarcane, a very water intensive crop, whose yields increased substantially (see Figure 4.2). Relative fertilizer-output prices were kept stable throughout this period (see Figure 4.3) and the domestic supply of fertilizer increased (see Figure 4.4). Fertilizer offtake increased further from 1965 when both imports and domestic production expanded.

In 1967 HYV wheat seeds were introduced and wheat yields increased dramatically. The government instigated a strong campaign to increase the adoption of this new technology, apparently bordering on coercion at times (see Gotsch and Brown, 1980, pp23-25). The number of tubewells installed increased as did the availability of both domestic and imported fertilizer (urea mainly). Then, in 1968 HYV rice seeds were introduced. The spread of new HYV seeds and the increase in irrigated acreage led to a dramatic rise in agricultural incomes. The late 1960s saw an attempt to capture some of this income and distribute it more widely. Both fertilizer and procurement prices were increased. The ratio of fertilizer-output prices reached a high in 1975 but

Figure 4.1: Irrigated Area

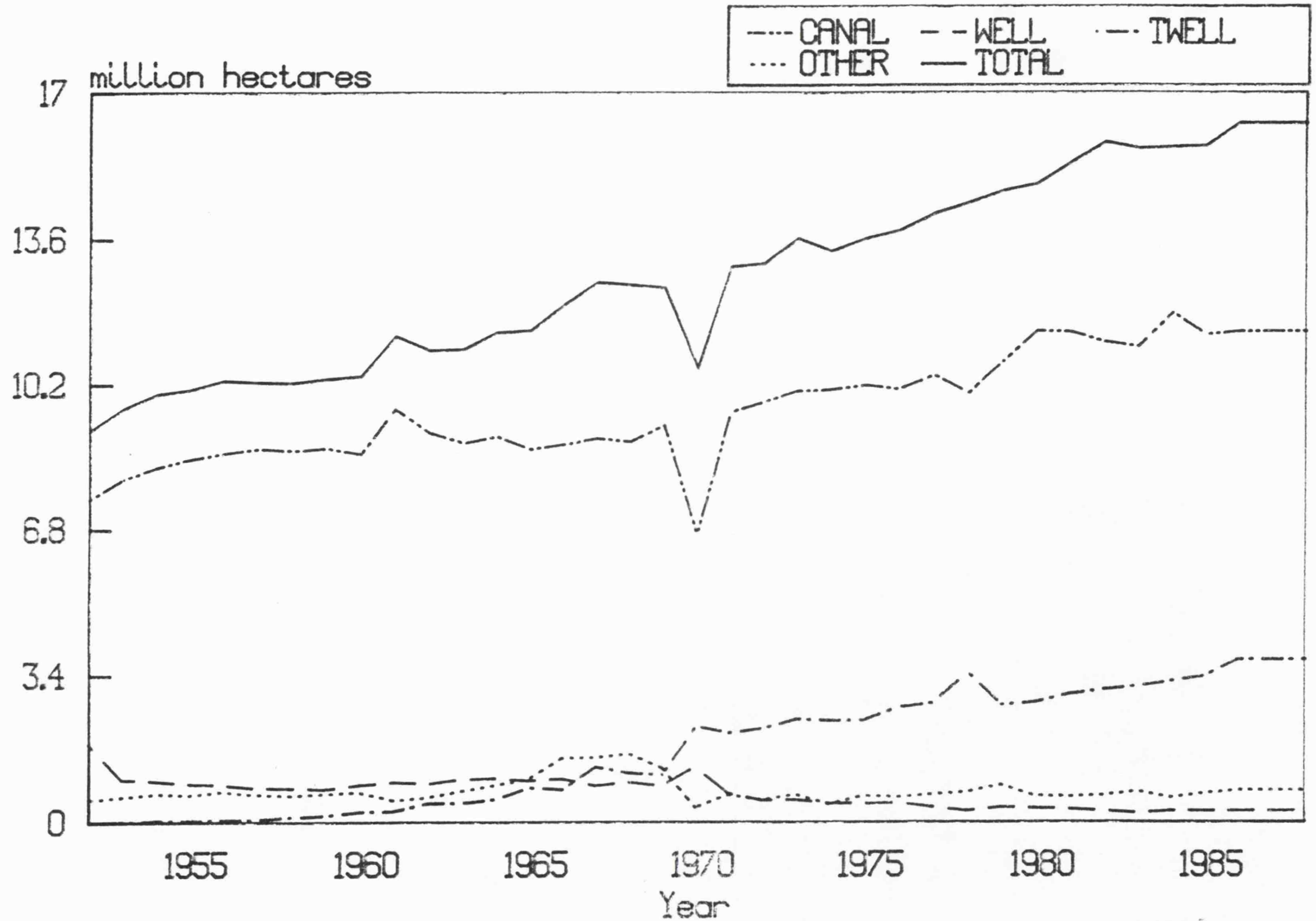


Figure 4.2a: Area Under Major Crops

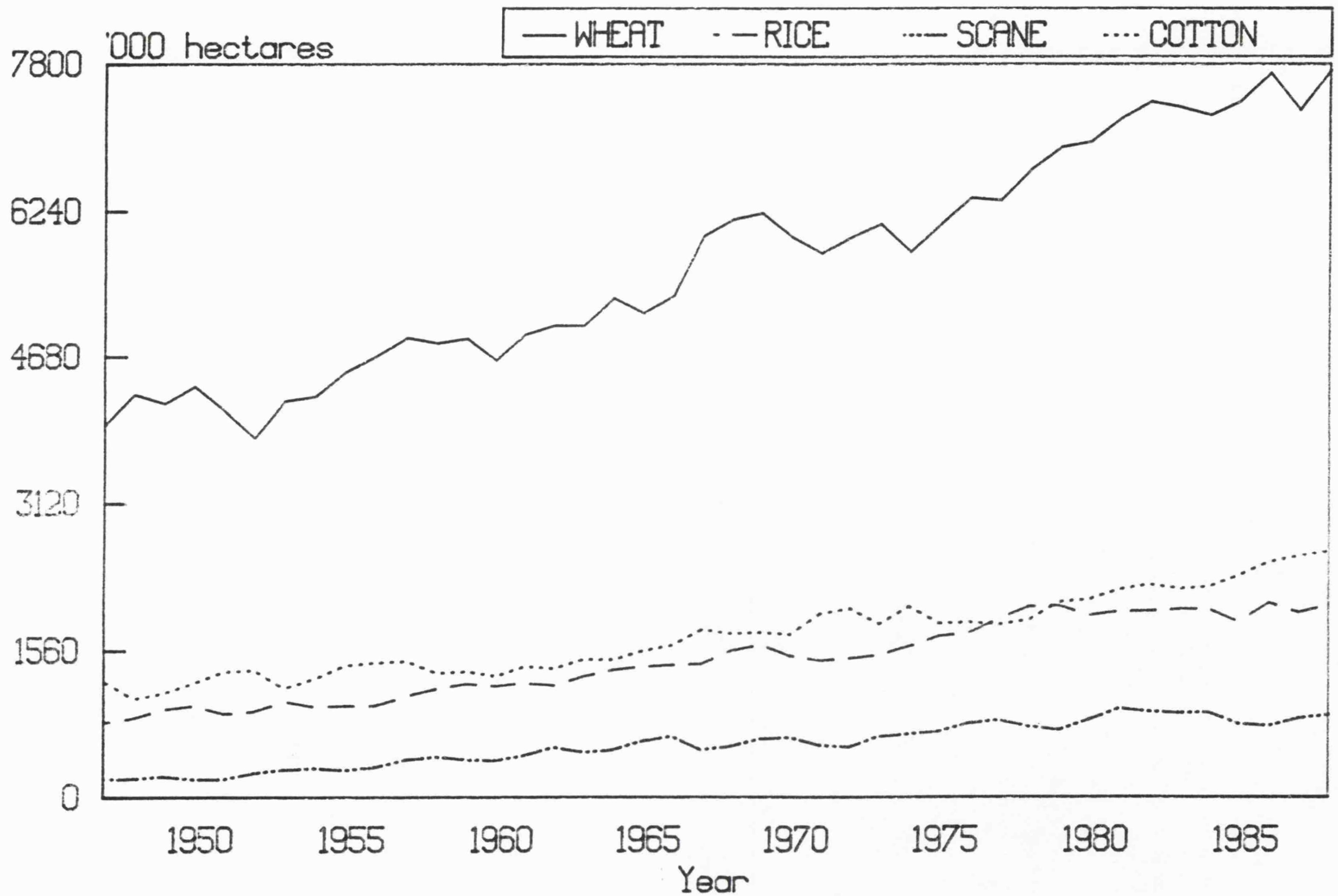


Figure 4.2b: Yields of Major Crops

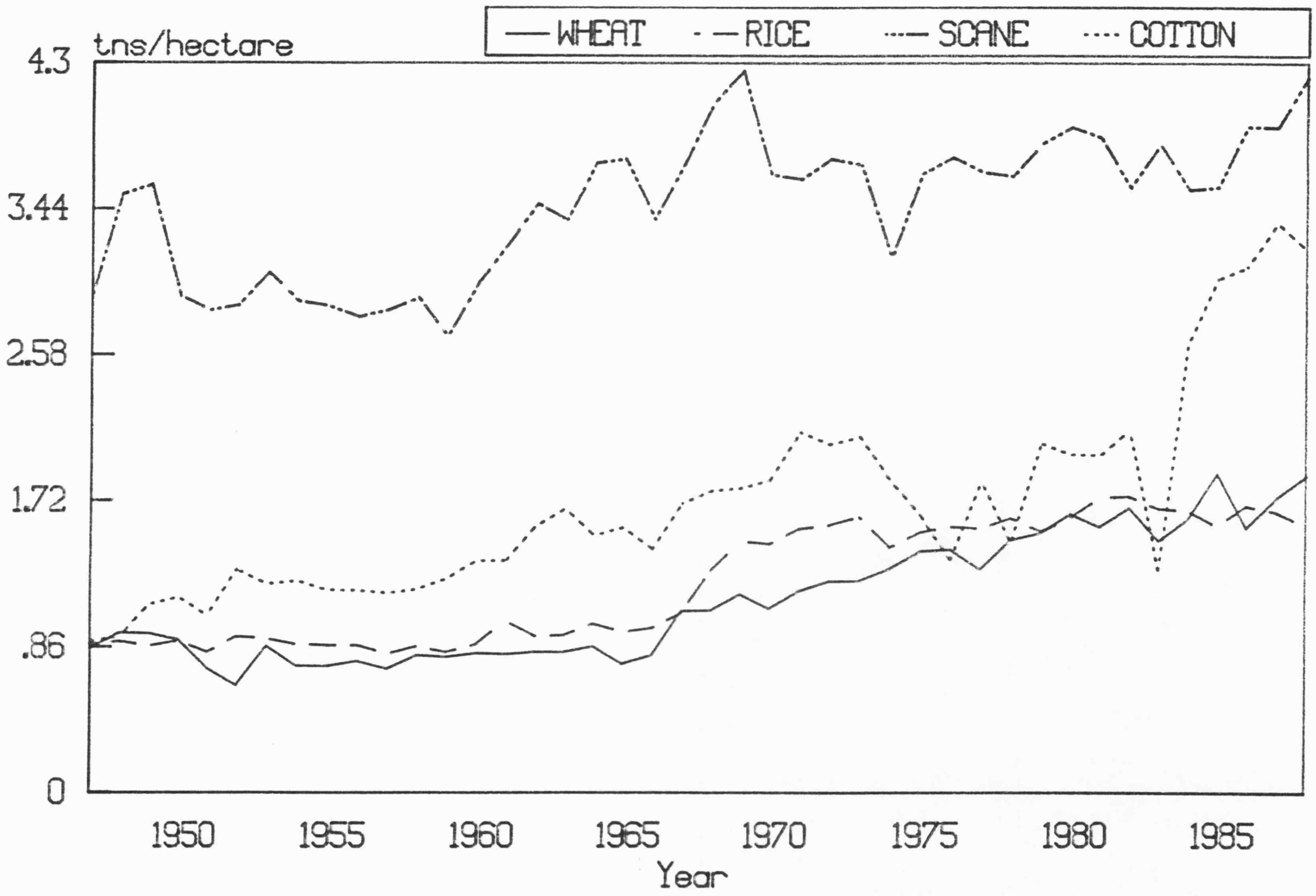


Figure 4.3: Prices

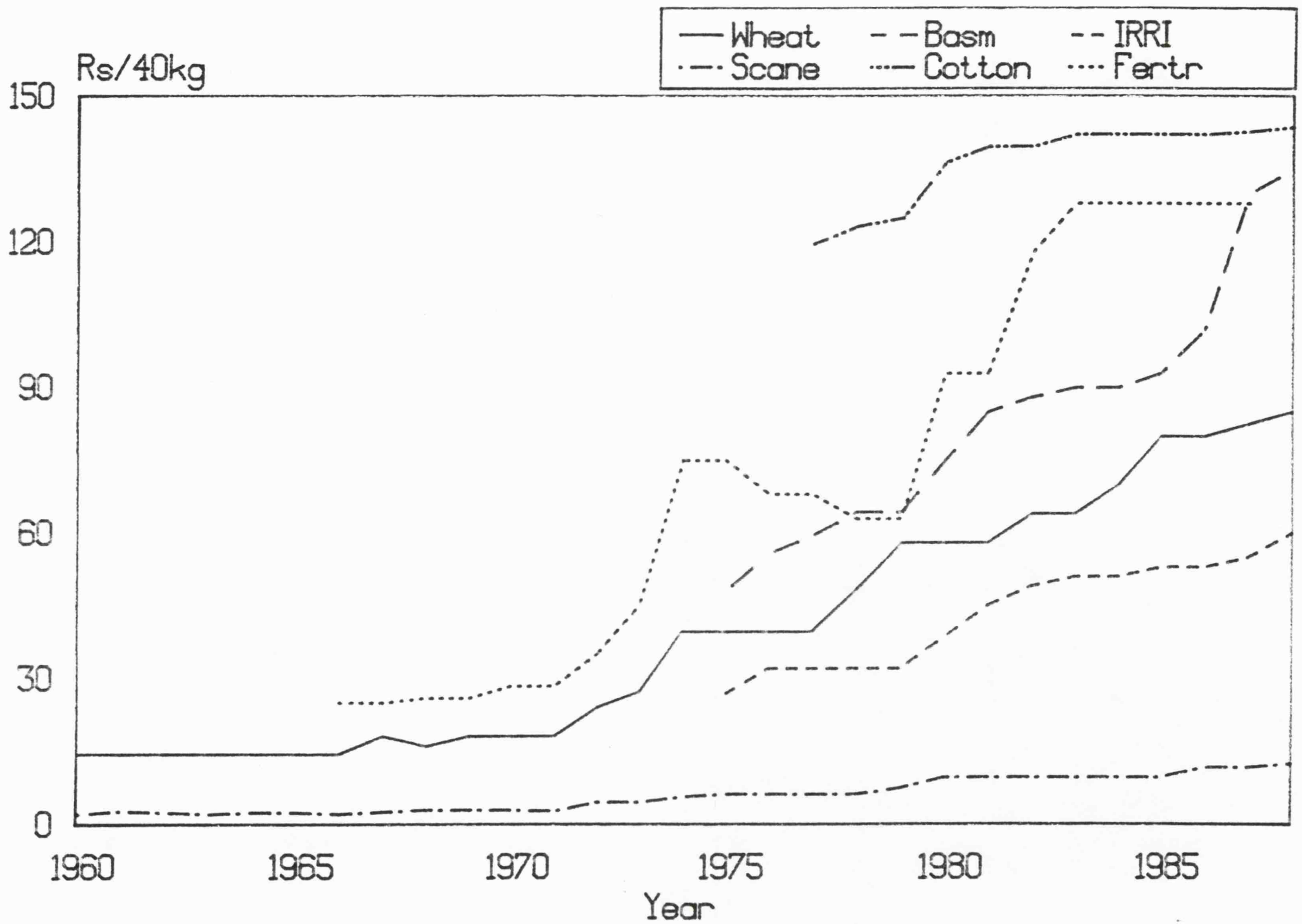
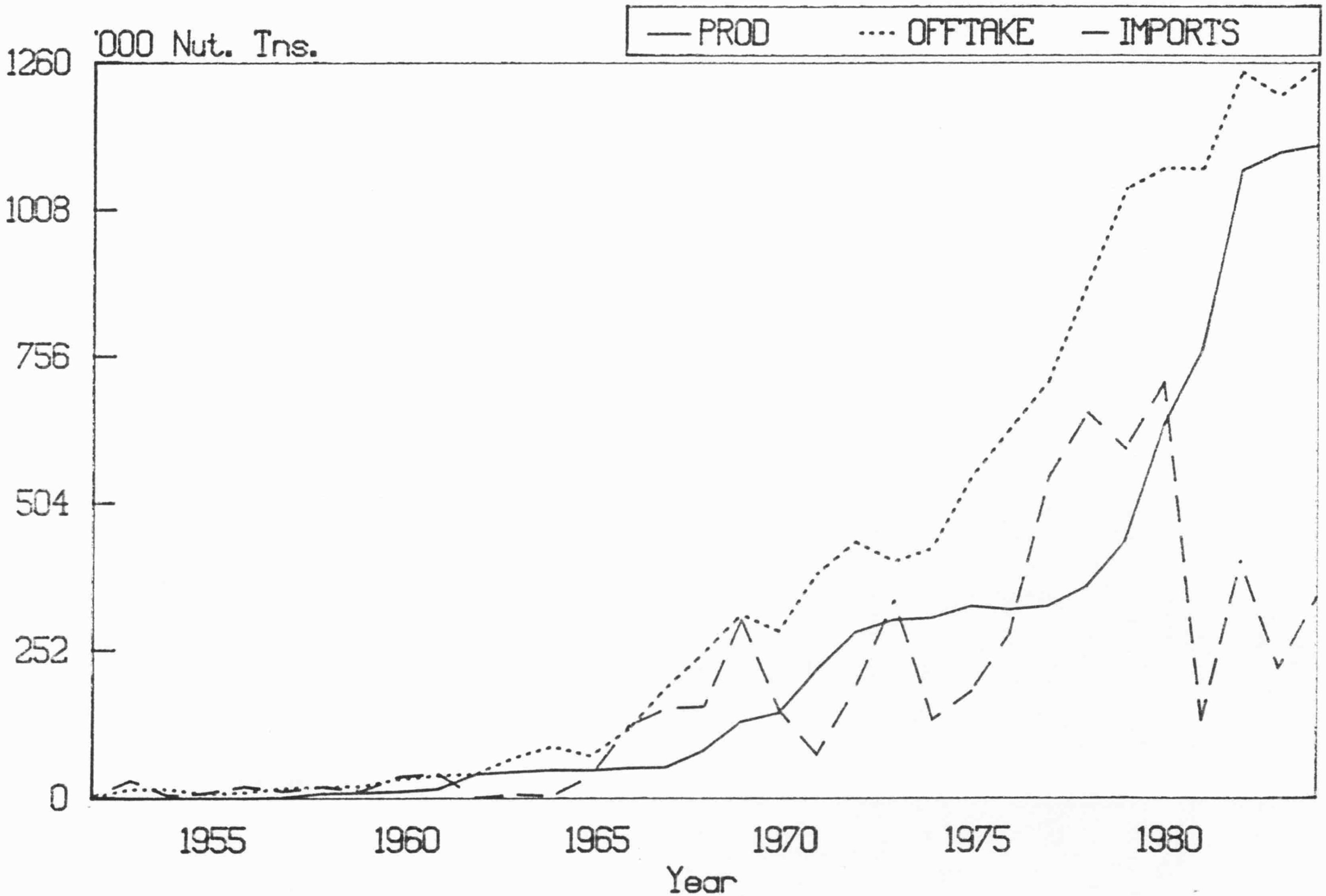


Figure 4.4: Fertilizer



decreased thereafter between 1975 and 1979 while procurement prices continued to rise. From 1975 to 1979 fertilizer offtake increased dramatically as did imports of fertilizer. The area allocated to HYVs continued to increase, especially for wheat (see Figure 4.5) mainly at the expense of traditional varieties.

The late 1970s and early 1980s saw renewed emphasis on the timely provision of inputs including fertilizer, seeds, pesticides and credit. The amount of credit channeled through formal institutions (e.g. the Agricultural Development Bank, Commercial Banks, and co-operatives) increased dramatically (see Figure 4.6). Greater emphasis was placed on private tubewell installation. Although credit and irrigation subsidies increased substantially, subsidies for pesticides were removed in 1982. In 1980 fertilizer prices rose by over 50% and, although procurement prices also rose, relative fertilizer-output prices increased. The early 1980s also saw an enormous rise in the domestic production of fertilizer as new plants came on-stream. As a result fertilizer imports fell sharply. New cotton varieties were introduced in 1984, greatly increasing cotton yields.

So, since the 1960s, irrigated acreage, credit availability (especially after the mid 1970s) and fertilizer supply have shown a continuous upward trend. Emphasis on extension services to improve farming practices have also increased. However, relative fertilizer-output prices have fluctuated. There have also been a number of isolated events which affect fertilizer availability and demand in a one-off manner. For example, 1964/5 had fertilizer shortages and 1965/6 saw war with India (with the consequent cut-off of American Community Aid) and severe drought. In 1970/1 West Pakistan and East Pakistan separated and there was again severe drought. In August and September of 1973 there were floods in Punjab and Sind and a severe drought between April 1974 and February 1975. In 1976 the cotton crop was adversely affected by excessive rainfall and pest attacks and fertilizer supply shortages occured in 1977. In spite of these events fertilizer offtake has shown a continuous upward trend.

There have been a few attempts to estimate the price elasticity of demand for fertilizer using time-series data for Pakistan (see Hamdani and Ul Haque, 1978, for a critical review). However, major difficulties encountered include the strong time-trend in most of the relevant variables, the presence of many isolated interruptions such as

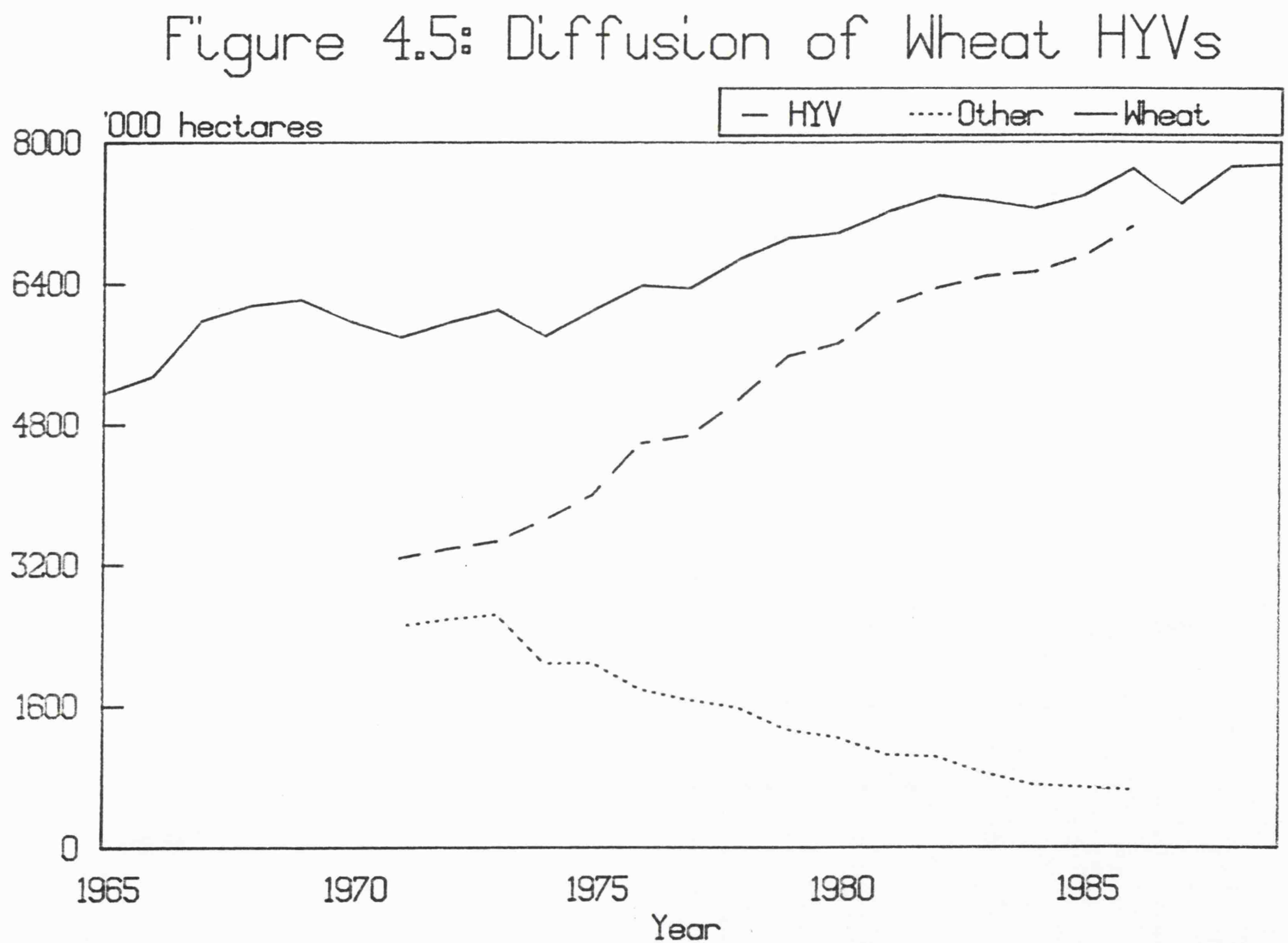
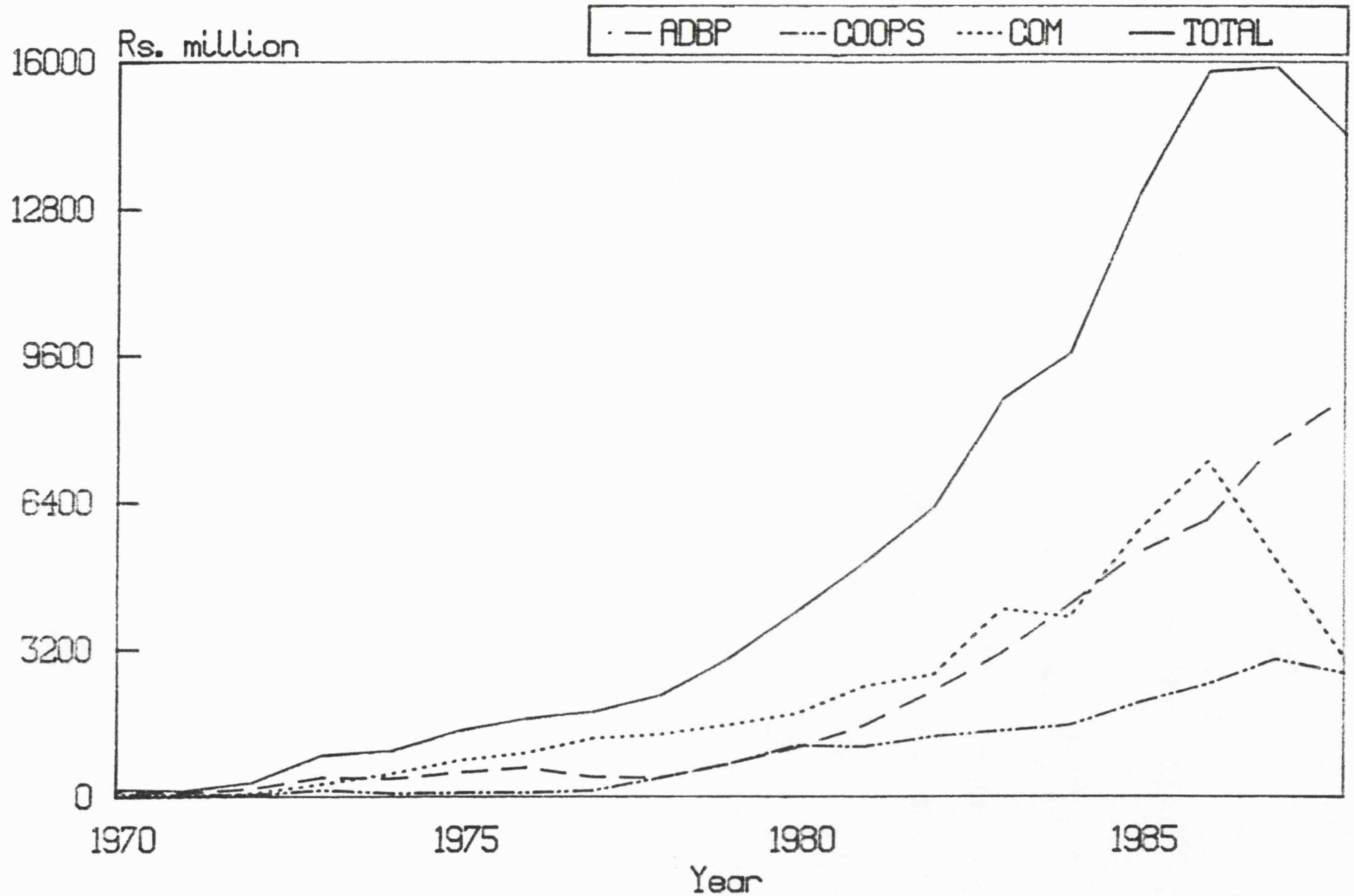


Figure 4.5: Diffusion of Wheat HYVs
HYV
Other
Wheat
'000 hectares
8000
6400
4800
3200
1600
0
1965
1970
1975
1980
1985
Year

Figure 4.6: Credit Disbursed



drought and war, and the small number of observations. Gotsch and Brown (1980, pp. 45-6), regressing fertilizer demand on relative fertilizer prices (which fluctuate over time) and a time trend, derived an estimate of 0.83 for the price elasticity of demand. The time trend accounts for most of the variation in fertilizer demand, possibly reflecting improvements in all the non-price aspects of fertilizer productivity.

§4.3 Theory

Given the nature of farming, where input costs are incurred some time prior to the receipt of revenue, uncertainty will impinge on household production decisions. Inputs must be applied before households are in a position to know with much confidence the level of output that will emerge. It is therefore essential that the theory used to explain farm household decisions should incorporate uncertainty. We can think of output as a function of a random variable θ (e.g. climatic conditions), the level of variable inputs $\mathbf{x}$ (a column vector with typical element x_i), and the level of fixed factors K (including land). We write

$$y = F(\theta,\mathbf{x},K) \qquad (4.1)$$

where y is output. Households are assumed to maximize the expected utility of wealth:

$$E[U(Z + qF - \mathbf{p}'\mathbf{x})] \qquad (4.2)$$

where U is the utility function, Z the wealth from other agricultural and non-agricultural sources, q the price of the output and $\mathbf{p}$ the column vector of input prices - we can view these prices as present values. Prime superscripts denote row matrices. Choosing x_i to maximize E[U(.)] we get, for any input i:

$$\frac{E(qF_i)}{p_i} = \frac{E(qF_i)\ E[U']}{E[qF_iU']} \qquad (4.3)$$

where $F_i=\partial F/\partial x_i$, U' is the first derivative of the utility function with respect to wealth. Assuming that U' is a decreasing function of wealth W (i.e. the utility function is concave) and that qF_i and W are positively related, then qF_i and U' are negatively related so that the the numerator on r.h.s. of (4.3) exceeds the denominator. This implies that the ratio of the expected value marginal product of an input to its price, i.e. $E(qF_i)/p_i$, is greater than unity. This ratio will be higher the greater the correlation between qF_i and W and can obviously differ over inputs. Note that in the absence of uncertainty profit maximizers apply inputs up to levels where their value marginal products equal the input price, i.e. the equivalent ratio is one.

To enable us to say more on the impact of household characteristics on decision making in an uncertain environment we assume multiplicative uncertainty, i.e.

$$F(\theta,\mathbf{x}) = \theta\ f(\mathbf{x}) \qquad (4.4)$$

The effect of uncertainty is represented by a factor, θ, which scales output up or down. We can think of uncertainty about q being incorporated into θ. Setting $\bar{q}=1$, p now represents mean relative factor-output prices. The first-order conditions for x_i give:

$$\frac{f_i\ E(\theta)}{p_i} = \frac{E(\theta)\ E(U')}{E(U'\theta)} \qquad (4.5)$$

Notice, from (4.5), that this ratio is constant over all inputs and, from (4.4), that the ratios of marginal products of inputs is independent of the state of nature, θ. If U(W) is a concave function and U' and θ are negatively correlated then the ratio in (4.5) is greater than unity (see Bliss and Stern, 1982, pp72-3).

One can analyse how the choice of inputs will vary with wealth in this model. This will depend on the shape of the utility function chosen and how risk aversion changes with wealth. We can think of total wealth being made up of stochastic assets or income (where the value of assets or income is related to agricultural conditions) and non-stochastic assets or incomes (where the value of assets or income are not related to agricultural conditions). So:

$$W(\theta,\mathbf{x},B) = B + Y(\theta,\mathbf{x}) \qquad (4.6)$$

where B is non-stochastic wealth and $\partial Y/\partial\theta>0$. Households choose **x** to maximize $G(\mathbf{x},B,\theta)=E[W(.)]$, with W(.) defined as in (4.6). Interpreting x as the optimum level we have:

$$\frac{dx}{dB} = - \frac{G_{xB}}{G_{xx}} \qquad (4.7)$$

Since G_{xx} is negative by the second-order conditions, the sign of dx/dB is determined by that of G_{xB}. Assuming decreasing absolute risk aversion Bliss and Stern (1982, pp73-4) show that G_{xB} is positive, i.e. a farmer with relatively more non-stochastic wealth will apply more variable inputs. Likewise, if we rewrite equation (6) as:

$$W(\theta,\mathbf{x},B,\lambda) = \lambda\ [B + Y(.)] \qquad (4.6)'$$

we can show that, in this case, $G_{x\lambda}$ [replacing **B** in (4.7) with λ] is negative (positive) if we assume increasing (decreasing) relative risk aversion. Therefore, 'if we compare two farmers who have identical patterns of wealth holding, but one has more of everything than the other, the richer farmer will have lower (per acre) levels of each input' (Bliss and Stern, 1982, p75). For example, if land is the only source of wealth then larger farms would, under the above assumptions, apply lower levels of inputs.

The above highlights the fact that the relationship between land size and the fertilizer-land ratio depends crucially on the relationship between risk aversion and wealth, and the make-up of wealth in terms of stochastic and non-stochastic components. We argued earlier that although the HYV technology may appear to be neutral to scale when considered from the point of the actual physical inputs applied, when one takes account of potential constraints such as access to credit, information or crucial inputs, scale becomes important for choice of technique. If these constraints are correlated with land size then the latter may be a surrogate for a whole range of important factors. Also, 'safety-first' models (see, for example, Bell, 1972) suggest that smaller farms will have lower fertilizer-land ratios reflecting the potentially catastrophic effects of falling below some 'disaster' level of income. Therefore, in empirical analyses it is necessary to be careful when interpreting results (e.g. the coefficient of farm size) and using them for policy prescriptions. For a survey of various theoretical models see Feder, Just and Zilverman (1985).

Other factors which determine the level of fertilizer applied are those which reflect differences in productivity. In §4.2 we discussed factors which affect productivity. In general variables which reflect good farming practices and the availability of complementary resources should be included. Higher input productivity increases expected profitability and can therefore lead to higher levels of input. As with the demand for any commodity, relative prices are also important.

§4.4 Model

A common observation from farm-household surveys in developing countries is that many households do not apply any (chemical) fertilizer. Many empirical analyses of fertilizer use have chosen to eliminate such observations from the sample and focus only on households with positive applications of fertilizer. In fact, this is what we have done in Chapter 2 in our analysis of the relationship between farm size and fertilizer use. Such an approach is not satisfactory since the elimination of observations based on values of the dependent variable can lead to sample selection bias in the estimates. Applying least squares to the full censored sample (i.e. with zeros included) the coefficient estimates are biased even in large samples (see Pudney, 1989, §4.11). An alternative approach is to apply the Tobit regression technique to the full censored sample. However, this ignores the fact that the zeros can be generated by more than one process. The zeros can reflect the decision by households not to apply fertilizer given the prices they face and the characteristics of the household (e.g. its level of fixed factors which affect the productivity of fertilizer). This is the interpretation behind the Tobit model. Alternatively, the zeros may reflect, for example, a lack of own funds or an inability to secure credit, lack of knowledge about the productivity of fertilizer, or the non-availability of fertilizer because of (say) the remoteness of the farm. In this sense zeros may arise for reasons other than thise embodied in the single equation Tobit framework. We will use the term 'lack of access' to describe this collection of impediments to fertilizer use. The double-hurdle model allows us to distinguish between these two mechanisms by which zeros can be generated.

The 'double-hurdle' model used to 'explain' the level of fertilizer applied has two equations: one which 'explains' access to fertilizer and the other which explains the level applied once access arises. These are:

$$u_i = \alpha' z_i + \eta_i \tag{4.8}$$

$$y_i = \beta' x_i + \varepsilon_i \tag{4.9}$$

where the vector **z** contains variables which determine access, the vector **x** contains variables which determine the level of fertilizer applied, β and α are vectors of parameters to be estimated, η is a random disturbance term with mean zero and variance one, ε is a random disturbance term with mean zero and variance σ^2, and i refers to a household or group of households. A prime superscript denotes a row vector. Since u_i is a zero-one variable, equation (1) corresponds to the usual probit equation so we refer to it as the 'probit stage'. The variable y_i is the level of fertilizer applied and is censored at zero so we refer to this equation as the 'tobit stage'. Note that it is (4.9) which is derived from the theory presented in §4.4. We can think of (4.8) as saying that when u_i=0 household i will not use fertilizer regardless of its productivity or price. However, (4.9) tells us that even if u_i=1 we may still observe zero for fertilizer use because, foe example, its price is too high and productivity low.

Note also that the common assumption of normality for ε is not appropriate for our sample since it attaches a positive probability to negative values of y. We therefore view y as a latent variable. Dropping subscript i for convenience, we think of the observed variable y^* arising as values:

$$y^* = y \text{ if } y>0 \text{ and } u>0$$

$$= 0 \quad \text{otherwise}$$

Therefore the observed y^* are generated by the following process:

$$y^* = \max\ (y,0)$$

The log-liklihood function for this double-hurdle model is described in Atkinson, Gomulka and Stern (1984, p17). We also assume that $E(\eta\varepsilon)=0$.

For the double-hurdle model we can write the conditional expectation of y^* as follows:

$$E(y^* \mid \mathbf{x}) = \Phi(\alpha' \mathbf{z})\ [\beta' \mathbf{x}\ \Phi(\beta' \mathbf{x}/\sigma) + \sigma\ \varphi(\beta' \mathbf{x}/\sigma)] \tag{4.10}$$

where $\Phi(.)$ and $\varphi(.)$ are the cumulative and probability density functions respectively for the standard normal. Notice that the term in square brackets is the conditional expectation of y^* for the Tobit model (see Pudney, 1989, Appendix 2). In the double-hurdle model this needs to be multiplied by $\Phi(\alpha' z)$, the probability of access. Differentiation with respect to x_j (where $x_j=z_j$, i.e. x_j appears in both equations) gives:

$$\frac{\partial E(y^* | \mathbf{x})}{\partial x_j} = \varphi(\alpha' \mathbf{z})\ \alpha_j\ D + \Phi(\alpha' \mathbf{z})\ \Phi(\beta' \mathbf{x})\ \beta_j \qquad (4.11)$$

where D is the term in square brackets in (4.10). Notice that if x_j does not affect access then $\alpha_j=0$ and we have only the second term on the r.h.s of (4.11). Also note that in this case we have the equivalent calculation for the Tobit model multiplied by the probability of access. In fact as $E(\eta_i)$ approaches ∞ we get the Tobit model. Also, in the special case where there is only a constant in the first hurdle, so that there is a constant probability of having access to fertilizer, we have the p-Tobit of Deaton and Irish (1982).

§4.5 Data

We now turn to the data used in our empirical analysis. The data come from the Indus Basin Survey (IBS) which is described in Chapter 2 in more detail. Farmers were asked a series of questions which help to identify the constraints they faced and (of more relevance to our analysis here) their reasons, where relevant, for not using fertilizer. We focus on households growing improved wheat varieties (1351 households) for our analysis.

Households were asked if they used fertilizer last year and if not why not. Over 88% answered yes. Of the 12% not using fertilizer, 71% quoted 'shortage of money' as the main reason, while nearly 2% quoted 'price too high' (see Table 4.1). Other reasons given for not using were 'not available' (6.4%), 'do not need' (10.3%), 'other' (5.2%), with 5.2% not giving any reason. Interpreting 'shortage of money', 'not available' and 'do not need' as indicating lack of access then 87% of households who did not use fertilizer did not do so due to lack of access.

Table 4.1

Use of Chemical Fertilizers

Response	Farm Size 1	2	3	4	All H'slds
Not Available	2.5	4.9	0	7.1	3.6
Shortage of Money	53.7	43.9	28.6	21.4	43.6
Do Not Need	11.2	4.9	0	7.1	6.3
Other	5.0	1.6	2.9	0	2.8
Price Too High	1.2	1.6	0	0	1.2
Used Last Year	26.2	43.1	68.6	64.3	42.5
No. of Households	80	123	35	14	252(19%)
Used This Year(%)	78.2	82.3	85.4	70.2	1099(81%)

Note: The response is in answer to the question 'If you did not use chemical fertilizers last year, why not?' Sample is households not using fertilizer this year, i.e. 252 households. Each column gives the percentage of households in each farm-size category quoting each answer. All numbers, except those underlined, are percentages. All households applying fertilizer this year also applied last year.

Source: Indus Basin Survey (1976).

Table 4.2

Reasons for Not Using Credit

Response	Farm Size 1	2	3	4	All H'slds
No Need	18.4	21.7	29.4	22.6	22.1
Not Know How	21.1	18.1	15.0	9.7	18.2
Too Much Trouble	44.1	46.8	41.1	61.3	45.5
No One To Guarantee	3.0	3.3	1.7	0	2.8
Other	2.7	1.7	3.3	0	2.2
Interest Too High	10.7	8.3	9.4	6.4	9.2
No. of Households	29.2	50.2	17.6	3.0	1025

Note: The response is in answer to the question 'If you did not use credit for production purposes last year, why not?' The 1025 not using credit were 75% of sample households. Nearly 22% of those not using credit last year did not apply fertilizer this year. Each column gives the percentage of households in each farm-size category quoting each answer. All numbers, except those underlined, are percentages.

Source: Indus Basin Survey (1976).

Since 'shortage of money' was the main reason for not using fertilizer it is worth examining this constraint further. Farmers were asked if they had 'used credit for production purposes last year', and if not why not. Over 75% of the sample said they did not (see Table 4.2), this percentage being higher among those using fertilizer (88%) compared to non-users (72%). The main reason for not using credit was given as 'too much trouble' (45%). Around 18% and 3% quoted 'do not know how to borrow' and 'cannot get anyone to guarantee' respectively as the reasons for not using credit. Interpreting these three reasons as lack of access (due to lack of knowledge or the relatively high fixed cost of acquiring credit as perceived by these households) then the data suggests that over 65% of households would not respond to higher output prices or lower input (fertilizer) prices by securing more credit and applying more inputs (at least for 'small' price changes). Around 22% of the sample quoted 'do not need credit', this figure being lower among non-users of fertilizer (13%). Around 9% of households quoted 'interest rate too high'. Therefore, this suggests that around 30% of those not using credit would be in a position to respond to a higher wheat-fertilizer price ratio by increasing their use of fertilizer, i.e. they are not constrained by lack of access to funds to purchase inputs.

Farmers were also asked if they thought they were achieving 'optimum' yields, and if not why not. Although the interpretation of and replies to the question are highly subjective, the answers can be suggestive. We focus on two of the answers. 'Insufficient irrigation' was quoted as the main reason for sub-optimum yields by over 50% of the sample. This can have the effect of reducing the productivity of fertilizer and thus lead to lower levels being applied. 'Lack of fertilizer' was quoted as the main reason by 7% of households, this figure being higher (13%) for non-users of fertilizer (see Table 4.3). This answer could be taken as an indication of lack of access to fertilizer.

In §4.4 we presented a 'double hurdle' model which we will use to examine the factors which determine the level of (nitrogenous) fertilizer applied by farms. The model has two equations. The first, the *probit* stage, identifies whether or not a household has 'access' to fertilizer. The second, the *tobit* stage, is meant to explain the

Table 4.3

Non-Optimum Yields: Fertilizer Constraint

Farm Size (acres)	Reasons First	Second	Third	No. of H'slds
Less than 5	6.3(11.2)	27.0(37.5)	24.2(22.5)	367
5 to less than 12.5	7.2(13.0)	22.8(32.5)	19.8(23.6)	697
12.5 to less than 25	7.1(17.1)	24.6(28.6)	19.2(11.4)	240
25 or over	6.4(14.3)	23.4(14.3)	25.5(35.7)	47
All	6.9(13.1)	24.3(32.5)	21.1(22.2)	1351
Non-optimum Yields	98.1(99.2)	98.1(98.2)	96.9(98.8)	

Note: Responses are answers to the question 'If you do not think that you are getting optimum yields, why not?' Households gave up to three reasons. Numbers in brackets relate to households not applying fertilizer this year, i.e. approx. 19% of the 1351 households. Numbers in columns give the percentage of households in each farm-size category quoting 'lack of fertilizer' as the reason for not achieving optimum yields.

Source: Indus Basin Survey (1976).

level of fertilizer applied, given 'access'. We now describe the data used in both stages.

Probit Stage:

(i) FACC: this takes the value one if the household quoted 'not available' or 'do not need' as the reason for not using chemical fertilizer; zero otherwise.

(ii) CRDUM: this takes the value one if the household quoted 'do not know how to borrow', 'too much trouble' or 'cannot get anyone to guarantee' as the reason for not using credit for production purposes last year; zero otherwise.

(iii) NOPTIM: this takes the value one if the household gives 'lack of fertilizer' as the main reason for not achieving optimum yields; zero otherwise;

(iv) AGE/EDUC: the age and number of years of formal education of the operator respectively. These reflect experience or knowledge or the ablility to acquire knowledge.

(v) DISTV/C: these represent the distance of the farm from the nearest village and nearest city respectively. This captures difficulties of access (or the transport costs involved).

(vi) PTEN/OWNL/OWNT: equals 1 where household is classified as 'pure tenant', 'owner-landlord' and 'owner-tenant' respectively; zero otherwise. The base for comparison is 'pure owners'.

(vii) PUNJ/NWFP: equals one if household located in Punjab or NWFP respectively; zero otherwise. The base for comparison is location in Sind.

Tobit Stage:

Other variables needed to estimate the model are those which determine the level of fertilizer used once we assume that a household has access. Obvious variables to include are those which affect the productivity of fertilizer. Our estimates of the production function in Chapter 2 suggest certain variables. However, the complementarity of inputs (e.g. number of harrowings, ploughings etc.) with fertilizer can lead to bias in the estimates if these variables are included, reflecting the fact that the levels of complementary inputs are determined simultaneously. We therefore use only two of the variables suggested by our production function analyses, namely, the use of phosphatic fertilizer (PHOS) and the application of nitrogen as a top dressing (NTOPD). To the extent that these represent knowledge of best-practice techniques they can be viewed as exogenous in our model. Other variables included are:

(a) TOTASS: this is the value of total assets for the household. It includes the value of buffaloes, bullocks, milk cows, beef cattle, sheep, goats and chickens, as well as the value of tractors and threshers. In the event of total or partial crop failure households may either rely on income from animal husbandry or the renting out of draught or tractor services. Alternatively these assets may be sold.

(b) LAND: This is the total cropped acreage of the household in the rabi season.

(c) CMYLR: This takes the value one when a household used a money-lender as a source of credit. Interest rates in the informal credit market are much higher than in the formal credit market and so the net price of fertilizer prices financed from such informal sources is higher. The fact that, on the margin, households resort to moneylenders suggests that they are constrained in other sources.

(d) NOPTIM1: This takes the value one if 'lack of fertilizer' was quoted as any one of the three reasons for suboptimal yields; zero otherwise. Alternatively we use NOPTIM2 which takes the value one when this answer was given as the second ot third most important reason for sub-optimal yields; zero otherwise.

(e) JOB: This variable takes the value 1 if the operator had another occupation or profession.

(f) E1/2/3: When landlords participate in costs and receive part of the output there may be situations where it is optimal for the operator (tenant) to apply inputs to a level where the ratio of the marginal product of the input to its price exceeds unity. We can put this more formally. Imagine an operator who produces output y using inputs x_i (i=1,2). The price of output is p and of inputs w_i (i=1,2). The landlord's share of total output is r and of input costs is s_i (i=1,2). The operator, if he is allowed to choose input levels, maximizes:

$$\Pi = (1 - r) F - (1 - s_1) w_1 x_1 - (1 - s_2) w_2 x_2$$

where F = py. By examining the first-order conditions for optimal inputs one can see that the profit-maximizing farmer will apply input 1 (think of it as fertilizer) up to a level where:

$$\frac{F_1}{w_1} = \frac{1 - s_1}{1 - r}$$

where F_1/w_1 is the ratio of the value marginal product of input 1 to its price, which we call the efficiency ratio ER. With decreasing returns a higher value of ER implies lower input levels.

When $r>s_1$ then ER>1. For owner operators obviously $r=s_1=0$ so that ER=1. This also holds for tenants who pay a fixed rent for land without landlords sharing in costs or outputs. Around 67% of households had ER=1. The efficiency ratio will also equal unity when the share of the landlord's costs equals his share of output (i.e. $s_1=r>0$) - this was the situation for about 15% of households. The dominant arrangement was where outputs and costs were split equally. Less than 7% of farmers had an agreement where landlords shared outputs but not costs (i.e. $s_1=0$, $r>0$), while less than 0.5% were in an arrangement where landlords shared costs but not outputs (i.e. $s_1>0$, $r=0$). Over 8% of operators had an arrangement whereby the landlord's share of costs exceeded his share of outputs ($s_1>r$) while over 10% had an arrangement whereby the landlords's share of output exceeded his share of costs ($r>s_1$). To capture these incentive effects we include $ER=(1-s_1)/(1-r)$ as an independent variable and expect a negative sign.

Some 37 households (3.4%) had an arrangement whereby $s_1=1$ which implied a value for ER=0 - profit-maximizing operators would effectively maximize outputs using inputs up to a level where their marginal products were zero. Also a further 53 (4.8%) farmers were in an agreement where ER<1. One could argue that where the landlord has a larger share of costs than of output then it is reasonable to expect that he will also decide on the level of inputs to be applied and that this level would be set (ignoring uncertainty) at ER=1. This essentially views such tenant operators as hired workers. To capture this aspect of tenancy agreements we introduce another variable ER2 which takes the value 1 if ER=<1 and if the landlord also decided on input levels. Otherwise ER2=ER. Tenants were asked which party to the agreement decided on the level of fertilizer to be applied. Where they answered 'landlord' or 'mutual' (we assume that this response is either an optimistic view by tenants or that both agree to maximize total profit) we take this as the landlord deciding on the level of inputs. One might still think that a situation where ER<1 is not acceptable. We allow for this by using another variable ER3 which equals unity if ER2<1, otherwise ER3=ER2.

(g) IPRIV/IINAD/IMIX: In Chapter 2 we described the sources of irrigation used by households (from September to February). Where households relied mainly on private sources IPRIV=1, zero otherwise. Where households did not have access to any source of irrigation for more than two months IINAD=1, zero otherwise. Where households relied on a mixture of public and private (including Persian wells) irrigation IMIX=1, zero otherwise. The base for comparison are households who relied on public irrigation, mainly canal irrigation.

(h) TW: takes the value one if the household owned a tubewell, zero otherwise.

(i) NUMTOT: This is the number of household members. The application of fertilizer is a labour intensive task. The cost of family labour may be much lower than hired labour. This increases the cost of fertilizer applied by hired labour. One may therefore expect households with more family labour to apply higher levels of fertilizer. Alternatively, one can think of households as viewing labour as an endowment of non-stochastic wealth. In the event of partial or complete crop failure households can work in agricultural-related or non-agricultural related activities. This source of income may be viewed as non-stochastic. To capture this we disaggregate NUMTOT into 'males over 15' (MLOF), 'females over 15' (FMOF), 'boys aged 10-15' (BOYS), 'girls aged 10-15' (GIRLS), and children less than 15 (CHILD). Given the low incidence of women, boys and girls working off-farm we expect that this non-stochastic human wealth effect will show up in the MLOF coefficient.

(j) WHPR: The IBS provides data on total expenditure on and total use of fertilizer for each household. Total expenditure includes both nitrogenous and phosphatic fertilizer. We can therfore calculate the price paid for nitrogen only for those households which purchased nitrogen and not phosphate (768 households). The price of nitrogenous fertilizer was fixed at Rs2.96/kg in 1976/77 and we calculate this price for 40% of households, with 80% of households having a price 10% either side of this figure. Households without prices were assigned their regional averages.

The price of wheat (which we assume to be the relevant marginal price) is taken directly from the survey. Some 63% of households do not sell any wheat in the market, their produce going towards 'family consumption' or other on-farm consumption. The wheat price was concentrated between Rs0.9/kg and Rs1.0/kg, with 42% of surplus households quoting Rs.0.938 and 27% quoting Rs0.964. In 1976 the procurement price for wheat was Rs0.99/kg, while the average market price was Rs1.12/kg. We calculated regional averages for prices and households without quoted prices were assigned their relevant regional average. Given the fixed nature of prices there is little variation in WHPR, the ratio of the wheat price to the fertilizer price.

(k) GSAL/SLSAL/NSAL: these take the value one if land was categorized as 'generally saline', 'slightly saline' or 'non saline' respectively, zero otherwise. The base is households with 'severely saline' land.

Variables (v)-(vii) above were also included as determinants of the level of fertilizer applied.

§4.6 Results

We now turn to the results of our empirical investigations. We first present the results from our analysis of access and then from the double-hurdle model. Statistical significance is taken with respect to the 95% confidence level unless specifically stated. Whereas in an OLS regression the consequence of heteroskedasticity is only inefficient (but unbiased) estimates, estimates from probit regressions and models like the 'double hurdle' model used here are also inconsistent in the presence of heteroskedasticity. Since heteroskedasticity is common in analyses of behaviour using agricultural household data (see Chapter 3 for a more detailed discussion) we present the White (1980) t-statistic and use it as a diagnostic statistic to test for the presence of heteroskedasticity. We refer to it as the 'robust' t-statistic. Also, if the classical and robust t-statistics are 'close' then one might interpret this as evidence of model acceptability. The presence of heteroskedasticity, as well as the problem of influential observations (see Chapter 3 for a discussion), lie behind our use of the log of cropped acreage in the empirical analysis.

§4.6.1 Access

In this section we present the results of some preliminary analyses of the variables used in the 'first hurdle' or probit stage of the model, i.e. in (4.8). Since it is a common argument that small farms are more resource constrained than large farms we test for relationships between these variables, which are used to identify households which do not have 'access' to fertilizer, and farm size. In particular we concentrate on the relationship between whether or not a household applied fertilizer ('use'), whether or not it is deemed to have access (as defined in §4.3), and farm size.

Table 4.4

Access and Use of Fertilizer and Credit (Probits)

Dependent Variable	Intercept	LAND
(1) Use of Fertilizer	0.71 (6.5)	0.09 (1.6)
(2) Access to Fertilizer (FACC)	0.70 (5.6)	0.31 (4.8)
(3) Shortage of Money	-0.09 (-6.6)	-0.28 (-4.0)
(4) Access to Credit (CRDUM)	-0.31 (-3.1)	0.15 (3.2)
– Too Much Trouble	-0.34 (-3.3)	-0.03 (-0.65)
(5) Fertilizer Constraint (NOPTIM)	-1.42 (-9.5)	-0.03 (-0.45)

Note: LAND, i.e. total cultivated acreage, is the only explanatory variable. Numbers in brackets are t-statistics.

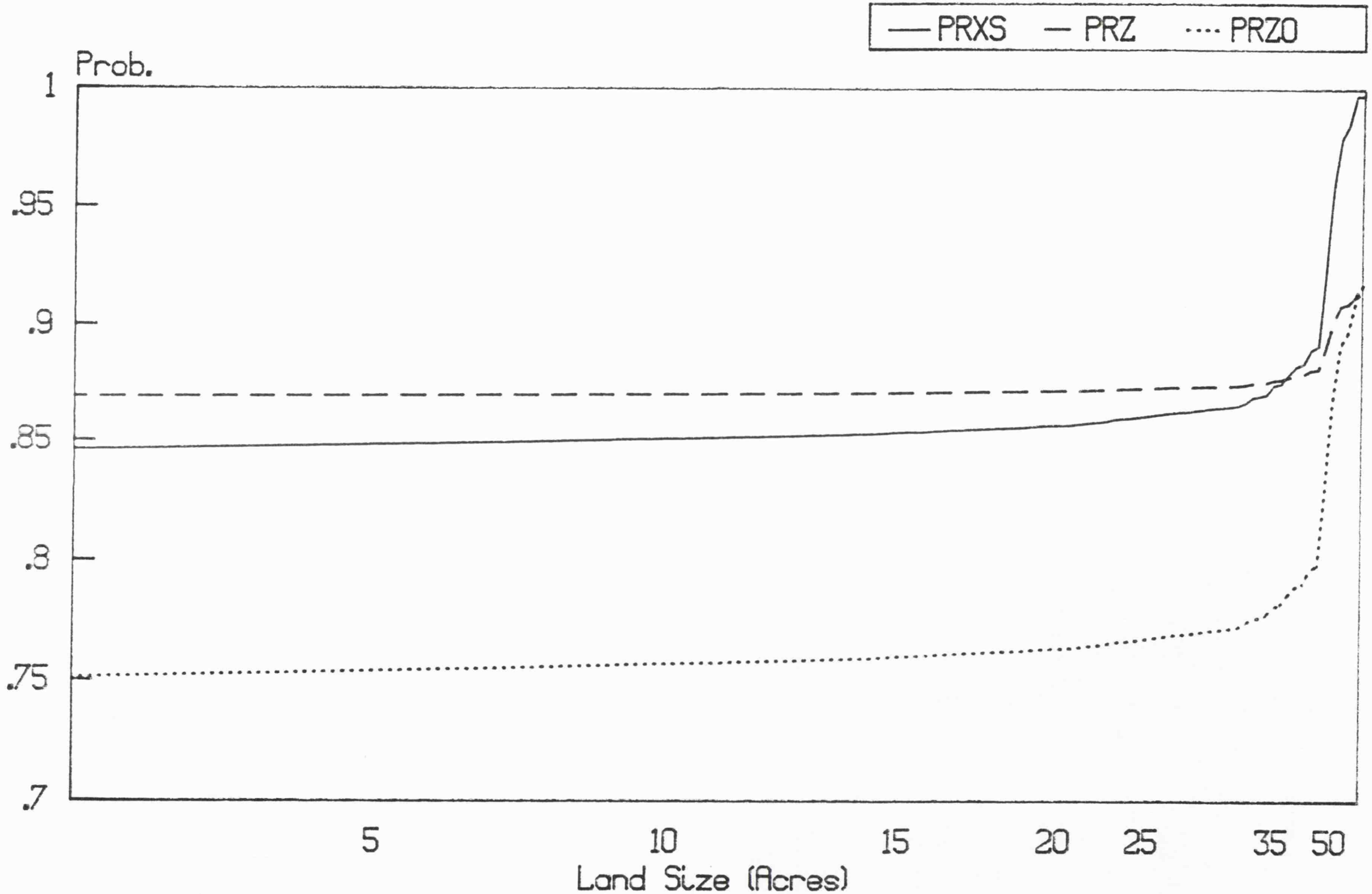
The results of various probits with farm size (in logs) as the only explanatory variable are presented in Table 4.4. In the first probit the dependent variable is a zero-one variable taking the value one if a household applies fertilizer, zero otherwise.

We find that the use of fertilizer is not significantly correlated with farm size. In the second probit the dependent variable takes the value one if households gave 'not available', 'shortage of money' or 'do not need' as reasons for not using fertilizer, zero otherwise. We interpret these answers as lack of access with the implication that such households would not apply fertilizer even if relative prices changed. We find that access is significantly positively correlated with farm size. The main reason for lack of access was 'shortage of money' and probit three indicates that this reason was also significantly negatively correlated with farm size.

The importance of 'shortage of money' as a constraint led us to analyse the reasons for not using credit. In probit four households are defined as not having access to credit if they answered 'too much trouble', 'not know how', 'no one to guarantee' or 'other'; and the dependent variable takes the value one (zero otherwise). We find a significantly positive relationship between farm size and access to credit. However, when we take 'too much trouble' as the only indicator of lack of access we find that there is no significant relationship. It may be that 'too much trouble' reflects easier sources of credit. For example, some farms will have the choice between own funds and cheap credit from agricultural banks. They may decide not to use cheap credit if the application procedure was complicated and necessitated bribes. They then rely on own funds to finance purchases and so should be categorized with households giving 'no need' as the reason for not using credit. Finally, probit five shows that when the dependent variable takes the value one if households gave 'lack of fertilizer' as the main reason for sub-optimum yields (zero otherwise) we find that this is also insignificantly related to farm size.

These results indicate that although the positive relationship between fertilizer use and farm size is only significant at the 90% level, access and farm size are more strongly and more significantly related. The main reason for lack of access to fertilizer was shortage of money. This indicates the importance of credit markets and is consistent with the policy, followed since the mid 1970s, of increasing credit availability. However, in spite of the substantial increase in credit availability through agricultural and commercial banks, these constraints still existed in the early 1980s (see §4.2). This

Figure 4.7: Probability of Access and Use



Note: PRXS is the probability of use given access; PRZ is the probability of access; PRZO is the probability of observing positive use (i.e. PRXS×PRZ) suggests that the design of schemes to get this extra credit to those who are more constrained in this respect could be improved, i.e. the targeting of credit should be made more effective.

§4.6.2 Double-Hurdle Model

Earlier we discussed certain variables which could be used to indicate households which do not have access to fertilizer, as defined in §4.3. In the *probit* stage we use two alternate sets of variables. Firstly, we identify households without access directly using the answers to the question concerning why households did not apply chemical fertilizer last year, i.e. FACC. Secondly, we use the answers to the questions concerning non-use of credit and non-optimum yields, i.e. CRDUM and NOPTIM, to indicate access. The comparison of the two is useful since identification of access directly through a variable like FACC is not always possible in data sets so that one often has to fall back on indirect variables such as CRDUM and NOPTIM. When we experimented with models which used both sets of these variables and the others described in §4.5 in the 'probit' equation we encountered problems with convergence and specification. The results presented here use both sets separately and exclude the other variables which, in any case, were always insignificant.

In Figure 4.7 we plot the relationship between farm size and both the probabilility of access, i.e. $\Phi(\alpha' z)$, and the probability that households apply fertilizer, i.e. $\Phi(\alpha' z)$ $\Phi(\beta' x/\sigma)$. These probabilities are moving averages calculated using the non-parametric technique described in §2.7 and in Deaton (1989). We can see that both the probability of access and the probability of having positive fertilizer levels increase with farm size. This reinforces the results above where we found that access to credit, the main constraint on fertilizer demand, is also positively correlated with farm size.

The purpose of the *tobit* stage is to explain the variation in fertilizer use across households once they are deemed to have access. The most significant variable is LAND, the log of total cropped acreage. To transform the estimated coefficient into elasticity form we divide (4.11) by (4.10). Since farm size does not appear in the probit stage of the model the first term on the r.h.s of (4.11) drops out. The elasticity,

Table 4.5a

Access and Use of Chemical Fertilizers (Double-hurdle Model)

	Coefficient	t-stat	Robust t
Probit Stage:			
Intercept	-2.30	-5.70	-5.30
**FACC	4.14	9.90	9.20
Tobit Stage:			
Intercept	-99.60	-4.10	-4.30
**LAND	79.50	19.00	16.00
**TOTASS	0.58	4.30	3.80
**NUMTOT	1.62	3.90	3.70
DISTV	-0.37	-0.11	-0.09
DISTC	-0.38	-0.90	-0.90
E2	7.44	0.81	0.88
WHPR	0.98	0.06	0.07
CMYLR	8.20	0.66	0.58
**PHOS	40.50	6.10	6.10
**NTOPD	42.20	6.40	6.40
**TW	30.70	4.60	4.80
JOB	8.70	0.89	0.92
*SLSAL	20.60	-2.00	-1.70
GSAL	10.80	1.40	1.30
NSAL	0.16	0.02	0.02
**OWNL	-26.80	-2.00	-2.00
OWNT	2.30	0.29	0.28
PTEN	7.12	1.10	1.10
IPRIV	0.23	0.03	0.03
**IINAD	-59.90	-4.10	-3.20
IMIX	-5.38	-0.36	-0.30
NOPTIM1	-3.51	-0.71	-0.70
PUNJ	-15.80	-1.40	-1.30
NWFP	-12.60	-0.89	-0.88
** σ	79.60	41.00	30.00

Log-likelihood at optimum	-5568
Log-likelihood for p-Tobit	-5724
Log-likelihood for Tobit	-6169
Number of observations	1351

Note: See Appendix C for notes.

Table 4.5b

Access and Use of Chemical Fertilizers (Double-hurdle Model)

	Coefficient	t-stat	Robust t
Probit Stage:			
Intercept	2.02	12.00	11.00
**CRDUM	-0.52	-2.70	-2.60
**NOPTIM	-0.80	-3.20	-2.70
Tobit Stage:			
Intercept	-90.00	-3.60	-3.80
**LAND	78.30	17.00	14.00
**TOTASS	0.59	4.20	4.00
**NUMTOT	1.78	4.10	4.00
DISTV	-2.70	-0.80	-0.66
DISTC	-0.44	-1.00	-1.00
*E2	-17.70	-1.90	-1.80
WHPR	2.20	0.13	0.16
CMYLR	10.00	0.76	0.67
**PHOS	49.60	6.90	6.40
**NTOPD	47.60	6.80	6.80
**TW	31.70	4.60	4.70
JOB	7.94	0.79	0.80
**SLSAL	27.80	2.70	2.40
GSAL	7.39	0.89	0.87
NSAL	-3.47	-0.46	-0.46
OWNL	-16.60	-1.20	-1.20
OWNT	7.06	0.85	0.81
PTEN	7.79	1.20	1.20
IPRIV	-1.87	-0.24	-0.24
**IINAD	-79.70	-5.70	-4.60
IMIX	-14.80	-0.99	-0.82
NOPTIM1	-7.81	-1.50	-1.50
PUNJ	-4.02	-0.36	-0.32
NWFP	-9.74	-0.67	-0.66
** σ	83.70	37.00	25.00

Likelihood at the optimum -5715
Number of observations 1351
Note: See Appendix C for notes.

calculated at the sample means of the explanatory variables, comes out at 0.6: a 10% increase in farm size leads to a 6% increase in fertilizer applied to wheat (see Table 4.5a). At the sample means for total cropped acreage (7.11 acres), wheat acreage (4.52 acres) and fertilizer applied to wheat (115.04 kgs), assuming that an extra acreage is allocated to wheat implies a fall in per acre fertilizer levels from 25.4 kg per acre to 23.3 kg per acre. To the extent that we have controlled, through other variables, for productivity differences, we might interpret this coefficient as evidence of increasing relative risk aversion: *ceteris paribus*, households with more land apply lower levels of fertilizer per acre. This conclusion might be reversed if one thought that the productivity of fertilizer was lower on larger farms, say, due to a lower standard of agricultural practices, and this variation in productivity was not captured by the other variables in the regression. Our discussion in §4.2 suggests that, if anything, practices are better on larger farms because of the concentration of extension services on these farms. A similar elasticity (0.61) emerges when we replace FACC by both CRDUM and NOPTIM (see Table 4.5b).

It is very common to find studies which regress fertilizer use on just farm size, controlling for no other household characteristics. In Chapter 3 our results from such a regression, applied to the truncated sample, found no systematic relationship between these variables. When we used the double-hurdle model for such an analysis (i.e. without controlling for other variables) we found a significant positive relationship and an elasticity of 0.69, implying lower per acre fertilizer levels on larger farms. This higher elasticity suggests that the combined net effect of the other variables which we did not control for is to increase relative fertilizer levels on larger farms. We return to this issue below.

Many of the theoretical models (see, for example, Feder, 1980) examine the allocation of land between a 'modern' crop and 'traditional' crops, usually where the former has higher average yields but a greater risk of lower yields (see Feder *et al*, 1985). In the above regressions the dependent variable is total (nitrogenous) fertilizer applied to the area under improved wheat while LAND is total cropped acreage. We ran an alternative regression using the double-hurdle model with both LAND and the

Table 4.6

Access and Use of Chemical Fertilizers (Double-hurdle Model)

	Coefficient	t-stat	Robust t
Probit Stage:			
Intercept	-2.32	-5.80	-5.40
**FACC	4.08	9.90	9.20
Tobit Stage:			
Intercept	-97.00	-4.50	-4.00
**LANDW	93.60	15.00	12.00
LAND	0.36	0.05	0.05
**TOTASS	0.66	5.50	5.30
**NUMTOT	1.22	3.30	3.10
DISTV	-2.31	-0.80	-0.62
DISTC	-0.27	-0.71	-0.69
E2	6.31	0.76	0.87
WHPR	-6.35	-0.43	-0.36
CMYLR	3.68	0.33	0.27
**PHOS	40.50	6.80	6.70
**NTOPD	36.80	6.20	6.20
**TW	18.20	3.00	3.10
JOB	2.77	0.31	0.31
*SLSAL	19.60	2.10	1.80
GSAL	10.00	1.40	1.40
NSAL	3.65	0.55	0.57
**OWNL	-25.20	-2.10	-2.00
OWNT	0.55	0.08	0.07
PTEN	1.64	0.28	0.28
IPRIV	-5.04	-0.75	-0.77
**IINAD	-45.50	-3.30	-2.70
IMIX	-5.93	-0.41	-0.31
NOPTIM1	-5.31	-1.20	-1.20
PUNJ	7.87	0.77	0.69
**NWFP	42.10	3.20	3.10
** σ	71.80	42.00	30.00

Log-likelihood at the optimum	-5472
Log-likelihood for p-Tobit	-5647
Log-likelihood for Tobit	-6169
Number of observations	1351

Note: See Appendix C for notes.

percentage of total cropped acreage under wheat (LANDW) as explanatory variables together with the others described earlier (see Table 4.6). Here the coefficient on LAND can be interpreted as the effect on total fertilizer applied to wheat when a household has greater total cropped acreage but the same pattern of allocation between 'modern' and 'traditional' crops. The decisions of how to allocate given land between various crops and how much fertilizer to apply to each crop are joint decisions. Theoretical models suggest that farmers with a comparative advantage in growing modern (high yield and high risk) crops will allocate more land to these crops. Comparative advantage will reflect endowments of factors (e.g. irrigation facilities or knowledge) which are used intensively in the production of modern crops and possibly reduce the variability of returns. Also, an ability to secure sufficient credit, maybe on more favourable terms, also enhances comparative advantage because of the purchased-input intensity of modern crops. However, farmers allocating more land to the more risky modern crops may compensate for the higher risk by reducing the levels of variable inputs such as fertilizer. The coefficient of LANDW captures this effect. The relationship between farm size and fertilizer intensity will depend on the farmer's attitude to risk and how the pattern of stochastic and non-stochastic wealth varies with farm size.

In our results the coefficient of LAND is significantly positive and implies an elasticity of 0.73, i.e. a 10% increase in total cropped acreage leads to a 7.3% increase in the level of fertilizer applied to wheat. At the sample means (and keeping the percentage of total cropped acreage under wheat constant) this implies a fall in per acre fertilizer levels from 25.4 kg per acre to 24.7 kg per acre. This is consistent with increasing relative risk aversion. The coefficient of LANDW is positive and significant and implies an elasticity of 0.73. At the sample averages this also implies that a 10% increase in the percentage of total cropped acreage allocated to wheat (from 0.64 to 0.7) leads to a fall in fertilizer intensity from 25.4 kg/acre to 24.7 kg/acre. This supports the view that households allocating more land to more risky 'modern' crops compensate for the additional risk by reducing input intensity for the modern crop.

The positive coefficient of TOTASS is consistent with decreasing absolute risk aversion: *ceteris paribus*, households with more non-stochastic wealth apply more fertilizer. Since farm size is held constant this implies that fertilizer intensities are positively related with TOTASS: calculated at the sample means this implies that a household with non-stochastic wealth of Rs26,535 would apply an extra kilogram of fertilizer per wheat acre compared to a household with only Rs16,980 of non-stochastic wealth. The results were very similar when we subtracted the value of tractors and threshers (possible sources of differential productivity) from TOTASS which is consistent with the suggestion that this variable is capturing the presence of absolute risk aversion.

The positive coefficient of NUMTOT is consistent with that found by Srinivasan (1972, p416) and implies that, at the sample means, an extra family member leads to an extra 1.39 kg of fertilizer applied to wheat (equivalent to 0.3 kg/acre), or that an extra 3.25 household members would lead to an extra kilogram of fertilizer per wheat acre. Bliss and Stern (1982, p75) suggest that we could interpret this in terms of labour being a safe asset (compared to cultivation) so that more family labour is equivalent to a higher level of non-stochastic assets (B in equation 4.6 above). If adult males are the only family members working off-farm then this effect will be associated with the number of adult males in the family (unless females and young male labour substitutes for adult male family members on-farm enabling adult males to work off the farm). In Chapter 2 we argued that the incidence of females and children working off-farm was very low. Indeed, when we disaggregated NUMTOT by age and gender only the number of adult males was significant (and positive). Alternatively, if one views fertilizer application as a labour-intensive task and the cost of family labour as being lower than for hired labour then the positive coefficient on NUMTOT captures this lower cost of applying fertilizer for households with a larger number of family members. Additionally, if one thinks that households have a preference for home-grown wheat then those with more family labour will seek higher output levels through applying more inputs.

The variables PHOS (whether or not phosphate was applied) and NTOPD (nitrogen applied as a top dressing) are meant to capture good fertilizer application practices. Their positive coefficients reflect the higher productivity of fertilizer on farms which

Table 4.7

Magnitude of Significant Zero-One Variables

Variable	E(Y|X)[1]	% Change[2]	Change In Fertilizer/Acre
PHOS			
1	136.8	+0.35	+7.77
0	101.6		
NTOPD			
1	137.9	+0.36	+9.84
0	101.1		
TW			
1	132.5	+0.20	+5.89
0	105.8		
SLSAL			
1	128.6	+0.16	+3.95
0	110.7		
OWNL			
1	93.1	-0.20	-5.01
0	115.8		
IINAD			
1	69.1	-0.41	-10.73
0	117.7		

Note: (1) Sample average of fertilizer levels, E(Y|X), calculated using equation (3), and the sample average of explanatory variables, X.
(2) Percentage change in E(Y|X) when dummy variable takes the value one compared to when it is zero.
(3) This is the change in E(Y|X) divided by the sample mean of wheat acreage, i,e 4.53 acres. It is interpreted as the change in per acre levels applied.

apply phosphate and where nitrogen is also applied as a top dressing. Their coefficients imply an extra 7.8 kg and 9.8 kilogram of fertilizer per wheat acre for households applying phosphate and nitrogen as a top dressing respectively (see Table 4.7). Because of their close association with the 'first hurdle' or probit stage we were worried that these variables may be endogenous. However, when we excluded these from the model the results were very similar.

Households whose land was classified as 'slightly saline' (SLSAL) also appear to apply an extra 3.9 kg of fertilizer compared to households with saline land. However, the insignificance of the other land quality variables (i.e. GSAL and NSAL) makes one suspicious that these are not capturing this effect adequately. SLSAL was significant only at the 10% level when LANDW and when both CRDUM and NOPTIM were included.

Households that owned a tubewell (TW) also apply an extra 5.9 kg of fertilizer per wheat acre. This probably captures the greater degree of control over the timing and level of irrigation and also less uncertainty about availability of the right amount at the right time. Another interpretation is that tubewell ownership also signifies a greater interest and involvement in 'modern' agriculture and a consequent stock of knowledge about the appropriate farm practices. Households which were classified as having inadequate irrigation supplies (IINAD) apply 10.7 kg of fertilizer less per wheat acre compared to households who had reliable public irrigation. However, the source of irrigation, i.e. private, public or a combination of both, does not appear to affect fertilizer levels. These results reinforce the importance of irrigation in increasing the productivity of fertilizer.

The nature of land tenure does not seem to influence fertilizer levels, except for 'owner-landlords' who apply lower levels. The significant negative coefficient of OWNL may reflect constrained resources which may in turn lie behind the decision to lease out land on a sharecropping basis. This also suggests that the Cheung (1969) view of leasing-in/out does not work perfectly since, if it did, production techniques and crop selection would be invariant to tenure type. When CRDUM and NOPTIM were used in the probit stage the coefficient of OWNL, although negative, was insignificant. However, in the same regression the coefficient of ER2 (which is meant to capture the incentive effects of the sharing of input costs and output levels) was significantly negative at the 10% level: where landlords have a higher share of output than of input costs tenants apply lower fertilizer levels.

When LANDW was included NWFP had a significantly positive coefficient. Other than this case provincial location did not appear to have any separate effect on fertilizer levels. Also, the insignificance of the price variable, WHPR, is not surprising given its small variation across households. This reflects the policy in Pakistan in the 1970s of

Table 4.8

Regression of Significant Explanatory Variables on LAND

Variable	Intercept	LAND
(1) TOTASS	-5.11	11.26
	(-3.5)	(16.1)
(2) NUMTOT	5.24	2.81
	(10.9)	(12.3)
(3) PHOS	-0.76	0.24
	(-7.3)	(4.9)
(4) NTOPD	-0.77	0.24
	(-7.6)	(5.0)
(5) TW	-0.58	0.10
	(-5.6)	(2.0)
(6) SLSAL	-0.51	-0.09
	(-4.9)	(-1.8)
(7) OWNL	-2.49	0.30
	(-9.3)	(2.6)
(8) IINAD	-1.48	-0.08
	(-8.4)	(-0.87)

Note: (1) and (2) are regressions with log of total cultivated acreage, LAND, as the only explanatory variable. (3)-(5) are probit regressions with LAND as the only explanatory variable.

fixing fertilizer and wheat prices and should not be interpreted as lack of response to relative prices. So, at least for this time period, cross-section data are unlikely to be useful for estimating the price elasticity of demand for inputs.

Finally, from the results of the double-hurdle model (see Table 4.6) we saw that the elasticity of fertilizer applied to total wheat acreage with respect to LAND was 0.6. For these estimates we controlled for other characteristics such as productivity. However, when all explanatory variables except LAND were dropped from the 'tobit' stage of the double-hurdle model we calculated a farm size elasticity of 0.69. This suggests that the combined effect of the other variables is to increase relative fertilizer levels on larger farms. To examine the relationship between farm size and the other significant explanatory variables we regressed them on farm size using OLS for continuous variables (i.e. TOTASS and NUMTOT) and probits for zero-one variables. The results are presented in Table 4.8. These show that both TOTASS and NUMTOT are significantly positively related to farm size, and that the probabilites of applying phosphate, of applying nitrogen as a top dressing and of being classified as an owner-landlord are higher on larger farms. The probability of having 'slightly saline' land is negatively related to farm size, but only significant at the 10% level, while the probability of having inadequate irrigation has no significant relationship with farm size. Although all these variables combine to increase fertilizer intensity on larger farms (probably reflecting higher fertilizer productivity) they are not strong enough to change the inverse relationship between farm size and fertilizer intensity. So the presence of increasing relative risk aversion, which has the effect of decreasing fertilizer intensity on larger farms, would appear to dominate all other (productivity and non-stochastic wealth) effects which combine to increase fertilizer intensity on larger farms.

§4.7 Conclusions

One of the stylized facts in developing countries is the wide variation in agricultural per acre input and output levels across farm households. In Chapter 2 we discussed this variability in detail for Pakistan using our data set for 1976/7. In this chapter we have focused on the variation in the level of nitrogenous fertilizer applied to improved wheat varieties. Since the increased use of fertilizer from the late 1960s is closely linked to the diffusion of HYVs, we described the nature of the new technology and highlighted the complementary nature of many inputs and farm practices. One of the conclusions from the analysis was the implications of the functioning of other markets, in particular the credit market, for the demand for fertilizer. An inability (or unwillingness) to secure any or enough credit was a major constraint on fertilizer use and we found this to be positively correlated with farm size. In spite of the large increase in credit availability through formal institutions this problem does not seem to have been alleviated by the mid 1980s.

Previous empirical analyses of fertilizer demand have neglected the need for a model which incorporates the mechanism by which the data were generated, in particular the separation of households not applying fertilizer into those who do not have access (due to, say, lack of credit or own funds to finance purchase) and those who have access but do not apply (due to, say, low profitability). The model used here tackles this problem and also incorporates the effect of uncertainty on input decisions. The simple theoretical models presented suggest that input levels are lower in the presence of uncertainty. Also, both the distribution of wealth between stochastic and non-stochastic components and the behaviour of farmers in response to additional exposure to risk determine the pattern of input intensity across farm size. Of course, a greater availability of knowledge, credit or complementary inputs (e.g. irrigation) also increases factor productivity and, therefore, intensity. Our results indicate that the factors which we expect affect fertilizer productivity (e.g. use of phosphate, application of nitrogen as a top dressing and access to reliable irrigation) are positively correlated with farm size and have the effect of increasing fertilizer intensity on larger farms. However, the presence of uncertainty operates to reverse this effect. Although larger farms have a higher level of non-stochastic wealth which, in the presence of decreasing absolute risk aversion, has the effect of increasing fertilizer intensity with farm size, the presence of increasing relative risk aversion means that the net relationship between farm size and fertilizer intensity is negative. Thus, while in the absence of uncertainty one may expect to observe fertilizer intensity increasing with farm size, reflecting their higher productivity of fertilizer, the presence of uncertainty appears to reverse this relationship.

Our results therefore highlight two separate areas for government policy. Firstly, there are the problems faced by farmers, in particular those with small landholdings (plots), in securing adequate credit, irrigation and access to knowledge provided by extension services. Preliminary results on more recent data sets suggest that these conclusions were still valid for the 1980s. In spite of the large increase in credit on favourable terms smaller farms appear to be unaware of or unsuccessful in obtaining this extra credit. One therefore needs to examine carefully the effectiveness of existing schemes in targeting this credit. The poor knowledge of farmers of recommended farm practices highlights similar problems in the diffusion of best-practice farming techniques through extension service schemes.

Secondly, the government should examine ways in which the creation of insurance markets can help to dilute the risk faced by farmers. Although our analysis did not attempt to discuss possible methods, we can point out that, if one accepts that such markets are unlikely to emerge (at least in the short to medium term) then one should look at ways in which the government can bear some of this risk through its price and income distribution schemes or in its selection of policy instruments, say for example, to raise revenue. It may be desirable to incorporate this into any reform of the credit markets since fear of losing land is often an important reason for farmers deciding not to take credit.

Chapter Five
Shadow Prices and Industrial Policy in Pakistan

§5.1 Introduction

In Chapter 1 we saw that there are many reasons why the market price of commodities may not reflect their true social value to the economy. When appraising government policies and the social value of public and private investments it is therefore necessary to allow for this divergence between relative social (or shadow) prices and relative market prices. We described how shadow prices can be used to identify welfare improving reforms in indirect taxes and government controlled prices. Shadow prices can also be used to evaluate possible reforms of trade and industrialization policy.

The main objective of this chapter is to calculate a set of shadow prices for Pakistan for 1975-6. Much of the chapter relies on the method set out in Ahmad, Coady and Stern (1988). However, we have revised and extended this paper in a number of ways. Firstly, we set out a more general model for the calculation of shadow prices which allows for the possibility of partially traded and non-traded commodities. This model is relatively easier to set up and manipulate, say, for the purposes of sensitivity analysis. Secondly, we can now use direct price comparisons between domestic and world prices which were not previously available. This eliminates the need to use crude assumptions to calculate these ratios and the results help to emphasise important issues which need to be considered when formulating industrialization and trade policies. Thirdly, we discuss how optimal short-term government policies (e.g. pricing and taxation policies) can deviate from optimal long-term policies due to the presence of non-linearities such as fixed costs or constrained government policies.

In §5.2 we give a brief description of the evolution of industrialization and foreign trade policies in Pakistan and summarize previous attempts at calculating their effect on the structure of incentives and relative prices. In §5.3 we discuss the principles employed to calculate shadow prices and §5.4 describes the data at our disposal. The results of our analysis are presented in §5.5, and §5.6 sets out some general conclusions.

§5.2 Industrialization and Foreign Trade Policy in Pakistan

Since Independence in 1947 the various governments in Pakistan have undertaken extensive intervention in the economy in an attempt to manipulate the incentives facing domestic producers. While these interventions have taken various forms all have had the consequence that the system of relative prices facing producers and consumers have diverged substantially from relative shadow prices. In this section we first give a brief description of government industrialization and trade policies in Pakistan since Independence. Much of the description is based on information from Ahmed and Amjad (1984), which in turn draws on many other studies of policy in Pakistan, e.g. Papanek (1967), Soligo and Stern (1965), Lewis and Guisinger (1968), Lewis (1970), Little *et al* (1970), Falcon and Papanek (1970), and Guisinger (1981). We show that there has been a gradual movement away from quantative restrictions on domestic production and foreign trade in favour of the manipulation of price incentives (see Guisinger and Scully, 1991, for a more detailed discussion). We then give a brief summary of previous attempts to empirically analyse the effects of government policy on price incentives.

§5.2.1 *The Evolution of Policy*

At Independence the manufacturing sector in Pakistan (both East and West) was minimal, reflecting their previous position as major supplier of primary raw materials to manufacturing industries in India. The main preoccupation of the newly installed parliamentary government concerned the rehabilitation of refugees, the setting up of a defence capability, price stability, and industrialization of an economy previously dominated by agriculture. Price controls were introduced and government policies focused on the promotion of industrial growth through such incentives as accelerated depreciation allowances, tax concessions on industrial profits and the duty-free import of capital goods. In September 1949 sterling devalued as did the Indian rupee. The decision by Pakistan not to devalue had important ramifications since, at that time, nearly 67% of Pakistani exports (e.g. jute and cotton) went to the UK and India and almost 68% of its imports originated in these two countries. India viewed the Pakistani decision as an attempt to extract higher prices for its major exports, particularly jute, and retaliated by suspending trade. This forced Pakistan to abandon its liberal import policy in September 1949 when it introduced loose trade controls. The outbreak of the Korean war in June 1950 led to an increased demand for raw materials with a consequent hike in their international prices. This presented an opportunity for Pakistan to diversify its trade to other countries in the sterling area and to relax import controls. In February 1951 India recognised the new exchange rate and trade was resumed, albeit at a much reduced level.

The initiation of peace negotiations between the superpowers in mid 1951 precipitated a downturn in the world prices of raw materials so that the terms of trade went against Pakistan with the consequent fall in export earnings and recession. The liberal import policy continued until mid 1952 but expectation of new import controls, because of a deteriorating balance of payments position, encouraged stockpiling. The balance of payments position was further worsened by food shortages. The 'open general licence' scheme (i.e. open to all producers) for imports was suspended in November 1952 and a stricter import licensing system introduced with a bias towards 'essential' raw materials and preferential treatment given to those who had imported during 1950-2. Since these were also the main domestic producers this policy operated so as to give an element of monopoly. The relatively high premium on consumer commodities, reflecting tighter control on imports of consumer items, encouraged their domestic production and high industrial growth. Export duties and price controls on agricultural commodities kept raw material prices low, further increasing the profitability of agro-based industries. Interregional movements of grain were tightly controlled and banned in some instances. Also, major industrial investments had to be sanctioned by the government. The industrial and import liscencing systems were seen as being corrupt and also responsible for the low capacity utilization in industry.

With the introduction of military pacts with Western countries in 1954, Pakistan secured significant aid flows from USA, Canada and Australia. As import substitution possibilities reduced and agriculture remained stagnant the country experienced a slowdown in growth. In an attempt to promote agricultural and export growth the rupee was devalued in July 1955 (by 30% in relation to sterling). However, an initial growth in exports did not persist and a more elaborate Export Promotion Scheme was introduced which entitled exporters to import licences to the extent of 25-40% of the value of exports for manufacturers and 15% for the exporters of raw materials. In an effort to stimulate agricultural output emphasis was placed on an improved distribution system for major agricultural inputs. However, by 1956 the balance of trade had entered into deficit reflecting declining exports and increasing imports due to growing development needs and increased imports of wheat and rice (reflecting more food shortages). A *coup d'ètat* in October 1958 saw the introduction of a military government under Ayub Khan, which later converted to a presidential form of government.

The new government of 1958 immediately imposed strict controls on prices, imports, black-market transactions and tax evasion. However, by mid 1960, prices were decontrolled and restrictions on investment decisions and foreign trade relaxed. The value of import liscences was increased and new exports encouraged (the list of 'approved' exports was replaced by a 'banned' list). Greater emphasis was placed on the reduction of government intervention and increasing reliance on market forces. Priority was given to agriculture and export-oriented industries. The Export Bonus Scheme, introduced in January 1959, gave import permits to exporters, initially to the value of 10-40% of export values but later made more uniform at 20-30% of export values. These permits were transferable and earned a premium of 100-190% of face value, reflecting the tight restrictions on the import of consumer goods, especially luxury items. The list of imports which could be purchased under the scheme was expanded as was the eligibility criteria for exporting industries. The number of 'automatically approved' imports was increased and the 'open general liscence' scheme reintroduced in March 1961 and included industrial items, agricultural items and also consumer goods. In order to facilitate planning by private firms 'advance liscencing' was introduced in the first half of 1962. In 1964 a 'free list' of goods which could be imported without liscences was introduced and the list expanded to 50 items by the end of 1964, although import duties were increased from 5% to 20%. In 1965, for the first time, the government announced import policy for the whole year. Other incentives included the Export Credit Guarantee Scheme, Export Preferential Licences, the setting up of an Export Market Development Fund and also of Trade Offices and Display Centres abroad. Easier access for imported raw materials helped to increase capacity utilization. Although exports increased consistently until the late 1960s the trade gap widened because of imports of raw materials and capital goods and the increased import of food. There was also a large increase in the level of foreign loans.

War with India broke out in September 1965 leading to an increase in defence expenditure and a fall in the inflow of foreign loans. Together with a bad harvest in 1966 these led to foreign exchange constraints and a fall in industrial growth. As a result import controls were made more strict. Although the introduction of high-yielding variety seeds was reflected in increased agricultural output, the unrest of winter 1968 was followed by the fall of the Ayub Khan government in March 1969 and the re-imposition of martial law. Civil War broke out in March 1971 and East Pakistan separated to become what is now called Bangladesh. In West Pakistan the Peoples' Party came to power in December 1971 with a parliamentary form of government.

An important task of the new Peoples' Party government was to find new markets for commodities previously 'exported' to East Pakistan (e.g. oilseeds, raw cotton, tobacco, foodgrains, cotton fabrics, yarn and thread, machinery, drugs and medicines, tobacco manufactures and cement) and new sources for goods previously imported from there (e.g. jute goods, tea, paper and products, and matches). In an attempt to promote agricultural and export growth, in May 1972 the rupee was devalued from Rs4.76/dollar to Rs11/dollar - the devaluation of the dollar in February 1973 by 10% implied a Rs9.9/dollar exchange rate. Export duties on rice and cotton were introduced but the government failed in its attempt to re-introduce 'compulsory' procurement of wheat in 1972/73 due to pressure from a powerful farming lobby. Fertilizer prices were almost doubled between September 1972 and August 1973 and distribution of the majority of fertilizer was only through government centres. The Export Bonus Scheme was abolished and restrictive importing liscencing replaced by a 'free' and 'tied' list. All imports not in these lists were banned. However, access to foreign exchange was still tightly controlled by the government, and import duties were reduced.

As well as introducing land reforms and increasing the procurement price of agricultural goods by almost 100% the government immediately set about nationalizing major industries previously controlled by a relatively small number of families. Initially nationalization was limited to intermediate and capital goods industries but was later extended to include others. In January 1972 the government nationalized 31 major manufacturing enterprises covering ten subsectors, including textiles, sugar refining, forestry, natural gas, cement, fertilizers, chemicals, heavy engineering, machine tools, ceramics, automobiles, steel mills and petroleum products. Later the vegetable ghee industry was included and in August 1976 the government took control of cotton ginning factories, and rice husking and flour mills. Exports of cotton and rice were also controlled by the public sector since 1973. In an attempt to remove the substantial power held by the large families due to their control of both industrial and financial interests, the banking and insurance sector was nationalized.

The policies implemented by the new government led to a substantial rise in exports. However, world events and unfavourable agricultural conditions combined to give low growth. The oil price hike in 1972-73 led to rising prices for major imports (e.g. petroleum and oil products, wheat, edible oils, fertilizers, chemicals, metals and machinery) and a fall in international demand for exports. A series of agricultural disasters further contributed to a fall in exports. Floods and pest attacks in 1973 and 1976 devastated large areas of cultivated land with adverse effect for exports of raw cotton (so that Pakistan was unable to reap the benefits of a hike in the world price of cotton). Recession in the cotton textile industry led to reduced export duties which were eventually abolished in 1974. The export duties of some raw cotton varieties were also reduced, or abolished completely for other varieties. The increased cost of raw cotton, balancing-modernization-replacement capital, and imported raw materials led to the introduction of rebates for textiles and other exported manufacturing products.

In spite of the high inflation rate of over 30% between 1972-74 the government invested heavily in large public investments (e.g. infrastructure and heavy capital goods industries) which had long gestation periods. The justification for these investments lay in a national policy of self-reliance in such areas as food, fertilizers, energy and basic industries. These investments were financed mainly through foreign aid and deficit financing and were intended to set up a capital goods base in the country. Remittances from abroad increased dramatically in the mid 1970s but it is often argued that, because of uncertainty concerning government policies about investment and nationalization, much of these were chanelled towards consumer goods thus exacerbating inflation. With exports stagnating and imports remaining high despite tougher import restrictions, the balance of payments deteriorated further. A bumper wheat crop in 1976 was not sufficient to prevent political opposition in early 1977 which eventually led to the overthrow of the Peoples' Party and the imposition of martial law.

President Zia immediately set about a process of gradual denationalization. In September 1977 agro-based industries were privatized and heavy industries, e.g. chemicals and cement, were made more open to private investment. So as to encourage the expansion of private investment both fiscal and non-fiscal incentives were introduced. Economic controls were relaxed and bureaucratic procedures simplified, in particular for sanctioning private sector investment. Emphasis was placed on agricultural and export growth. In an attempt to remove pricing distortions, agricultural input subsidies were reduced and procurement prices for major crops increased. The rationing of wheat flour and sugar was ended in 1985 and price controls on edible oils lifted. Export industries were entitled to rebates of trade tariffs (from 3% to 35% of export value), 'compensatory rebates' of domestic indirect taxes varying between 7.5% and 12.5% of export values (for cotton textiles, engineering goods, canvas, fertilizer, acetate yarn, cutlery, carpets, sports goods and surgical instruments and other commodities), income tax rebates of 55% of the amount of income tax and super tax payable, duty-free import of certain new machinery and equipment under the Balancing Modernization and Replacement Scheme (which now included 'new investment' and 'expansion' investment), duty-free import of certain raw materials and access to imports that would otherwise be banned, and access to cheap credit. Export Processing Zones were set up to encourage investment by foreigners, including Pakistanis living abroad. Exporting firms located in these zones could import machinery and raw materials free of import duties, and were exempt from all federal, provincial and municipal taxes. These policies along with good weather helped to stimulate growth. However, inflation and foreign debt remained high, as did the deficit on the balance of payments despite substantial increases in emigrants' remittances.

From the above one can see that, since 1970, the government has employed a wide range of incentives in order to stimulate agricultural growth and promote the export of both agricultural and manufacturing commodities. Before one can judge the appropriateness of such incentives one needs to indentify which industries are socially profitable and we turn to this in §5.5.

§5.2.2 *Empirical Studies*

One of the most common methods of analyzing the system of indirect taxes and other government controls is the calculation of effective protection rates (EPRs). The EPR of an industry is defined as its value added at domestic prices less that at world prices, as a proportion of value added at world prices. It is a positive, as opposed to a normative, concept which purports to identify the resource-pull effects of government indirect tax and trade policies. However, as an indicator of resource pull it is not completely reliable since

> 'it is possible that without this assumption (of fixed coefficients for intermediate inputs) the effective protection given to an activity rises, but this induces such strong substitution of intermediate inputs for primary ones, that the primary factor use in that industry actually falls' (Dixit and Norman, 1980, p163).

Also the results of EPR studies are often interpreted in a way which suggests that the tax rates (or effective protection provided by trade taxes) on industries with high EPRs whould be reduced while those on industries with low EPRs should be increased. This is very similar to the argument for uniform taxes which requires very special assumptions in order to be optimal (see Chapter 1). A comparison of the EPR of an activity with its nominal protection rate (NPR) captures the effects of input taxes on domestic value added. For example, if input taxes are negligible then the EPR and NPR will coincide, while, for a given output tax (domestic or trade), the higher the input taxes (domestic or trade) the lower the EPR for the activity.

In Chapter 1 we saw that when distortions which create a divergence between relative producer and shadow prices exist in the economy one should use shadow prices when evaluating government policies and identifying welfare-improving reforms. Since the EPR approach does not take into account divergences between market prices and social opportunity costs (or shadow prices) for non-traded and factor inputs, it cannot be legitimately used in this manner. It is important to appreciate that EPRs do not tell us what protection should be given but only what (in a rather narrow sense) is given as a result of tariffs, quantitative restrictions and domestic taxes. If we evaluate non-traded inputs at shadow prices then we have essentially moved to the notion of domestic resource costs, and the additional step of evaluating factor inputs at shadow prices takes us to our system of shadow prices.

A comparison of the EPR for manufacturing activities for 1963/4, 1970/1, and 1972/3 is presented in Table 5.1. The broad features are as follows. Firstly, both the NPRs and EPRs are highest for consumer goods, followed by investment goods and then intermediate goods. Secondly, NPRs underestimate the degree of protection in virtually all cases. It is also noticeable that seven industries (i.e. sugar, edible oils, other textiles, motor vehicles, rubber products, fertilizers and metal products) had negative value added at world prices in 1963/4, and yet all except for fertilizers were among those industries with the highest NPRs. By 1970/1 none of these industries had negative value added at world prices. This may reflect movements in world prices or increased technical efficiency in production but it is also the case that the levels of nominal protection have been consistently falling over time.

Another approach used to summarize the system of indirect taxes in Pakistan is the 'effective tax' approach recently formulated by Ahmad and Stern (1986). The effective tax on an activity is defined as the increase in government revenue as a result of a unit increase in the output of that activity. These were calculated for Pakistan for 1975/6 using data very similar to those used here to calculate shadow prices. The calculations, presented in Table 5.2, assume 100% forward shifting of taxes and that imports are complementary to domestic production.

By comparing nominal with effective taxes we can capture the extent of taxation

Table 5.1

Nominal and Effective Protection Rates for Manufacturing Activities

	1963/4		1970/1		1972/3
	NPR	EPR	NPR	EPR	NPR
Consumer Goods					
Sugar	215	nva	266	585	57
Edible Oils	106	nva	54	130	62
Cotton Textiles	56	733	76	172	0
Other Textiles	350	nva	141	317	88
Printing and Publishing	28	22	43	36	57
Soaps	94	178	43	106	34
Motor Vehicles	249	nva	270	595	61
Simple Average	157	nc	128	277	63
Intermediate Goods					
Wood and Lumber	73	1150	85	197	108
Leather Tanning	56	567	76	177	0
Rubber Products	153	nva	55	132	48
Fertilizers	15	nva	25	64	na
Paints and Varnishes	102	257	56	134	34
Chemicals	81	300	56	106	34
Petroleum Products	107	-6	121	274	65
Paper Products	94	376	57	177	69
Simple Average	85	nc	66	158	43
Investment Goods					
Nonmetallic Mineral Pdts.	154	335	76	182	70
Cement	75	64	76	182	70
Basic Metals	66	525	96	220	32
Metal Products	95	nva	102	235	64
Nonelectrical Machinery	89	355	81	188	44
Electrical Machinery	60	138	83	192	47
Simple Average	90	nc	86	200	50
All Industries					
Simple Average	110	nc	92	52	

Source: Guisinger (1978).

Note: nva=negative value added, nc=not calculable because of presence of negative value-added industries, na=not available.

Table 5.2

Nominal and Effective Taxes in Pakistan, 1975/6

	Sector	t^d	t^e	t^{diff}	t^{diff}/t^d
01	Wheat	-0.020	-0.014	0.006	-0.321
02	Rice	0.000	0.023	0.023	-
03	Cotton	0.000	0.010	0.010	-
04	Sugarcane	0.000	0.009	0.009	-
05	Tobacco Growing	0.188	0.198	0.010	0.054
06	Oilseeds	0.000	0.010	0.010	-
07	Pulses	0.000	0.020	0.020	-
08	Other Crops	0.000	0.007	0.007	-
09	Livestock	0.000	0.005	0.005	-
10	Fishing	0.000	0.011	0.011	-
11	Forestry	0.000	0.008	0.008	-
12	Mining & Quarrying	0.013	0.044	0.031	2.436
13	Grain Milling	0.000	-0.048	-0.048	-
14	Rice Milling & Husking	0.000	0.045	0.045	-
15	Edible Oils	0.092	0.139	0.047	0.504
16	Sugar Refining	0.268	0.287	0.019	0.071
17	Gur and Khandsari	0.000	0.016	0.016	-
18	Tea Blending	0.070	0.112	0.043	0.615
19	Fish & Preparations	0.000	0.026	0.026	-
20	Confectionery & Bakery	0.105	0.185	0.080	0.763
21	Other Food Industries	0.003	0.043	0.040	15.431
22	Beverages	0.076	0.166	0.091	1.193
23	Tobacco Products	0.720	0.777	0.057	0.079
24	Bidis	0.000	0.065	0.065	-
25	Cotton Yarn	0.028	0.087	0.059	2.096

26	Cotton Ginning	0.000	0.024	0.024	-
27	Cotton Textiles (Large Scale)	0.022	0.095	0.073	3.277
28	Cotton Textiles (Small Scale)	0.000	0.060	0.060	-
29	Silk & Synthetic Textiles	0.079	0.194	0.115	1.451
30	Woollen Textiles & Hosiery	0.083	0.157	0.074	0.886
31	Threadballs and Other Textiles	0.000	0.079	0.079	-
32	Carpets & Rugs	0.000	0.091	0.091	-
33	Made-up Garments	0.000	0.148	0.148	-
34	Footwear (Non-rubber)	0.014	0.073	0.059	4.124
35	Wood, Cork & Furniture	0.000	0.050	0.050	-
36	Paper & Products	0.064	0.149	0.085	1.317
37	Printing and Publishing	0.000	0.080	0.080	-
38	Leather & Products	0.011	0.032	0.021	1.987
39	Rubber Footwear	0.000	0.107	0.107	-
40	Rubber Products	0.310	0.379	0.069	0.221
41	Pharmaceuticals	0.000	0.169	0.169	-
42	Fertilizer	-0.267	-0.152	0.115	-0.431
43	Perfumes & Cosmetics	0.344	0.453	0.109	0.316
44	Paints & Varnishes	0.288	0.400	0.112	0.391
45	Soaps & Detergents	0.121	0.187	0.066	0.545
46	Chemicals	0.053	0.138	0.085	1.612
47	Plastic Products	0.290	0.398	0.108	0.372
48	Petroleum Products	0.311	0.350	0.039	0.125
49	Cement	0.120	0.271	0.151	1.250
50	Glass & Products	0.207	0.399	0.193	0.932
51	Non-metal Mineral Products	0.004	0.096	0.092	23.997
52	Basic Metals	0.000	0.076	0.076	-
53	Metal Products	0.073	0.152	0.079	1.082
54	Iron & Steel Remoulding	0.000	0.035	0.035	-
55	Agricultural Machinery	-0.078	0.029	0.107	-1.368
56	Other Non-electrical Machinery	0.000	0.082	0.082	-
57	Electric Machinery	0.000	0.096	0.096	-

58	Bicycles	0.000	0.100	0.100	-
59	Transport (Large Scale)	0.003	0.112	0.109	33.643
60	Shipbuilding	0.000	0.065	0.065	-
61	Transport Equipment (Small Scale)				
62	Office Equipment	0.000	0.099	0.099	-
63	Sports Goods	0.000	0.067	0.067	-
64	Surgical Instruments	0.000	0.054	0.054	-
65	Other Large Scale Manufacturing	0.471	0.534	0.063	0.133
66	Other Small Scale Manufacturing	0.000	0.095	0.095	-
67	Low-cost Residential Building	0.000	0.081	0.081	-
68	Luxurious Residential Building	0.000	0.095	0.095	-
69	Rural Buildings	0.000	0.037	0.037	-
70	Factory Buildings	0.000	0.103	0.103	-
71	Public Buildings	0.000	0.076	0.076	-
72	Roads	0.000	0.029	0.029	-
73	Infrastructure	0.000	0.126	0.126	-
74	Ownership of Dwellings	0.000	0.035	0.035	-
75	Electricity	0.000	0.216	0.216	-
76	Gas	0.402	0.544	0.141	0.351
77	Wholesale & Retail Trade	0.000	0.012	0.012	-
78	Road Transport	0.000	0.084	0.084	-
79	Rail Transport	0.000	0.111	0.111	-
80	Air Transport	0.000	0.097	0.097	-
81	Water Transport	0.000	0.014	0.014	-
82	Television	0.000	0.067	0.067	-
83	Radio	0.000	0.034	0.034	-
84	Phone, Telegraph & Post	0.000	0.034	0.034	-
85	Banking & Insurance	0.002	0.044	0.041	16.697
86	Government	0.000	0.045	0.045	-
87	Services	0.003	0.016	0.013	4.172

Source: Ahmad and Stern (1988), Table 3, pp. 63-65.

Notes: t^d and t^e are nominal and effective taxes respectively, and are given as percentages of purchaser prices. Also, $t^{diff} = t^e - t^d$.

of an activity arising from the taxation of its inputs, inputs into these inputs and so on. To the extent that the consequences of cascading taxation were not taken into account when setting tax rates one can interpret divergences between effective and nominal rates as the unintended consequences of the tax system. So one could use the results as the basis of arguments for tax rebates, as is often done by exporting activities in Pakistan. For example, a study by Khan (1978) for the mid 1970s suggested that many exporting activities (e.g. cloth, canvas, carpets, shoes, sports goods and surgical instruments) are effectively taxed by the protection system. The results from the effective tax study suggest that the degree of cascading in the indirect tax system is high. In the mid 1980s compensatory rebates, ranging from 7.5% to 12.5% of export value, were given to many exportables. The results in Table 5.2 suggest that these rebates were appropriate although maybe slightly higher than the extent of intermediate taxation. Also, major exports such as carpets and rugs, made-up garments, cotton textiles, sports goods and surgical instruments, which are exempt from nominal taxes, are effectively taxed through the taxation of intermediate inputs to the extent of 5-15% of market values.

§5.3 Principles for the Computation of Shadow Prices

The shadow price of a good is defined as the increase in social welfare which would arise if an extra unit of public supplies were to be made available. This definition requires us to calculate the full consequences of an extra unit taking into account all the interactions of the economy and then to evaluate the changes using some definition of social welfare. This is the definition that underlies the standard cost-benefit manuals (see e.g. Little and Mirrlees, 1974; or Dasgupta, Marglin and Sen, 1972) and it can easily be shown that this is essentially required for a cost-benefit test to correctly identify a social improvement - see Drèze and Stern (1987). Modelling the consequences of a small change in public supplies is, in principle, a formidable task and most methods of calculating shadow prices involve shortcuts in an attempt to simplify this task. One of the best known procedures is that of Little and Mirrlees (1974) - henceforth LM - and this is the one followed here. We shall describe the method briefly below indicating some of the most important assumptions involved in its justification.

Once shadow prices have been calculated they can be put to use in a much more disaggregated way than would be possible when using a fully articulated model of the economy. And they can also be adapted to incorporate different views about, for example, the functioning of labour markets more easily than would be possible in a completely specified general equilibrium model. Hence whilst one loses something in the description of the economy, in particular concerning the effects of big changes or the use of short-cuts which may do violence to the reality, there is much to be gained in terms of disaggregation and flexibility.

The method employed here to calculate shadow prices is that presented in LM which is based on a set of guiding principles which stand in place of a fully articulated model. These simple rules give us robust estimates of shadow prices without having to go through difficult and often dubious modelling. Firstly, shadow (or accounting) prices for traded goods should be based on world or border prices: 'border prices can be used as accounting prices for all traded goods, because they represent the opportunity costs or benefits of using or producing a traded good' (LM, p68). The terms shadow and accounting prices will be used interchangeably in this paper.

Secondly, 'when considering the use of a non-traded good whose output will be consequentially expanded then the accounting price is equal to the marginal social costs of production' (LM, p70). In practice when computing a system of accounting prices this marginal social cost rule is generally used for all non-traded goods, and that is the method adopted here. The assumptions involved in using the rule across the board in this way are rather stringent and involve strong assumptions concerning the optimality of government policy (they are discussed formally in Drèze and Stern, 1987). One hopes, however, that in the terms of the broad sectoral accounting prices calculated here they are not overly misleading and they do have the advantage of not requiring detailed demand information. For more disaggregated sectoral work one can be more refined, asking in particular how much of an extra input used comes from extra production and how much from extra consumption. Some sensitivity analysis to the marginal social cost assumptions is provided by calculating shadow prices under various alternative assumptions concerning which goods are traded and which are not.

Thirdly, the method takes explicit account of the way in which a project affects the distribution of income between public and private sectors and across individuals: 'Thus government consumption, government saving, private consumption and private savings may all be considered to have different social values' (LM, p71) and 'we put considerable weight on the use of shadow wages as a means of allowing for the effects of a project on equality' (LM, p72), and 'The profits from a project are, of course, weighted according to whom they accrue' (LM, p72). The estimates of shadow prices thus incorporate judgements on income distribution, most notably through the shadow wage.

The method requires the classification of goods as being imported, exported or non-traded at the margin. If it is assumed that extra supplies of a good are met through imports, then the sector is treated as imported, and similarly for the other possibilities. Notice that the classification therefore depends, in part, on government policy - if there is a quota on a good which can be imported but the quota will not be changed than we must treat the good as non-traded. One also has to consider how world markets and domestic production and consumption activities are likely to change over the future. Hence one should never be completely confident about the appropriateness of one particular set of classifications and, accordingly, we shall investigate a number of them in this paper.

The numeraire, or the unit of account for cost-benefit calculations, in the LM method is uncommitted foreign exchange in the hands of the government. All domestic values are converted to a foreign exchange equivalent, and incomes committed to particular uses (e.g. the consumptions of certain groups) are evaluated relative to uncommitted government income. The calculation of shadow prices for goods which are traded at prices which may be treated as fixed on the world market is, in principle, straightforward. If the good is imported then its shadow price is the c.i.f. price, plus transport and distribution costs at shadow prices. Note that trade taxes are excluded. If a good is exported, the shadow price is the f.o.b. price less transport and distribution costs at shadow prices. What matters is the foreign exchange earnings or savings as a result of the increased supply. These foreign exchange earnings may have a different value from that given by the official exchange rate but the relative values of traded goods are given by their relative world prices. Also, where world prices are not fixed one uses marginal revenues or marginal costs.

The shadow price for non-tradeables proposed by LM is the marginal cost of an extra unit, valuing the inputs at shadow prices. The calculation of the marginal cost of non-traded goods at shadow prices therefore requires us to know the input requirements and the shadow prices of these inputs. The inputs will be traded goods, non-traded goods and the factors of production. Thus to calculate the shadow price of one non-traded good we must know the shadow prices of the other non-traded goods. One also needs to know the shadow prices of factors and we return to these below.

The calculation of the shadow prices of non-traded goods then proceeds by decomposing the cost of a good into its constituent elements of taxes, payments for traded goods and payments for each factor involved. The appropriate shadow prices are then applied to each element (zero in the case of taxes). This is possible using an input-output table provided (i) we can classify goods as traded or non-traded; (ii) we are prepared to make the assumption that the coefficient matrix, A, represents marginal requirements (at the relevant level of production); and (iii) we are able to decompose value-added into constituent payments to factors.

To calculate the shadow price of non-traded commodities we therefore need to calculate the shadow values of domestic factors of production used in their production. We have to calculate the opportunity cost, defined in terms of social welfare, of the employment of and payment to each type of factor. If the employment of an extra unit of a factor does not involve a payment to it over and above its earnings elsewhere, and those earnings represent its marginal product at market prices, then the shadow value of the factor may be calculated by multiplying the market price of the factor by the ratio of shadow price to market price for the type of goods the factor might have produced. This ratio is often called a 'standard conversion factor' (SCF). Given that the numeraire is foreign exchange this SCF may be interpreted as the reciprocal of a 'shadow exchange rate' (used in other methods of cost-benefit analysis).

It should be emphasised, however, that there is no single SCF. The SCF we choose should depend on the bundle of goods that the factor would have produced elsewhere. This would differ, for example, between rural and urban workers (see Drèze and Stern, 1987, for further discussion).

§5.3.1 *Labour*

Where the employment of an extra unit of a factor gives rise to earnings above those which would have been earned elsewhere then the payment to the factor overstates the cost since we have to take account of the benefits arising from the extra consumption. If c is the payment to the factor and m its earnings elsewhere (assumed equal to the marginal product), both at market prices, then the shadow price (i.e. the shadow wage rate - or SWR) is the (appropriate) SCF times

$$c - \mu(c - m) \qquad (5.1)$$

where μ is the value of extra income to the factor in terms of government revenue (which is taken as the numeraire). The SCF used to convert c and m from market to shadow prices is a weighted average of the accounting ratios (ARs), defined as shadow prices divided by market prices, of the appropriate bundle of goods. In the case of m the appropriate bundle of goods is that containing the commodities which labour would have produced elsewhere and, in the case of c, that containing commodities consumed by the worker.

Examples of the use of SCF and (5.1) are as follows. If labour is hired from a competitive labour market then $c=m$ so that SWR is simply the SCF times c. Alternatively, if the government attaches no value to extra income to the workers because, say, it thinks it has overwhelmingly important uses for further funds, then $\mu=0$ and the SWR is again calculated as the SCF times c, even if $c>m$. Also, if redistribution of income can be achieved using non-distortionary policy instruments then $\mu=1$ and the SWR is again the SCF times c. However, if both $\mu>1$ and $c>m$ then the SWR will be lower reflecting the social value of extra consumption. It is therefore clear that the SWR will depend on the functioning of the labour market.

Note that we have assumed that only one worker leaves employment elsewhere for each job created. However, if more (or less) than one leaves, as is the case of Harris-Todaro type models of the labour market (see Harris and Todaro, 1970), this can be easily incorporated into (5.1). We also assumed that previous earnings *m* were equal to the marginal product elsewhere, e.g. in the rural sector. But if labour was earning an amount *a* (say on a farm) and its marginal product *m* was less than *a* (both in previous employment) then the earnings of those left on the farm increases by (*a*-*m*) and his income increases by (*c*-*a*) so that the total increase is still (*c*-*m*). There is therefore a wide class of possibilities for the SWR depending inter alia upon the priority on government expenditure, the redistributional policy instruments available to the government, the structure of the labour market and labour's marginal product elsewhere.

§5.3.2 ***Capital***

Value added, conventionally measured, generally constitutes payments to labour, land, capital and an element of pure profits. The social cost of labour (i.e. the SWR) has been discussed above and the social cost of land will be discussed in Appendix C to this chapter. The social cost of capital is made up of depreciation (the amount needed to maintain capital), valued at shadow prices, plus an interest cost (i.e. fixed and working capital stock valued at shadow prices and multiplied by an accounting rate of interest or social discount rate). The social discount rate (SDR) is the rate at which the social value of the numeraire (foreign exchange in the hands of the government) falls through time. A necessary condition for the optimality of public sector investment is that the SDR equals the social rate of return (SRR) on the marginal public sector project. Marginal here implies that the project breaks even at shadow prices. If we view government borrowing (or lending) activities on the world financial market as a marginal project, with foreign exchange as the numeraire and facing fixed interest rates, the SRR is simply the interest rate the government faces on the world capital market, so that the SDR also equals the international interest rate. One might also argue that whether or not it is optimal borrowing will be the marginal source of funds.

§5.3.3 Pure Profits

Pure profits or monopoly rents do not involve any direct resource inputs. Using equation (1), thinking of m as zero, and interpreting c as pure profits we have the social cost of a transfer from government to profits equal to:

$$(1 - \mu)\ c$$

where μ is now the welfare weight on capitalist income, so that a unit of capitalists' income contributes μ to social welfare. For a public sector firm we can treat μ=1 so that there is zero social cost. As with labour above we must also multiply by an SCF reflecting a weighted average of accounting ratios for commodities in the capitalists' consumption bundle. If μ is zero, i.e. we attach zero weight to capitalists' income, then we simply multiply pure profits by the SCF.

§5.4 Data

The results presented in the next section are based on an 87-sector input-output table derived from the PIDE 118-sector matrix for the year 1975-76 (PIDE, 1985). We have used the smaller number of sectors since we wish to match the input-output data to tax revenue information for the calculation of shadow prices and in the analysis of tax reform. The 87 sectors must be classified, as we saw in the preceding section, into traded and non-traded activities. This classification is based on an assumed response of supply to demand changes. We consider only marginal changes. If a change in demand leads to a change in imports (exports) then the good is treated as importable (exportable) on the margin. If the change leads to an adjustment in home production then the good is treated as non-traded.

One can make different sets of plausible assumptions concerning these adjustments and they are, in part, dependent on government policy. Accordingly we work with two rather different classifications. In case A we have 52 traded goods and 35 non-traded, and this has the maximum number of traded sectors (see Table A5.1). In going from case A to case B we have reclassified an extra fourteen sectors as non-traded to allow for the possibility of binding quotas giving 49 non-traded sectors in all. These categories include: (16) 'sugar refining', (18) 'tea blending', (29) 'silk and synthetic textiles', (30) 'woollen textiles', (35) 'wood, cork and furniture', (36) 'paper and products', (40) 'rubber products', (41) 'pharmaceuticals', (43) 'perfumes and cosmetics', (46) 'chemicals', (48) 'petroleum products', (59) 'transport (large-scale)', (61) 'transport equipment', and (62) 'office equipment'. We have based this reclassification on PIDE (1983, Vol. 1, p97) in which implicit nominal protection rates (NPRs), which use market prices, are compared with explicit NPRs, which use published tariff rates. When the former exceed the latter, then quotas are taken as binding. Also, in this case, tariffs are redundant from a protection point of view and act solely to capture some of the economic rents accruing to import quota-holders as government revenue. Whilst the PIDE study was conducted for the year 1981, we have made the supposition that the position is not dissimilar from the earlier period 1975/76.

In practice, within an input-output category, there may be several commodities which are non-traded, or which have quotas associated with them, and others which are clearly traded. When classifying sectors as traded or non-traded we have tried to use informed judgement on the basis of data relating to imports and exports. The shadow prices emerging from this 'aggregate' analysis can, however, be used as data inputs into more detailed analyses, in which commodities may be more adequately identified as tradeable or non-tradeable.

Once we have assembled information on inputs, outputs and taxes, and classified sectors into tradeables and non-tradeables we can then apply the guidelines set out in §5.3 to calculate shadow prices. We work in terms of accounting ratios (ARs) which are defined as the shadow price of a commodity divided by its market price. It is also useful to define the border price ratio (BPR) of a commodity as the border price divided by the market price. The values of the input-output table are in purchaser (i.e. market) prices which include taxes and trade and transport margins. So, for example, an input-output column, representing the various inputs used by a given industry, will include the price paid by the industry (inclusive of trade and transport costs and indirect taxes) for the input. There will also be separate entries for the tax paid on the output of this industry and payments to factor inputs. Summing over all entries then gives the total value of the industry output at purchaser prices.

§5.4.1 *Exported Commodities*

The shadow price of an exportable commodity used in a domestic project is its world price, minus the shadow cost of the trade and transport (henceforth referred to as transport) saved by not exporting the commodity, plus the shadow cost of the transport incurred in getting the commodity from its domestic producer to the user, i.e.

$$p_i^a = p_i^{fob} - p_r^a (a_{ri} - a'_{ri}) \qquad (5.2)$$

where p_i^a is the shadow price of commodity i, p_i^{fob} is the border price of commodity i, p_r^a is the shadow price of transport, a_{ri} is the transport incurred in getting i to the border and a'_{ri} is the transport incurred in getting i from the domestic producer to its user. To calculate the border price we assume that:

$$p_i^{fob} = p_i \ (1 + t_i + p_r a_{ri}) \qquad (5.3)$$

where p_i is the purchaser price of i, t_i the taxes on the exports of i, p_r is the price of transport, and a_{ri} represents transport to the border. Both t_i and p_r should be interpreted as proportions of the purchaser price of i. Producers of export commodity i receive p_i^{fob} at the border but must also pay export taxes and transport costs to the border. Any difference between the domestic price of commodity i and its net export price (i.e. its border price less export taxes and transport costs) encourages the domestic producer to redirect output to either domestic consumption or exports. For example, if p_i^{fob} exceeded the r.h.s of (5.3) then the domestic producer would increase profits by exporting more output. So (assuming a competitive domestic market) domestic users will have to pay a p_i which satisfies (5.3). The social cost of using commodity i domestically is the foreign exchange forgone, minus the social value of the transport saved by not having to get i to the border, but plus the social value of the transport incurred in getting i from the domestic producer to the domestic consumer - see (5.2).

If we assume that the social cost of the transport of i from the domestic producer to the domestic consumer equals the transport cost saved (at shadow prices) by not having to get i from the domestic producer to the border (i.e. $a_{ri} = a'_{ri}$) then, using (5.2) and (5.3) we can write the shadow price of i as:

$$p_i^a = p_i \ (1 + t_i + p_r a_{ri}) \qquad (5.4)$$

The accounting ratio for export commodity i, AR_i, is then defined as:

$$AR_i = \frac{p_i^a}{p_i} = (1 + t_i + p_r a_{ri}) = BPR_i \qquad (5.5)$$

where the first equality follows from (5.2).

The commodities with major export taxes in 1975-6 were rice, raw cotton and leather products. For rice we have actual border and domestic price comparisons for both IRRI and basmati varieties from Cheong and D'Silva (1984, p34-5). We use a weighted price for IRRI and basmati using their total domestic output values at market prices as weights. To calculate shadow prices for cotton and leather we add export duties and transport costs (assumed to be 25% and 20% of market prices of cotton and leather respectively). The shadow price of other exported commodities is calculated using the transport margins from the input-output table (summation over the coefficients of sectors 77 to 81 in Table A5.1). If we choose commodity units such that purchaser prices are one then shadow prices can be interpreted as accounting ratios. The ARs for exported commodities (here also equal to their BPRs) are presented in Table 5.3.

§5.4.2 Imported Commodities

The shadow price of imported commodities is defined as the world (cif) price plus the social cost of transport incurred in getting the import to the user, i.e.

$$p_i^a = p_i^{cif} + p_r^a \ a_{ri} \qquad (5.6)$$

Since purchaser prices include taxes and transport costs we assume:

$$p_i^{cif} = p_i \ (1 - t_i - p_r a_{ri}) \qquad (5.7)$$

Table 5.3

Border Price Ratios for Imported and Exported Commodities

		Total Imports	Import Duties	Sales Taxes	Transport Margins	Border Price Ratios Imports	Border Price Ratios Exports
01	Wheat	2296.06	0.00	0.00	0.12	1.30	1.12
02	Rice	0.05	0.00	0.00	0.24	0.76	2.51
03	Cotton	0.00	0.00	0.00	0.18	0.82	2.42
04	Sugarcane	0.00	0.00	0.00	0.18	0.82	1.18
05	Tobacco Growing	26.57	5.90	0.00	0.12	0.66	1.12
06	Oilseeds	78.22	9.02	10.29	0.11	0.65	1.11
07	Pulses	0.00	0.00	0.00	0.12	0.88	1.12
08	Other Crops	546.75	195.78	13.50	0.12	0.50	1.12
09	Livestock	5.12	0.00	0.00	0.06	0.94	1.06
10	Fishing	0.00	0.00	0.00	0.13	0.87	1.13
11	Forestry	115.45	0.00	0.00	0.19	0.81	1.19
12	Mining & Quarrying	3973.44	88.90	21.67	0.10	0.87	1.10
13	Grain Milling	0.00	0.00	0.00	0.05	0.95	1.05
14	Rice Milling & Husking	0.00	0.00	0.00	0.19	0.81	1.19
15	Edible Oils	2061.02	11.50	0.00	0.11	0.89	1.11
16	Sugar Refining	6.01	1.90	0.00	0.11	0.57	1.11
17	Gur and Khandsari	0.00	0.00	0.00	0.11	0.89	1.11
18	Tea Blending	1724.18	59.00	0.00	0.05	0.92	1.05
19	Fish & Preparations	1.49	0.00	0.00	0.15	0.85	1.15
20	Confectionery & Bakery	0.18	0.00	0.00	0.22	0.78	1.22
21	Other Food Industries	797.76	7.70	13.90	0.23	0.75	1.23
22	Beverages	12.42	9.40	0.00	0.22	0.02	1.22
23	Tobacco Products	19.06	0.00	0.00	0.12	0.88	1.12
24	Bidis	0.00	0.00	0.00	0.12	0.88	1.12
25	Cotton Yarn	65.11	0.23	0.00	0.01	0.62	1.01
26	Cotton Ginning	79.33	10.68	0.00	0.06	0.58	1.06
27	Cotton Textiles (Large Scale)	301.96	0.69	0.00	0.02	0.62	1.02

28	Cotton Textiles (Small Scale)	0.00	0.00	0.00	0.12	0.88	1.12
29	Silk & Synthetic Textiles	129.25	4.20	0.00	0.15	0.41	1.15
30	Woollen Textiles & Hosiery	114.02	41.00	1.41	0.19	0.44	1.19
31	Thr'balls and Oth. Textiles	1751.18	525.50	10.52	0.16	0.53	1.16
32	Carpets & Rugs	14.59	1.30	0.00	0.03	0.88	1.03
33	Made-up Garments	6.02	0.00	0.00	0.02	0.98	1.02
34	Footwear (Non-rubber)	0.62	0.00	0.00	0.06	0.94	1.06
35	Wood, Cork & Furniture	184.48	0.00	2.44	0.00	0.98	1.00
36	Paper & Products	492.31	86.90	31.06	0.19	0.57	1.19
37	Printing and Publishing	33.27	0.00	3.62	0.20	0.69	1.20
38	Leather & Products	91.48	1.80	0.00	0.02	0.96	1.50
39	Rubber Footwear	0.00	0.00	0.00	0.19	0.81	1.19
40	Rubber Products	469.71	97.70	23.82	0.20	0.55	1.20
41	Pharmaceuticals	441.39	2.40	0.00	0.13	0.87	1.13
42	Fertilizer	890.06	0.00	0.00	0.23	1.33	1.23
43	Perfumes & Cosmetics	32.17	23.50	1.82	0.10	0.12	1.10
44	Paints & Varnishes	19.63	87.90	9.09	0.13	0.69	1.13
45	Soaps & Detergents	19.54	0.00	0.00	0.13	0.87	1.13
46	Chemicals	1678.04	185.50	27.96	0.12	0.75	1.12
47	Plastic Products	281.36	0.00	25.46	0.11	0.85	1.11
48	Petroleum Products	5782.76	320.00	0.00	0.15	0.80	1.15
49	Cement	0.00	0.00	0.00	0.15	0.85	1.15
50	Glass & Products	166.66	61.30	17.03	0.11	0.31	1.11
51	Non-metal Mineral Products	218.65	0.00	0.00	0.14	0.86	1.14
52	Basic Metals	2167.37	545.60	106.47	0.22	0.61	1.22
53	Metal Products	905.56	46.30	12.73	0.17	0.76	1.17
54	Iron & Steel Remoulding	0.00	0.00	0.00	0.22	0.78	1.22
55	Agricultural Machinery	746.05	0.00	0.00	0.11	0.89	1.11
56	Other Non-elec. Machinery	2964.95	431.10	95.45	0.10	0.77	1.10
57	Electric Machinery	2025.42	303.90	72.46	0.09	0.75	1.09
58	Bicycles	26.07	0.00	0.00	0.10	0.90	1.10
59	Transport (Large Scale)	2270.00	613.30	166.20	0.10	0.59	1.10
60	Shipbuilding	144.63	0.00	0.00	0.10	0.90	1.10
61	Trans. Equip. (Small Scale)	0.00	0.00	0.00	0.04	0.96	1.04
62	Office Equipment	116.76	0.00	0.00	0.11	0.89	1.11

63	Sports Goods	9.73	2.80	0.00	0.04	0.68	1.04
64	Surgical Instruments	25.25	0.00	0.00	0.13	0.87	1.13
65	Other LS Manufacturing	473.51	65.60	25.33	0.11	0.69	1.11
66	Other SS Manufacturing	0.00	0.00	0.00	0.07	0.93	1.07
67	Low-cost Residential Bldg	0.00	0.00	0.00	0.00	1.00	1.00
68	Luxurious Residential Bldg	0.00	0.00	0.00	0.00	1.00	1.00
69	Rural Buildings	0.00	0.00	0.00	0.00	1.00	1.00
70	Factory Buildings	0.00	0.00	0.00	0.00	1.00	1.00
71	Public Buildings	0.00	0.00	0.00	0.00	1.00	1.00
72	Roads	0.00	0.00	0.00	0.00	1.00	1.00
73	Infrastructure	0.00	0.00	0.00	0.00	1.00	1.00
74	Ownership of Dwellings	0.00	0.00	0.00	0.00	1.00	1.00
75	Electricity	0.00	0.00	0.00	0.00	1.00	1.00
76	Gas	0.00	0.00	0.00	0.00	1.00	1.00
77	Wholesale & Retail Trade	0.00	0.00	0.00	0.02	0.98	1.02
78	Road Transport	0.00	0.00	0.00	0.00	1.00	1.00
79	Rail Transport	0.00	0.00	0.00	0.00	1.00	1.00
80	Air Transport	0.00	0.00	0.00	0.00	1.00	1.00
81	Water Transport	0.00	0.00	0.00	0.00	1.00	1.00
82	Television	0.00	0.00	0.00	0.03	0.97	1.03
83	Radio	0.00	0.00	0.00	0.03	0.97	1.03
84	Phone, Telegraph & Post	0.00	0.00	0.00	0.04	0.96	1.04
85	Banking & Insurance	0.00	0.00	0.00	0.02	0.98	1.02
86	Government	0.00	0.00	0.00	0.01	0.99	1.01
87	Services	0.00	0.00	0.00	0.02	0.98	1.02

Source: Import duties and sales taxes are taken from Government of Pakistan, Memorandum to the Budget, various years. Total imports and transport margins are taken from PIDE (1985).

Notes: Total imports, import duties and sales taxes are in Rs. million. The border price ratios for imports (i.e. p_i^{cif}/p_i) are calculated using (5.7) in the text while those for exports (i.e. p_i^{fob}/p_i) are calculated using (5.3) in the text. The ratio for imported fertilizer is calculated using data from Chemonics (1985). The ratio for exported rice was calculated using data from Cheong and D'Silva (1984, pp34-5), where we used the f.o.b prices of IRRI and basmati rice divided by domestic wholesale prices, and calculated a weighted average using the value of their domestic production as weights. For exported raw cotton and leather we use (5.3) and export duties of Rs. 980.5 million and Rs. 595.5 million, together with transport margins of 25% and 20% (of border prices) respectively. Transport margins are given as a % of market prices.

where t_i are import taxes (tariffs and sales taxes) and other variables are as before. Using (6) and (7) we can write the shadow price of i as:

$$p_i^a = p_i\ (1 - t_i - p_r a_{ri}) + p_r^a\ a_{ri} \qquad (5.8)$$

The accounting ratio for import commodity i, AR_i, is then defined as:

$$AR_i = \frac{p_i^a}{p_i} = (1 - t_i - p_r a_{ri}) + p_r^a\ a_{ri} \qquad (5.9)$$

$$= BPR_i + p_r^a\ a_{ri}$$

where we choose units so that the market price of i is unity. Notice that the shadow prices for imported commodities depend on the shadow price for transport. Since transport is a non-traded commodity its shadow price is taken as its marginal social cost of production and so depends on the shadow price of other non-traded commodities. The shadow price for all non-traded commodities depend on the shadow price of traded and non-traded inputs. Therefore, the shadow prices for imported and non-traded commodities must be calculated simultaneously, whereas the shadow prices for exported commodities are simply their world prices. From (5.9) we see that the AR for imported commodities is made up of their border price ratio plus an adjustment for transport. PIDE (1985) presents gross absorptions of imports at purchaser prices. Deducting taxes and transport margins (derived from the relevant rows of the input-output table) we get imports at border (i.e. c.i.f.) prices and calculate the BPR using (5.7). The relevant data are presented in Table 5.3.

§5.4.3 Non-traded Commodities

Since the shadow prices of imported and non-traded commodities depend on each other they must be calculated simultaneously. Table 5.4 presents such a system of equations (for 3 commodites and one factor). Here we think of n commodities (i = 1, ... ,n) for which an increase in demand can be met from either a fall in exports, an increase in imports or an increase in domestic production. Let α_i, β_i, and γ_i be the proportion of the increase in demand for good i which is met from domestic production,

Table 5.4

Shadow Prices for Non-traded Commodities

$$
\begin{aligned}
p_1 &= p_1(\alpha_1 a_{11}) + p_2(\alpha_2 a_{21}) + p_3(\alpha_3 a_{31}) + p_1^m(\gamma_1 a_{11}) + p_2^m(\gamma_2 a_{21}) + p_3^m(\gamma_3 a_{31}) + p_1^x(\beta_1 a_{11}) + p_2^x(\beta_2 a_{21}) + p_3^x(\beta_3 a_{31}) + p_4 a_{41} \\
p_2 &= p_1(\alpha_1 a_{12}) + p_2(\alpha_2 a_{22}) + p_3(\alpha_3 a_{32}) + p_1^m(\gamma_1 a_{12}) + p_2^m(\gamma_2 a_{22}) + p_3^m(\gamma_3 a_{32}) + p_1^x(\beta_1 a_{12}) + p_2^x(\beta_2 a_{22}) + p_3^x(\beta_3 a_{32}) + p_4 a_{42} \\
p_3 &= p_1(\alpha_1 a_{13}) + p_2(\alpha_2 a_{23}) + p_3(\alpha_3 a_{33}) + p_1^m(\gamma_1 a_{13}) + p_2^m(\gamma_2 a_{23}) + p_3^m(\gamma_3 a_{33}) + p_1^x(\beta_1 a_{13}) + p_2^x(\beta_2 a_{23}) + p_3^x(\beta_3 a_{33}) + p_4 a_{43} \\
p_1^m &= \qquad + p_3(\alpha_3 \; a_{31}) \qquad + p_3^m(\gamma_3 \; a_{33}) \qquad + p_3^x(\beta_3 \; a_{31}) + p_1^c \\
p_2^m &= \qquad + p_3(\alpha_3 \; a_{32}) \qquad + p_3^m(\gamma_3 \; a_{32}) \qquad + p_3^x(\beta_3 \; a_{32}) + p_2^c \\
p_3^m &= \qquad + p_3(\alpha_3 \; a_{33}) \qquad + p_3^m(\gamma_3 \; a_{33}) \qquad + p_3^x(\beta_3 \; a_{33}) + p_3^c
\end{aligned}
$$

(a) p_i, p_i^m and p_i^x (i = 1, 2, 3) are the shadow prices for commodity i when it is produced domestically, imported and exported respectively. p_4 is the shadow price of factors and p_i^c is the border c.i.f price of commodity i.

(b) a_{ij} is the input of commodity i required to produce one unit of commodity j.

(c) α_i, β_i and γ_i are the proportion of commodity i which is met from domestic production, exports and imports, respectively, and sum to unity . We assume that sector 3 is trade and transport and (in the analysis) that α_3=1 (so that γ_3=β_3=0). For other commodities we assume that either α_1=1, β_1=1 or γ_i=1. So the issue of partially-traded commodities is not dealt with in our analysis.

This model can be written in matrix notation as (with prime denoting row vectors).

$$p' = V'[I - \theta\tilde{A}]^{-1} \quad \text{and} \quad V' = p_w'\beta\bar{A}.$$

where: p' is a vector of shadow prices for non-traded and imported commodities respectively, i.e. $p' = [p_1, \ldots, p_n, p_1, \ldots, p_n]$.

p_w' is a vector of border (world) prices for exported and imported commodities respectively, and the shadow price of factor inputs, i.e.

$p_w' = [p_1^x, \ldots, p_n^x, p_1^c, \ldots, p_n^c, p^f]$ and p^f is the shadow price of factor inputs (one for each of F factors).

θ is a diagonal matrix with diagonal $[\alpha_1, \ldots, \alpha_n, \gamma_1, \ldots, \gamma_n]$

β is a diagonal matrix with diagonal $[\beta_1 \ldots \beta_n, 1(n \text{ times}), 1(F \text{ times})]$.

Assuming N = 3 (and sector 3 is trade and transport, a non-traded input) and F = 1 (called sector 4) then:

$$\tilde{A} \begin{bmatrix} a_{11} & a_{12} & a_{12} & 0 & 0 & 0 \\ a_{21} & a_{22} & a_{23} & 0 & 0 & 0 \\ a_{31} & a_{32} & a_{33} & a_{31} & a_{32} & a_{33} \\ a_{11} & a_{12} & a_{13} & 0 & 0 & 0 \\ a_{21} & a_{22} & a_{23} & 0 & 0 & 0 \\ a_{31} & a_{32} & a_{33} & a_{31} & a_{32} & a_{33} \end{bmatrix} \qquad \bar{A} \begin{bmatrix} a_{11} & a_{12} & a_{13} & 0 & 0 & 0 \\ a_{21} & a_{22} & a_{23} & 0 & 0 & 0 \\ a_{31} & a_{32} & a_{33} & a_{31} & a_{32} & a_{33} \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \\ a_{41} & a_{42} & a_{42} & 0 & 0 & 0 \end{bmatrix}$$

where the a_{ij}'s are the total input-output coefficients.

exports and imports respectively so that:

$$\alpha_i + \beta_i + \gamma_i = 1$$

Writing the equations in Table 5.5 in matrix notation (and assuming n commodities) we have:

$$p' = p' \, \theta \, \tilde{A} + p_w' \, \beta \, \bar{A} \qquad (5.10)$$

where the prime superscript denotes a row vector. The vector p' is made up of elements which are the shadow prices of non-traded and imported commodities, i.e.

$$p' = [\, p_1, \ldots, p_n, p_1^m, \ldots, p_n^m \,]$$

where p is a vector of shadow prices for non-tradeables and p^m a vector of shadow prices for importables. The row vector p_w' has as elements the f.o.b. prices of exports (which are also the shadow prices of exports in this model), the c.i.f. prices of imports and the shadow prices of factors (taken as exogenous in this model), that is:

$$p_w' = [\, p_1^x, \ldots, p_n^x, p_1^c, \ldots, p_n^c, p^f \,]$$

where p^x is a vector of f.o.b. prices for exports, p^c a vector of c.i.f. prices for imports, and p^f a vector of shadow prices for factor inputs (there may be F>1 factor inputs, e.g. land, labour and capital). The matrix θ is a diagonal matrix with the following diagonal elements

$$\theta = [\alpha_1, \ldots, \alpha_n, \gamma_1, \ldots, \gamma_n]$$

The matrix β is also a diagonal matrix with the following diagonal elements:

$$\beta = [\beta_1, \ldots, \beta_n, 1(n+F \text{ times})]$$

The matrix $\tilde{A}$ (with typical element $\tilde{a}_{ij}$) has dimension (2n x 2n) made up of input-output coefficients, where:

$$\tilde{a}_{ij} = \tilde{a}_{i+n,j} = a_{ij} \qquad i,j = 1 \text{ to } n$$

where a_{ij} is the input of commodity i used to produce one unit of commodity j (taken from the input-output coefficient matrix A). If we assume that commodity r is transport then:

$$\tilde{a}_{i,j+n} = \tilde{a}_{i+n,j+n} = 0 \quad \text{for } i \neq r \quad \text{and} \quad i,j = 1 \text{ to } n$$

and

$$\tilde{a}_{r,j+n} = \tilde{a}_{r+n,j+n} = a_{rj} \quad \text{for } i,j = 1 \text{ to } n$$

The matrix $\bar{A}$ (with typical element $\bar{a}_{ij}$) has dimension [(2n+F) x 2n] where:

$$\begin{aligned} \bar{a}_{ij} &= a_{ij} \\ \bar{a}_{i+n,j} &= 0 \\ \bar{a}_{i,j+n} &= 0 \quad \text{for } i \neq r \\ \bar{a}_{r,j+n} &= a_{rj} \\ \bar{a}_{i+n,i+n} &= 1 \\ \bar{a}_{2n+f,i+n} &= 0 \end{aligned}$$

where i = 1 to n, j = 1 to n, f = 1 to F, and F is the number of factor inputs. If we interpret a_{fj} as the input of factor f required to produce one unit of output j then:

$$\bar{a}_{2n+f,j} = a_{fj}$$

Rearranging (5.9) we get:

$$p' = V'[I - \theta A]^{-1}$$

where $V' = p_W' \, \theta \, \bar{A}$.

In the results presented below we classify commodities as either importable, exportable or non-tradeable and so do not allow for the case of partially-traded goods. This classification is presented in Table A5.1. Note also that if we define units such that the value at market (purchaser) prices equals unity then shadow prices and accounting ratios coincide and we can use these terms interchangeably. The purpose of describing the general case above is that it allows the simultaneous representation of the various classifications chosen but also shows how the method can be extended easily to the partially traded case.

§5.4.4 Factors of Production

To calculate the shadow prices of non-traded commodities (and the social profitability of traded sectors) we need to calculate the shadow cost of factor inputs.

Since each factor input can have a different shadow price we need to separate value added (VA) into payments to each factor input. Here we take the sub-groups labour, land, capital and a residual (or pure profit). The input-output table available from PIDE (1985) gives a single value for VA and does not separate payments across factor inputs. We therefore calculate these payments using other data. Employment costs for large-scale manufacturing were taken from estimates calculated from the Census of Manufacturing Industry (CMI) for the 118-sector classification. However, since the values for VA in the input-output tables were lower than those for large-scale manufacturing from the CMI, the employment costs have been adjusted downwards (by a factor of 0.66 - see PIDE, 1985, p33) to match the input-output estimates. We have assumed other employment costs as follows (see Appendix C for a more detailed discussion): 0.5 of VA in agriculture and small-scale industries, and 0.6 of VA in construction and services. For agriculture we have taken the opportunity cost of land at market prices as 0.3 of VA. For capital coefficients we have used more aggregate data from the Government of Pakistan (1982 and 1983a) and have derived them as investment (i.e. 10% of capital stocks) divided by gross output at market prices. The residual of VA after these elements have been deducted is 'pure profit'. It is sometimes positive and sometimes negative. Given that it is an item derived as a residual after many assumptions it is not likely to be accurate. We have ignored it in the calculation of shadow prices which essentially involves treating it as a transfer payment with no social cost. The breakdown of VA into labour, land, capital and the residual is presented in Table 5.5.

In calculating ARs for non-traded activities (and the social profitability of traded activities) we need the ARs for traded activities (discussed above) and for the disaggregated VA terms. For land we assume throughout an AR or land conversion factor (LCF) of 1.6 (see Appendix C for discussion). For the labour accounting ratio, or the wage conversion factor (WCF), we experiment with the values of 1.4, 1.15 and 0.9. It should be noted that there may be several models which could yield these WCFs. Rewriting (5.1):

$$\text{WCF} = \frac{\text{SCF}\ [c - \mu\ (c - m)]}{c}$$

Table 5.5

Breakdown of Value Added (VA)

		Labour	Capital	Residual	Value Added
01	Wheat	0.2812	0.0202	0.0923	0.5625
02	Rice	0.2356	0.0202	0.0741	0.4712
03	Cotton	0.2879	0.0202	0.0950	0.5758
04	Sugarcane	0.3308	0.0202	0.1122	0.6616
05	Tobacco Growing	0.3696	0.0202	0.1277	0.7391
06	Oilseeds	0.3006	0.0202	0.1001	0.6012
07	Pulses	0.1178	0.0202	0.0270	0.2357
08	Other Crops	0.3114	0.0202	0.1044	0.6228
09	Livestock	0.2842	0.0202	0.0935	0.5684
10	Fishing	0.4305	0.2784	0.1520	0.8609
11	Forestry	0.3952	0.0202	0.1379	0.7904
12	Mining & Quarrying	0.3189	0.0400	0.0875	0.6378
13	Grain Milling	0.0335	0.0920	-0.0498	0.0756
14	Rice Milling & Husking	0.0498	0.0920	-0.0414	0.1004
15	Edible Oils	0.0274	0.0920	-0.0401	0.0792
16	Sugar Refining	0.0400	0.0920	0.0255	0.1575
17	Gur and Khandsari	0.0435	0.0166	0.0270	0.0871
18	Tea Blending	0.0565	0.0920	0.0254	0.1738
19	Fish & Preparations	0.0372	0.0920	0.0169	0.1460
20	Confectionery & Bakery	0.0536	0.0920	0.0348	0.1804
21	Other Food Industries	0.1415	0.0920	0.1125	0.3459
22	Beverages	0.1661	0.0920	0.0844	0.3425
23	Tobacco Products	0.0278	0.0920	0.0183	0.1380
24	Bidis	0.1648	0.0166	0.1483	0.3297
25	Cotton Yarn	0.0919	0.0920	0.0664	0.2503

26	Cotton Ginning	0.0133	0.0920	-0.0176	0.0876
27	Cotton Textiles (Large Scale)	0.1547	0.0920	-0.0369	0.2097
28	Cotton Textiles (Small Scale)	0.1138	0.0166	0.0972	0.2275
29	Silk & Synthetic Textiles	0.0802	0.0920	-0.0272	0.1450
30	Woollen Textiles & Hosiery	0.0985	0.0920	0.0220	0.2124
31	Threadballs and Other Textiles	0.0853	0.0920	0.0582	0.2355
32	Carpets & Rugs	0.1387	0.0920	0.0868	0.3174
33	Made-up Garments	0.1049	0.0920	0.1794	0.3763
34	Footwear (Non-rubber)	0.1822	0.0920	0.0931	0.3672
35	Wood, Cork & Furniture	0.1804	0.0920	0.1110	0.3833
36	Paper & Products	0.0875	0.0920	0.1063	0.2858
37	Printing and Publishing	0.0846	0.0920	0.0961	0.2726
38	Leather & Products	0.0337	0.0920	0.0747	0.2004
39	Rubber Footwear	0.0496	0.0920	-0.0406	0.1009
40	Rubber Products	0.0456	0.0920	0.0235	0.1611
41	Pharmaceuticals	0.0294	0.0920	-0.0159	0.1055
42	Fertilizer	0.0570	0.0920	0.1774	0.3263
43	Perfumes & Cosmetics	0.1649	0.0920	-0.1099	0.1470
44	Paints & Varnishes	0.0046	0.0920	-0.0554	0.0411
45	Soaps & Detergents	0.0428	0.0920	-0.0043	0.1305
46	Chemicals	0.1021	0.0920	0.1232	0.3173
47	Plastic Products	0.1704	0.0920	0.1210	0.3834
48	Petroleum Products	0.0263	0.0920	0.0324	0.1506
49	Cement	0.0901	0.0920	0.0269	0.2089
50	Glass & Products	0.2066	0.0920	-0.1822	0.1164
51	Non-metal Mineral Products	0.1357	0.0920	0.0425	0.2702
52	Basic Metals	0.0638	0.0920	0.0236	0.1794
53	Metal Products	0.2618	0.0920	0.0687	0.4224
54	Iron & Steel Remoulding	0.2386	0.0166	0.2221	0.4772
55	Agricultural Machinery	0.0420	0.0920	-0.0355	0.0985
56	Other Non-electrical Machinery	0.0835	0.0920	0.1733	0.3488
57	Electric Machinery	0.0693	0.0920	-0.0067	0.1546
58	Bicycles	0.0576	0.0920	0.0493	0.1989

59	Transport (Large Scale)	0.0611	0.0920	0.0794	0.2324
60	Shipbuilding	0.1520	0.0920	0.2136	0.4575
61	Transport Equipment (Small Scale)	0.1962	0.0920	0.1043	0.3925
62	Office Equipment	0.0538	0.0920	-0.0955	0.0503
63	Sports Goods	0.0827	0.0920	0.2020	0.3766
64	Surgical Instruments	0.1744	0.0920	0.2614	0.5278
65	Other Large Scale Manufacturing	0.0945	0.0920	0.3764	0.5629
66	Other Small Scale Manufacturing	0.1729	0.0166	0.1564	0.3459
67	Low-cost Residential Building	0.2620	0.0047	0.1700	0.4366
68	Luxurious Residential Building	0.2398	0.0047	0.1552	0.3997
69	Rural Buildings	0.3000	0.0047	0.1953	0.5000
70	Factory Buildings	0.2422	0.0047	0.1568	0.4036
71	Public Buildings	0.2555	0.0047	0.1656	0.4258
72	Roads	0.3329	0.0047	0.2173	0.5549
73	Infrastructure	0.2499	0.5001	-0.3335	0.4165
74	Ownership of Dwellings	0.5398	0.2299	0.1300	0.8997
75	Electricity	0.4602	1.4573	-1.1505	0.7671
76	Gas	0.4895	1.4573	-1.1310	0.8159
77	Wholesale & Retail Trade	0.5670	0.1072	0.2708	0.9449
78	Road Transport	0.1894	0.0576	0.0687	0.3157
79	Rail Transport	0.3306	0.3950	-0.1746	0.5510
80	Air Transport	0.2455	0.0576	0.1061	0.4092
81	Water Transport	0.4919	0.0576	0.2703	0.8198
82	Television	0.3213	0.0576	0.1566	0.5354
83	Radio	0.4601	0.0576	0.2491	0.7669
84	Phone, Telegraph & Post	0.4833	0.3134	0.0087	0.8055
85	Banking & Insurance	0.4371	0.0274	0.2641	0.7285
86	Government	0.3205	0.2715	-0.0578	0.5342
87	Services	0.5749	0.1072	0.2761	0.9581

Note: All coefficients are given as percentages of gross output at market prices. Land coefficients for sectors (1)-(9) and (11)-(12) were calculated as 0.3 of value added.

where SCF is the AR corresponding to labour's marginal product (which we shall assume to be agricultural produce). If we assume a tight labour market then we have $c=m$ (at market prices) and the WCF is simply the weighted average of the ARs for output forgone. If labour is taken from agriculture then this refers to agricultural commodities: the appropriate AR in this case was calculated at around 1.4 in Table A1. If labour is in surplus at wage c (say, because $c > m$) and if we treat extra income to labour as having no social value, i.e. $\mu = 0$, then we also get WCF = 1.4 (if we assume that the consumption bundle is also made up of agricultural produce). However, if $c > m$ and if we treat extra income as at least equal in value to income accruing to the government, i.e. $\mu \geq 1$, then the WCF is lower. We may view the lower WCFs, e.g. 1.15 or 0.9, as representing examples of such situations.

The market cost of capital is made up of depreciation (the amount needed to maintain capital) plus an interest cost. The shadow cost is calculated by valuing depreciation (and capital) using a SCF for assets and by using an accounting rate of interest ($\bar{i}$). If we define the asset conversion factor (ACF) as the shadow divided by the market cost of capital then (see Appendix C for details)

$$\text{ACF} = \frac{\bar{i} - \beta}{i - \beta} \cdot \text{SCF}$$

where $\bar{i}$ and i are the accounting and market rate of interest respectively and β is the rate of depreciation of assets. The results in Ahmad, Coady and Stern (1988) suggest an SCF for assets of around 0.8. Since we are uncertain of the relationship between $\bar{i}$ and i and given the crude method used to calculate investment, we use a range for ACF: we experimented with ACFs of 1.2, 1.0 and 0.8.

§5.5 Results

We now present our calculation of shadow prices (accounting ratios - ARs) and social profitabilities for Pakistan for 1975/6. We first present a technical analysis of the results. Then we interpret the results from a policy viewpoint and indicate the type of detail and the issues that one needs to go into when analysing policy.

§5.5.1 Technical Analysis

Estimates are calculated for two cases (Case A and Case B) and for various combinations of WCFs and ACFs. The ARs for non-traded commodities, calculated as the marginal social cost (MSC) of production, are presented in Table A5.2. Since we treat the calculated residual in value-added as having zero cost (thus treating it as a transfer payment with no social cost) we would expect that, *ceteris paribus*, non-traded activities which exhibit high positive residuals will have relatively low ARs and those with high negative residuals will have relatively high ARs (because the social input costs are high relative to the value of their output). Table 5.6 presents results for Case A for WCF = 1.15 and ACF = 1.0 and shows that the above holds true for most non-traded activities. However, the ARs for some sectors are greatly affected by those for other sectors which are major inputs into their production process. For example sector (1) 'wheat' has a high AR of 1.40 and this gives (13) 'grain milling' a high AR of 1.38 (grain milling also has a negative residual). Also, sectors (2) 'rice' and (3) 'cotton' have high ARs of 2.51 and 2.42 respectively, and these give sectors (14) 'rice milling' and (26) 'cotton ginning' high ARs of 2.07 and 2.12 respectively. The high ARs of (73) 'infrastructure', (75) 'electricity', (76) 'gas' and (79) 'rail transport' are due to high negative residuals which in turn are caused by high capital services coefficients - thus charging appropriately for capital inputs implies a high social cost of production relative to the market value of output. Also notice, from Table A5.2, that activities with high labour coefficients are most sensitive to the WCF chosen - for example, sector (77) 'wholesale trade'. Sectors with high capital coefficients are most sensitive to the ACF chosen - for example, (73) 'infrastructure', (74) 'ownership of dwellings', (75) electricity' and (76) 'gas'.

We now turn to the social profitability of various traded activities. Here we define this as the social value of output minus its marginal social cost (MSC) of production, divided by the social value of output. Given this definition, the social profitability of non-traded activities will be zero since their ARs are calculated as their marginal social cost. The analysis of social profitabilities involves an examination of the social profitability of expanding the domestic production of importables or

Table 5.6

Results for Case A : WCF=1.2 and ACF=1.0

		Social Return	Residual	AR	Indirect Taxes	Classification
01	Wheat	0.227	0.092	1.399	0.000	M
02	Rice	0.569	0.074	2.510	0.000	X
03	Cotton	0.554	0.095	2.420	0.000	X
04	Sugarcane	0.000	0.112	1.042	0.000	N
05	Tobacco Growing	-0.392	0.128	0.756	0.000	M
06	Oilseeds	-0.414	0.100	0.734	0.000	M
07	Pulses	0.000	0.027	1.017	0.000	N
08	Other Crops	-0.713	0.104	0.595	0.000	M
09	Livestock	0.008	0.094	0.990	0.000	M
10	Fishing	0.209	0.152	1.127	0.000	X
11	Forestry	0.000	0.138	1.028	0.000	N
12	Mining & Quarrying	-0.073	0.088	0.958	0.011	M
13	Grain Milling	0.000	-0.050	1.377	0.000	N
14	Rice Milling & Husking	0.000	-0.041	2.071	0.000	N
15	Edible Oils	-0.150	-0.040	0.974	0.108	M
16	Sugar Refining	-0.069	0.026	0.664	0.253	M
17	Gur and Khandsari	0.000	0.027	0.993	0.000	N
18	Tea Blending	0.109	0.025	0.957	0.076	M
19	Fish & Preparations	0.094	0.017	1.146	0.000	X
20	Confectionery & Bakery	0.000	0.035	0.874	0.057	N
21	Other Food Industries	0.232	0.112	1.228	0.001	X
22	Beverages	-2.165	0.084	0.207	0.157	M
23	Tobacco Products	0.632	0.018	1.118	0.499	X
24	Bidis	0.000	0.148	0.716	0.000	N

25	Cotton Yarn	-0.517	0.066	1.015	0.020	X
26	Cotton Ginning	0.000	-0.018	2.119	0.000	N
27	Cotton Textiles (Large Scale)	-0.327	-0.037	1.018	0.046	X
28	Cotton Textiles (Small Scale)	0.180	0.097	1.122	0.000	X
29	Silk & Synthetic Textiles	-0.540	-0.027	0.541	0.059	M
30	Woollen Textiles & Hosiery	-0.626	0.022	0.594	0.015	M
31	Threadballs and Other Textiles	-0.331	0.058	0.665	-0.002	M
32	Carpets & Rugs	0.288	0.087	1.033	0.066	X
33	Made-up Garments	0.203	0.179	1.023	0.007	X
34	Footwear (Non-rubber)	0.011	0.093	1.057	0.000	X
35	Wood, Cork & Furniture	0.130	0.111	0.987	0.012	M
36	Paper & Products	-0.065	0.106	0.726	0.068	M
37	Printing and Publishing	0.000	0.096	0.766	0.000	N
38	Leather & Products	0.403	0.075	1.500	0.038	X
39	Rubber Footwear	0.244	-0.041	1.195	0.024	X
40	Rubber Products	-0.240	0.024	0.707	0.042	M
41	Pharmaceuticals	0.176	-0.016	0.973	0.022	M
42	Fertilizer	0.389	0.177	1.544	0.007	M
43	Perfumes & Cosmetics	-2.990	-0.110	0.196	0.238	M
44	Paints & Varnishes	0.078	-0.055	0.798	0.201	M
45	Soaps & Detergents	0.103	-0.004	0.979	0.090	M
46	Chemicals	0.068	0.123	0.852	0.093	M
47	Plastic Products	0.151	0.121	0.939	0.057	M
48	Petroleum Products	-0.020	0.032	0.925	-0.027	M
49	Cement	0.123	0.027	1.153	0.157	X
50	Glass & Products	-1.619	-0.182	0.398	0.148	M
51	Non-metal Mineral Products	0.047	0.043	0.980	0.003	M
52	Basic Metals	-0.070	0.024	0.794	0.026	M
53	Metal Products	0.030	0.069	0.909	0.000	M
54	Iron & Steel Remoulding	0.000	0.222	0.734	0.000	N
55	Agricultural Machinery	0.072	-0.035	0.984	0.000	M
56	Other Non-electrical Machinery	0.128	0.173	0.861	0.003	M
57	Electric Machinery	0.010	-0.007	0.836	0.099	M

58	Bicycles	0.000	0.049	0.842	0.002	N
59	Transport (Large Scale)	-0.205	0.079	0.693	0.058	M
60	Shipbuilding	0.000	0.214	0.962	-0.198	N
61	Transport Equipment (Small Scale)	0.089	0.104	0.993	0.000	M
62	Office Equipment	0.137	-0.095	0.983	0.190	M
63	Sports Goods	0.117	0.202	1.037	0.010	X
64	Surgical Instruments	0.378	0.261	1.131	0.014	X
65	Other Large Scale Manufacturing	0.484	0.376	1.110	0.005	X
66	Other Small Scale Manufacturing	0.000	0.156	0.690	0.000	N
67	Low-cost Residential Building	0.000	0.170	0.877	0.000	N
68	Luxurious Residential Building	0.000	0.155	0.866	0.000	N
69	Rural Buildings	0.000	0.195	0.846	0.000	N
70	Factory Buildings	0.000	0.157	0.860	0.000	N
71	Public Buildings	0.000	0.166	0.838	0.000	N
72	Roads	0.000	0.217	0.830	0.000	N
73	Infrastructure	0.000	-0.334	1.351	0.000	N
74	Ownership of Dwellings	0.000	0.130	0.935	0.000	N
75	Electricity	0.000	-1.150	2.268	0.000	N
76	Gas	0.000	-1.131	2.201	0.000	N
77	Wholesale & Retail Trade	0.000	0.271	0.811	0.000	N
78	Road Transport	0.000	0.069	0.850	0.018	N
79	Rail Transport	0.000	-0.175	1.162	0.000	N
80	Air Transport	0.000	0.106	0.846	0.033	N
81	Water Transport	0.000	0.270	0.795	0.000	N
82	Television	0.000	0.157	0.884	0.000	N
83	Radio	0.000	0.249	0.851	0.000	N
84	Phone, Telegraph & Post	0.000	0.009	1.046	0.000	N
85	Banking & Insurance	0.000	0.264	0.816	0.000	N
86	Government	0.000	-0.058	1.060	0.000	N
87	Services	0.000	0.276	0.810	0.000	N

Note: Indirect taxes are taken from PIDE (1985).

exportables, at the margin. When calculating the MSCs we interpreted the input-output coefficients as marginal, i.e. reflecting the extra inputs required to produce an extra unit of output. Our results are therefore more valid for the evaluation of new investments as opposed to the evaluation of output increases in industries where capacity underutilization is a problem.

Since we look at the social profitability of tradeables, the classification of sectors into traded and non-traded is crucial. We have two cases: Case A with 52 traded sectors, and Case B with 38 traded sectors. In practice, given the level of aggregation, one might expect to find within any one sector commodities or sub-sectors which may be traded or non-traded. Note that commodities can be non-traded for physical/'natural' reasons (e.g. due to high transport costs) or because of the existence of binding quotas. Therefore, our results indicate the general social profitability of aggregate sectors, but more detailed analysis of specific 'within-sector' industries may reveal the co-existence of socially profitable and socially unprofitable activities. This may even be so within any particular activity where production technologies vary, e.g. capital-intensive and labour-intensive production techniques.

Tables A5.3 present the social profitability of traded sectors for Case A for various WCF and ACF combinations (i.e. WCFs of 1.4, 1.15 and 0.9 and ACFs of 1.2, 1.0 and 0.8). We concentrate mainly on the signs and relative magnitudes of the results. As a general guideline, when analysing social profitabilities one can argue that, *ceteris paribus*, (a) a high (low) indirect tax element will lead to a high (low) social profit since indirect taxes are treated as transfer payments with zero social costs and are subtracted to reach marginal social costs, (b) a negative residual will have the opposite effect since the imputed costs of labour and capital are higher than the value added in the input-output table, and (c) a high (low) AR for an output leads to a high (low) social profit.

Focusing on Case A for WCF = 1.15 and ACF = 1.0 (see Table 5.6 above) we see that, broadly speaking, activities with ARs less than 0.8 exhibit negative social profitabilities. However, from the point of view of the above general guidelines some results require further explanation. For example, (16) 'sugar refining' has a very large tax coefficient of 0.25 but exhibits a social loss reflecting both its low AR of 0.66 and the high AR (=1.04) of its major input, sugarcane. Also, (15) 'edible oils' exhibits a social loss even though it has a relatively high AR of 0.97 and a tax coefficient of 0.11. This is due to the very high AR (=2.12) of its major input, (26) 'cotton ginning', combined with a negative residual. Sector (19) 'fish and preparations' has a lower social profit than would be expected from its high AR (=1.15) due to the high AR (=1.13) of its major input, (10) 'fishing'. Sector (22) 'beverages' has a very low AR of 0.21 (due to high import tariffs) and this gives a social loss despite its high tax coefficient and positive residual. Because of its low AR of 0.20 (due to high import tariffs) and high negative residual, (43) 'perfumes and cosmetics' exhibits a social loss in spite of the fact that it also has a high tax coefficient. Also, (44) 'paints and varnishes' has a greater return than would be expected from its AR of 0.8 and negative residual mainly because of its high tax coefficient.

From Table A5.3 one can see that some sectors have negative social profitabilities across all combinations of WCF and ACF. These are (5) 'tobacco growing', (6) 'oilseeds', (7) 'other crops', (15) 'edible oils', (22) 'beverages', (25) 'cotton yarn', (27) 'cotton textiles (large scale)', (29) 'silk and synthetic textiles', (30) 'woollen textiles and hosiery', (31) 'threadball and other textiles', (40) 'rubber products', (43) 'perfumes and cosmetics', (50) 'glass and products', and (59) 'transport (large scale)'. Other sectors which have negative social profitability at high combinations of WCF and ACF switch to having positive social profitability as we reduce these conversion factors. These are (9) 'livestock', (12) 'mining and quarrying', (16) 'sugar refining', (34) 'footwear (non-rubber)', (36) 'paper and products', (46) 'chemicals', (48) 'petroleum products', (49) 'cement', (51) 'non-metallic mineral products', (52) 'metal products' and (57) 'electric machinery'. Thus, if lower conversion factors are appropriate for the activities in the latter list, investment in these appears socially attractive; but, even at the lowest conversion factors considered, investment in the former activities is not socially desirable.

Moving from Case A to Case B an additional fourteen sectors are classified as non-traded, reflecting the possible existence of binding quotas. Given that, by definition, there is zero net social profit for non-traded activities, the policy interest in the calculations for these activities lies in examining their MSCs. For example, we could ask whether there would be any benefit in the relaxation of import quotas in a sector (if this is the reason why it is non-traded) by comparing the shadow price with the import price. This question is similar to asking whether or not the activity is socially profitable since the MSC of a socially profitable sector will be less than its world price (suitably adjusted for trade and transport margins). Therefore, traded sectors which were socially profitable (unprofitable) in Case A have a lower (higher) AR in Case B where they are classified as non-traded. If the domestic production of a commodity is socially profitable then it is desirable to meet any extra demand (or even replace existing imports) with increased domestic production rather than by relaxing quotas. For commodities that are naturally non-traded we can ask if there are particularly beneficial uses to which extra output (e.g. extra electricity supply) can be put. If the shadow value of the use exceeds the MSC of its production then output should be expanded so as to satisfy this demand. An appealing feature of the results (presented in Table A5.5 to Table A5.7) is that the social profitabilities of traded activities are very insensitive to the reclassification of these extra 14 sectors as non-traded.

It is also interesting to compare social profitabilities with commercial profitabilities as reflected by the residual. Because of the crude manner in which the residuals were calculated we concentrate on sign differences. Table 5.7 presents a comparison for Case A for WCF = 1.15 and ACF = 1.0. There are large number of sectors which show a commercial profit but which are socially unprofitable (and vice-versa). This reflects the degree of distortion in the price mechanism, which encourages the domestic production of many commodities which are socially unprofitable. However, one must keep in mind the level of aggregation of many of the sectors. For instance, there may exist various sub-sectors, or various technologies within one sector, which are socially profitable and others which are not. This may be particularly the case for textile activities which incorporate technologies which vary according to their degree of labour-intensiveness.

For the results presented we have valued the residual at zero thus treating it as a transfer with no resource cost. The analysis was repeated with the residual valued at 0.8. This may be interpreted as assuming that profits have a social value of only 0.2,

Table 5.7

Comparison of Social and Commercial Profitabilities

Sector	Social Profitability	Commercial Profitability
(5) Tobacco Growing	-0.39	0.13
(6) Oilseeds	-0.41	0.10
(8) Other Crops	-0.71	0.10
(12) Mining and Quarrying	-0.07	0.09
(16) Sugar Refining	-0.07	0.03
(22) Beverages	-2.16	0.08
(25) Cotton Yarn	-0.52	0.07
(30) Woollen Textiles	-0.63	0.02
(31) Other Textiles	-0.33	0.06
(36) Paper and Products	-0.06	0.10
(40) Rubber Products	-0.24	0.02
(48) Petroleum Products	-0.02	0.03
(52) Basic Metals	-0.07	0.02
(59) Transport (large-scale)	-0.20	0.08
(30) Rubber Footwear	0.24	-0.04
(41) Pharmaceuticals	0.18	-0.02
(44) Paints and Varnishes	0.08	-0.05
(45) Soaps and Detergents	0.10	-0.01
(55) Agricultural Machinery	0.07	-0.04
(57) Electrical Machinery	0.01	-0.01
(62) Office Equipment	0.14	-0.10

Note: These results are for Case A with ACF=1.0 and WCF=1.15.

so that a transfer of a unit of public funds to private profit has a social cost of 0.8. The social profitability of seven sectors exhibit sign changes for such a move: whereas sectors (9) 'livestock', (34) 'footwear (non-rubber)', (35) 'wood, cork and furniture', (53) 'metal products', (56) 'other non-electrical machinery', (61) 'transport equipment (small-scale)', and (63) 'sports goods' previously had positive social returns they now have negative returns.

§5.5.2 Policy Analysis

An analysis of the social returns should indicate which industries should be encouraged using the various policy instruments at the government's disposal, e.g. tax and pricing policies. We focus first on agriculture. Relative output prices and yields are important determinants of the relative profitabilities of various crops (or various crop combinations in a double-cropping system). Since individual crops have varying requirements in terms of water and climate their yields vary according to the agro-climatic environment and this can be a major factor in determining whether or not a crop has a comparative advantage in certain locations. For example, in areas where water is scarce, cotton is often the dominant crop because of its efficiency in water use. Alternatively, in areas well endowed with irrigation, rice is often the dominant crop because of its superior yields (relative to cotton) – improved varieties of rice respond sensitively to additional water. This is often what lies behind the idea of 'rice areas' and 'cotton areas' in Pakistan. In areas where relative yields do not play a dominant role in determining the allocation of land between crops we should find that the resource allocation decision is very sensitive to relative output prices.

The four major crops in Pakistan are wheat, rice (IRRI and basmati), cotton and sugarcane. Wheat is the dominant rabi (winter) crop reflecting its high yields, especially in well-irrigated areas. In the double-cropping system, wheat/IRRI, wheat/basmati and wheat/cotton are the dominant rotations. In well irrigated areas wheat/IRRI-basmati dominate wheat/cotton in terms of profitability, and vice versa in areas less well endowed with water. These three rotations all compete with sugarcane. However, since sugarcane is a very water-intensive crop, it probably is a substitute mainly for the wheat/rice rotations. In 1973, when world sugar prices were very high, sugarcane had a strong comparative advantage in certain areas. However, with world prices plummeting by 1976/7 this was no longer the case and the continued existence of sugarcane production reflected high support prices and the operation of sugarcane zones in the vicinity of sugar mills. It is also often assumed (see Gotsch and Brown, 1980, pp. 70-87) that farmers using animal power would not be able to implement wheat/basmati or wheat/cotton rotations (presumably due to time constraints and the sensitivity of returns to the time of planting) so that the next best alternative to sugarcane is the wheat/IRRI rotation.

According to Gotsch and Brown (1980) the ranking of crop allocations, in descending order of profitability (using domestic resource costs) for 1970/1, was: wheat/IRRI, wheat/ basmati, wheat/cotton and sugarcane. The rankings of wheat/IRRI and wheat/basmati were reversed in the 1975/6 period when basmati prices improved relative to IRRI prices which fell sharply. These results are consistent with those found by Lawrence (1970). However, he also found rapeseed to have the lowest domestic resource cost (DRC) and that the DRC of fall-planted oilseed, which competes with wheat, is lower compared to summer-planted oilseeds which compete with rice. However, Gotsch and Brown (1980) suggest that expansion of oilseed production needs to be considered in conjunction with increased crushing facilities. (Similar considerations apply to the production of sugarcane whose social profitability is higher if we consider the low MSC of sugar refining in the short-run). Maize also appeared with a DRC lower than cotton and higher than IRRI which suggests that one should examine its use in certain agro-industries (e.g. production of starch, sugars and glutin). Traditional rice had the highest DRC. Results from a study by Khan (1975) for 1972/3 also support the above conclusions, with sugarcane and wheat/cotton reversing positions, reflecting the sharp increase in world sugar prices in this period.

Our social profitability results are very similar to those from the earlier studies for a similar period. Wheat, rice and cotton dominate all other crops in terms of social profitability. In the mid 1970s subsidies on imported wheat and export duties on rice and cotton operated to encourage farmers to allocate more land to non-traded crops (such as sugarcane) then would otherwise have been the case. However, recall that we have calculated the opportunity cost of land assuming that a given unit of land is allocated to the production of various crops, using the proportion of total cropped land allocated to a particular crop in 1975/6 as the relevant proportions. Therefore, if we think that certain 'minor' crops do not compete with wheat, rice and cotton then these may be socially profitable. This may also be the case if high yielding varieties are introduced for such crops as maize, vegetables, pulses or oilseeds, or if better practices are encouraged by extension services. So we should interpret the negative profitability of, for example, (8) 'other crops' in this light.

The social profitabilities of food processing industries such as (15) 'edible oils', (16) 'sugar refining', and (19) 'fish and preparations' depend on the world prices of processed food, the resource costs of their major agricultural inputs and the technical efficiencies of the production technologies used. Our results suggest that the domestic productions of edible oils and sugar should not be encouraged, suggesting a greater reliance on imports. In the case of sugar, for example, this reflects its low world price, the existence of more profitable alternatives to sugarcane and the low recovery rate of sugar from sugarcane. The low profitability of processed fish reflects the high opportunity cost of raw fish in terms of foreign exchange from exports. But one must ask how much fish can be exported to neighbouring countries and also take account of the cost of exporting farther afield, e.g. using freezer ships to transport fish to the Gulf region. It also appears that the protection given to (22) 'beverages', through import taxes, is not desirable. It is interesting to note that excises on beverages were increased substantially during the 1980s. Sector (23) 'tobacco products' exhibits a high social return and is an efficient earner of foreign exchange. However, if one thought that further production would require the use of domestically produced raw tobacco (which exhibits a negative social profitability), or if one sees tobacco as a 'demerit' good, then this would probably be much lower. The technical difficulties in maintaining the quality and transporting of raw tobacco suggest that it is probably a non-tradeable. Notice that although Table 5.1 suggests that the private profitably of sugar and edible oil production has improved since the mid 1960s, our results suggest that the industries have not yet reached a stage where they are socially profitable.

An interesting feature of the results is the negative social returns of (25) 'cotton yarn' and (27) 'cotton textiles (large scale)', together with a positive return for (28) 'cotton textiles (small scale)'. This reflects the opportunity cost (in terms of foreign exchange from exports) of using raw cotton domestically (as opposed to its export) and the capital intensiveness of large scale producers. Small scale cotton textile producers are more labour intensive and socially profitable. These results are all the more important given that cotton producers are the major industrial employers in the country and are subsidized through low domestic prices for cotton. One has to ask whether the social unprofitability of large-scale cotton textiles reflects any natural comparative disadvantage or just 'organizational' inefficiencies. It may be that privileged treatment, as reflected in artificially low cotton prices, have made them slack as regards monitoring efficiency. It also appears that import substitution in (29) 'silk and synthetic textiles', (30) 'woollen textiles and hosiery' and (31) 'threadballs and other textiles' should not be encouraged. Notice that 'other textiles' was one of the sectors with negative value added at world prices in 1963/4 (see Table 5.1).

The relatively high social returns for exported manufactures, especially for traditional sectors, emphasises the need to encourage export-oriented manufacturing. Major exporting sectors, such as (32) 'carpets and rugs', (33) 'made-up garments', (38) 'leather and products', (39) 'rubber footwear', (63) 'sports goods' and (64) 'surgical instruments', exhibit high social returns. It is interesting that the results also suggest that the production of (49) 'cement' for export should be encouraged. The low or negative returns of many import-substituting sectors reflects the fact that the protection of these activities may no longer be desirable. Any pleadings for continued protection on 'learning-by-doing' or 'infant industry' grounds should therefore be considered with caution. The above results relating to textiles would also suggest that one should ask whether high tariffs are the most effective way of improving technical efficiency where learning-by-doing is important. However, there does appear to be an argument for the continuation of import substitution for some imported commodities, namely, (41) 'pharmaceuticals', (42) 'fertilizers', (45) 'soap and detergents', (47) 'plastic products',

(56) 'other non-electrical machinery' and (62) 'office equipment'. It is also possible that there exists some scope for continued import substitution within such sectors as (44) 'paints and varnishes', (46) 'chemicals', (55) 'agricultural machinery' and (61) 'transport equipment (small scale)'.

So far we have focused solely on medium and long-term industrialization policy. However, at any point in time, we are faced with the problem of selecting the appropriate policy given the level and nature of investment that presently exists. It is possible that appropriate short-term policies differ (possibly substantially) from the appropriate long-run policies, especially where there exists over-capacity (or underutilization of existing capacity) and large fixed investments. In many industries there are large fixed costs which cannot be avoided once the investment is in place. Therefore, one should focus on marginal costs (and not average costs as in the above analysis) when selecting between policy options. It is also the case that within any one industry there can be a number of different technologies, varying in their levels of fixed costs. This feature of an industry must be incorporated into any analysis used to guide policy. In order to highlight some of the issues involved we concentrate on the sugar refining industry, but many of these issues are also pertinent to other industries.

At the time of partition there were only two-sugar refining plants in Pakistan. By 1960 there were twelve plants, by 1970 nineteen plants, thirty one by 1980 and 41 by 1986. The more recent investments have been in more capital-intensive plants and have been the focus of much criticism because of the high costs of domestic production. Since the early 1960s the government has regulated the industry, the extent of its involvement varying over time. Between 1972 and 1981 the government determined the support price for sugarcane, the ex-mill and retail prices of refined sugar, and also monopolized its purchase and sale. Retail prices were kept substantially above world prices and sugar was sold through ration shops. Each mill was allocated a zone in which farmers were obliged to sell sugarcane to the mill.

Sugarcane output is very unstable due to the vagaries of the weather, pests and disease. The objective of cane support prices is to protect farmers in 'good' seasons and mills in 'bad' seasons. In good seasons mills must pay the minimum support price, and they operate at full capacity. In bad seasons mills are often unwilling to purchase cane at prices greater than the support price because of fixed prices for sugar. Farmers then may find it more profitable to use cane to produce gur and khandsari, and this further exacerbates the problem of cane shortages. So capacity utilization varies substantially between good and bad years. This is more of a problem in Punjab and NWFP where the cottage sugar industry is more established. In Sind, the absence of a cottage sector, a more favourable (humid) climate and larger landholdings all combine to make sugar production more profitable.

Whereas many of the modern plants may be profitable, many of the smaller, older plants are not. The social profitability of sugar production depends on the social cost of production of cane. The social cost of producing cane will depend on the social value of alternative land use (for wheat, rice, cotton, etc.). Up to the mid 1960s cane competed with traditional varieties of wheat and rice so that the opportunity cost of producing cane was lower. The high world prices for sugar in the early 1960s ensured that the domestic production of sugar and cane were socially profitable. In the late 1960s high yielding varieties of wheat and rice were introduced and the world price of sugar fell dramatically. Sugarcane yields remained static and its sucrose content low. Sugarcane and refined sugar were profitable only because of high support prices for cane and the fixing of the domestic price of sugar well above world prices. The hike in world sugar prices in the early 1970s helped to divert arguments for the closure of some plants and a greater reliance on imports. However, the plummeting of world sugar prices from 1976 renewed such pressure.

While we might conclude that, in the long run, the domestic production of sugar (and hence cane) is not socially profitable, in the short run we can argue that, because of the low marginal cost of sugar production, the allocation of land to cane should be maintained and the older sugar plants kept open. However, over time the less profitable plants should close and the land switched away from cane to wheat, rice and cotton (or other socially profitable crops). This obviously also has implications for short-run pricing policies and we discuss these further in Chapter 6. The question of optimal buffer stocks in the face of fluctuating world prices is likewise of much importance but we do not discuss that here.

Many other industries encompass a range of production technologies with varying levels of social return. For example, while some fertilizer plants may be socially profitable at world prices, older plants may not. We also saw that although large-scale cotton textile production was not socially profitable in the mid 1970s, small-scale plants had a positive social return suggesting that these labour-intensive techniques were preferable to the more modern capital intensive ones. Whereas the question of the social profitability of sugar production has immediate consequences for the level of cane production this is not so for fertilizer and cotton textiles because of the possibility of foreign trade. The interesting questions in the fertilizer sector are the optimal level of domestic production in the long run and the choice of production technique. With cotton textiles we should ask: Given world prices for raw cotton and cotton textiles, should the former be exported or used to produce textile products domestically? The answer will depend on the production technique (i.e. labour or capital intensive) employed, the efficiency with which raw cotton is transformed into textiles and relative labour and capital costs.

§5.6 Summary and Conclusions

From our discussion of industrialization and trade policies in Pakistan since Independence we saw that there has been a gradual movement away from quantative restrictions on domestic production and foreign trade in favour of manipulating price incentives for investment in various industries. Up to the 1970s this liberalization of the economy was gradual and took the form of loosening, rather than eliminating, quantity controls. The 1970s saw a rapid and major move towards price controls as a way of adjusting the incentives facing producers and consumers. Our summary of previous studies into the extent of the consequent pricing distortions in the economy shows that the distortions were large and that the complexity of the price and tax system may have had unintended consequences, especially the effective taxation of exporting industries. Such distortions may give wrong signals to private agents and encourage investments in industries which are socially unprofitable.

In Chapter 1 we emphasised the need to use shadow prices when evaluating government economic policies and reforms. In this chapter we have set out a method for the calculation of a set of shadow prices for aggregate sectors. We discussed and interpreted the basic principles of the Little-Mirrlees approach for the calculation of shadow prices and argued that this method is easy to use and is also a very flexible and useful way of evaluating and formulating government policies. We then showed how this approach can be put into practice using data which are available for many developing countries. The specific model we set out for the calculation of shadow prices is easy to construct and can be applied in a very flexible manner.

We have calculated a set of shadow prices for Pakistan for the mid 1970s and have showed how these can be used in a discussion of industrialization and trade policies. The technical analysis of our results highlights the origin and nature of the distortions, e.g. trade or domestic taxes, and summarizes their combined effect on the overall level of distortion. We explored various assumptions about the workings of product and factor markets and their implications for shadow prices. We then went on to interpret the results from a policy viewpoint and showed how they could be used to guide government economic decisions concerning investment and pricing. We focused, in turn, on agriculture, agriculture- related industries, and manufacturing industries.

With agriculture the results suggest that the emphasis in Pakistan on wheat, rice and cotton is justified. These crops emerged as the most socially profitable crops. However, we also suggested that some of the minor crops may not compete directly with these major crops, i.e. the land they take up is not suitable for the major crops, in which case our policy conclusions would need to be adjusted accordingly. Our analysis of agriculture- related industries showed that policy towards industries based on crops such as sugarcane and oilseeds needs to be re-evaluated. Unless scientific research leads to higher sugarcane or oilseed yields, or unless the technical efficiency of the relevant processing industries is improved, a greater reliance on imports may be desirable. The results for cotton based industries also highlighted similar issues. The social unprofitability of the cotton yarn and the large-scale cotton textile industries emphaises the need to question whether or not there is a genuine infant industry argument for protection and, if so, whether tariff protection will actually achieve this, or are more direct policies required. Similar issues apply to some import-substituting industries. One must decide whether domestic production can ever be socially profitable and recognize the implications of inefficient production for government revenue and consumer welfare. Also, the social profitability of major exporting industries reinforces arguments for their continued encouragement, or at least not to discourage them through duties or input taxes.

Finally, we pointed out that much of our analysis was focused on the medium to long term. Using the sugar industry as an example, we argued that for industries in which there already exists large fixed investments short-run policies may look very different from longer-term objectives. For example, if a socially unprofitable industry has large fixed costs then we may want to maintain production levels (and those of non-traded inputs) but phase it out gradually, i.e. discourage new investments. In fact, if there is underutilization of capacity we may want to increase production. The implications of such issues for pricing policies are discussed in Chapter 6.

Chapter Six

Indirect Taxation and Pricing Policy in Pakistan

§6.1 Introduction

In Chapter 1 we highlighted that due to administrative and political constraints governments in developing countries often have to rely to a large extent on the manipulation of prices and the imposition of indirect taxes to raise a substantial proportion of the revenue required to finance government expenditures. We further argued that these constraints are particularly apparent when it comes to the taxation of the agricultural sector. While the theoretical models which analyse optimum commodity taxation or pricing are useful in identifying the desirable characteristics of a system of indirect taxation and price controls they are less useful when it comes to the analysis of agricultural pricing policy. The standard assumptions of optimal profits taxation and an ability to tax total consumption are less acceptable when applied to agriculture. It is generally agreed that the taxation of agricultural profits would be very difficult as would the taxation of the total consumption of agricultural households who are both consumers and producers. However, if agriculture is seen as part of the consumer sector then the results from the standard models are still valid, but now consumption elasticities are replaced with elasticities of net trade defined as the difference between production and consumption.

In spite of the ability of the standard models to incorporate the idiosyncracies of the agricultural sector one must recognize that the systems of indirect taxes and price controls observed in practice rarely conside with those suggested by these models. But risk-averse governments who require revenue to finance politically sensitive expenditures will be understandably wary of implementing major reforms. However, they may be more willing to undertake gradual reform and in §1.3 we presented a theory of price reform and showed how it can be used to identify welfare-improving changes in the existing system of price controls and indirect taxes. In this chapter we apply this approach to Pakistan using data from the mid 1970s. This is an interesting period to analyse since the government had access to many policy instruments reflecting its nationalization of numerous agricultural and industrial sectors. The results of our analysis, however, carry lessons for policies beyond this period. We use these lessons to comment on policies followed in the 1980s and to set out recommendations for the future.

The layout of the chapter is as follows. In §6.2 we recap on how the theory of price reform can be applied in practice and then set out a model which is intended to allow normative analysis of the instruments available to the government in the mid 1970s. Although our modelling of the operation of government pricing policies may not be completely representative of the actual system in the mid 1970s and may appear somewhat 'optimistic' from the point of view of the degree of control excercised by the government, we think that it does capture the essential features of the system. In §6.3 the data used in the analysis are discussed. Our results are presented in §6.4, and §6.5 uses these to discuss policies followed in the 1980s and to make recommendations for future policy. Some conclusions are given in §6.6.

§6.2 A Model for Pakistan

In §1.4 we set out an approach which can be used to analyse price reform. We defined the statistic λ_i as the marginal social cost of raising extra revenue by changing the price (tax) on good i. We also showed that this could be written as the sum of direct effects on individual households (weighted by their marginal social utilities of income) divided by the indirect cost of changing demands as captured by the change in shadow revenue. Using (1.4.1), (1.4.3) and (1.4.4) this can be written in a form convenient for empirical analysis as:

$$\lambda_i = \frac{\Sigma_h \beta^h q_i s_i^h}{-q_i s_i - \Sigma_j \tau_j \varepsilon_{ji} q_j s_j} \qquad (6.2.1)$$

or alternatively as $\lambda_i = D_i/E_i$ where

$$D_i = \frac{\Sigma_h \beta^h q_i s_i^h}{-q_i s_i}$$

and $$E_i = [1 + (\Sigma_j \tau_j \varepsilon_{ji} q_j s_j)/q_i s_i]$$

The term D_i is the distributional characteristic of good i and reflects the pattern of net trade in i (defined as production minus consumption) across households with different marginal social utilities of income. s_i^h is the net trade in good i by household h: if a household is a net producer (consumer) of good i then s_i^h is positive (negative). For certain goods (e.g. wheat or labour in rural areas) individual households can be net purchasers or net sellers, or have zero trade when they consume what they produce. For other goods households may always be net purchasers (e.g. chemical fertilizers in rural areas or final commodities in urban areas), or always net sellers (e.g. cash crops in rural areas). The term $s_i = \Sigma_h s_i^h$ captures the net market trade in good i by the consumer sector as a whole (remember it now includes the agricultural sector). This can be positive or negative depending on whether the consumer sector as a whole is a net buyer or seller. For example, if the government is a net buyer of good i from the rural consumer sector, as is the case for wheat, then s_i is positive reflecting the surplus over consumption in rural areas. Therefore, an increase in q_i represents a net transfer of resources to the rural consumer sector although among rural consumers there are some losers (net purchasers) and some gainers (net sellers). Alternatively, if the consumer sector as a whole is a net buyer of good i, as is the case with fertilizer in rural areas and many consumer goods in rural and urban areas, then s_i is negative and an increase in q_i represents a net transfer of resources out of the consumer sector.

The term E_i is the change in government (shadow) revenue with respect to q_i [multiplied by q_i, i.e. $q_i(\partial R_v/\partial q_i)$, where q_i is the price being changed], τ_j is the shadow tax rate on good j and ε_{ji} is the elasticity of s_j with respect to q_i. The first term captures the change in revenue when demands are fixed and the second term calculates the effect on revenue when consumers respond to a price change by switching net demands between goods with varying tax rates.

We now examine the revenue equations (i.e. E_i) for each commodity, the nature of government involvement in each sector and the elasticity of government revenue with respect to various prices set by the government. The analysis is presented in terms of actual revenue but one only needs to replace producer prices and marginal costs with shadow prices and shadow costs to get to shadow revenue. Our applied work focuses on shadow revenue.

§6.2.1 *Wheat and Atta*

Government involvement in the wheat and atta (flour) markets is modelled as follows. The government sets the procurement price of wheat, p_1, which also determines the market price. At this price producers decide how much to produce and to consume on farm, the difference being their marketed surplus. Rural non-producers also decide on their level of consumption. The government procures the residual after these decisions, i.e.

$$G_1 = S_1 - X_1 \qquad (6.2.1)$$

where G_1 is government procurement of wheat, S_1 is producers' marketed surplus and X_1 is demand by non-producers (mainly landless rural households). Note that G_1, not S_1, captures the extent of government involvement in wheat trade and thus corresponds to s_i in (6.1.1). We assume that the wheat milling industry is in the public sector. Notice that it is now uninteresting to focus on the 'issue price' of wheat to millers since changes in this price act only as a transfer between the government 'wheat revenue account' and its 'atta revenue account'. The prices of interest are the procurement price of wheat and the consumer prices of market and rationed atta set by the government.

The government sets both the price of atta in the ration shops, $\bar{q}_2$, and the open-market price of atta, q_2. At these prices it forecasts total atta demand, X_2, where:

$$X_2 = X_2^o + \bar{X}_2 \qquad (6.2.2)$$

X_2^o is demand in the open-market and $\bar{X}_2$ is demand for rationed wheat. We assume that ration quotas received by a household are fixed by the government and depend on the composition of the household. In reality some households do not take up the full quota to which they are entitled so we further assume that the factors which determine take up are exogenous and not affected by the price changes considered.

Given total demand for atta this in turn implies a demand for wheat through the relationship:

$$Y_1 = \psi X_2 \qquad (6.2.3)$$

where Y_1 is demand for wheat by the milling industry and ψ is the fixed amount of wheat required to produce one unit of atta, i.e. the physical input-output coefficient Y_1/X_2. The difference between this demand and the amount procured by the government is imported so that:

$$M_1 = Y_1 - G_1 = \psi X_2 - G_1 \qquad (6.2.4)$$

where M_1 is wheat imports which are controlled by the government.

Using (6.2.1)-(6.2.4) government revenue from its operations in the wheat-atta market can be written as:

$$R = -p_1 G_1 + q_2 X_2^O + \bar{q}_2 \bar{X}_2 - \bar{c} - \tilde{c} X_2 - p_1^* M_1 \qquad (6.2.5)$$

where R is government revenue, $\bar{c}$ the total fixed costs of millers, $\tilde{c}$ the variable cost of production (per unit of X_2) and p_1^* the price paid by the government for imports (the border price plus trade and transport margins). So:

$$p_1 \frac{\partial R}{\partial p_1} = \frac{-(p_1 - p_1^*)}{p_1} \epsilon_{11}^G p_1 G_1 - p_1 G_1 \qquad (6.2.6)$$

where ϵ_{11}^G is the elasticity of government procurement of wheat with respect to the procurement price of wheat and $p_1 G_1$ is the cost of wheat procured by the government. It is this equation which enters into the calculation of λ_1, the effect on social welfare of raising one extra unit of revenue by changing the procurement price of wheat. When revenue is valued at shadow prices we interpret p_1^* as the shadow price of wheat. Note that the relevant elasticity is that of government procurement and that, from (6.2.4), $(\partial M_1/\partial p_1)=(-\partial G_1/\partial p_1)$ so that changes in government procurement affect import levels.

The effect on revenue of a change in the market price of atta is given by:

$$q_2 \frac{\partial R}{\partial q_2} = \frac{(q_2 - \tilde{c} - p_1^* \psi)}{q_2} \epsilon_{22}^o \; q_2 \; X_2^o + q_2 \; X_2^o \qquad (6.2.7)$$

where ϵ_{22} is the elasticity of open-market atta demand with respect to the open-market price and $q_2 X_2$ is the value of open-market purchases. The term $(\tilde{c} + p_1^* \psi)$ is the marginal cost of production. The effect on R of a change in the ration price is given by:

$$\bar{q}_2 \frac{\partial R}{\partial \bar{q}_2} = \frac{(q_2 - \tilde{c} - \psi p_1^*)}{q_2} \bar{\epsilon}_{22} \; q_2 \; X_2^o + \bar{q}_2 \; \bar{X}_2 \qquad (6.2.8)$$

where $\bar{\epsilon}_{22}$ is the elasticity of demand for open-market atta with respect to the ration price of atta and ration levels are fixed so that a change in the ration price acts as an income transfer which in turn leads to a change in demand for open market atta. In a similar manner to above one can derive the effect on R of a change in any other price, p_i, so that:

$$p_i \frac{\partial R}{\partial p_i} = \frac{(q_2 - \tilde{c} - \psi p_1^*)}{q_2} \epsilon_{2i}^o \; q_2 \; X_2^o - \frac{(p_1 - \overset{*}{p}_1)}{p_1} \epsilon_{1i}^G \; p_1 \; G_1 \qquad (6.2.9)$$

where ϵ_{2i}^o and ϵ_{1i}^G are the elasticities, with respect to p_i of open-market atta demand and government procurement of wheat respectively.

The direct effect on welfare of all these price changes is given by the welfare-weighted sum of the relevant household surplus. From (6.2.6)-(6.2.9) we can see that the relevant elasticities for our tax reform analysis in the wheat-atta sector are the own- and cross-price elasticities of government procurement of wheat and market atta demand. A detailed analysis of household production-sales-purchases profiles (using Government of Pakistan, 1979) indicates that no farmer who purchased wheat from the market also purchased market atta and less than 1% purchased ration atta. Atta was mainly consumed in urban areas with wheat consumption predominant in rural areas. The data therefore suggests that whether or not a household purchases wheat or atta is determined mainly by location and is not very sensitive to relative wheat and atta prices. In deriving the above we assumed that changes in urban atta prices do not affect rural wheat production, consumption or government procurement. Information on overall production, marketed surplus and government procurement is presented in Table 6.1 for major crops.

§6.2.2 *Rice*

In the rice industry the government sets the procurement price of rice (unhusked grain), p_4. Given p_4, rice farmers decide how much to produce. The farmer sells all this grain to the public sector rice husking plant and buys back his consumption requirements at a price of q_5 which is fixed by the government. We also assume that q_5 is the price faced by other consumers so the government can confront all consumers with q_5, even rice producers. The government has a price fixing rule given by:

$$q_5 = \gamma p_4 \qquad (6.2.10)$$

so that $q_5/p_4 = \partial q_5/\partial p_4 = \gamma$. We can think of γ being fixed to guarantee a certain level of profits to millers.

Table 6.1

Procurement and Marketed Surplus of Major Crops

	Proportion of total output			r=S/Y	S/G
	Procured	Consumed On Farm	Sold to Open Mkt.		
Wheat	0.25	0.60	0.15	2.50	1.60
Rice	0.30	0.20	0.50	-	-
Sugarcane	0.30	0.70	-	3.33	-
Cotton	1.00	-	-	1.00	-

Note: S is marketed surplus, Y total production and G government procurement.
Source: Agricultural Statistics of Pakistan (1985) and Government of Pakistan (1979).

Let Y_4 be the total production of rice, all of which is procured by the government. This level of production is a function of p_4. Given p_4, the government sets q_5 to satisfy equation (6.2.10) and this determines the level of demand for (husked) rice, X_5. The demand for unhusked rice by the domestic rice husking industry, X_4, is then determined by the following relationship:

$$X_4 = \alpha X_5 \qquad (6.2.11)$$

where α is the physical input-output coefficient, i.e. the amount of unhusked rice required to produce one unit of husked rice. The difference between domestic demand for and supply of unhusked rice is exported with:

$$E_4 = Y_4 - X_4 \qquad (6.2.12)$$

where E_4 is net exports of rice.

Using (6.2.10)-(6.2.12) the revenue equation for the rice sector can be written as:

$$R = - p_4 Y_4 + q_5 X_5 - \bar{c} - \tilde{c} X_5 + p_4^* E_4 \qquad (6.2.13)$$

where $\bar{c}$ represents the fixed costs of the rice husking plants, $\tilde{c}$ their per unit variable costs of production and p_4^* is the rice export price. The effect of a change in the procurement price of rice on R is then:

$$p_4 \frac{\partial R}{\partial p_4} = - \frac{(p_4 - p_4^*)}{p_4} \eta_{44} p_4 Y_4 - p_4 Y_4 + \frac{(q_5 - \tilde{c} - \alpha p_4^*)}{q_5} \epsilon_{55} q_5 X_5 + q_5 X_5 \qquad (6.2.14)$$

where $(\tilde{c} + \alpha p_4^*)$ is the marginal cost of producing husked rice, p_4^* is the world price of unhusked rice, and η_{44} is the elasticity of rice production with respect to changes in the procurement price of rice.

The effect on R of a change in any other price p_i can similarly be written as:

$$p_i \frac{\partial R}{\partial p_i} = - \frac{(p_4 - p_4^*)}{p_4} \eta_{4i} p_4 Y_4 + \frac{(q_5 - \tilde{c} - \alpha p_4^*)}{q_5} \epsilon_{5i} q_5 X_5 \qquad (6.2.15)$$

where η_{4i} and ϵ_{5i} are, respectively, the elasticity of rice production and rice consumption with respect to p_i. So the relevant elasticities for the tax analysis are the supply elasticities (own and cross) for rice, and rice demand elasticities.

The direct effect on welfare of a change in p_4 is $\Sigma_h \beta^h (p_4 y_4^h - q_5 x_5^h)$, where we interpret the surplus as the difference between the value of rice production (zero for non-producers) minus the value of rice consumption. This crude modelling of the rice sector was necessary given the lack of detailed information concerning its operation. Notice that we have not distinguished between basmati and coarse varieties of rice due to lack of data.

§6.2.3 Sugarcane and Refined Sugar

In the sugar industry we assume that the government sets the procurement price of cane, p_6. Given this price farmers decide on the level of their marketed surplus, G_6, all of which is sold to the government. The government then sets both the market and ration prices for sugar as well as the sugar ration quota for various households. We assume that the ration quota received by households is fixed for the household according to household composition. As with wheat, in reality we find that some households do not take up their full ration entitlement, so we further assume that the take up decision is exogenous in the sense that it is not affected by the price changes considered. The market price of sugar is set at q_9 and the ration price at $\bar{q}_9$. At these prices consumers decide on their consumption of refined sugar so that:

$$X_9 = X_9^o + \bar{X}_9 \qquad (6.2.16)$$

where X_9 is total demand for sugar, X_9^o demand for open-market sugar and $\bar{X}_9$ demand for

ration sugar. Domestic production of sugar is a function of the amount of cane procured by the government and is given by the relationship:

$$Y_9 = \Upsilon G_6 \qquad (6.2.17)$$

where Y_9 is domestic production of sugar and Υ is the amount of sugar produced from one unit of cane or the 'recovery percentage' (the inverse of the physical input-output coefficient). The excess of demand over domestic production is met through imports of sugar:

$$M_9 = X_9 - Y_9 = X_9 - \Upsilon G_6 \qquad (6.2.18)$$

where M_9 represents imports of refined sugar.

The revenue from the sugar industry is given by:

$$R = - p_6 G_6 + q_9 X_9^o + \bar{q}_9 \bar{X}_9 - \bar{c} - \tilde{c} X_9 - p_9^* M_9 \qquad (6.2.19)$$

where $\bar{c}$ is the fixed cost of the sugar refining industry, $\tilde{c}$ unit variable costs and p_9 the cost of importing sugar. The effect on R of changing the procurement price of cane is:

$$p_6 \frac{\partial R}{\partial p_6} = \frac{\Upsilon\xi(p_9^* - \tilde{c} - \bar{\Upsilon}\, p_6)}{q_9}\, \epsilon_{66}^{G}\, p_6\, G_6 - p_6\, G_6 \qquad (6.2.20)$$

where $\bar{\Upsilon}$ is the inverse of Υ (or the physical input-output coefficient) or amount of sugarcane required to produce one unit of sugar), ξ is the ratio of the market price of sugar to the procurement price of cane, q_9/p_6, and ϵ^G is the elasticity of government procurement of cane with respect to the procurement price. Note that in our model we do not regard ξ as fixed. The term in brackets is positive if the marginal cost of producing sugar domestically is less than the cost of importing sugar, i.e. if domestic production is privately (socially if valued at shadow prices) profitable on the margin.

The effect on R of a change in the market price of sugar is:

$$q_9 \frac{\partial R}{\partial q_9} = \frac{(q_9 - p_9^*)}{q_9}\, \epsilon_{99}^{o}\, q_9\, X_9^o + q_9\, X_9^o \qquad (6.2.21)$$

and the revenue effect of a change in the ration price is:

$$\bar{q}_9 \frac{\partial R}{\partial \bar{q}_9} = \frac{(q_9 - p_9)}{q_9}\, \epsilon_{99}^{o}\, q_9\, X_9^o + \bar{q}_9\, \bar{X}_9 \qquad (6.2.22)$$

The effect on R of a change in any other price, p_i, is:

$$p_i \frac{\partial R}{\partial p_i} = \frac{(q_9 - p_9^*)}{q_9}\, \epsilon_{9i}^{o}\, q_9\, X_9^o + \frac{\Upsilon\xi(p_9^* - c - \bar{\Upsilon}p_6)}{q_9}\, \epsilon_{6i}^{G}\, p_6\, G_6 \qquad (6.2.23)$$

with all variables as earlier. From (6.2.20)-(6.2.22) we see that the elasticities of government procurement and of open-market demand for sugar are the relevant elasticities when analysing price reforms.

Data from the Agricultural Statistics of Pakistan (Government of Pakistan, 1977 and 1985) indicate that around 30% of total sugarcane output was purchased by the sugar refining industry. On the other hand, Government of Pakistan (1979) suggests that farmers sold on average 80% of sugarcane production. It is most likely that the 50% difference was sales to the gur industry. In this paper we treat this element of supply as on-farm consumption so that the elasticity of demand for sugarcane (taken as that for sugar) is assumed to reflect the decision as to how much sugarcane to withhold for the gur industry. Although this is not satisfactory, a more detailed analysis would need to undertake an in-depth study of the existence of a gur industry side by side with the sugar refining industry. This is not attempted here.

§6.2.4 *Cotton*

We assume that all raw cotton is sold to the government so that the procurement elasticity is simply the supply elasticity for cotton. Since other prices are held constant the domestic demand for cotton does not change and the change in the domestic supply of cotton is matched by a corresponding change in cotton exports.

§6.2.5 *Fertilizer*

In Pakistan the government fixes the consumer price of fertilizer. Some fertilizer producers are in the private sector while others are in the public sector. However, since the government guarantees producers a fixed return, and subsidizes or taxes (surcharge) any deviations from this return, we can proceed as if the fertilizer sector is totally within the public sector. We assume that domestic producers are producing at full capacity and that domestic demand for fertilizer exceeds domestic supply with the difference being imported. Any changes in demand brought about by price reforms will therefore lead to an adjustment in imports. The relevant elasticity is then the elasticity of demand for fertilizer.

§6.2.6 *Other Final Commodities*

We assume that all other goods are final consumer goods. The relevant elasticities are then the conventional demand elasticities and the direct effect on welfare of changes in their prices depends on the extent of consumption by each household.

§6.2.7 *Labour*

In order to incorporate the workings of the labour market into our analysis we assume that the government can determine wages only in what we call the formal or organized sector. This sector will include large-scale manufacturing and some of the services sector. We assume that total labour supply in the economy is fixed at L and that net labour supply from the consumer sector to the formal sector, L_3, is:

$$L_3 = L - L_1 - L_2$$

where L_1 is labour demand in the agricultural crop sector and L_2 labour demand in the informal sector which includes non-crop agricultural activities (e.g. fishing and forestry), small-scale manufacturing and small-scale services (e.g. construction activities). We could rewrite the above equation to reflect a sequential flow of labour from the agricultural to the informal sector and then on to the formal sector but this would serve only to complicate matters unnecessarily.

For expositional purposes it is more useful to focus specifically on shadow revenue. The government shadow revenue equation for labour is then:

$$R = -(w-w^*)\ L_3$$

where L_3 is net labour supply from the consumer sector (sectors 1 and 2), w is the wage paid by the formal sector and w^* the social value to the economy of an extra unit of labour, i.e. the shadow wage rate. Therefore,

$$p\,\frac{\partial R}{\partial p} = -\ (1 - WCF)\ \eta_3\ \ wL_3$$

where the wage conversion factor (WCF) is defined as in Chapter 5 (the ratio of w^* to w), η_3 is the elasticity of net labour supply to the formal sector with respect to a price p, and wL_3 is the formal sector wage bill.

To simplify things we assume that both L and L_2 do not respond to changes in p, in which case the response of labour demand in the crop sector determines η_3 so that:

$$\eta_3 = -\eta_1\ \frac{L_1}{L_3}$$

where η_1 is the elasticity of demand for labour with respect to p in the agricultural crop sector. Take, for example, an increase in the price of wheat. This increases the demand for labour in the agricultural sector thus decreasing the net supply to the formal sector. If WCF<1 reflecting, say, the high welfare weight attached to wage income (which increases), then government revenue increases making a change in the price of wheat more attractive.

§6.3 Data

To calculate the marginal social cost for each policy instrument we need information on the patterns of net trade across consumers, the direction and extent of net trade by the consumer sector as reflected in the degree of control exercised by the government, shadow tax rates, and the elasticities of net trade. We now discuss these in more detail.

§6.3.1 *Surplus Trade* ($q_i s_i^h$)

This value is taken as the value of output minus the value of consumption for household h. For commodities such as wheat, rice and sugarcane there is both output and consumption for most households. For cotton, consumption is zero. For all other commodities the surplus is simply minus the value of consumption. These values are taken directly from Government of Pakistan (1979).

§6.3.2 *Government Trade* (G_i)

For most of the final commodities considered we have assumed that the government can tax total consumption so that $p_i s_i$ in (6.2.1) is equivalent to total consumption for those commodities. For other commodities allowance must be made for the degree of government intervention in total trade. In the case of wheat, sugarcane and cotton the relevant values are those for government procurement. To calculate these values we multiply the total value of output for each commodity (as given in Government of Pakistan, 1979) by the percentage procured by the government (see Table 6.1). Note also that these values are preceded by a negative sign reflecting the fact that an increase in the procurement price leads to a fall in revenue from that commodity. With rice some extra calculations need to be made. From (6.2.14) we see that the relevant entry for $p_i s_i$ is taken as the value of total consumption of rice less the value of total output, i.e.

$$q_5 \, x_5 - p_4 \, y_4$$

Using (6.2.10)-(6.2.12) this becomes:

$$p_4 \, y_4 \, [\gamma \, \alpha^{-1} \, (1 - r_e) - 1] \qquad (6.3.2)$$

where γ is the ratio of the consumer price of rice to the procurement price, α the amount of unhusked rice required to produce one unit of husked rice, and r_e is the ratio of government procurement of rice for export to the total production of rice. The value of output is taken from Government of Pakistan (1979) as is γ, the ratio of q_5 to p_4 (calculated as 1.16). The value of r_e is taken from the Agricultural Statistics of Pakistan (Government of Pakistan, 1977, p122) and approximately equals 0.35. The first term inside the brackets of (6.3.2) is used to calculate the value of domestic consumption of rice implied by the value of output.

§6.3.3 Accounting Ratios (ARs) and Prices

The ARs, defined as the ratio of the shadow price of a good to its market price, are all taken from Chapter 5. It is necessary to merge these from their 87-sector classification based on input-output information to the 20-sector classification used in our tax analysis. Where more than one sector of the former was allocated to a single sector in the latter we calculated a weighted AR, using the private consumption values for the relevant sectors (given in the input-output tables) as weights. These merged ARs are presented in Table A6.1 and were discussed, at the 87-sector classification level, in Chapter 5.

For sugarcane the relevant entry for the shadow tax is the difference between the shadow price of refined sugar the marginal social cost of the domestic production of sugar, adjusted to allow for the 'recovery' of refined sugar from sugarcane - see (6.2.20). The recovery percentage is taken as 10% and the ratio of the market price of sugar to the procurement price of sugarcane as 54.1 and was calculated as follows. The prices for sugarcane derived from Government of Pakistan (1979), using quantities sold and value of sales, are very unreliable. However, data from the Agricultural Statistics of Pakistan (Government of Pakistan, 1985, p183) indicate a support price just above Rs. 5.6 per maund (approx. 37kg) in Punjab and Sind and just below this for NWFP. We therefore take Rs. 5.6 per maund as the procurement price of sugarcane. The market price of sugar is taken (from Government of Pakistan, 1979) as the average sample market price of Rs. 303 per maund.

The cotton output is valued at Rs. 100 per maund, the approximate average sample price (derived using value of sales and quantities sold). The Government of Pakistan (1979) does not provide data on use of fertilizer so we impose certain values on the sample. We assume that the per acre levels of fertilizer applied are 35 kg/acre on irrigated farms less than 25 acres and on non-irrigated farms over 25 acres, 20 kg/acre on non-irrigated farms less than 25 acres, and 45 kg/acre on irrigated farms over 25 kg/acre. This is obviously a crude method but has some support from values calculated from the Indus Basin Survey which was used in Chapter 3 and Chapter 4. The consumer price fixed by the government is taken as Rs. 3 per kg.

In our analysis we examine the sensitivity of our reform proposals to various sets of shadow prices. Different sets of ARs were calculated using a range of ARs for labour (the wage conversion factor, WCF) and capital (the asset conversion factor, ACF). The values for the ACF were taken as 1.2, 1.0 and 0.8, and for the WCF were 1.4, 1.15 and 0.9. The basis of these values was explained in Chapter 5. In presenting our results we focus on the (WCF,ACF) combination of (1.4,1.2). However, we compare the results derived using the other (WCF,ACF) combinations with this base case.

§6.3.4 *Welfare Weights* (β^h)

To evaluate tax reforms we need to select welfare weights. These weights are attached to households and reflect judgements as to how the relative social value of income varies over households. It is usual to make this rate a decreasing function of income (income taken as an indicator of the present level of well-being so that we view a unit increase in income as more valuable if it accrues to lower-income families rather than higher-income households). The relative weights chosen therefore reflect our attitude towards the present distribution of income and our aversion to inequality. A useful way of representing our views of the prevailing distribution of income is:

$$\beta^h = (I^k / I^h)^e \qquad (6.3.3)$$

where β^h is the welfare weight for household h (the marginal social value of income to h), I^h the per capita income level of household h and I^k that for the k'th (reference) household. The term e reflects the extent of aversion to inequality. The higher e the greater the dislike for an unequal distribution of income and, consequently, the greater the weight (in relative terms) attached to income accruing to lower-income households. For example, if household k has income half that of h then with e=0 a unit of income accruing to k is seen as just as valuable as a unit to h, with e=1 it is seen as twice as valuable, with e=2 four times as valuable and with e=5 as thirty two times as valuable. This approach has also been used elsewhere (see, for example, Ahmad and Stern, 1984 and 1990).

In this paper we normalize the welfare weights by setting the weight for the lowest income (per capita) household equal to unity, i.e. the household with the lowest per capita income is taken as the reference household. This normalization involves the assumption that a unit of government revenue is equal in value to a unit of income for the poorest household. Households are classified into income groups according to their per capita income level (see Table A6.2). Using average group expenditures we calculate group welfare weights applying (6.3.3). The welfare weight of any household is the welfare weight of the income group to which it belongs. We check the sensitivity of our results to different values of e, choosing e=0, 0.5, 1.0, 2.0 and 5.0. Notice that we focus on the 'household' as the basic unit and therefore ignore important questions concerning the distribution of income or consumption between household members of different ages and gender. Such a breakdown becomes very important when analysing issues like individual nutrition and when designing schemes to target certain household members.

When calculating welfare weights we used 'total expenditure' as a proxy for 'total income'. This has obvious drawbacks since one might argue that *ceteris paribus* welfare weights should be a decreasing function of savings and thus total income. Even ignoring this problem we find that an analysis of Government of Pakistan (1979) makes it quite clear that prices vary widely over regions for many commodities. Therefore, we cannot be very confident that the relative levels of household expenditures reflect relative levels of welfare. It is more realistic to think of household welfare as a function of quantities consumed so that two households with the same levels of consumption of each commodity but facing different prices should be seen as having the same level of welfare even though their total expenditures may differ. To correct for this discrepancy we apply single prices to certain commodities rather than regional prices as above and calculate a new set of welfare weights using the implied total expenditures. This procedure can only be carried out on certain commodities, such as wheat and atta, which are relatively homogenous. Other more aggregate commodity groups prevent the application of such procedures since commodities within these groups are not homogenous and the composition of within group consumption may vary widely over households. However, since the results are virtually identical, we do not present these here. Welfare weights and expenditure levels are presented in Table A6.2.

§6.3.5 Distributional Characteristic (D_i)

In §6.2 we decomposed λ_i, the marginal social cost of raising revenue by changing the price of good i, into the product of a distributional characteristic for the good, D_i, and the inverse of its revenue elasticity. The distributional characteristic is calculated as $D_i=[\Sigma_h\beta^h q_i s_i^h/-q_i s_i]$ and encapsulates the direct effects on household welfare of price changes - individual household effects are weighted by welfare weights which reflect concern about income distribution. If welfare weights are a decreasing function of income then commodities which account for a relatively large proportion of the budgets of higher income groups will have a relatively lower distributional characteristic implying a lower social cost of raising revenue by taxing these commodities, and *ceteris paribus* making them more attractive candidates for taxation. Also, as our aversion to inequality, e, increases there is a greater proportional decrease in the distributional characteristic of such commodities making them still more attractive as sources of additional revenue. Such guidelines, however, are less straightforward when producer and shadow prices are not proportional. In this case that tax elasticity involves shadow prices which may be dependent on welfare weights.

Let us divide commodities into those traded and non-traded at the margin. The shadow price of a non-traded commodity is taken as the marginal social cost of production. As e increases the welfare weight for lower income households increases in relative terms so that the shadow cost of employing such household labour decreases (see §5.3.1). Therefore, the shadow price of commodities whose production is relatively intensive in its use of low-income labour falls relative to other shadow prices. The social profitability of industries which use this commodity increases thus suggesting investment in industries which use this input intensively. In our tax reform analysis this is reflected in a higher (lower) shadow tax (subsidy) on this commodity so that reforms which switch demand towards this commodity become more desirable as e increases. Therefore, commodities which have a relatively high distributional characteristic and whose production involves the use of a large amount of low-income labour will exhibit a relatively greater increase in λ, the marginal social cost of raising revenue through taxing this commodity. This suggests reforms which increase demand for these commodities and investment in industries which use these commodities intensively, i.e. it encourages lower taxes on goods consumed and produced by the worse off.

The shadow price of traded commodities does not vary with e (ignoring the social cost of domestic trade and transport margins which, in any case, usually have little effect - see Chapter 5) reflecting our definition of traded commodities as those for which a change in net demand leads to a change in net foreign trade with no adjustment in domestic production. However, as e increases the social profitability of domestic production of traded commodities increases, the extent of the increase depending on the extent to which traded industries use low-income labour. This suggests that the government should encourage investment in such industries leading to a fall in imports or an expansion of exports. So a change in e affects the optimal level of domestic production of traded commodities. From the point of view of the reform of final commodity taxation, however, an increases in e suggests a switch in taxation from non-traded to traded commodities since domestic production appears more socially profitable and changes in the taxation of tradeables, by definition, leads to changes in foreign trade with no effect on domestic production. However, the desirability of such a switch is reduced if traded commodities figure prominently in the budgets of low-income households. Crucial here, of course, is the assumption that more direct instruments for income distribution are not available.

§6.3.6 Net Trade Elasticities

In §6.2 we described the relevant elasticities for our analysis of various price reforms. To calculate these elasticities we use the demand elasticities from Ahmad and Ludlow (1987), the agricultural output and fertilizer elasticities from Ali (1988), and the labour and fertilizer elasticities derived in Appendix E. When calculating the net trade elasticities we have taken into account the fact that some price changes do not affect all of the consumer sector. For example, changes in procurement prices affect only farmers while changes in ration prices affect only those entitled to rations. Therefore, the elasticities used in our analysis take account of the limited incidence of certain price changes. The net trade elasticities used in our analysis are presented in Table A6.3 and the supply elasticities in Table 6.2.

Table 6.2

Price Elasticities of Supply for Major Agricultural Crops

	Wheat	Rice	Cotton	Sugarcane
Wheat	0.327	0.248	-0.217	0
Rice	0.641	1.920	-0.462	0
Cotton	0	-0.616	1.339	0
Sugarcane	0	0	-0.230	0.810

Source: Ali (1988).

§6.4 Results

For the purpose of presenting our results it is useful to focus on the decomposition of λ_i, the marginal social cost of raising revenue by changing the price of good i, into its distributional and efficiency effects. We have from (6.2.1):

$$\lambda_i = D_i \ / \ E_i$$

where D_i is the distributional characteristic for i and E_i the elasticity of revenue with respect to the price (tax) of i. This decomposition enables us to set out some general rules of thumb when selecting commodities as candidates for taxation. The higher the distributional characteristic of a commodity the higher the cost of using it as a source of revenue. The distributional characteristic of a commodity is higher the more it is consumed by poorer households. In the case of agricultural output, the distributional characteristic will be lower the more it is produced by richer households. Therefore, as *e* (our inequality aversion parameter) increases, commodities for which poorer households are net consumers and richer households net producers become major candidates for taxation.

The more elastic is revenue to a commodity tax the lower the social cost of using it as a source of revenue. The revenue elasticity reflects the elasticities of demand and supply, and the prevailing tax rates. The lower the own-price elasticity of a commodity the higher the revenue elasticity thus making it an attractive source of revenue. Also, extra taxation of a commodity becomes more attractive the more an increase in its tax switches demand towards commodities with relatively high tax rates. We now analyse the distributional (Ds) and efficiency (Es) effects of price changes. We first look at each separately but then combine both to examine the overall impact on social welfare. We then check the sensitivity of our results to various parameter changes and focus on some of the lessons arising from our analysis.

§6.4.1 *Equity*

We focus first on the distributional characteristic, D. Table 6.3 presents the distributional characteristics and their rankings for various values of *e*. From the results we see that the D for wheat becomes negative at very low values for *e*. This reflects the fact that poorer households are net consumers of wheat and richer households net producers. An increase in the tax on wheat corresponds to a decrease in its procurement price and also in the market price. This makes wheat (i.e. lower procurement prices) the most attractive source of revenue from a distributional point of view. Notice that a tax on wheat producers is simultaneously a subsidy to consumers. Also note that increasing a tax on commodities with negative Ds is a net welfare improvement even if we throw away the revenue. Other commodities with low distributional characteristics are rice (where D becomes negative for e=5), meat, other foods and other non-foods. So, for example, lower procurement prices for rice and higher consumer taxes on meat are among the best ways of raising revenue from an equity viewpoint. Commodities exhibiting high Ds are atta (market and rationed), sugar (rationed), maize and pulses. The high Ds for rationed commodities are, of course,

Table 6.3

Ds for Various Values of ϵ

Commodity	ϵ=0		ϵ=0.5		ϵ=1.0		ϵ=2.0		ϵ=5.0	
	D	R	D	R	D	R	D	R	D	R
(1) Wheat	1	1	-0.126	1	-0.410	1	-0.397	1	-0.174	1
(2) Atta (M)	1	1	0.580	18	0.359	18	0.166	18	0.056	16
(3) Atta (R)	1	1	0.598	20	0.389	20	0.201	20	0.082	19
(4) Rice	1	1	0.500	4	0.258	2	0.070	2	-0.006	2
(5) Sugarcane	1	1	0.524	11	0.293	11	0.109	6	0.013	3
(6) Cotton	1	1	0.533	14	0.318	15	0.150	16	0.064	17
(7) Fertilizer	1	1	0.520	10	0.291	10	0.111	8	0.023	7
(8) Sugar (M)	1	1	0.529	13	0.305	13	0.126	13	0.029	10
(9) Sugar (R)	1	1	0.582	19	0.369	19	0.186	19	0.078	18
(10) Pulses	1	1	0.553	16	0.332	16	0.148	15	0.046	15
(11) Maize	1	1	0.558	17	0.339	17	0.164	17	0.082	20
(12) Meat	1	1	0.500	5	0.273	5	0.102	5	0.021	6
(13) Milk	1	1	0.517	7	0.288	6	0.111	7	0.024	8
(14) Veg.,Fruit & Spices	1	1	0.518	9	0.291	9	0.116	10	0.030	11
(15) Edible Oils	1	1	0.517	8	0.290	8	0.113	9	0.026	9
(16) Tea	1	1	0.534	15	0.310	14	0.130	14	0.034	14
(17) Housing,Fuel & Light	1	1	0.513	6	0.289	7	0.118	11	0.034	13
(18) Clothing	1	1	0.524	12	0.296	12	0.118	12	0.030	12
(19) Other Foods	1	1	0.496	3	0.265	4	0.093	3	0.015	4
(20) Other Non-foods	1	1	0.492	2	0.263	3	0.095	4	0.021	5

Note: ϵ is an inequality aversion parameter (see §6.3.4 for discussion), D captures the distributional effects of the reforms, R is the reform ranking with R=1 indicating the most distributionally attractive reform, and (M) and (R) refer to market and rationed commodities respectively.

expected since rationing systems are designed to channel certain commodities to lower income households. Therefore, if the government wishes to raise more revenue it should avoid increasing ration prices or decreasing subsidies to market atta. Sugarcane and fertilizer become more attractive sources of revenue as *e* increases with cotton becoming a less attractive candidate. These results suggest that, from an equity standpoint, the government could improve welfare by lowering wheat, rice and sugarcane prices, and use the (first round) increase in revenue to finance lower ration prices, higher subsidies to market atta and higher cotton prices. However, these recommendations totally ignore the concomitant efficiency losses, to which we now turn.

§6.4.2 *Efficiency*

We now turn to the revenue elasticities. Note that when e=0 (i.e. D = 1) the λs are simply the inverse of the revenue elasticities. Table 6.4 presents the λs over various values of *e*. Focusing on values for e=0, the striking feature is that decreasing the procurement prices for wheat and rice, and increasing the sales price of fertilizer, actually decrease revenue. This is a consequence of the signs and magnitudes of the own- and cross-price net supply elasticities. In the case of wheat a decrease in the procurement price leads to a substantial fall in government procurement. This shortfall is met through higher levels of more costly imports. Lower wheat procurement prices also lead to lower rice production implying lower exports of rice at world prices higher than domestic procurement prices. These effects swamp the increase in revenue from a fall in demand for subsidized fertilizer.

Lower rice procurement prices lead to lower exports of rice and a rise in expensive wheat imports. The increase in sugarcane production is reflected in a rise in the domestic production of socially unprofitable refined sugar. These effects swamp the increased revenue from higher production and exports of cotton and falling fertilizer demand. Higher fertilizer prices increase wheat imports, and lead to a fall in rice and cotton export levels. These adverse effects on revenue swamp the revenue increases which arise from lower levels of socially unprofitable sugar output and falling fertilizer demand. The negative effects of lower cotton prices on cotton exports is dominated by

Table 6.4

Lambdas for Various Values of ϵ

Commodity	ϵ=0		ϵ=0.5		ϵ=1.0		ϵ=2.0		ϵ=5.0	
	λ	R	λ	R	λ	R	λ	R	λ	R
(1) Wheat	-0.278	3	0.035	3	0.114	4	0.110	9	0.048	16
(2) Atta (M)	0.900	7	0.522	12	0.323	14	0.149	15	0.050	17
(3) Atta (R)	0.993	11	0.594	17	0.386	18	0.200	20	0.082	19
(4) Rice	-0.225	2	-0.112	2	-0.058	2	-0.016	2	0.001	2
(5) Sugarcane	0.224	4	0.118	4	0.066	3	0.024	3	0.003	3
(6) Cotton	0.745	5	0.397	5	0.237	5	0.112	11	0.048	15
(7) Fertilizer	-0.119	1	-0.062	1	-0.035	1	-0.013	1	-0.003	1
(8) Sugar (M)	1.216	19	0.643	18	0.370	16	0.153	16	0.036	12
(9) Sugar (R)	1.016	15	0.591	16	0.375	17	0.189	18	0.079	18
(10) Pulses	0.982	10	0.543	14	0.326	15	0.146	14	0.045	13
(11) Maize	1.185	18	0.661	19	0.401	19	0.194	19	0.097	20
(12) Meat	0.995	13	0.498	10	0.272	10	0.102	7	0.021	6
(13) Milk	1.005	14	0.519	11	0.290	11	0.111	10	0.024	7
(14) Veg.,Fruit & Spices	1.577	20	0.817	20	0.460	20	0.183	17	0.047	14
(15) Edible Oils	1.045	17	0.540	13	0.303	12	0.119	12	0.027	9
(16) Tea	1.027	16	0.548	15	0.318	13	0.134	13	0.035	11
(17) Housing,Fuel & Light	0.914	8	0.470	7	0.264	9	0.108	8	0.031	10
(18) Clothing	0.828	6	0.434	6	0.245	6	0.098	6	0.025	8
(19) Other Foods	0.995	12	0.493	9	0.263	8	0.092	4	0.015	4
(20) Other Non-foods	0.974	9	0.479	8	0.256	7	0.093	5	0.020	5

Note: See note to Table 6.3. λ is the marginal social cost of each reform. The results are based on a (WCF,ACF) combination of (1.4,1.2) and net labour supply elasticities are assumed equal to zero.

the consequent fall in wheat and fertilizer imports, even though sugar production increases. Lower sugarcane prices lead to lower sugar production and fertilizer imports, both which increase revenue.

So in order to increase revenue, while minimizing efficiency losses, the government should increase the procurement prices of wheat and rice or decrease fertilizer prices. From an efficiency perspective increasing wheat or rice procurement prices, or lowering those for sugarcane, cotton or fertilizer, are the most attractive policy instruments for raising revenue. The attractiveness of lower fertilizer prices arises from the large distortions in the prices of major agricultural crops. The fact that the reform of agricultural pricing policies could lead to major efficiency gains is an important feature of our results.

§6.4.3 Equity and Efficiency

The interaction of efficiency and distributional considerations is captured by the λs for $e>0$. The fall in the correlation between the ranks of the λs from 1 to 0.39 when e goes from 0 to 5 indicates that there is a strong conflict between equity and efficiency. However, focusing on the correlation coefficient alone does not adequately capture the direction or size of changes in the distributional effect of price changes. For example, although increasing the procurement prices of rice increases revenue it also increases the social welfare of the consumer sector which is a net seller of rice to the government. But for $e=5$ the distributional characteristic for rice becomes negative reflecting the higher welfare weight attached to net consumers of rice, i.e. the increased income of rice farmers is valued using a relatively low welfare weight. The high ranking throughout for higher rice prices as a source of revenue reflects the dominance of efficiency considerations. Likewise, decreasing the price of fertilizer increases revenue and also farmers' incomes. This ensures that decreasing the price of fertilizer remains the most attractive reform throughout, in spite of the increasing attractiveness of higher fertilizer prices from a distributional point of view. Lower procurement prices for sugarcane are attractive using both efficiency and equity criteria.

In contrast to rice and fertilizer, the ranking of wheat falls as e increases.

Decreasing the procurement price of cotton also becomes less attractive at higher levels of inequality aversion. Other goods which become unattractive as sources of revenue as *e* increases are market and rationed atta and rationed sugar. The rankings of market sugar, meat, milk, vegetables, edible oils, tea and other foods and non-foods increase with *e* thus making them more attractive as sources of revenue. Higher taxes on maize remain an unattractive source of revenue throughout since both distributional and efficiency considerations suggest lower taxes.

§6.4.4 Sensitivity of Results

We now turn to the sensitivity of our results to various parameters in the analysis. First of all we analyse the effect of allowing for responses in the labour market. Then we see how our results change when we use various sets of shadow prices for labour and capital, and when we make different assumptions concerning the restoration of equilibrium after the reform through changes in foreign trade or domestic production. Finally, we generate a new set of results based on the demand elasticities from a less restricted demand model estimated by Deaton and Grimand (1991).

In the results presented above we assumed that the elasticity of net supply of labour from the consumer sector was zero with respect to all price reforms. We now drop this assumption. Since these elasticities only affect the efficiency aspects (including indirect distributional consequences) of the reforms we focus on the results for e=0. When the WCF is high, reflecting a high opportunity cost of labour in terms of output forgone, reforms which increase the demand for labour (thus decreasing the net supply of labour from the consumer sector) become less attractive. Therefore, higher wheat and rice prices become less attractive, while higher fertilizer prices and lower sugarcane and cotton prices become more attractive. When the WCF is low, reflecting, for example, the social benefits of higher incomes to wage earners, reforms which increase the demand for labour, and thus wages, become more attractive. We now comment on the sensitivity of our policy conclusions to changes in our assumptions concerning the price elasticities of net labour supplies.

A very useful feature of our results is their lack of sensitivity to our assumption

Table 6.5

Lambdas for Various Values of ϵ

Commodity	$\epsilon=0$		$\epsilon=0.5$		$\epsilon=1.0$		$\epsilon=2.0$		$\epsilon=5.0$	
	λ	R	λ	R	λ	R	λ	R	λ	R
(1) Wheat	-0.482	3	0.061	3	0.198	5	0.191	18	0.084	19
(2) Atta (M)	0.900	7	0.522	12	0.323	14	0.149	14	0.050	16
(3) Atta (R)	0.993	11	0.594	17	0.386	18	0.200	20	0.082	18
(4) Rice	-0.245	2	-0.122	2	-0.063	2	-0.017	2	0.001	2
(5) Sugarcane	0.140	4	0.074	4	0.041	3	0.015	3	0.002	3
(6) Cotton	0.446	5	0.238	5	0.142	4	0.067	4	0.029	10
(7) Fertilizer	-0.128	1	-0.066	1	-0.037	1	-0.014	1	-0.003	1
(8) Sugar (M)	1.216	19	0.643	18	0.370	16	0.153	15	0.036	13
(9) Sugar (R)	1.016	15	0.591	16	0.375	17	0.189	17	0.079	17
(10) Pulses	0.982	10	0.543	14	0.326	15	0.146	13	0.045	14
(11) Maize	1.185	18	0.661	19	0.401	19	0.194	19	0.097	20
(12) Meat	0.995	13	0.498	10	0.272	10	0.102	8	0.021	6
(13) Milk	1.005	14	0.519	11	0.290	11	0.111	10	0.024	7
(14) Veg.,Fruit & Spices	1.577	20	0.817	20	0.460	20	0.183	16	0.047	15
(15) Edible Oils	1.045	17	0.540	13	0.303	12	0.119	11	0.027	9
(16) Tea	1.027	16	0.548	15	0.318	13	0.134	12	0.035	12
(17) Housing,Fuel & Light	0.914	8	0.470	7	0.264	9	0.108	9	0.031	11
(18) Clothing	0.828	6	0.434	6	0.245	6	0.098	7	0.025	8
(19) Other Foods	0.995	12	0.493	9	0.263	8	0.092	5	0.015	4
(20) Other Non-foods	0.974	9	0.479	8	0.256	7	0.093	6	0.020	5

Note: See note to Tables 6.3 and 6.4. Here, labour net supply responses are not assumed to be zero.

regarding the net labour supply from the consumer sector (see Table 6.5). Whether or not we assume net labour supply elasticities to be zero makes no difference to the ranking of our policy instruments, except in the case where 0.9 is taken as the value for the WCF (see Tables A6.4 and A6.5). But even in this case these differences arise from the sensitivity of one good, sugarcane, to the change. When the WCF=0.9 (and the ACF$\leq$1.0) the production of refined sugar becomes profitable and lower sugarcane prices reduce output and also the demand for labour. On both these counts this reform is not desirable and, in fact, when the ACF=0.8 the sign of the λ for sugarcane becomes negative so that lower sugarcane prices also reduce shadow revenue. For these values higher sugarcane prices increase the welfare of sugarcane producers, increase the production of socially profitable sugar and thus shadow revenue. It is useful, though, to point out here that when we use different commodity demand elasticities (see below) this negative revenue effect disappears and the assumption of net labour supply elasticities makes virtually no difference to our results.

We now analyse the results generated using various (WCF,ACF) combinations (see Table A6.4). In Chapter 5 we discussed the assumption behind the various conversion factors and the values chosed cover a wide range of possibilities concerning the operation of factor markets. For most goods the ARs do not change much, reflecting their traded classification. For these goods, changes in demand lead to changes in net foreign trade flows with no change in their domestic production. Therefore, the valuation of domestic factors does not come into play. Sugarcane, however, does experience a drastic change, reflecting the movement of sugar production into social profitability for (WCF, ACF) combinations of (0.9,1.0) and (0.9,0.8) This is a major factor in the low correlation coefficient across these factor valuations, since the ranking of sugarcane moves from 4 to 20 when the (WCF, ACF) combination moves from (1.4,1.2) to (0.9,0.8). Other commodities which experience movements between being (shadow) taxed or subsidized are pulses, meat, housing and other foods and non-foods. Although these commodities show relatively large changes in ranking they remain within the middle rankings. So, in spite of the low correlations, the thrust of our results remain the same. From an efficiency point of view, increases in rice and wheat prices, and lower fertilizer and cotton prices are always attractive ways of raising revenue. Sugar, vegetables, maize and edible oils retain their relatively high social costs of raising revenue, while sugarcane and other non-foods join them for lower valuations of domestic factor inputs. At higher levels of aversion to inequality (e.g. e=5), distributional considerations dominate and, these being unaffected by domestic resource valuations, the correlation between the ranks of the λs is very high at 0.97 or greater. Also, when we use a different set of demand elasticities (with a smaller number of commodity classifications) the robustness of our results is enhanced since important commodities are traded and others get allocated to more aggregate categories (see below).

When we make different assumptions about how equilibrium is restored in the wake of our reforms the results emerging are very similar to those above. A number of commodities, previously classified as imported on the margin, are reclassified as non-traded in an attempt to capture the presence of binding quotas. Any changes in demand are then assumed to be met by changes in domestic production. Since many of the reclassified sectors are allocated to more aggregated groups, the effect of these changes is diluted and, on the whole, the ranking of policy instruments is not very sensitive to this change (see Table A6.6). Notice that although the shadow tax on sugar is reduced, reflecting the high marginal social cost of production relative to the fixed market price, its ranking remains very similar.

Finally, we repeat our tax analysis with a different set of demand elasticities. Above we used estimates from Ahmad and Ludlow (1987) who used a modified linear expenditure system. We now use estimates provided by Deaton and Grimand (1991) who, using a less restricted functional form, argues that:

> 'The Pakistani substitution patterns between rice, wheat, sugar and edible oils are not consistent with additive preferences and so cannot be accommodated within a model like the linear expenditure system...... Nor could additive preferences accommodate the pattern of total expenditure and own-price elasticities that characterise demand patterns in Pakistan...... Additive preferences require that the ratio *of own-price to expenditure elasticities* be (approximately) uniform over goods. Yet it is this ratio that is the principal determinant of how the balance between equity and efficiency ought to be struck' (p34, italics added).

This issue becomes more important when focusing on the elasticity of marketed surplus since small differences in own- and cross-price elasticities can become magnified when moving to marketed surplus elasticities.

Fortunately, from the viewpoint of policy analysis, the results based on the alternative set of demand elasticities are very similar to those presented above (see Table 6.6). Like Deaton and Grimand (1991) we work with a smaller number of commodity categories: pulses, maize, vegetables and tea are now included in the 'other foods' category, while housing and clothing are included in 'other non-foods'. Focusing on the results for e=0 we find that the negative λs for fertilizer, rice and wheat remain, so that increasing shadow revenue involves increasing the procurement prices of wheat or rice, but decreasing the price of fertilizer. However, the λ for edible oils now becomes negative reflecting the negative effect of higher edible oil prices on wheat procurement and on the demand for highly taxed sugar, combined with the positive effect on sugarcane procurement. This is in spite of the positive effect on demand for subsidized rice (to consumers) and the high own-price elasticity for edible oils.

These results suggest that, from an efficiency point of view, the best way of raising revenue is by decreasing the price of fertilizer or increasing the procurement prices of rice or wheat. Lowering taxes on edible oils is the next best alternative, followed by lower procurement prices for sugarcane and cotton. The least attractive ways of raising revenue are by increasing the prices of marketed or ration sugar, market atta other foods or non-foods.

Using distributional considerations the least attractive ways of raising revenue are lowering the prices of rationed or market atta, rationed or market sugar, or cotton. The most attractive instruments are decreasing the prices of wheat, rice, sugarcane, meat or other foods. Therefore, as before, there is a strong conflict between equity and efficiency when contemplating increasing revenue through increasing wheat or rice procurement prices, or decreasing cotton prices. However, decreasing sugarcane prices is an desirable reform using both efficiency and equity criteria. Also, increasing the prices of market atta, or rationed and market sugar is not desirable from either viewpoint. Note also that the efficiency considerations dominate pricing policy for rice and fertilizer, even at high levels of aversion to inequailty. Neither does the introduction of

Table 6.6a

Lambdas for Various Values of ϵ

Commodity	ϵ=0		ϵ=0.5		ϵ=1.0		ϵ=2.0		ϵ=5.0	
	λ	R	λ	R	λ	R	λ	R	λ	R
(1) Wheat	-0.296	3	0.037	4	0.121	5	0.117	10	0.052	11
(2) Atta (M)	1.049	12	0.609	13	0.376	12	0.174	11	0.059	12
(3) Atta (R)	0.998	8	0.597	12	0.388	13	0.201	14	0.082	14
(4) Rice	-0.191	2	-0.095	2	-0.049	2	-0.013	2	0.001	3
(5) Sugarcane	0.215	5	0.113	5	0.063	4	0.023	4	0.003	4
(6) Cotton	0.741	6	0.395	6	0.235	6	0.111	8	0.048	10
(7) Fertilizer	-0.120	1	-0.062	1	-0.035	1	-0.013	1	-0.003	1
(8) Sugar (M)	1.406	14	0.743	14	0.428	14	0.177	12	0.041	9
(9) Sugar (R)	1.010	10	0.588	11	0.373	11	0.188	13	0.079	13
(10) Meat	1.010	9	0.505	8	0.276	8	0.103	6	0.021	5
(11) Milk	0.876	7	0.453	7	0.253	7	0.097	5	0.021	6
(12) Edible Oils	-0.546	4	-0.282	3	-0.158	3	-0.062	3	-0.014	2
(13) Other Foods	1.039	11	0.524	9	0.285	9	0.105	7	0.022	7
(14) Other Non-foods	1.050	13	0.533	10	0.294	10	0.113	9	0.027	8

Table 6.6b

Lambdas for Various Values of ϵ

Commodity	ϵ=0		ϵ=0.5		ϵ=1.0		ϵ=2.0		ϵ=5.0	
	λ	R	λ	R	λ	R	λ	R	λ	R
(1) Wheat	-0.539	3	0.068	4	0.221	6	0.214	14	0.094	14
(2) Atta (M)	1.049	12	0.609	13	0.376	12	0.174	10	0.059	11
(3) Atta (R)	0.998	8	0.597	12	0.388	13	0.201	13	0.082	13
(4) Rice	-0.205	2	-0.102	2	-0.053	2	-0.014	2	0.001	3
(5) Sugarcane	0.137	5	0.072	5	0.040	4	0.015	4	0.002	4
(6) Cotton	0.445	6	0.237	6	0.141	5	0.067	5	0.029	9
(7) Fertilizer	-0.128	1	-0.067	1	-0.037	1	-0.014	1	-0.003	1
(8) Sugar (M)	1.406	14	0.743	14	0.428	14	0.177	11	0.041	10
(9) Sugar (R)	1.010	10	0.588	11	0.373	11	0.188	12	0.079	12
(10) Meat	1.010	9	0.505	8	0.276	8	0.103	7	0.021	5
(11) Milk	0.876	7	0.453	7	0.253	7	0.097	6	0.021	6
(12) Edible Oils	-0.546	4	-0.282	3	-0.158	3	-0.062	3	-0.014	2
(13) Other Foods	1.039	11	0.524	9	0.285	9	0.105	8	0.022	7
(14) Other Non-foods	1.050	13	0.533	10	0.294	10	0.113	9	0.027	8

Note: These results are based on demand elasticities presented in Deaton(1991, Tbale VI, p24) and on a (WCF,ACF) combination of (1.4,1.2). In Table 6.6a we assume net labour supply responses to be zero but not in Table 6.6b.

net labour supply elasticities change the rankings.

§6.4.5 *Comments*

We now focus on some of the lessons from the analysis. Firstly, the results emphasize that any discussion of commodity taxation or pricing in a partial equilibrium framework can be severely misleading, especially when large price distortions already exist. This is particularly so for agricultural outputs and inputs. Such concerns may also be magnified by our focus, in certain cases, on surplus rather than supply or demand elasticities alone. Thus tax reform analysis should be set in a general equilibrium framework. Secondly, our sensitivity analysis suggests that our policy conclusions are robust. This robustness stems from the very high degree of price distortion that existed for major agricultural commodities in the mid 1970s and also from the traded nature of most important agricultural outputs and consumer goods.

Thirdly, the case of sugarcane highlights the impact of industry profitability on pricing policy. The appropriate pricing of sugarcane is determined mainly by the social profitability of domestically produced refined sugar, which in turn depends on the marginal social cost of sugarcane production reflecting the opportunity cost of land and other agricultural outputs forgone. The higher (lower) the social profitability of refined sugar production the less (more) attractive lower sugarcane prices. We also found that lower sugarcane prices were desirable on equity grounds. A further issue raised by our analysis is the desirability of investment in the sugar refining industry and we return to this topic later.

Higher procurement prices should also be accompanied by higher fertilizer prices: when we set the shadow tax rates of the major agricultural crops equal to zero, *increasing* fertilizer prices became the most attractive way of raising extra revenue from an efficiency viewpoint. This is probably also applicable to other subsidized agricultural inputs such as water and electricity. Note that if such inputs are more accessible to larger farmers then there is an additional distributional argument for the removal of these subsidies. We have implicitly assumed that other tax instruments are, for whatever reason, unavailable to the government. If land taxes were to become feasible then these would probably be desirable from both equity and efficiency standpoints.

Some of our commodity categories are very broad, encompassing a wide variety of individual commodities. It is probable that a more detailed analysis of these commodity groups will suggest the existence of certain commodities which are more attractive than other commodities in the group as sources of revenue. For example, poorer households may consume only certain types of fuel (included in the 'housing' category) making the taxation of these fuels less acceptable when applying distributional considerations. However, where an individual commodity has strong substitutes one will wish to apply similar tax rates on this commodity and its substitutes unless there are major distributional reasons for setting differential rates. Feasibility from an administrative point of view may be an important consideration here.

We have said very little about the desirability of input taxes on the manufacturing side. A general rule of thumb is that, where possible, we should focus on the taxation of final outputs. If this is not possible then taxation of inputs may be the best proxy for output taxes, and such input taxes should be focused on materials for which there is an inelastic demand. From this viewpoint taxes on cement, for instance, may be a useful way of taxing the services accruing from housing. This is probably desirable from a distributional stance given the large increase in construction of new houses by wealthy families, many of which may be returned migrants from the Middle East. Where monopoly rents exist these should be taxed directly, if possible. Such taxes are more easily administered when monopoly profits accrue to large establishments (e.g. large factories) given the ease with which these can be identified. Output or input taxes should be regarded as second best methods for taxing such rents.

§6.5 Agricultural Pricing Policy

The results presented above suggested that in the mid 1970s there were substantial efficiency gains to be had by reforming agricultural pricing policies. The desirability of lowering the price of fertilizer was based on the large price distortions for major agricultural crops. If these were to be removed then so too would the attractiveness of lower fertilizer prices as a source of revenue. Higher procurement prices for rice and wheat, and lower prices for sugarcane, also provided large efficiency gains. However, except for sugarcane, these reforms appear to have adverse distributional consequences. In particular, the efficiency gains from higher wheat procurement prices are dominated by the beneficial distributional impact of lower prices. Also, the desirability of lower cotton prices from an efficiency perspective disappeared when we took account of the distributional consequences.

Our results also indicate that lower prices for atta and sugar (both rationed and market, especially rationed) are very attractive using distributional considerations. Combining this with the efficiency consequences set out above, we suggest that the adverse distributional consequences of higher wheat and rice procurement prices could be offset by lowering the prices of rationed commodities. In the absence of lump-sum transfer mechanisms, rationing schemes, given their similarity to such policy instruments, are a useful way of redistributing income. It is often argued, though, that the high administrative costs of running rationing schemes and their ineffectiveness at targeting income to the poor should eliminate them from the policy agenda. Such concerns seem to have impinged heavily on the decision by the goverment to abolish the rationing of sugar (in 1983) and the atta (in 1987):

> 'The abolision of the rationing system......would allow the goverment to save the subsidy of Rs 3000 million which hardly ever reached its intended beneficiaries' (Pakistan Economic Survey, 1986, p71).

However, Rogers (1988a) argues that appropriate design of rationing schemes can go a long way in allievating many such problems. In Rogers (1988b, p252) she concludes that for Pakistan:

> 'The ration system, though far from perfect, nonetheless has a number of attributes which recommend its preservation. These include its widespread accesibility, its relatively low administrative burden on the government, its flexibility and the long-standing experience of those who operate it. Serious thought should be given to improving its benefits rather than eliminating them.'

Additionally, when the costs of ration schemes are set against the potential efficiency gains from increased prices for major agricultural commodities they may become more acceptable. The attractiveness of low wheat procurement prices from a distributional viewpoint stemmed from the fact that poorer rural households (e.g. landless labourers and those with small landholdings) were net consumers. Therefore, with higher wheat prices one should examine the feasibility of extending rationing to rural areas. If this was considered too costly from an administrative viewpoint then other schemes would need to be put in place, e.g. rural work schemes (see, for example, World Development Report, 1990, Chapter 6, for discussion). It must also be remembered that higher crop prices may increase agricultural wages making such reforms more attractive. The absence of less distortionary policy instruments (e.g. land taxes) to raise revenue means that one probably has to resort to agricultural pricing policies in order to tax rural incomes. Note, however, that with higher rice prices, low procurement prices for wheat are less distortionary. This reflects the complementarity between these two crops implied by the positive price elasticities of supply.

Since the mid 1970s the Goverment of Pakistan has followed the policy of increasing the procurement prices of major agricultural commodities (see Figure 4.3). However, wheat and rice procurement prices have remained below world prices (see Table 6.7). This is especially so for basmati rice in which Pakistan is thought to have some monopoly power (so that marginal revenue from increased sales is below the actual world price). The variability in the domestic-world price ratio for cotton reflects volatile world prices so that the relatively constant domestic procurement prices since 1980 were intended to reduce the uncertainty facing producers. This will be reflected in uncertain goverment revenue. Although the price of fertilizer fell rapidly from 1974 to 1980, since then it has increased sharply but has remained constant after 1983. But it remains below world prices.

Our result indicate that lower sugarcane prices are desirable using both efficiency and distributional criteria. This result is a consequence of domestic sugar production being socially unprofitable, reflecting the high cost of producing sugarcane. In spite of the fact that sugarcane is essentially a crop for the tropics, Pakistan ranks fifth in the world in terms of acreage under sugarcane. Ideally, sugarcane requires a humid climate, well distributed rainfall and stable temperatures. Because of the extreme temperature ranges in Pakistan the growing period is very short (8-12 months compared to 12-14 months in other countries). Combined with poor farm practices (reflecting inadequate extention services), disasters such as drought, inadequate control of disease and pests,

Table 6.7

Ratio of Domestic to World Market Prices, 1979/80 to 1985/6

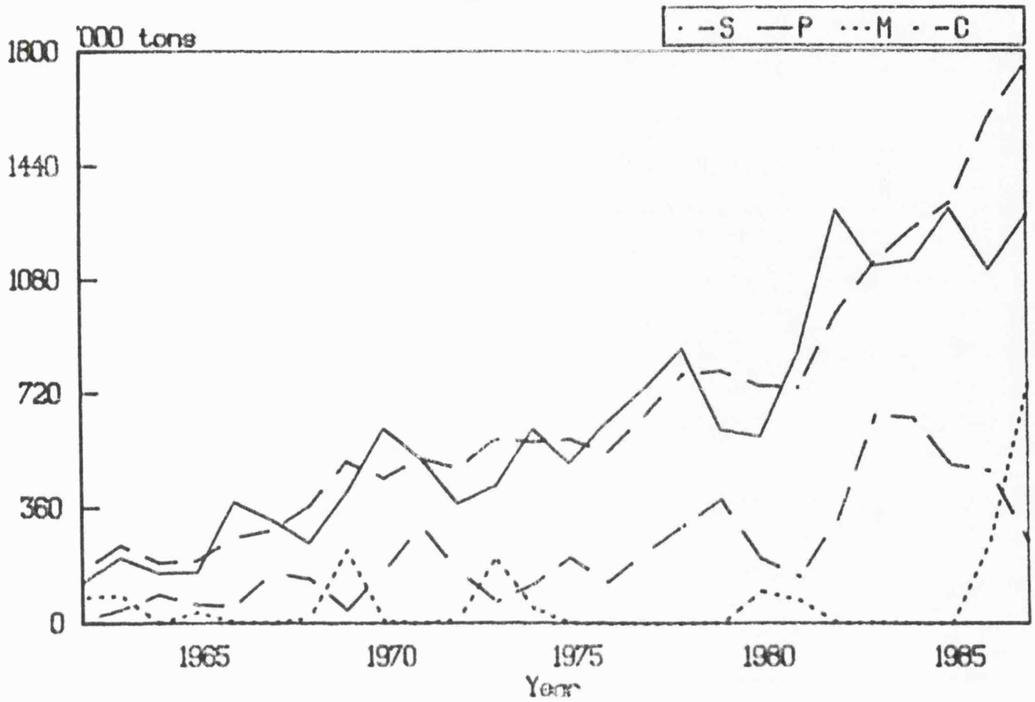
	1979	1980	1981	1982	1983	1984	1985
Wheat	0.77	0.63	0.72	0.80	0.63	0.73	0.75
Rice							
Basmati	0.61	0.84	0.88	0.87	0.61	0.57	0.56
Irri-6	0.60	0.51	0.65	0.87	0.81	0.87	0.90
Cotton (Lint)	0.81	0.69	0.95	0.83	1.28	0.80	0.90
Sugar	0.99	1.39	2.00	1.35	1.42	1.64	1.56

Source: Pakistan Economic Survey (1985 and 1987).

and unreliable water supplies, this acts to give low sugarcane yields. At less than 39 tons per hectare, Pakistan has one of the lowest yields in the world compared to 88 tons/ha and 57 tons per hectare in the USA and India respectively (see Hussain, 1989). These factors also lead to low sugar content, a problem which is reinforced by the policy of payment according to the weight and lack of co-ordination between mills and farmers at harvesting. Although the recovery rate of sugar from sugarcane is very low (on average, 8.5%) by international standards, the amount of sugar extracted in mills as a percentage of sugar available is comparable.

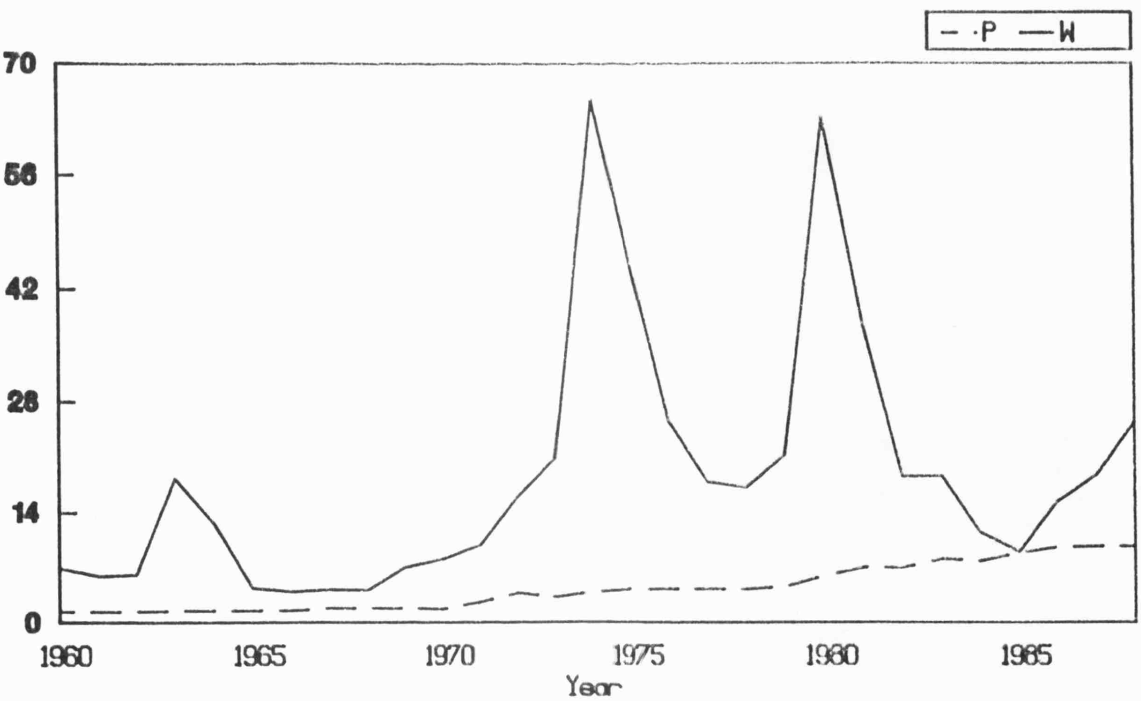
The opportunity cost of sugarcane is the output of wheat, rice and cotton forgone. In the early 1960s sugarcane benefited most from improved irrigation availability and yields increased substantially (see Figure 4.2). This lowered the opportunity cost of a given amount of sugarcane so that the production of sugar would have appeared more profitable. However, since then the yields of other crops have increased with the introduction of new high-yielding seeds while sugarcane yields have remained stagnant. This acts to reduce the social profitability of domestic sugar production. In spite of this, goverment policy has been directed towards increasing sugar production and thus increasing acreage under sugarcane. From 1979 to 1987 ten new mills were installed and sugar production more than doubled (see Figure 6.1). The basis of the self-sufficiency policy is the desire by the goverment to protect consumers from the uncertainty of very volatile world prices (see Figure 6.2). Many countries have very protectionist policies for their sugar industries with regulated consumer prices. Therefore, given the low demand elasticity for sugar, the variable world sugarcane

Figure 6.1
Sugar Flows



Note: P is production, S stocks, M imports and C consumption

Figure 6.2
Sugar Prices



Note: P is domestic price in Rs/kg. W is world price in $/ten tons.
Source: Lodhi (1988, p71 and p80).

production (due to pests and adverse climatic conditions) is reflected in volatile world prices.

Prior to 1981 the goverment set high sugarcane and sugar prices so as to encourage production. All sugar output was procured by the goverment and sold through ration shops at prices which, although below the price paid to producers, were above world prices. Differences between production and demand were met by government imports. With increasing demand, subsidy bills began to rise so in 1981 the market was partially decontrolled with firms allowed to sell 10% of their production on the open market. In 1983 sugar rationing was decontrolled and all price and distribution controls were lifted. Imports by private firms were allowed but subject to import duties. The goverment now uses imports, sold through the Utility Stores Corporation, to influence domestic prices.

We argued above for an decrease in sugarcane prices because of the high opportunity cost of land allocated to sugarcane and the social unprofitability of domestic sugar production. Protection for the consumer (and producers) against unstable world prices could be provided by running down government sugar stocks in times of world sugar shortages and high import prices. However, there are arguments for the maintaining some domestic capacitity:

(1) There is a large existing investment is sugar capacity and the marginal cost of production may be quite low. In the short run at least, it may be optimal to maintain production capacity and high sugarcane prices.

(2) Since the high cost of domestic sugar production stems from low sugarcane yields and low sugar content, if this can be rectified domestic production will become more profitable. The present large discrapency between best and worst yields (and quality) suggest that improved extension services and farms practices may be able to achieve large increases in yields and quality and increase the profitability of domestic production.

(3) Sugarcane yields and sugar extraction rates are higher in Sind reflecting more favourable climatic conditions and better coordination between the more moden mills and the relatively large landholdings. Sugar and sugarcane production could be concentrated here.

(4) If funds were directed torwards research into developing high-yielding sugarcane seeds then, along with better farm practices, this would decrease the opportunity cost of sugarcane.

(5) Low world prices reflect subsidies provided by foreign governments. The continuation of these should not be taken for granted.

(6) Domestic demand is increasing rapidly with income. In the absence of an expansion of domestic production this implies greater reliance on imports with volatile world prices. However, the ability to use buffer stocks to reduce the import of temporarily high world prices dilutes this argument.

All these factors must be taken into account when analysing the pricing policy for sugar. From Table 6.7 we see that domestic sugar prices have continually been maintained at levels higher than world prices (around twice as high in 1980). Since poorer households have a higher budget share for sugar they benefit most from lowering sugar prices towards world prices.

The issues arising from the analysis of pricing policy for sugar are also relevant for other sectors. For example, consumers of edible oils are taxed by a complex system of producer subsidies and controlled prices. By 1984/5 subsidies to edible oils stood at Rs2251 million, representing around 42% of total current subsidies (nearly 0.5% of GDP) and 27% higher than wheat subsidies for the same year (Pakistan Economic Survey, 1986/7, p44-5). Our results suggest that lower consumer taxes would have substantial efficiency gains and beneficial distributional effects.

Since 1980 the procurement price of sugarcane has remained static (see Figure 4.3) while fertilizer, wheat and rice prices have risen sharply. Also, the yields of cotton, a major competitor with sugarcane for land, have increased dramatically since 1983, implying an even higher opportunity cost for sugarcane. Therefore, the arguments discussed above for maintaining sugar and sugarcane production must take account of the increasing efficiency gains from lower sugarcane prices and the alternative possibility of using sugar stocks to protect consumers from high world sugar prices. The decision to abandon sugar rationing needs to be analysed in a similar manner to atta above.

§6.6 Conclusions

In this chapter we have set out a model which we used to analyse government pricing policies in Pakistan. Our results indicate that in the mid 1970s there was substantial scope for price reforms, particularly as regards major agricultural crops, which provided large efficiency gains. We also argued that, although the mechanism for allievating the adverse distributional consequences associated with some of the reforms was already in place (i.e. rationing and subsidized market atta), one would have to pay particular attention to the extension of this mechanism to rural areas. If this were not possible then one should examine the possibility of implementing other schemes. In the absence of such schemes, low procurement prices for wheat, a policy actually followed in the mid 1970s, may be desirable.

Our discussion of policy since the mid 1980s concluded that, while the policy of increasing procurement prices and prices of major agricultural inputs removed the high level of distortion that existed in the 1970s, the elimination of rationing was not consistent with our suggestions here. Given that the prices of major agricultural commodities remained below world prices in the mid 1980s, our assessment of the efficiency gains to be reaped by increasing procurement prices is still valid. However, it is essential that the ability to counteract the adverse distributional effects of this policy, through rationing or other schemes, be addressed.

Given the absence of less distortionary policy instruments, the revenue requirement will require the use of agricultural pricing policy to tax rural incomes. In this case, our results suggest that with higher rice prices (say, for irri rice) low procurement prices for wheat are less distortionary and have a beneficial impact on income distribution. Also, if the extension of income support schemes to rural areas is considered too administratively burdensome, such a policy becomes more attractive.

Our discussion of the results has highlighted the importance of considering pricing policies in a general equilibrium framework. Focusing on one commodity in isolation can lead to misleading conclusions about appropriate pricing policies since the effects on production and consumption of other commodities can have substantial efficiency and revenue implications. This was particularly apparent for important agricultural outputs and inputs (such as wheat, rice and fertilizer) where the revenue effects arising from net supply changes in each other's markets had a considerable influence on the direction of price changes required to raise revenue. The analysis of the pricing of sugar and sugarcane also helped to show clearly that the efficiency and distributional consequences in one market can have important implications for pricing policy in another. We also emphasised the need to consider the availability of more direct distributional mechanisms when recommending price reforms.

Chapter Seven

Conclusion

It is a common characteristic of governments in many developing countries that they rely to a large extent on setting prices and indirect taxes as a means of raising the bulk of their revenue requirement. This reflects the limitations on other more direct policy instruments (e.g. land or income taxes) due to administrative or political difficulties. Pakistan is no different in this respect with over 80% of total tax revenue accounted for by indirect taxes. This reliance on indirect taxes and price controls is likely to persist since, in the short to medium term at least, the government is likely to rely further on this source to finance rising current expenditures. One therefore has to ask what is the most efficient and equitable way of raising revenue using these instruments. This has been the central focus of the thesis.

We have shown in Chapter 1 how the standard theoretical models of optimum indirect taxation can be adapted to incorporate the special features of the agricultural sector and the constraints on revenue-raising instruments. Price controls are widespread in the agricultural sector where the government is often limited to the taxation of net market trade. This is particularly relevant for foodgrains such as wheat where a large proportion of production is consumed on farm. We have also suggested that risk averse governments with politically sensitive expenditures to finance may be more receptive to gradual or piecemeal reforms as opposed to a major redesign of the tax system. It is, in part, for this reason that we have focused our analysis on the evaluation of marginal reforms in prices and indirect taxes.

Although we recognize that one must combine basic economic principles with an understanding of the political, legal and administrative environment of a country when evaluating and recommending price reforms, we have concentrated for the most part on economic criteria. Therefore, we have analysed price reforms by examining their implications for equity and efficiency. However, we also try to allow for political, legal and administrative consequences when examining possible policies.

The effectiveness with which governments can raise revenue by manipulating prices facing producers and consumers, and the implications of these policy instruments for equity and efficiency, depends on the nature of the relationships between economic agents, the organization and operation of markets, and the decision-making framework of households. We focus primarily on agricultural pricing policy. Our analysis of the organization of agriculture in Pakistan in Chapter 2, using data for the mid 1970s, led us to a number of conclusions. These include that knowledge of household decision making in the presence of uncertainty, the absence of certain markets (e.g. for spreading risk), and the presence of market imperfections, especially for agricultural inputs, is required if one is to understand agricultural decisions and the observed variation in agricultural practices. Our exploratory analysis of the data suggests that the combination of the synchronic timing of many farm operations with farming activities concentrated into certain periods (e.g. planting and harvesting), the need for reliable access to crucial factor inputs and the imperfect operation of the markets for draught animals, credit and labour, leads farmers to transact in the land market (mainly through renting and sharecropping in or out) so as to match land operated with these imperfectly mobile factors. Observed cropping decisions and the greater use of labour on smaller farms may be the result of more expensive hired labour, the latter reflecting the need to monitor tasks carefully given the high level of husbandry skills required by modern agricultural technology. It also appears that sharecropping plays a role in overcoming some of the informational problems associated with credit provision and in ensuring a reliable labour supply. Landlords and tenants may interlink transactions in markets through the sharetenancy arrangement with, for example, the former providing credit and land in return for guaranteed labour at crucial times.

The data also show that small farms have a greater proportion of their landholdings under cultivation as well as higher cropping and resource intensities. This is consistent with the findings of studies of other developing countries and suggests that the much-debated and commonly observed inverse relationship between productivity and farm size also holds for Pakistan. However, our analysis of the physical yields for individual crops suggests that rice and cotton yields are negatively related to farm size while wheat and sugarcane yields are positively related to farm size. This may be explained, in part, by the greater labour intensity of the former group and more costly hired labour. We also find that farms which allocate a higher proportion of cultivated land to risky crops appear to 'compensate' for this by having lower input levels and consequently, *ceteris paribus*, lower yields. This may explain the productivity result for wheat.

Our analysis of what farmers perceive to be the main factors constraining productivity levels suggests that availability of credit and irrigation were the main constraints with the former appearing to be more constraining among smaller farms. The results from our production function analysis reinforce this since we find that variations in fertilizer use and irrigation levels were statistically significant in explaining variations in physical yields for individual crops. Constraints on credit mean that farmers have to rely on 'own-funds' to finance the purchase of inputs such as fertilizer. Preliminary results from more recent surveys for Pakistan suggest that, despite a large increase in institutional credit and tubewell finance, these constraints still persisted in the mid 1980s. They also show that smaller farms are more likely to be unaware of the possibility of cheaper sources of credit or of recommended farming practices. The effectiveness of policies regarding the increase in credit availability and extension services should therefore be examined. Our analysis of the organization of agriculture in Pakistan reinforces the fact that an understanding of behaviour under uncertainty and the imperfect nature of markets for inputs and factors of production is required if economic analysis of the organization of agriculture in Pakistan is to contribute to the formulation of welfare-improving policy recommendations.

It is common in developing countries for governments to tax agriculture by procuring outputs at prices below world prices. For example, in Pakistan in the mid 1970s the procurement of wheat was on a voluntary basis with wheat procured at low prices and a ban on trade between provinces. This can be viewed as a tax on net producers and a subsidy to net consumers with both being effected according to the extent of their net trade or marketed surplus (MS). The implications of such price controls for equity and efficiency depend, respectively, on the pattern of MS across households (possibly with differing welfare weights) and on how aggregate MS responds to price changes. In Chapter 3 we focus on wheat, the major foodgrain in Pakistan. We show how we can gain insights into the variation in levels of MS across households using cross-section data and how agricultural household models are useful when deciding how an empirical analysis should be formulated, what variables should be included and how the model should be specified. With simple examples we show the likely direction and magnitude of household responses to parameters of interest. For example, using parameters for Pakistan for the mid 1970s and 'low' estimates for production elasticities we calculate aggregate price elasticities of MS of 0.86 and 0.26 for wheat and rice respectively. We also argue that these elasticities are unlikely to be negative and are likely to exceed their output elasticities.

Because of the way in which data are collected and given the highly skewed distribution of land size, an analysis of MS using cross-section surveys will encounter estimation problems including measurement error, sample selection, heteroskedasticity and influential observations. These become less problematic if we estimate a reduced form equation which includes only exogenous variables such as farm size, household composition and locational variables, and use the well-known Heckman technique for correcting sample selection bias. We find that the probability of having market sales increases with farm size. It also seems that the land and price elasticities of MS decrease with farm size with the latter being substantially greater than one. Extra land increases both wheat output and wheat consumption (because of higher income), with the output effect dominating. The origin of the positive price effect on MS was traced to the production response suggesting that the positive income effect from higher prices (for those with market sales) cancelled out the negative pure substitution effect in consumption. Extra family members also increase wheat consumption and decrease MS. The lack of any significant relationship between the number of family members (in particular the number of adult males) and production may possibly be explained by the reallocation of land away from wheat which counteracts the higher wheat yields per acre due to extra labour input. We prefer this reasoning rather than the argument that one does not expect to find any relationship between production levels and the number of family members (or adult males) if labour markets are functioning well. We also find evidence of a consumption preference for wheat in both Punjab and NWFP compared to Sind.

The observation that MS increases with farm size with large farms being net producers and small farms net consumers suggests that low procurement prices are attractive from an equity viewpoint. This conclusion is further reinforced when one recognizes that landless labourers, who are often among the poorest in developing countries, are also net consumers (although they may benefit if real wages increase). However, the high price elasticity of MS suggests that low procurement prices may be associated with large efficiency losses. We comment further on this trade-off between equity and efficiency below. The high price elasticity also tells us that small changes in prices may have substantial effects on government procurement, the level of rural food surpluses to be transferred to urban areas, and foreign exchange earnings. All these effects should be taken into account when formulating pricing policy.

Theoretical models indicate that when we include the agricultural sector in the consumer sector for the purpose of analysing pricing policy it is no longer the case that economic efficiency is necessarily desirable for this sector. Thus, whether agricultural (purchased) inputs should be taxed or subsidized will depend on the pattern and responsiveness of use across farms. In Chapter 4 we focus on the use of chemical fertilizer which is the main purchased input and whose increased use is closely linked with the spread of the green revolution in Pakistan. In empirical analyses it is important to treat separately households which do not apply fertilizer because they are constrained, say, in the credit market and those who do not apply fertilizer because at current relative prices it is not profitable for them to do so. We use a 'double-hurdle' model, which enables us to take account of zeros which can arise in more than one way, to explain the pattern of fertilizer use across farms. A simple model of behaviour under uncertainty is used as the basis of our empirical investigation and our interpretation of the results.

The simple theoretical models presented suggest that input levels are lower in the presence of uncertainty. Also, both the distribution of wealth between stochastic and non-stochastic components and the behaviour of farmers in response to additional exposure to risk determine the pattern of input intensity across farm size. Of course, a greater availability of knowledge, credit or complementary inputs (e.g. irrigation) also increases factor productivity and, therefore, intensity. The presence of irrigation (e.g. tubewells) also reduces the uncertainty of water availability. Our results indicate that the factors which we expect to affect fertilizer productivity (e.g. use of phosphate, application of nitrogen as a top dressing and access to reliable irrigation) are positively correlated with farm size and have the effect of increasing fertilizer intensity on larger farms. However, the presence of uncertainty operates to reverse this effect. Although larger farms have a higher level of non-stochastic wealth which, in the presence of decreasing absolute risk aversion, has the effect of increasing fertilizer intensity with farm size, the presence of increasing relative risk aversion means that the net relationship between farm size and fertilizer intensity is negative. Thus, while in the absence of uncertainty one may expect to observe fertilizer intensity increasing with farm size, reflecting their higher productivity of fertilizer, the presence of uncertainty appears to reverse this relationship.

The finding that problems in securing credit, especially among smaller farms, constrains the use of fertilizer highlights how the operation of one market can affect that of another. As indicated above, the fact that credit constraints among smaller farms have persisted into the 1980s in spite of increased government involvement suggests that the effectiveness of policies followed should be examined. Also, although our analysis was not specifically policy oriented, we might conclude that if one assumes that markets for spreading risk are unlikely to emerge in the short to medium run, then the government should be aware that its selection and use of policy instruments (e.g. for revenue raising from the agricultural sector) may be able to act as a partial substitute.

From our discussion in Chapter 5 of industrialization and trade policies in Pakistan since Independence we saw that there has been a gradual movement away from quantitative restrictions on domestic production and foreign trade in favour of manipulating price incentives for investment in various industries. Up to the 1970s this liberalization of the economy was gradual and took the form of loosening, rather than eliminating, quantity controls. The 1970s saw a rapid and major move towards price controls as a way of adjusting the incentives facing producers and consumers. Our summary of previous studies into the extent of the consequent pricing distortions in the economy shows that the distortions were large and that the complexity of the price and tax system may have had unintended or hidden consequences, especially the effective taxation of exporting industries. Such distortions may give wrong signals to private agents in the sense of encouraging investments in industries which are socially unprofitable.

It is generally agreed that in developing countries, because of the imperfect operation or absence of many markets (in particular factor and risk markets) and the nature of government involvement in the economy, market prices of commodities may not reflect their social value to the economy. When evaluating government policies and investment decisions it is necessary to take account of this divergence between social and market prices. Fortunately, from the point of view of pricing policy, much of the standard tax analysis goes through as before but with producer prices being replaced by shadow prices and by viewing the difference between shadow and consumer prices as a shadow tax. Using data of a kind which are often available for many developing countries we calculate a set of economy-wide shadow prices (for the mid 1970s) and show how these can be used to evaluate possible reforms of trade and industrialization policies. The model presented is based on the well-known Little-Mirrlees procedure for calculating shadow prices and is easy to manipulate for the purposes of sensitivity analysis.

The technical analysis of our results highlights the origin and nature of the distortions, e.g. trade or domestic taxes, and summarizes their combined effect on the overall level of distortion. We explore various assumptions about the workings of product and factor markets and their implications for shadow prices. We then interpret the results from a policy viewpoint and show how they could be used to guide government economic decisions concerning investment and pricing. We focus, in turn, on agriculture, agriculture-related industries, and manufacturing industries.

With agriculture the results suggest that the emphasis in Pakistan on wheat, rice and cotton production is justified in the sense that these crops emerge as the most socially profitable crops. However, we also suggest that some of the minor crops may not compete directly with these major crops, i.e. the land they take up is not suitable for the major crops, in which case our policy conclusions would need to be adjusted accordingly. Our analysis of agriculture-related industries show that policy towards industries based on crops such as sugarcane and oilseeds should be re-evaluated. Unless better agricultural practices or new high-yielding variety seeds lead to higher sugarcane or oilseed yields, or unless the technical efficiency of the relevant processing industries is improved, a greater reliance on imports may be desirable. The results for cotton-based industries also highlighted similar issues. The social unprofitability of the cotton yarn and the large-scale cotton textile industries emphaises the need to question whether or not there is a genuine infant industry argument for protection and, if so, whether tariff protection will actually achieve this, or whether more direct policies are required. Similar issues apply to some import-substituting industries. One must decide whether domestic production can ever be socially profitable and recognize the implications of inefficient production for government revenue and consumer welfare. Also, the social profitability of major exporting industries reinforces arguments for their continued encouragement, or at least not to discourage them through duties or input taxes.

Much of our analysis focuses on the medium to long term. However, using the sugar industry as an example, we argue that for industries in which there already exists large fixed investments policies appropriate in the short-run may look very different from those suggested by longer-term objectives. For example, if a socially unprofitable industry has large fixed costs then we may want to maintain production levels (and those of non-traded inputs) but phase it out gradually, i.e. discourage new investments. In fact, if there is underutilization of capacity we may want to increase production.

In Chapter 1 we discuss the standard models for tax analysis and showed how these can be adapted to incorporate the special features of the agricultural sector and the limitations on the policy instruments available to the government, and described how the theory of tax reform can be used to identify welfare-improving marginal reforms in the tax and price system. We further suggest that risk averse governments with politically sensitive expenditures to finance may be more willing to undertake piecemeal reforms.

In Chapter 6 we present a model specific to Pakistan which is intended to allow normative analysis of the instruments available to the government in the mid 1970s. Using data for this period we calculate and compare the marginal social costs of raising additional revenue across the various price and tax instruments available to the government. We use these to identify possible welfare-improving reforms in the existing system for the mid 1970s. However, our results also carry lessons for policies beyond this period and we use these to comment on policies followed in the 1980s and to set out recommendations for future policy.

Our results indicate that in the mid 1970s there was substantial scope for price reforms, particularly as regards major agricultural crops, which provided large efficiency gains. Efficiency considerations alone suggested that higher producer prices for wheat, rice and cotton were desirable. We also argue that, although the mechanism for alleviating the adverse distributional consequences associated with some of the reforms was already in place (i.e. rationing and subsidized market atta), one would have to pay particular attention to the extension of this mechanism to rural areas. If this were not possible then one should examine the possibility of implementing other schemes. In the absence of such schemes (e.g. if they were considered too administratively costly), low procurement prices for wheat, a policy actually followed in the mid 1970s, may be desirable. It appears that the effects on the net demand for agricultural labour and wages does not change these results.

Our discussion of policy since the mid 1980s suggests that, while the policy of increasing procurement prices and prices of major agricultural inputs removed the high level of distortion that existed in the 1970s, the elimination of rationing was not consistent with our suggestions here. Given that the prices of major agricultural commodities remained below world prices in the mid 1980s, our assessment of the efficiency gains to be reaped by increasing procurement prices is still valid. However, it is essential that the ability to counteract the adverse distributional effects of this policy, through rationing or other schemes, be addressed.

Given the absence of less distortionary policy instruments, the revenue requirement will require the use of agricultural pricing policy to tax rural incomes. In this case, our results suggest that with higher rice prices (say, for irri rice) low procurement prices for wheat are less distortionary: the high efficiency gains from higher wheat prices when both wheat and rice prices are 'low' reflects the fact that higher wheat prices make the wheat-rice crop rotation more profitable and thus increase the production of these crops both of which are highly taxed. Additionally, lower wheat prices have a beneficial impact on income distribution. Also, if the extension of income support schemes to rural areas is considered too administratively burdensome, such a policy becomes more attractive.

Our discussion of the results has highlighted the importance of considering pricing policies in a general equilibrium framework. Focusing on one commodity in isolation can lead to misleading conclusions about appropriate pricing policies since the effects on production and consumption of other commodities can have substantial efficiency and revenue implications. This was particularly apparent for important agricultural outputs and inputs (such as wheat, rice and fertilizer) where the revenue effects arising from net supply changes in other commodity and factor markets had a considerable influence on the direction of price changes required to raise revenue. The analysis of the pricing of sugar and sugarcane also helps to show clearly that the efficiency and distributional consequences in one market can have important implications for pricing policy in another. Although one may wish to rely more on sugar imports in the future and reduce reliance on domestic sugar production (and hence reduce sugarcane production), the low short-run social marginal cost of sugar production (with a large existing domestic sugar capacity) suggests that sugarcane production should be maintained, at least in the short-run. Therefore, if the prices of other major agricultural commodities were increased then one may also want to increase sugarcane prices so as to encourage farmers to continue to grow sugarcane. Similarly, in such circumstances, low sugarcane prices would increase the attractiveness of low prices for other major agricultural commodities. Finally, we also emphasised the need to consider the availability of more direct distributional mechanisms when recommending price reforms.

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Appendix A

Modified Cobb-Douglas Production Function

The production function we estimate is a modified version of the standard Cobb-Douglas (C-D) production function. It is usual to estimate the parameters of the standard C-D function in its log-linear form. Dummy variables are introduced as multiplicative shifts in the production function. For example, take a log-linear equation with dependent variable y, a continuous explanatory variable x and a zero-one dummy variable d, i.e.

$$\ln y = a + b_1 d + b_2 \ln x + \epsilon \qquad \text{(A2.1)}$$

The multiplicative form is:

$$y = A\, e^{b_1 d}\, x^{b_2}\, e^{\epsilon} \qquad \text{(A2.2)}$$

where $A = e^a$ and ϵ is the stochastic term. When the dummy variable d equals one then $e^{b_1 d}$ takes the value e^{b_1} and when it equals zero $e^{b_1 d}$ takes the value one. So the dummy variable acts as a multiplicative shift in the production function.

A problem exists when estimating the standard function as it is described in (A2.1). Any variable which takes on a value zero for any observation must be included as a dummy variable rather than an 'x' variable since we cannot take the log of zero. Where the level of such a variable is important in determining the level of the dependent variable this is unsatisfactory. To overcome this difficulty we use a modified version of the C-D production function.

The modified function used here in estimating production functions for each crop is:

$$y = A\, e^{b_1 d}\, e^{b_2 z}\, e^{b_3 z^2}\, x^{b_4} \qquad \text{(A2.3)}$$

where z is a continuous variable containing some zero values and other variables are as above. In its log-linear form this is written as:

$$\ln y = a + b_1 d + b_2 z + b_3 z^2 + b_4 \ln x \qquad \text{(A2.4)}$$

The marginal product (MP) of input x is as with the standard function, i.e.

$$\frac{\partial y}{\partial x} = b_4 \frac{y}{x} \qquad \text{(A2.5)}$$

and it seems appropriate that when taking average values these should be calculated at the geometric mean since the estimated function for y will go through this value. Also, the estimate of b_4 is an estimate of the elasticity of y with respect to input x.

The MP of input z is:

$$\frac{\partial y}{\partial z} = y(2b_3 z + b_2) \qquad \text{(A2.6)}$$

and we can take average values at the arithmetic means of y and z. Notice that, depending on the values on the right-hand side of (A2.6), the MP of z can take on negative values. However, if we have strong *a priori* expectations that the MP should be positive we are not concerned with this property of (A2.6) as long as the MP is positive for the range of z considered. The elasticity of y with respect to z is given by:

$$z(2b_3 z + b_2) \qquad \text{(A2.7)}$$

or, alternatively, by the MP of z multiplied by z/y. The dummy variables can be interpreted as multiplicative shifts, as before, where the percentage shift in y due to d taking on the value 1 is given by $(e^{b_1} - 1)$.

Table A1

Fertilizer Use and Farm Size

Farm Acreage	Wheat		Rice		Cotton		S'cane	
	N	U	N	U	N	U	N	U
(a) Nitrogen:								
Less than 5	287	0.78	113	0.62	133	0.64	147	0.67
5-12.5	574	0.82	232	0.70	313	0.81	261	0.76
12.5-25.0	205	0.85	114	0.81	92	0.84	97	0.84
Over 25	34	0.71	29	0.78	20	0.83	42	0.84
All	1100	0.81	488	0.71	558	0.81	547	0.75
(b) Phosphorous:								
Less than 5	105	0.29	25	0.14	40	0.19	49	0.22
5-12.5	293	0.42	67	0.20	150	0.39	110	0.32
12.5-25.0	108	0.45	47	0.33	50	0.46	45	0.39
Over 25	20	0.42	14	0.38	11	0.46	23	0.46
All	526	0.39	153	0.22	251	0.34	227	0.31

Note: N is the number of households applying positive amounts of nitrogen and U is N divided the total number of households.
Source: Indus Basin Survey (1976)

APPENDIX B

Influential Observations

One of the striking features of agriculture in Pakistan is the very unequal distribution of land with 76% of farm households owning less than 40% of total cultivated land (see Table A3.2). This is also a common characteristic of many other developing countries. Therefore, in any farm household survey one often observes a very small number of large farms. Because many other agricultural characteristics (e.g. output) are highly correlated with farm size the distribution of these variables are also often highly skewed. Econometric models used to try to explain certain features of agriculture in developing countries or to estimate certain behavioural responses regularly use such data as explanatory variables. The skewed distribution of such variables can have undesirable consequences for estimates in these analyses.

Influential observations are those which lie outside the pattern set by the majority of the data. These are usually located far from the centre (i.e. majority) of the data and are referred to as 'leverage points'. Such points can have an unreasonable influence on regression estimates when we use OLS. Using regression diagnostics we can attempt to identify these observations.

An excellent survey of the regression diagnostics used to detect influential observations is provided by Krasker et al (1983). We focus here on two indicators:

$$h_i = x_i(X'X)^{-1}x_i'$$

and

$$e_i^* = e_i/[s(i)\sqrt{(1-h_i)}]$$

where X is the matrix of explanatory variables, x_i the vector of i'th observations of the explanatory variables, y_i and $\hat{y}_i$ are the actual and predicted value of the dependent variable for the i'th observation respectively, $e_i=y_i-\hat{y}_i$ is the i'th residual and $s(i)^2$ is the error variance estimate after deleting the i'th observation. The h_i's are therefore the diagonal elements of the OLS 'hat' matrix and e_i^* the studentized residual. Since OLS works by minimizing squared residuals these residuals need to be augmented by leverage information when identifying influential observations. The h_i's capture the influence of observation i on regression estimates. We can use h_i to look for imbalance in the x-data.

To analyse the influence that any single observation has on regression estimates we can compare the OLS estimates generated using all observations with those obtained when the relevant observation is deleted from the sample. Two comparisons are particularly useful:

(i) DFFITS = $[\hat{y} - \hat{y}(i)]/[s(i)\sqrt{h(i)}]$ where the i in brackets denotes the parameter without the i'th observation. DFFITS is a scaled measure of the change in the predicted value for the i'th observation and tells us by how many standard deviations the predicted value of y would shift if the relevant observation were deleted.

(ii) $DFBETAS_j = [b_j - b_j(i)]/[s(i)\sqrt{(X'X)^{jj}}]$ where $(X'X)^{jj}$ indicates the (j,j)'th element of $(X'X)^{-1}$. This captures the change in a coefficient estimate in terms of the standard error of the coefficient.

Both of these indicators use the h_i's and e_i^*'s in their derivation (see Krasker et al, 1983). It is possible that an observation has a substantial influence on regression estimates even though residuals are small when the relevant h_i is large. The common approach of focusing solely on residuals can therefore fail to detect observations which do not fit in with the pattern set by the bulk of the data especially when these observations are extreme (leverage) points. If many influential observations exist in a tight cluster then the single row deletion method described here may fail to reveal their existence.

An analysis of the influential diagnostics indicates substantial imbalance in the farm size (i.e. LAND) variable. Tables B1 to B3 present the relevant diagnostics where we use both farm size (LAND) and its square (LAND2) as explanatory variables along with other variables. From Table B1 we can see the substantial influence exerted on the regression estimates by the top five values of LAND - all have high h's. Krasker suggests that any observation which has h greater than two or three times the number of parameters divided by the number of observations can be viewed as having an unreasonable influence on regression estimates. In our case we have nineteen parameters and 526 observations - a ratio of 0.036. The h's in Table B1 are substantially greater than 0.108 (i.e. 0.036 x 3), observation 526 being a major problem with h = 0.61. This is in spite of the fact that it also has a very high scaled residual (i.e. 3.27). Its deletion from the sample would shift the predicted value of MS by over four standard deviations. Its inclusion also has an substantial impact on the estimated coefficients of LAND and LAND2.

The origins of the above problem lie in the fact that we have observations which lie a long way from the majority of the data and these can have a substantial impact. It is possible that these data are either part of a completely separate population and our model is not valid for these households. For example, it may be that some large farms should not be included in our model which is meant to explain the behaviour of farm households, but should be viewed as similar to commercial estates. Since estates will sell all of their output on the market, i.e. they do not consume any on-farm, our modelling of consumption as a function of income is not valid for such observations. We would therefore not wish these observations to have such an influence on our estimates. Of course, in this case we should just exclude such farms from the sample and indeed this was our reason for excluding farms where on-farm consumption of wheat was zero. However, our fear is that there may be other such 'household' idiosyncracies which are not captured by our data and which necessitate the exclusion of the observations from the sample. Because of the extremely heterogenous nature of agriculture in developing countries we should always be aware of the possible existence of such idiosyncries and indeed this is why we often observe low R^2 s in cross-section studies. Our model is meant to explain the behaviour of the majority of farms and we are not always able to identify characteristics which may exclude certain households from the population under study. It is for this reason that we are wary of any observation which has a very strong influence on our estimates.

Krasker *et al* suggest three methods for dealing with influential observations:

(i) use bounded influence (i.e. robust or resistant) estimators,

(ii) transform the data in such a way that the x-data become more balanced,

or (iii) delete observations with unreasonable influence.

Tables B2 and B3 show how the h's and scaled residuals change as we eliminate observations. We see that as we delete observations with high influence the influence of the other observations increase. This problem has its origins in the distribution of LAND. We saw earlier (see Table A3.2) that the distribution of farm units according to farm size is very much skewed to the right. Therefore, when we delete one influential observation another will take its place. Eliminating all leverage points would imply a loss of a substantial number of observations. It is in circumstances such as this that bounded influence (BIF) estimators are most useful.

In the absence of BIF estimators and since the deletion method would lead to the loss of many observations we chose option (ii), i.e. we transform the data in such a way that the relevant variables become more balanced. One such transformation is to express the variable in log form. So we select the exponential model, which is linear in logs, for our analysis. This function is made more attractive since we also expect problems with heteroskedastic error terms. The log transformation reduces the dispersion in the tails of the distribution of a given variable (thus making it more symmetric) and so reduces the impact on estimates of observations which lie a long distance from the centre of the data. When we use the log of LAND as an explanatory variable the h statistic for observations 526 to 522 are reduced to 0.10, 0.08, 0.07, 0.05 and 0.04 respectively.

Table B1

Effect of Influential Observations on Regression Results

Obs.	h_i	e^*	DFFITS	DFBETAS LAND	DFBETAS LAND2
522	0.09	-2.09	-0.66	-0.04	-0.17
523	0.11	-0.80	-0.28	0.05	-0.11
524	0.12	1.28	0.46	0.04	0.13
250	0.15	0.46	0.19	-0.02	0.09
526	0.61	3.27	4.06	-1.64	3.16

Table B2

Effect of Deletions of Influential Observations on h's

Obs.	No. of Observations				
	526	525	524	523	522
522	0.09	0.13	0.17	0.20	0.25
523	0.11	0.16	0.20	0.24	-
524	0.12	0.21	0.27	-	-
525	0.15	0.27	-	-	–
526	0.61	-	-	-	–

Table B3

Effect of Deletion of Influential Observations on e^*

Obs.	No. of Observations				
	541	525	524	523	522
522	-2.09	-1.47	-1.10	-0.05	-0.20
523	-0.80	0.01	0.38	1.13	-
524	1.28	2.54	3.18	-	-
525	0.46	1.86	-		
526	3.27	-			

Notes: The h_i's capture the influence of observation i on the regression results. Our threshold level, above which an observation is deemed to have excessive leverage on the results, is 0.123. e^* is the studentized residual. DFFITS captures the effect of an observation on the fitted values, while DFBETAS captures its effect on coefficient estimates.

Appendix C

Notes to Tables

Table 4.5 :	(a) uses FACC in the probit stage while (b) uses both CRDUM and NOPTIM. The 'robust t' statistic is calculated using White (1980). '**' indicates variables significant at the 5% level and '*' variables significant at the 10% level (both using the robust t-statistic. Variables LAND and WHPR are in logs, TOTASS is in Rs'000 and the dependent variable if the total nitrogenous fertilizer applied to wheat (in kgs).
Table 4.6:	Same as Table 4.5 except LANDW, the percentage of total cropped acreage under improved wheat, is included as an explanatory variable in the tobit stage, with FACC as the only explanatory variable in the probit stage.
Table A4.1:	LAND, LANDW and WHPR are in logs. TOTASS is in Rs'000 and NIT is kgs of nitrogen applied to total wheat acreage.

Appendix D

Value Added and the Shadow Price of Land

To calculate the shadow prices of non-traded commodities (and the social profitability of traded sectors) we need to calculate the shadow cost of factor inputs. Since each factor input can have a different shadow price we need to separate value added (VA) into payments to each factor input, i.e. labour, land, capital and a residual (or pure profits). The input-output table available from PIDE (1985) gives a single value for VA and does not separate payments across factor inputs. In order to separate VA into factor payments we make some crude assumptions. We assumed in Ahmad, Coady and Stern (1988) that labour and land payments were a certain percentage of VA (e.g. 0.5 and 0.3 respectively for agriculture). We present here a simple model which helps to develop our intuition in this respect and is also used to select plausible shadow conversion factors (SCFs) for factor payments.

To develop our model of the agricultural sector we think in terms of a sharecropping system. We assume that a tenant retains 50% of output but must also pays for 50% of the cost of certain purchased inputs (i.e. seeds and fertilizer). The tenant incurs all other costs (e.g. draught power) except for the transport costs of getting grain to the market and the cost of capital both of which we assume are paid for by the landlord. The landlord receives the residual after all payments, which we interpret as the rental on land (which effectively assumes that land is paid what is necessary to prevent it from switching to alternative uses). So:

$$pY = r_{\ell}L + w_nN + p_fF + p_sS + p_tT + p_oO + iK \qquad \text{(D5.1)}$$

where Y, L, N, F, S, T, K and O are total output and land, labour, fertilizer, seed, transport, capital and 'other' inputs respectively. The coefficients preceeding each of these (with lowercase subscripts) are the appropriate input prices or factor payments. The PIDE (1985) input-output matrix provides data on the share of certain input costs (i.e. fertilizer, seed, transport and 'other' and VA) as a proportion of the value of total output. The relevant data are presented in Table D1 and can be used to calculate the shares of land and labour in VA.

From (D5.1) the payment to the landlord ($r_\ell L$), interpreted as the land rental, is:

$$r_\ell L = pY - 0.5pY - 0.5p_fF - 0.5p_sS - p_tT - iK \qquad (D5.2)$$

since w_nN, the direct payment to labour, equals 0.5pY. Substituting the values from Table D1 this implies:

$$\frac{r_\ell L}{pY} = 0.19$$

Since VA is 56% of pY this in turn implies that:

$$\frac{r_\ell L}{VA} = 0.34$$

The net income of the sharecropper (i.e.the return to labour) is:

$$I_n = 0.5pY - 0.5p_fF - 0.5p_sS - p_oO \qquad (D5.3)$$

The values in Table D1 imply that:

$$\frac{I_n}{pY} = 0.25$$

so that

$$\frac{I_n}{VA} = 0.45$$

The values calculated here for ($r_\ell L/VA$) and (I_n/VA) suggest that those used in Ahmad, Coady and Stern (1988), i.e. 0.3 and 0.5, as the ratio of factor payments for land and labour, respectively, to total factor payments, are reasonable assumptions. We use these ratios (i.e. 0.3 and 0.5) in deriving our results presented in §5.5.

We now turn to the SCFs for land and capital. The SCF for land (LCF) is given by the land rental at shadow prices divided by the land rental at market prices:

$$LCF = \frac{\bar{p}Y - 0.5\bar{p}Y - 0.5\bar{p}_fF - 0.5\bar{p}_sS - \bar{p}_tT - \hat{i}K}{pY - 0.5pY - 0.5p_fF - 0.5p_sS - p_tT - iK}$$

where $\bar{p}$ is a shadow price. Dividing both numerator and denominator by pY and interpreting prices as accounting ratios we get:

$$LCF = \frac{0.5\bar{p} - 0.5\bar{p}_f\theta_f - 0.5\bar{p}_s\theta_s - p_t\theta_t - \hat{\imath}\theta_k}{0.5 - 0.5\theta_f - 0.5\theta_s - \theta_t - \theta_k} \qquad (D5.4)$$

where θ_j is the share of j's costs in the total value of output (for j=f, s, t, and k). Substituting values from Table D1 we get (assuming $\hat{\imath}$=1.5):

$$LCF = \frac{0.5(1.39) - 0.5(1.52)0.04 - 0.5(1.39)0.04 - 0.8(0.15) - 01.5(0.03)}{0.5 - 0.5(0.04) - 0.05(0.04) - 0.15 - 0.03}$$

$$\frac{0.4718}{0.28} = 1.685$$

Alternatively we can use a simpler model where

$$pY = r_\ell L + w_n N$$

with only land and labour as inputs. The LCF is then

$$LCF = \frac{\bar{p} - \bar{w}\,\theta_n}{1 - \theta_n} \qquad (D5.5)$$

where we again interpret $\bar{p}$ and $\bar{w}$ as the ARs for output and labour respectively, and θ_n is the share of labour costs. If we take θ_n = 0.3, $\bar{p}$ = 1.39 and $\bar{w}$ = 1.5 then we get LCF = 1.49. In the results presented in §5.5 we take a value between 1.68 and 1.49, i.e. we use LCF = 1.6.

The shadow cost of capital is made up of depreciation (the amount needed to maintain capital), valued at shadow prices, plus an interest cost, (i.e. fixed and working capital stock valued at shadow prices and multiplied by an accounting rate of interest). We therefore need to estimate the cost of capital at market prices and multiply by a SCF for capital goods (i.e. by an asset conversion factor - ACF). From the data available to us (Federal Bureau of Statistics, 1982 and 1983) we have been able to put together an estimate of the market cost of capital under some admittedly crude assumptions. If we assume that all assets depreciate by a fraction β per year and that a fraction α of current investment I is used for replacement then:

$$K = (\alpha/\beta)\ I$$

where K is the capital stock. The cost of capital (C) is made up of interest plus depreciation so that:

$$C = [i\ (\alpha/\beta) + \alpha]\ I \qquad \text{(D5.6)}$$

In our analysis we have assumed that $[i(\alpha/\beta)+\alpha]=1$ since we do not have good information on α and β. One example consistent with this is $i = \beta$ (say 10%) and $\alpha=0.5$. If we define the asset conversion factor (ACF) as the ratio of the shadow to the market cost of capital then:

$$ACF = \left[\frac{\hat{\imath}\ \frac{\alpha}{\beta} + \alpha}{i\ \frac{\alpha}{\beta} + \alpha} \right] .SCF \qquad \text{(D5.7)}$$

where SCF is the shadow cost of assets (e.g. their world price) divided by their domestic price, and $\hat{\imath}$ is the accounting rate of interest (all interest rates are in real terms). Dividing above and below by β/α we get

$$ACF = \Phi\ SCF.$$

where

$$\Phi = \frac{\hat{\imath} + \beta}{i + \beta}$$

If $\hat{\imath} = i$ then $\Phi = 1$, so the ACF is then the SCF for capital goods. Since capital is mostly imported in Pakistan with high tariffs we expect the SCF for assets to be below unity. The values in Ahmad, Coady and Stern (1988) suggest a rough average over assets at about 0.8.

In Pakistan the government has placed great emphasis on the growth of the manufacturing industry. The manufacturing sector, in particular the large-scale manufacturing sector, has benefitted from a number of incentives which reduce the cost of capital, e.g. subsidized interest rates, accelerated depreciation allowances, tax holidays and licences for the import of capital goods (whose scarcity values were several times their face value). Guisinger (1981) argues that the market cost of capital, C, is substantially lower than the opportunity cost, $\bar{C}$, defined as the cost that would have prevailed if a neutral set of government policies had been in effect and if all markets had functioned smoothly, especially for large-scale manufacturing. Allowing for all these incentives he calculates a ratio $\bar{C}/C=1.27$ for 1972-75. But this is an overestimate of the ratio for the whole economy since the small-scale sector did not benefit from many of the incentives, and Guisinger (1981, p333) suggests that this sector paid close to the opportunity cost of capital.

Under certain conditions (see §5.4.4) the accounting rate of interest, $\bar{i}$, can be taken as the interest rate on foreign loans. In 1975 the LIBOR was 10.19%. However, this may not have been the marginal rate facing Pakistan since it could probably not borrow freely at this rate. In his analysis of the cost of capital for the early 1960s Guisinger (1981;p330) assumed $\bar{i}=15\%$ and a subsidized rate to large-scale manufacturing of $i=5.74\%$. Applying these to the equation for ACF above, with $\beta=10\%$, we get a value of $\theta=1.59$ and an ACF=1.27. This value is, fortunately, the same as that calculated by Guisinger (1981;p332). Since all producers did not benefit from these incentives (with many probably facing a cost nearer the opportunity cost of capital) we choose a range of values for ACF of 1.2, 1.0 and 0.8 in calculating the results presented in §5.5.

Table D1

	Acreage[1]	Shares	Shadow Prices[2]
Wheat	6110 (0.37)	-	1.39
Rice	1710 (0.10)	-	2.51
Cotton	1852 (0.11)	-	2.42
Sugarcane	700 (0.04)	-	0.97
Other	6524 (0.38)	-	0.85
Seed	-	0.04	1.39
Fertilizer	-	0.04	1.52
Transport	-	0.15	0.80
Other	-	0.21	0.80
Capital	-	0.03	0.80[3]
Value Added	-	0.56	-

Notes:

(1) Acreage is taken from the Pakistan Statistical Yearbook (1985), p120-5, for the year 1975-76. Figures in brackets are individual crop acreage as a proportion of total acreage allocated to these for these crops (i.e. 16.6 million hectares). These ratios are used as weights to calculate a single shadow price (or accounting ratio) for seeds.

(2) The accounting ratios for wheat, rice, cotton, cane and fertilizer are taken from the text. The AR for seeds is a weighted average of those for all crops. The AR's for cane, transport and 'other' are approximations of those calculated in Ahmad, Coady and Stern (1988).

(3) The SCF for capital is taken at 0.8, reflecting high tariffs on imports. The share of capital includes a rent of 0.01, taken from Ahmad, Coady and Stern (1988).

Appendix E

Some Elasticities fot Tax Reform Analysis

For our analysis we use the own- and cross-price supply elasticities for agricultural crops with respect to crop and fertilizer prices taken from Ali (1988) who estimated own- and cross-price elasticities for the major crops in Pakistan with respect to each others prices and to the price of fertilizer. In order to calculate plausible price elasticities for fertilizer and labour demands we assume a Cobb-Douglas profit function. Although restrictive, this is a very convenient form which requires only average input shares to calculate the remaining relevant elasticities. This approach has also been used by Newbery (1987b) for a similar analysis of agricultural price reform.

The aggregate profit function is assumed to be:

$$\pi = \Sigma_i \ \pi^i = \Sigma_i \ A_i \ K_i \ q_i^{1+\eta_i} \ p^{-\alpha_i} w^{-\nu_i}$$

where K_i is land allocated to crop i (determined by total demand), and α_i, η_i and ν_i are the shares of each commodity, fertilizer and labour in the net profit of good i respectively. By differentiation we get:

$$Y_i = \frac{\partial \pi}{\partial q_i} = \frac{(1+\eta_i)\pi^i}{q_i} = (1+\eta_i) \ A_i \ K_i \ q_i^{\eta_i} \ p^{-\alpha_i} \ w^{-\nu_i}$$

$$Y_f = \frac{\partial \pi}{\partial p} = \Sigma_i \frac{-\alpha_i \pi^i}{p} = -\Sigma_i \ \alpha_i A_i K_i q_i^{1+\eta_i} p^{-(1+\alpha_i)} \ w^{-\nu_i} \qquad = \Sigma_i Y_f^i$$

$$L = \Sigma_i \frac{\partial \pi^i}{\partial w} = -\Sigma_i \frac{\nu_i \pi^i}{w} = -\Sigma_i \ \nu_i A_i K_i q_i^{1+\eta_i} p^{-\alpha_i} w^{-(1+\nu_i)} = \Sigma_i L_i$$

From these equations we can show that η_i is the own-price elasticity of supply for crop i and that $-\alpha_i$ is the elasticity of supply of i with respect to p, the price of fertilizer. We can further derive the own-price elasticity of demand for fertilizer as $(1+\bar{\alpha})$ where $\bar{\alpha}$ is the weighted share across crops of fertilizer expenditure in net profit, with fertilizer shares as weights. The elasticity of fertilizer demand with respect to the price of crop i is:

$$(1+\eta_i)\frac{Y^i}{Y}$$

where Y^i and Y are the consumption of fertilizer by crop i and the total aggregated across crops respectively.

Likewise we can calculate labour demand responses and show that the elasticities of labour demand with respect to crop prices and fertilizer prices are $(1+\eta_i)\theta_i$ and $-\Sigma_i\alpha_i\theta_i$ respectively where θ_i is the labour allocated to crop i as a proportion of total labour demand.

While the use of the Cobb-Douglas profit function is restrictive it does provide us with a simple way of calculating some elasticities necessary for our tax analysis. The own- and cross-price elasticities of supply for the major crops in Pakistan are taken from Ali (1988, p21). The elasticities of crop supply with respect to the fertilizer price were also taken from this source. The proportion of total fertilizer demand applied to individual crops were taken from the Pakistan Statistical Yearbook (1985, p132): the shares allocated to wheat, rice, cotton and sugarcane were calculated as 0.48, 0.12, 0.16 and 0.11 respectively. Using these data we calculate the fertilizer demand elasticities with respect to individual crop prices as 0.64, 0.35, 0.37 and 0.2 for wheat, rice, cotton and sugarcane respectively.

The share of fertilizer expenditures in net profit for each crop are taken from Qureshi (1987): these are 0.29, 0.25, 0.35 and 0.13 for wheat, rice, cotton and sugarcane respectively. Using these shares we calculate an own-price fertilizer elasticity of -1.239. However, one should note that if the Cobb-Douglas profit function was appropriate (in the sense of describing decision making by a household) then the share of fertilizer expenditures in net profit should be given by α_i, which is also the supply elasticity of crop i with respect to the fertilizer price. using these elasticities as the relevant shares (taken from Ali, 1988) we calculate an own-price fertilizer demand elasticity of -1.567. The elasticity reported in Chapter 4 was -0.83. This highlights a restriction of the Cobb-Douglas profit function that the term for the own-price fertilizer demand elasticity, i.e. $-(1+\bar{\alpha})$, exceeds unity in absolute terms since fertilizer shares in net profit are positive. In our applied analysis we experiment with the range of fertilizer elasticities calculated here.

To derive the elasticity of demand for net labour supply to the formal sector with respect to crop and fertilizer prices we need the proportion of total labour supply allocated across crops and between the agricultural, informal and formal sectors. In Chapter 5 we calculated labour coefficients for each sector. Using these we find that the proportion of total agricultural wage income originating in wheat, rice, cotton and sugarcane is 0.27, 0.07, 0.13 and 0.13 respectively. Using the national accounts data on sectoral value added (Pakistan Statistical Yearbook, 1985, p368-79), allocating sectors between the agricultural, informal and formal sectors, and assuming that wage income accounts for 0.3, 0.5 and 0.6 of value added for the formal (large-scale manufacturing and some services), agricultural and informal (small-scale industry), and service sectors respectively, we find that wage income in the agricultural sector is 0.72 times that in the formal sector. We can then calculate the elasticity of net labor supply from the consumer sector with respect to crop prices as -0.258, -0.147, -0.219 and -0.169 respectively for wheat, rice, cotton and sugarcane. Using the fertilizer shares provided by Qureshi (1987) we derive a net labour supply elasticity with respect to the price of fertilizer of 0.114, but using the own- and cross-price supply elasticities from Ali (1988) as fertilizer shares we get a figure of 0.277.

Finally, the national accounts data can be used to estimate a value for total labour income in the formal sector at Rs18,916 million, equivalent to nearly 30% of the total wage bill calculated for the whole economy. We need to reduce this number to our sample level. To do this we calculate the total expenditure for the sample and divide it by total consumer expenditure for the economy. The resulting figure, i.e. 0.0001, is used to scale down the formal sector wage bill to get to the sample equivalent.

Table A3.1a

Marketed Surplus for Wheat (Improved)

Farm Size (acres)	No. of Farms	% with Surplus=0	s[1]	S[2]
Less than 5.0	369	0.87	0.37	0.02
5.0 - 12.5	713	0.64	0.38	0.18
12.5 - 25.0	259	0.43	0.41	0.20
Over 25.0	114	0.22	0.56	0.60
All	1455	0.63	0.41	1.00
Province				
Punjab	1036	0.60		
Sind	372	0.67		
NWFP	47	0.91		
Farm Tenure				
Pure owners	849	0.59		
Pure tenants	376	0.75		
Owner-landl's	54	0.50		
Owner-tenants	176	0.58		

Source: Indus Basin Survey (1976).

Note: (1) s is the average surplus share for households that have sales.
(2) S is the share in total sample surplus.

Table A3.1b

Marketed Surplus for Rice (Improved)

Farm Size (acres)	No. of Farms	% with Surplus>0	s[1]	S[2]
Less than 5.0	181	0.67	0.53	0.04
5.0 - 12.5	332	0.47	0.55	0.26
12.5 - 25.0	147	0.35	0.59	0.30
Over 25.0	51	0.18	0.70	0.40
All	711	0.48	0.57	1.00
Province				
Punjab	460	0.48		
Sind	247	0.47		
NWFP	4	1.00		
Farm Tenure				
Pure owners	382	0.47		
Pure tenants	215	0.53		
Owner-landl's	30	0.67		
Owner-tenants	84	0.59		

Source: Indus Basin Survey (1976).

Note: (1) s is the average surplus share for households that have sales.
(2) S is the share in total sample surplus.

Table A3.2

(a) Number and Area of Farms by Size, 1972

Farm Size	No. of Farms		Farm Area		Cultivated Area	
(acres)	%	Cuml%	%	Cuml%	%	Cuml %
Less than 2.5	14	14	1	1	2	2
2.5 - 5.0	14	28	4	5	4	6
5.0 - 12.5	15	43	7	12	8	14
12.5 - 25.0	24	67	18	30	20	34
25.0 - 50.0	28	96	19	76	19	82
Over 50.0	4	100	24	100	18	100

(b) Number and Area of Farms by Size, 1980

Farm Size	No. of Farms		Farm Area		Cultivated Area	
(hectares)[1]	%	Cuml%	%	Cuml%	%	Cuml %
Less than 0.5	10	10	1	1	1	1
0.5 - 1.0	10	20	2	3	2	3
1.0 - 2.0	17	37	5	8	6	9
2.0 - 3.0	17	54	9	17	10	19
3.0 - 5.0	22	76	19	36	20	39
5.0 - 10.0	16	92	24	60	26	65
10.0 - 20.0	6	98	18	78	17	82
20.0 - 60.0	2	100	14	92	12	94
Over 60.0	-	100	8	100	6	100

Sources: Pakistan Statistical Yearbook (1981 and 1986).

Notes: (1) 1 hectare = 2.471 acres.

Table A3.3

Data Summary Statistics

Variable	Mean	SD	Min	Max
Full Sample (1437 observations)				
LAND	11.20	12.71	0.70	156.00
LANDL	2.06	0.81	-0.36	5.05
WHPR	0.96	0.06	0.54	2.14
WHPRL	-0.05	0.05	-0.62	0.76
NUMTOT	11.07	6.81	1.00	63.00
NUMTOTL	2.24	0.58	0.00	4.14
MEN	3.12	1.99	1.00	20.00
MENL	0.96	0.60	0.00	3.00
WOMEN	2.66	1.78	0.00	16.00
BOYS	1.23	1.48	0.00	14.00
GIRLS	1.04	1.48	0.00	16.00
CHILD	3.02	3.02	0.00	31.00
NUMOTH	7.95	5.49	0.00	0.53
DIST	0.47	0.53	0.00	5.00
TRAC	0.05	0.21	0.00	1.00
BULL	0.37	0.48	0.00	1.00
DONK	0.33	0.47	0.00	1.00
OTHTR	0.14	0.34	0.00	1.00
PTEN	0.26	0.44	0.00	1.00
OTEN	0.12	0.33	0.00	1.00
OLRD	0.04	0.19	0.00	1.00
CREDIT	0.25	0.43	0.00	1.00
JOB	0.07	0.25	0.00	1.00
SLSAL	0.19	0.39	0.00	1.00
GSAL	0.05	0.22	0.00	1.00
SVSAL	0.22	0.41	0.00	1.00
PUNJ	0.71	0.45	0.00	1.00
NWFP	0.03	0.18	0.00	1.00

Truncated Sample (529 observations)

LAND	16.80	17.37	0.70	156.00
LANDL	2.49	0.77	-0.36	5.05
WHPR	0.95	0.09	0.54	2.14
WHPRL	-0.05	0.08	-0.62	0.76
NUMTOT	11.62	7.21	1.00	53.00
NUMTOTL	2.28	0.61	0.00	3.97
MEN	3.37	2.09	1.00	15.00
MENL	1.04	0.61	0.00	2.71
WOMEN	2.79	1.85	0.00	14.00
BOYS	1.27	1.52	0.00	14.00
GIRLS	1.09	1.44	0.00	10.00
CHILD	3.10	3.06	0.00	22.00
NUMOTH	8.24	5.79	0.00	41.00
NUMOTHL	1.90	0.69	0.00	3.71
DIST	0.51	0.51	0.00	5.00
TRAC	0.08	0.28	0.00	1.00
BULL	0.36	0.48	0.00	1.00
DONK	0.37	0.48	0.00	1.00
OTHTR	0.12	0.33	0.00	1.00
PTEN	0.17	0.38	0.00	1.00
OTEN	0.14	0.34	0.00	1.00
OLRD	0.05	0.22	0.00	1.00
CREDIT	0.30	0.46	0.00	1.00
JOB	0.04	0.19	0.00	1.00
SLSAL	0.17	0.38	0.00	1.00
GSAL	0.02	0.14	0.00	1.00
SVSAL	0.23	0.42	0.00	1.00
PUNJ	0.76	0.42	0.00	1.00
NWFP	0.01	0.09	0.00	1.00
MS	3494.60	6827.10	37.32	79130.00
MSL	7.34	1.21	3.62	11.28
FC	2523.70	2598.60	112.00	26130.00
FCL	7.52	0.78	4.72	10.17
Y	8079.40	10416.00	373.20	91220.00
YL	8.59	0.85	5.92	11.42

Note: The values of NUMOTHL are in relation to the smaller sample of 524 observations. See Table 3.3 for variable definitions.

Table A3.4

Results from Probit Regression

	Coefficient	t-stat	Robust t
Intercept	-1.93	-8.00	-7.80
LANDL	0.82	13.00	14.00
NUMTOT	-0.02	-3.90	-3.90
DIST	-0.02	-0.27	-0.30
TRAC	0.45	1.90	1.90
BULL	0.36	2.60	2.50
DONK	0.36	2.50	2.50
OTHTR	0.08	0.47	0.46
PTEN	-0.56	-5.70	-5.70
OTEN	-0.16	-1.40	-1.50
OLRD	-0.21	-1.10	-0.96
CREDIT	0.19	2.20	2.20
JOB	-0.08	-0.46	-0.44
SLSAL	0.01	0.04	0.04
GSAL	-0.23	-0.78	-0.73
SVSAL	0.04	0.42	0.42
PUNJ	-0.06	-0.33	-0.33
NWFP	-0.08	-1.90	-1.70

Log-Likelihood = -771.89

Log-Likelihood with constant only = -945.48

Likelihood ratio test statistic = 347.16

Number of observations = 1437

Note: The robust t-statistic is calculated using White (1980).

Table A4.1

Data Statistics

(a) Households Applying Fertilizer (NIT>0):

Variable	Mean	S.D.	Min.	Max.
FACC	1.00	0.03	1.00	1.00
LANDW	1.53	0.70	-1.61	3.55
LAND	1.98	0.71	-0.36	4.29
TOTASS	17.26	20.89	0	316.50
NUMTOT	10.81	6.43	1.00	63.00
DISTV	0.72	0.77	0	7.00
DISTC	8.24	6.08	0	40.00
E2	1.02	0.28	0	2.43
WHPR	-1.15	0.14	-2.29	2.17
CMYLR	0.04	0.20	0	1
PHOS	0.48	0.50	0	1
NTOPD	0.47	0.50	0	1
TW	0.37	0.48	0	1
JOB	0.07	0.25	0	1
SLSAL	0.26	0.44	0	1
GSAL	0.20	0.40	0	1
NSAL	0.32	0.47	0	1
OWNL	0.03	0.18	0	1
OWNT	0.12	0.32	0	1
PTEN	0.27	0.44	0	1
IPRIV	0.24	0.42	0	1
IINAD	0.02	0.15	0	1
IMIX	0.03	0.16	0	1
NOPTIM1	0.49	0.50	0	1
PUNJ	0.71	0.45	0	1
NWFP	0.04	0.19	0	1
NIT	141.46	108.58	8.49	598.49

No. of Observations = 1099

(b) All Households:

Variable	Mean	S.D.	Min.	Max.
FACC	0.90	0.30	0	1
LANDW	1.51	0.72	-1.61	3.91
LAND	1.96	0.72	-0.36	4.29
TOTASS	16.98	20.30	0	316.50
NUMTOT	10.75	6.43	1.00	63.00
DISTV	0.72	0.76	0	7.00
DISTC	8.42	6.14	0	40.00
E2	1.05	0.32	0	2.43
WHPR	-1.15	0.14	-2.89	2.17
CMYLR	0.04	0.20	0	1
PHOS	0.39	0.49	0	1
NTOPD	0.39	0.49	0	1
TW	0.35	0.48	0	1
JOB	0.07	0.26	0	1
SLSAL	0.25	0.43	0	1
GSAL	0.20	0.40	0	1
NSAL	0.33	0.47	0	1
OWNL	0.03	0.17	0	1
OWNT	0.12	0.32	0	1
PTEN	0.27	0.44	0	1
IPRIV	0.22	0.41	0	1
IINAD	0.05	0.22	0	1
IMIX	0.04	0.19	0	1
NOPTIM1	0.52	0.50	0	1
PUNJ	0.70	0.46	0	1
NWFP	0.03	0.18	0	1
NIT	115.01	112.37	8.49	598.49

No. of Observations = 1351

Note: See Appendix for notes.

Table A5.1

Classification of Sectors

Sector		Case A	Case B
01	Wheat	M	M
02	Rice	X	X
03	Cotton	X	X
04	Sugarcane	N	N
05	Tobacco Growing	M	M
06	Oilseeds	M	M
07	Pulses	N	N
08	Other Crops	M	M
09	Livestock	M	M
10	Fishing	X	X
11	Forestry	N	N
12	Mining & Quarrying	M	M
13	Grain Milling	N	N
14	Rice Milling & Husking	N	N
15	Edible Oils	M	M
16	Sugar Refining	M	N
17	Gur and Khandsari	N	N
18	Tea Blending	M	N
19	Fish & Preparations	X	X
20	Confectionery & Bakery	N	N
21	Other Food Industries	X	X
22	Beverages	M	M
23	Tobacco Products	X	X
24	Bidis	N	N
25	Cotton Yarn	X	X
26	Cotton Ginning	N	N
27	Cotton Textiles (Large Scale)	X	X
28	Cotton Textiles (Small Scale)	X	X
29	Silk & Synthetic Textiles	M	N
30	Woollen Textiles & Hosiery	M	N
31	Threadballs and Other Textiles	M	M
32	Carpets & Rugs	X	X
33	Made-up Garments	X	X
34	Footwear (Non-rubber)	X	X
35	Wood, Cork & Furniture	M	N
36	Paper & Products	M	N
37	Printing and Publishing	N	N
38	Leather & Products	X	X
39	Rubber Footwear	X	X
40	Rubber Products	M	N
41	Pharmaceuticals	M	N
42	Fertilizer	M	M
43	Perfumes & Cosmetics	M	N
44	Paints & Varnishes	M	M
45	Soaps & Detergents	M	M
46	Chemicals	M	N
47	Plastic Products	M	M
48	Petroleum Products	M	N
49	Cement	X	X
50	Glass & Products	M	M
51	Non-metal Mineral Products	M	M

52	Basic Metals	M	M
53	Metal Products	M	M
54	Iron & Steel Remoulding	N	N
55	Agricultural Machinery	M	M
56	Other Non-electrical Machinery	M	M
57	Electric Machinery	M	M
58	Bicycles	N	N
59	Transport (Large Scale)	M	N
60	Shipbuilding	N	N
61	Transport Equipment (Small Scale)	M	N
62	Office Equipment	M	N
63	Sports Goods	X	X
64	Surgical Instruments	X	X
65	Other Large Scale Manufacturing	X	X
66	Other Small Scale Manufacturing	N	N
67	Low-cost Residential Building	N	N
68	Luxurious Residential Building	N	N
69	Rural Buildings	N	N
70	Factory Buildings	N	N
71	Public Buildings	N	N
72	Roads	N	N
73	Infrastructure	N	N
74	Ownership of Dwellings	N	N
75	Electricity	N	N
76	Gas	N	N
77	Wholesale & Retail Trade	N	N
78	Road Transport	N	N
79	Rail Transport	N	N
80	Air Transport	N	N
81	Water Transport	N	N
82	Television	N	N
83	Radio	N	N
84	Phone, Telegraph & Post	N	N
85	Banking & Insurance	N	N
86	Government	N	N
87	Services	N	N

Note: M, X and N denote, respectively, sectors which are importable, exportable and non-traded on the margin.

Table A5.2

Non-traded Accounting Ratios : Case A

ACF = 1.2:

Sector	WCF = 1.40	1.15	0.90
04 Sugarcane	1.170	1.054	0.937
07 Pulses	1.090	1.031	0.971
11 Forestry	1.164	1.037	0.910
13 Grain Milling	1.430	1.402	1.375
14 Rice Milling & Husking	2.132	2.100	2.068
17 Gur and Khandsari	1.129	1.009	0.888
20 Confectionery & Bakery	0.961	0.905	0.850
24 Bidis	0.822	0.727	0.632
26 Cotton Ginning	2.157	2.141	2.125
37 Printing and Publishing	0.866	0.795	0.724
54 Iron & Steel Remoulding	0.872	0.752	0.633
58 Bicycles	0.907	0.868	0.830
60 Shipbuilding	1.058	0.992	0.926
66 Other Small Scale Manufacturing	0.767	0.698	0.630
67 Low-cost Residential Building	0.959	0.880	0.801
68 Luxurious Residential Building	0.954	0.872	0.790
69 Rural Buildings	0.949	0.851	0.753
70 Factory Buildings	0.941	0.864	0.786
71 Public Buildings	0.931	0.844	0.756
72 Roads	0.920	0.832	0.744
73 Infrastructure	1.540	1.457	1.374
74 Ownership of Dwellings	1.124	0.982	0.840
75 Electricity	2.701	2.576	2.450
76 Gas	2.621	2.495	2.368
77 Wholesale & Retail Trade	0.983	0.835	0.687
78 Road Transport	0.944	0.869	0.793
79 Rail Transport	1.336	1.243	1.150
80 Air Transport	0.969	0.869	0.768
81 Water Transport	0.950	0.812	0.674
82 Television	0.999	0.903	0.808
83 Radio	1.017	0.881	0.745
84 Phone, Telegraph & Post	1.254	1.116	0.978
85 Banking & Insurance	0.973	0.838	0.703
86 Government	1.264	1.131	0.998
87 Services	0.982	0.834	0.686

ACF = 1.0:

Sector	WCF = 1.40	1.15	0.90
04 Sugarcane	1.158	1.042	0.925
07 Pulses	1.077	1.017	0.958

11	Forestry	1.155	1.028	0.901
13	Grain Milling	1.404	1.377	1.349
14	Rice Milling & Husking	2.103	2.071	2.039
17	Gur and Khandsari	1.114	0.993	0.872
20	Confectionery & Bakery	0.929	0.874	0.818
24	Bidis	0.811	0.716	0.621
26	Cotton Ginning	2.135	2.119	2.104
37	Printing and Publishing	0.837	0.766	0.695
54	Iron & Steel Remoulding	0.853	0.734	0.614
58	Bicycles	0.881	0.842	0.803
60	Shipbuilding	1.027	0.962	0.896
66	Other Small Scale Manufacturing	0.759	0.690	0.622
67	Low-cost Residential Building	0.955	0.877	0.798
68	Luxurious Residential Building	0.948	0.866	0.784
69	Rural Buildings	0.945	0.846	0.748
70	Factory Buildings	0.937	0.860	0.782
71	Public Buildings	0.925	0.838	0.751
72	Roads	0.918	0.830	0.742
73	Infrastructure	1.434	1.351	1.268
74	Ownership of Dwellings	1.078	0.935	0.793
75	Electricity	2.394	2.268	2.142
76	Gas	2.328	2.201	2.074
77	Wholesale & Retail Trade	0.959	0.811	0.663
78	Road Transport	0.925	0.850	0.774
79	Rail Transport	1.255	1.162	1.069
80	Air Transport	0.946	0.846	0.745
81	Water Transport	0.932	0.795	0.657
82	Television	0.979	0.884	0.789
83	Radio	0.987	0.851	0.715
84	Phone, Telegraph & Post	1.184	1.046	0.908
85	Banking & Insurance	0.951	0.816	0.681
86	Government	1.193	1.060	0.927
87	Services	0.958	0.810	0.663

ACF = 0.8:

Sector	WCF =	1.40	1.15	0.90
04	Sugarcane	1.147	1.030	0.914
07	Pulses	1.064	1.004	0.944
11	Forestry	1.146	1.019	0.892
13	Grain Milling	1.378	1.351	1.323
14	Rice Milling & Husking	2.075	2.042	2.010
17	Gur and Khandsari	1.098	0.977	0.857
20	Confectionery & Bakery	0.898	0.842	0.787
24	Bidis	0.800	0.705	0.609
26	Cotton Ginning	2.113	2.098	2.082
37	Printing and Publishing	0.808	0.737	0.666
54	Iron & Steel Remoulding	0.835	0.715	0.595
58	Bicycles	0.855	0.816	0.777
60	Shipbuilding	0.997	0.931	0.865
66	Other Small Scale Manufacturing	0.750	0.682	0.613
67	Low-cost Residential Building	0.952	0.873	0.795
68	Luxurious Residential Building	0.943	0.861	0.779
69	Rural Buildings	0.940	0.841	0.743
70	Factory Buildings	0.934	0.856	0.778

71	Public Buildings	0.919	0.832	0.745
72	Roads	0.916	0.828	0.740
73	Infrastructure	1.327	1.244	1.161
74	Ownership of Dwellings	1.031	0.889	0.747
75	Electricity	2.086	1.961	1.835
76	Gas	2.034	1.907	1.781
77	Wholesale & Retail Trade	0.935	0.787	0.639
78	Road Transport	0.907	0.831	0.755
79	Rail Transport	1.174	1.081	0.988
80	Air Transport	0.924	0.823	0.723
81	Water Transport	0.915	0.777	0.640
82	Television	0.960	0.865	0.770
83	Radio	0.957	0.821	0.685
84	Phone, Telegraph & Post	1.114	0.976	0.838
85	Banking & Insurance	0.929	0.794	0.659
86	Government	1.122	0.989	0.856
87	Services	0.934	0.787	0.639

Note: ACF and WCF are, respectively, the asset and wage conversion factors. See Table A5.1 for sector classifications.

Table A5.3

Social Profitability : Case A

ACF = 1.2:

	Sector WCF =	1.40	1.15	0.90
01	Wheat	0.166	0.222	0.279
02	Rice	0.527	0.563	0.599
03	Cotton	0.506	0.549	0.591
05	Tobacco Growing	-0.512	-0.397	-0.277
06	Oilseeds	-0.520	-0.421	-0.319
08	Other Crops	-0.836	-0.720	-0.598
09	Livestock	-0.078	0.002	0.084
10	Fishing	0.047	0.156	0.265
12	Mining & Quarrying	-0.191	-0.088	0.018
15	Edible Oils	-0.195	-0.177	-0.159
16	Sugar Refining	-0.193	-0.106	-0.014
18	Tea Blending	0.063	0.088	0.113
19	Fish & Preparations	0.042	0.072	0.103
21	Other Food Industries	0.144	0.206	0.269
22	Beverages	-2.156	-2.216	-2.294
23	Tobacco Products	0.586	0.611	0.636
25	Cotton Yarn	-0.602	-0.557	-0.512
27	Cotton Textiles (Large Scale)	-0.423	-0.365	-0.306
28	Cotton Textiles (Small Scale)	0.129	0.172	0.215
29	Silk & Synthetic Textiles	-0.630	-0.587	-0.540
30	Woollen Textiles & Hosiery	-0.693	-0.662	-0.628
31	Threadballs and Other Textiles	-0.408	-0.371	-0.331
32	Carpets & Rugs	0.211	0.265	0.319
33	Made-up Garments	0.144	0.182	0.220
34	Footwear (Non-rubber)	-0.066	-0.010	0.047
35	Wood, Cork & Furniture	0.013	0.105	0.196
36	Paper & Products	-0.166	-0.112	-0.054
38	Leather & Products	0.373	0.388	0.403
39	Rubber Footwear	0.153	0.218	0.283
40	Rubber Products	-0.324	-0.277	-0.226
41	Pharmaceuticals	0.121	0.151	0.182
42	Fertilizer	0.315	0.347	0.380
43	Perfumes & Cosmetics	-3.135	-3.063	-2.981
44	Paints & Varnishes	0.031	0.051	0.071
45	Soaps & Detergents	0.052	0.079	0.107
46	Chemicals	-0.031	0.021	0.075
47	Plastic Products	0.055	0.125	0.198
48	Petroleum Products	-0.064	-0.044	-0.024
49	Cement	-0.016	0.047	0.110
50	Glass & Products	-1.875	-1.744	-1.603
51	Non-metal Mineral Products	-0.019	0.025	0.070
52	Basic Metals	-0.150	-0.107	-0.062
53	Metal Products	-0.085	0.004	0.097
55	Agricultural Machinery	0.024	0.050	0.076
56	Other Non-electrical Machinery	0.050	0.097	0.146
57	Electric Machinery	-0.052	-0.016	0.020
59	Transport (Large Scale)	-0.265	-0.234	-0.201
61	Transport Equipment (Small Scale)	0.014	0.069	0.124
62	Office Equipment	0.076	0.109	0.144
63	Sports Goods	0.053	0.094	0.136
64	Surgical Instruments	0.288	0.355	0.422
65	Other Large Scale Manufacturing	0.417	0.462	0.507

ACF = 1.0:

	Sector	WCF = 1.40	1.15	0.90
01	Wheat	0.171	0.227	0.285
02	Rice	0.533	0.569	0.605
03	Cotton	0.511	0.554	0.596
05	Tobacco Growing	-0.507	-0.392	-0.271
06	Oilseeds	-0.512	-0.414	-0.311
08	Other Crops	-0.830	-0.713	-0.590
09	Livestock	-0.072	0.008	0.089
10	Fishing	0.100	0.209	0.318
12	Mining & Quarrying	-0.176	-0.073	0.034
15	Edible Oils	-0.169	-0.150	-0.131
16	Sugar Refining	-0.158	-0.069	0.023
18	Tea Blending	0.084	0.109	0.134
19	Fish & Preparations	0.064	0.094	0.125
21	Other Food Industries	0.169	0.232	0.294
22	Beverages	-2.110	-2.165	-2.237
23	Tobacco Products	0.607	0.632	0.657
25	Cotton Yarn	-0.562	-0.517	-0.472
27	Cotton Textiles (Large Scale)	-0.386	-0.327	-0.269
28	Cotton Textiles (Small Scale)	0.137	0.180	0.223
29	Silk & Synthetic Textiles	-0.585	-0.540	-0.491
30	Woollen Textiles & Hosiery	-0.659	-0.626	-0.590
31	Threadballs and Other Textiles	-0.370	-0.331	-0.289
32	Carpets & Rugs	0.234	0.288	0.342
33	Made-up Garments	0.165	0.203	0.242
34	Footwear (Non-rubber)	-0.046	0.011	0.068
35	Wood, Cork & Furniture	0.039	0.130	0.222
36	Paper & Products	-0.121	-0.065	-0.004
38	Leather & Products	0.388	0.403	0.418
39	Rubber Footwear	0.179	0.244	0.308
40	Rubber Products	-0.289	-0.240	-0.187
41	Pharmaceuticals	0.146	0.176	0.208
42	Fertilizer	0.356	0.389	0.423
43	Perfumes & Cosmetics	-3.067	-2.990	-2.901
44	Paints & Varnishes	0.058	0.078	0.099
45	Soaps & Detergents	0.076	0.103	0.132
46	Chemicals	0.015	0.068	0.123
47	Plastic Products	0.080	0.151	0.224
48	Petroleum Products	-0.040	-0.020	0.000
49	Cement	0.060	0.123	0.187
50	Glass & Products	-1.756	-1.619	-1.473
51	Non-metal Mineral Products	0.003	0.047	0.093
52	Basic Metals	-0.113	-0.070	-0.023
53	Metal Products	-0.059	0.030	0.125
55	Agricultural Machinery	0.046	0.072	0.099
56	Other Non-electrical Machinery	0.080	0.128	0.177
57	Electric Machinery	-0.026	0.010	0.047
59	Transport (Large Scale)	-0.237	-0.205	-0.172
61	Transport Equipment (Small Scale)	0.033	0.089	0.145
62	Office Equipment	0.103	0.137	0.172
63	Sports Goods	0.076	0.117	0.158
64	Surgical Instruments	0.311	0.378	0.445
65	Other Large Scale Manufacturing	0.439	0.484	0.529

ACF = 0.8:

	Sector	WCF = 1.40	1.15	0.90
01	Wheat	0.176	0.233	0.290
02	Rice	0.539	0.575	0.611
03	Cotton	0.516	0.558	0.601
05	Tobacco Growing	-0.502	-0.386	-0.265
06	Oilseeds	-0.505	-0.406	-0.302
08	Other Crops	-0.823	-0.706	-0.582
09	Livestock	-0.067	0.014	0.095
10	Fishing	0.152	0.261	0.370
12	Mining & Quarrying	-0.162	-0.057	0.050
15	Edible Oils	-0.142	-0.123	-0.104
16	Sugar Refining	-0.123	-0.033	0.061
18	Tea Blending	0.106	0.131	0.156
19	Fish & Preparations	0.086	0.117	0.147
21	Other Food Industries	0.195	0.257	0.319
22	Beverages	-2.062	-2.111	-2.177
23	Tobacco Products	0.627	0.652	0.677
25	Cotton Yarn	-0.521	-0.476	-0.431
27	Cotton Textiles (Large Scale)	-0.348	-0.290	-0.231
28	Cotton Textiles (Small Scale)	0.145	0.188	0.231
29	Silk & Synthetic Textiles	-0.540	-0.492	-0.441
30	Woollen Textiles & Hosiery	-0.625	-0.590	-0.552
31	Threadballs and Other Textiles	-0.331	-0.291	-0.247
32	Carpets & Rugs	0.257	0.311	0.365
33	Made-up Garments	0.186	0.224	0.263
34	Footwear (Non-rubber)	-0.025	0.032	0.088
35	Wood, Cork & Furniture	0.064	0.156	0.247
36	Paper & Products	-0.075	-0.016	0.046
38	Leather & Products	0.403	0.418	0.433
39	Rubber Footwear	0.204	0.269	0.334
40	Rubber Products	-0.253	-0.202	-0.148
41	Pharmaceuticals	0.171	0.202	0.234
42	Fertilizer	0.398	0.431	0.466
43	Perfumes & Cosmetics	-2.997	-2.914	-2.819
44	Paints & Varnishes	0.084	0.105	0.127
45	Soaps & Detergents	0.100	0.128	0.157
46	Chemicals	0.062	0.116	0.172
47	Plastic Products	0.106	0.178	0.251
48	Petroleum Products	-0.017	0.004	0.025
49	Cement	0.137	0.200	0.263
50	Glass & Products	-1.635	-1.493	-1.341
51	Non-metal Mineral Products	0.025	0.070	0.116
52	Basic Metals	-0.077	-0.032	0.016
53	Metal Products	-0.034	0.057	0.152
55	Agricultural Machinery	0.069	0.095	0.122
56	Other Non-electrical Machinery	0.110	0.159	0.208
57	Electric Machinery	0.001	0.038	0.075
59	Transport (Large Scale)	-0.208	-0.175	-0.142
61	Transport Equipment (Small Scale)	0.053	0.109	0.165
62	Office Equipment	0.130	0.165	0.200
63	Sports Goods	0.099	0.140	0.181
64	Surgical Instruments	0.335	0.402	0.469
65	Other Large Scale Manufacturing	0.461	0.506	0.551

Note: See note to Table A5.2.

Table A5.4

Imported Accounting Ratios : Case A

Sector		WCF = 1.40	1.15	0.90
ACF = 1.2:				
01	Wheat	1.416	1.402	1.388
05	Tobacco Growing	0.775	0.759	0.743
06	Oilseeds	0.752	0.737	0.721
08	Other Crops	0.614	0.598	0.582
09	Livestock	0.998	0.991	0.985
12	Mining & Quarrying	0.975	0.961	0.948
15	Edible Oils	0.992	0.977	0.962
16	Sugar Refining	0.682	0.667	0.651
18	Tea Blending	0.965	0.959	0.952
22	Beverages	0.242	0.212	0.183
29	Silk & Synthetic Textiles	0.566	0.545	0.523
30	Woollen Textiles & Hosiery	0.625	0.599	0.573
31	Threadballs and Other Textiles	0.691	0.669	0.646
35	Wood, Cork & Furniture	0.987	0.987	0.987
36	Paper & Products	0.758	0.731	0.704
40	Rubber Products	0.739	0.712	0.685
41	Pharmaceuticals	0.993	0.976	0.959
42	Fertilizer	1.577	1.553	1.529
43	Perfumes & Cosmetics	0.212	0.199	0.186
44	Paints & Varnishes	0.819	0.802	0.784
45	Soaps & Detergents	0.999	0.982	0.965
46	Chemicals	0.872	0.855	0.838
47	Plastic Products	0.955	0.941	0.928
48	Petroleum Products	0.947	0.928	0.910
50	Glass & Products	0.414	0.400	0.387
51	Non-metal Mineral Products	0.993	0.982	0.972
52	Basic Metals	0.824	0.799	0.774
53	Metal Products	0.935	0.914	0.892
55	Agricultural Machinery	0.997	0.987	0.977
56	Other Non-electrical Machinery	0.873	0.864	0.855
57	Electric Machinery	0.847	0.839	0.830
59	Transport (Large Scale)	0.707	0.698	0.688
61	Transport Equipment (Small Scale)	0.999	0.994	0.989
62	Office Equipment	0.999	0.986	0.972
ACF = 1.0:				
01	Wheat	1.413	1.399	1.386
05	Tobacco Growing	0.772	0.756	0.740
06	Oilseeds	0.749	0.734	0.719
08	Other Crops	0.612	0.595	0.579
09	Livestock	0.997	0.990	0.983
12	Mining & Quarrying	0.972	0.958	0.945
15	Edible Oils	0.990	0.974	0.959
16	Sugar Refining	0.680	0.664	0.648
18	Tea Blending	0.964	0.957	0.951
22	Beverages	0.236	0.207	0.177
29	Silk & Synthetic Textiles	0.562	0.541	0.519
30	Woollen Textiles & Hosiery	0.620	0.594	0.568
31	Threadballs and Other Textiles	0.687	0.665	0.643
35	Wood, Cork & Furniture	0.987	0.987	0.987

36	Paper & Products	0.753	0.726	0.699
40	Rubber Products	0.734	0.707	0.680
41	Pharmaceuticals	0.990	0.973	0.956
42	Fertilizer	1.569	1.544	1.520
43	Perfumes & Cosmetics	0.209	0.196	0.183
44	Paints & Varnishes	0.815	0.798	0.781
45	Soaps & Detergents	0.996	0.979	0.962
46	Chemicals	0.869	0.852	0.835
47	Plastic Products	0.953	0.939	0.925
48	Petroleum Products	0.944	0.925	0.906
50	Glass & Products	0.411	0.398	0.384
51	Non-metal Mineral Products	0.991	0.980	0.969
52	Basic Metals	0.819	0.794	0.769
53	Metal Products	0.931	0.909	0.888
55	Agricultural Machinery	0.994	0.984	0.974
56	Other Non-electrical Machinery	0.870	0.861	0.852
57	Electric Machinery	0.844	0.836	0.827
59	Transport (Large Scale)	0.703	0.693	0.683
61	Transport Equipment (Small Scale)	0.998	0.993	0.989
62	Office Equipment	0.997	0.983	0.969

ACF = 0.8:

01	Wheat	1.411	1.397	1.383
05	Tobacco Growing	0.769	0.753	0.737
06	Oilseeds	0.746	0.731	0.716
08	Other Crops	0.609	0.593	0.576
09	Livestock	0.996	0.989	0.982
12	Mining & Quarrying	0.969	0.955	0.942
15	Edible Oils	0.987	0.972	0.957
16	Sugar Refining	0.677	0.661	0.645
18	Tea Blending	0.963	0.956	0.950
22	Beverages	0.230	0.201	0.171
29	Silk & Synthetic Textiles	0.559	0.537	0.516
30	Woollen Textiles & Hosiery	0.616	0.590	0.564
31	Threadballs and Other Textiles	0.683	0.661	0.639
35	Wood, Cork & Furniture	0.987	0.987	0.986
36	Paper & Products	0.749	0.722	0.695
40	Rubber Products	0.729	0.702	0.676
41	Pharmaceuticals	0.987	0.970	0.953
42	Fertilizer	1.560	1.536	1.512
43	Perfumes & Cosmetics	0.207	0.194	0.181
44	Paints & Varnishes	0.812	0.795	0.778
45	Soaps & Detergents	0.993	0.976	0.959
46	Chemicals	0.866	0.849	0.832
47	Plastic Products	0.950	0.936	0.922
48	Petroleum Products	0.940	0.922	0.903
50	Glass & Products	0.408	0.395	0.381
51	Non-metal Mineral Products	0.988	0.977	0.966
52	Basic Metals	0.814	0.789	0.764
53	Metal Products	0.927	0.905	0.883
55	Agricultural Machinery	0.992	0.982	0.972
56	Other Non-electrical Machinery	0.868	0.859	0.850
57	Electric Machinery	0.841	0.832	0.824
59	Transport (Large Scale)	0.698	0.688	0.679
61	Transport Equipment (Small Scale)	0.997	0.993	0.988
62	Office Equipment	0.994	0.980	0.967

Note: See note to Table A5.2.

Table A5.5

Non-traded Accounting Ratios : Case B

ACF = 1.2:

	Sector	WCF = 1.40	1.15	0.90
04	Sugarcane	1.173	1.055	0.938
07	Pulses	1.094	1.034	0.973
11	Forestry	1.165	1.038	0.911
13	Grain Milling	1.435	1.406	1.378
14	Rice Milling & Husking	2.142	2.108	2.073
16	Sugar Refining	0.816	0.738	0.660
17	Gur and Khandsari	1.132	1.011	0.890
18	Tea Blending	0.842	0.764	0.687
20	Confectionery & Bakery	0.994	0.923	0.853
24	Bidis	0.828	0.731	0.634
26	Cotton Ginning	2.159	2.143	2.127
29	Silk & Synthetic Textiles	1.059	0.977	0.894
30	Woollen Textiles & Hosiery	1.103	1.034	0.964
35	Wood, Cork & Furniture	0.980	0.881	0.783
36	Paper & Products	0.932	0.840	0.749
37	Printing and Publishing	0.930	0.835	0.739
40	Rubber Products	0.991	0.918	0.845
41	Pharmaceuticals	0.895	0.821	0.747
43	Perfumes & Cosmetics	0.898	0.811	0.723
46	Chemicals	0.913	0.839	0.766
48	Petroleum Products	1.012	0.973	0.934
54	Iron & Steel Remoulding	0.880	0.759	0.637
58	Bicycles	0.936	0.891	0.845
59	Transport (Large Scale)	0.921	0.883	0.844
60	Shipbuilding	1.064	0.997	0.929
61	Transport Equipment (Small Scale)	0.985	0.888	0.791
62	Office Equipment	0.946	0.877	0.809
66	Other Small Scale Manufacturing	0.782	0.708	0.634
67	Low-cost Residential Building	0.960	0.881	0.802
68	Luxurious Residential Building	0.955	0.873	0.790
69	Rural Buildings	0.951	0.852	0.753
70	Factory Buildings	0.943	0.865	0.787
71	Public Buildings	0.933	0.845	0.758
72	Roads	0.922	0.834	0.745
73	Infrastructure	1.542	1.458	1.374
74	Ownership of Dwellings	1.124	0.982	0.840
75	Electricity	2.713	2.583	2.454
76	Gas	2.623	2.496	2.369
77	Wholesale & Retail Trade	0.984	0.836	0.687
78	Road Transport	1.000	0.912	0.824
79	Rail Transport	1.348	1.252	1.155
80	Air Transport	0.984	0.879	0.774
81	Water Transport	0.951	0.813	0.675
82	Television	0.999	0.898	0.797
83	Radio	1.027	0.889	0.751
84	Phone, Telegraph & Post	1.257	1.118	0.979
85	Banking & Insurance	0.981	0.843	0.706
86	Government	1.267	1.133	0.999
87	Services	0.983	0.835	0.687

ACF = 1.0:

	Sector	WCF = 1.40	1.15	0.90
04	Sugarcane	1.160	1.043	0.926
07	Pulses	1.080	1.019	0.958
11	Forestry	1.155	1.028	0.901
13	Grain Milling	1.408	1.379	1.351
14	Rice Milling & Husking	2.111	2.076	2.042
16	Sugar Refining	0.788	0.711	0.633
17	Gur and Khandsari	1.116	0.994	0.873
18	Tea Blending	0.779	0.702	0.624
20	Confectionery & Bakery	0.953	0.883	0.812
24	Bidis	0.815	0.718	0.621
26	Cotton Ginning	2.137	2.121	2.104
29	Silk & Synthetic Textiles	1.008	0.926	0.843
30	Woollen Textiles & Hosiery	1.069	1.000	0.931
35	Wood, Cork & Furniture	0.951	0.852	0.754
36	Paper & Products	0.877	0.785	0.693
37	Printing and Publishing	0.882	0.786	0.690
40	Rubber Products	0.955	0.882	0.810
41	Pharmaceuticals	0.841	0.768	0.694
43	Perfumes & Cosmetics	0.856	0.769	0.682
46	Chemicals	0.859	0.785	0.712
48	Petroleum Products	0.985	0.946	0.907
54	Iron & Steel Remoulding	0.860	0.738	0.616
58	Bicycles	0.905	0.859	0.814
59	Transport (Large Scale)	0.892	0.853	0.815
60	Shipbuilding	1.032	0.965	0.897
61	Transport Equipment (Small Scale)	0.953	0.856	0.760
62	Office Equipment	0.896	0.828	0.759
66	Other Small Scale Manufacturing	0.769	0.695	0.621
67	Low-cost Residential Building	0.957	0.878	0.798
68	Luxurious Residential Building	0.949	0.867	0.785
69	Rural Buildings	0.946	0.847	0.748
70	Factory Buildings	0.939	0.861	0.783
71	Public Buildings	0.927	0.839	0.751
72	Roads	0.920	0.831	0.743
73	Infrastructure	1.435	1.351	1.267
74	Ownership of Dwellings	1.078	0.935	0.793
75	Electricity	2.401	2.272	2.142
76	Gas	2.328	2.201	2.074
77	Wholesale & Retail Trade	0.960	0.812	0.663
78	Road Transport	0.969	0.880	0.792
79	Rail Transport	1.263	1.166	1.069
80	Air Transport	0.956	0.851	0.746
81	Water Transport	0.933	0.795	0.657
82	Television	0.975	0.874	0.773
83	Radio	0.995	0.857	0.719
84	Phone, Telegraph & Post	1.186	1.047	0.908
85	Banking & Insurance	0.956	0.819	0.682
86	Government	1.195	1.062	0.928
87	Services	0.959	0.811	0.663

ACF = 0.8:

	Sector	WCF = 1.40	1.15	0.90
04	Sugarcane	1.148	1.031	0.913
07	Pulses	1.066	1.005	0.944
11	Forestry	1.146	1.019	0.892
13	Grain Milling	1.381	1.352	1.324
14	Rice Milling & Husking	2.080	2.045	2.011
16	Sugar Refining	0.761	0.683	0.605
17	Gur and Khandsari	1.099	0.978	0.856
18	Tea Blending	0.717	0.639	0.561
20	Confectionery & Bakery	0.913	0.842	0.772
24	Bidis	0.802	0.705	0.609
26	Cotton Ginning	2.115	2.098	2.082
29	Silk & Synthetic Textiles	0.957	0.875	0.792
30	Woollen Textiles & Hosiery	1.035	0.966	0.897
35	Wood, Cork & Furniture	0.921	0.823	0.725
36	Paper & Products	0.821	0.729	0.638
37	Printing and Publishing	0.833	0.737	0.642
40	Rubber Products	0.919	0.847	0.774
41	Pharmaceuticals	0.788	0.715	0.641
43	Perfumes & Cosmetics	0.815	0.728	0.640
46	Chemicals	0.805	0.732	0.658
48	Petroleum Products	0.958	0.919	0.880
54	Iron & Steel Remoulding	0.839	0.717	0.596
58	Bicycles	0.873	0.828	0.782
59	Transport (Large Scale)	0.862	0.824	0.785
60	Shipbuilding	1.000	0.933	0.865
61	Transport Equipment (Small Scale)	0.921	0.824	0.728
62	Office Equipment	0.847	0.778	0.710
66	Other Small Scale Manufacturing	0.756	0.682	0.608
67	Low-cost Residential Building	0.953	0.874	0.795
68	Luxurious Residential Building	0.943	0.861	0.779
69	Rural Buildings	0.941	0.842	0.743
70	Factory Buildings	0.935	0.856	0.778
71	Public Buildings	0.921	0.833	0.745
72	Roads	0.917	0.828	0.740
73	Infrastructure	1.328	1.244	1.160
74	Ownership of Dwellings	1.031	0.889	0.747
75	Electricity	2.089	1.960	1.831
76	Gas	2.034	1.907	1.780
77	Wholesale & Retail Trade	0.936	0.787	0.639
78	Road Transport	0.937	0.849	0.761
79	Rail Transport	1.178	1.081	0.984
80	Air Transport	0.928	0.823	0.718
81	Water Transport	0.915	0.777	0.640
82	Television	0.950	0.849	0.748
83	Radio	0.963	0.825	0.687
84	Phone, Telegraph & Post	1.115	0.976	0.837
85	Banking & Insurance	0.932	0.795	0.658
86	Government	1.124	0.990	0.856
87	Services	0.935	0.787	0.639

Note : See note to Table A5.2

Table A5.6

Social Profitability : Case B

ACF = 1.2:

	Sector	WCF = 1.40	1.15	0.90
01	Wheat	0.164	0.221	0.278
02	Rice	0.523	0.560	0.598
03	Cotton	0.505	0.548	0.590
05	Tobacco Growing	-0.512	-0.397	-0.277
06	Oilseeds	-0.521	-0.422	-0.320
08	Other Crops	-0.836	-0.720	-0.598
09	Livestock	-0.078	0.002	0.084
10	Fishing	0.044	0.154	0.264
12	Mining & Quarrying	-0.194	-0.090	0.017
15	Edible Oils	-0.197	-0.178	-0.158
19	Fish & Preparations	0.039	0.071	0.102
21	Other Food Industries	0.136	0.201	0.266
22	Beverages	-2.210	-2.239	-2.278
23	Tobacco Products	0.581	0.608	0.635
25	Cotton Yarn	-0.620	-0.572	-0.524
27	Cotton Textiles (Large Scale)	-0.447	-0.382	-0.316
28	Cotton Textiles (Small Scale)	0.120	0.165	0.209
31	Threadballs and Other Textiles	-0.430	-0.388	-0.343
32	Carpets & Rugs	0.089	0.156	0.224
33	Made-up Garments	0.137	0.178	0.219
34	Footwear (Non-rubber)	-0.085	-0.018	0.048
38	Leather & Products	0.371	0.388	0.405
39	Rubber Footwear	0.097	0.182	0.266
42	Fertilizer	0.312	0.345	0.379
44	Paints & Varnishes	0.008	0.058	0.110
45	Soaps & Detergents	0.046	0.078	0.111
47	Plastic Products	0.042	0.118	0.196
49	Cement	-0.024	0.041	0.107
50	Glass & Products	-1.890	-1.739	-1.576
51	Non-metal Mineral Products	-0.027	0.020	0.068
52	Basic Metals	-0.153	-0.110	-0.064
53	Metal Products	-0.090	0.001	0.095
55	Agricultural Machinery	0.019	0.046	0.073
56	Other Non-electrical Machinery	0.044	0.094	0.145
57	Electric Machinery	-0.057	-0.018	0.023
63	Sports Goods	0.048	0.091	0.135
64	Surgical Instruments	0.284	0.352	0.420
65	Other Large Scale Manufacturing	0.405	0.461	0.517

ACF = 1.0:

	Sector	WCF = 1.40	1.15	0.90
01	Wheat	0.170	0.227	0.284
02	Rice	0.530	0.567	0.604
03	Cotton	0.510	0.553	0.596
05	Tobacco Growing	-0.507	-0.391	-0.270
06	Oilseeds	-0.513	-0.414	-0.311
08	Other Crops	-0.830	-0.713	-0.590
09	Livestock	-0.072	0.008	0.090

10	Fishing	0.097	0.207	0.317
12	Mining & Quarrying	-0.178	-0.074	0.034
15	Edible Oils	-0.169	-0.150	-0.129
19	Fish & Preparations	0.062	0.093	0.124
21	Other Food Industries	0.163	0.228	0.293
22	Beverages	-2.152	-2.174	-2.202
23	Tobacco Products	0.603	0.630	0.657
25	Cotton Yarn	-0.577	-0.529	-0.480
27	Cotton Textiles (Large Scale)	-0.404	-0.339	-0.273
28	Cotton Textiles (Small Scale)	0.130	0.174	0.219
31	Threadballs and Other Textiles	-0.387	-0.344	-0.297
32	Carpets & Rugs	0.121	0.189	0.257
33	Made-up Garments	0.160	0.201	0.242
34	Footwear (Non-rubber)	-0.057	0.010	0.076
38	Leather & Products	0.387	0.404	0.421
39	Rubber Footwear	0.138	0.223	0.308
42	Fertilizer	0.354	0.388	0.423
44	Paints & Varnishes	0.600	0.113	0.167
45	Soaps & Detergents	0.074	0.107	0.141
47	Plastic Products	0.072	0.149	0.228
49	Cement	0.054	0.120	0.185
50	Glass & Products	-1.756	-1.598	-1.429
51	Non-metal Mineral Products	-0.002	0.045	0.094
52	Basic Metals	-0.116	-0.072	-0.024
53	Metal Products	-0.063	0.029	0.125
55	Agricultural Machinery	0.042	0.070	0.097
56	Other Non-electrical Machinery	0.076	0.127	0.178
57	Electric Machinery	-0.028	0.012	0.053
63	Sports Goods	0.072	0.116	0.160
64	Surgical Instruments	0.309	0.377	0.445
65	Other Large Scale Manufacturing	0.436	0.492	0.548

<u>ACF = 0.8</u>:

	Sector	WCF = 1.40	1.15	0.90
01	Wheat	0.176	0.233	0.291
02	Rice	0.537	0.574	0.611
03	Cotton	0.516	0.558	0.601
05	Tobacco Growing	-0.502	-0.386	-0.264
06	Oilseeds	-0.505	-0.406	-0.302
08	Other Crops	-0.823	-0.706	-0.582
09	Livestock	-0.066	0.014	0.096
10	Fishing	0.150	0.260	0.370
12	Mining & Quarrying	-0.163	-0.057	0.051
15	Edible Oils	-0.142	-0.121	-0.101
19	Fish & Preparations	0.085	0.116	0.147
21	Other Food Industries	0.190	0.255	0.321
22	Beverages	-2.091	-2.104	-2.122
23	Tobacco Products	0.625	0.652	0.679
25	Cotton Yarn	-0.533	-0.485	-0.437
27	Cotton Textiles (Large Scale)	-0.361	-0.295	-0.230
28	Cotton Textiles (Small Scale)	0.139	0.184	0.228
31	Threadballs and Other Textiles	-0.344	-0.299	-0.250
32	Carpets & Rugs	0.154	0.222	0.290
33	Made-up Garments	0.184	0.225	0.266
34	Footwear (Non-rubber)	-0.029	0.038	0.104
38	Leather & Products	0.404	0.421	0.438
39	Rubber Footwear	0.180	0.264	0.349

42	Fertilizer	0.397	0.432	0.468
44	Paints & Varnishes	0.116	0.169	0.224
45	Soaps & Detergents	0.103	0.136	0.171
47	Plastic Products	0.102	0.180	0.260
49	Cement	0.133	0.198	0.264
50	Glass & Products	-1.619	-1.455	-1.279
51	Non-metal Mineral Products	0.023	0.071	0.120
52	Basic Metals	-0.079	-0.033	0.017
53	Metal Products	-0.036	0.057	0.154
55	Agricultural Machinery	0.066	0.094	0.122
56	Other Non-electrical Machinery	0.109	0.160	0.212
57	Electric Machinery	0.002	0.043	0.084
63	Sports Goods	0.097	0.141	0.185
64	Surgical Instruments	0.333	0.401	0.469
65	Other Large Scale Manufacturing	0.468	0.524	0.580

Note: See note to Table A5.2.

Table A5.7

Imported Accounting Ratios : Case B

ACF = 1.2:

	Sector WCF =	1.40	1.15	0.90
01	Wheat	1.418	1.404	1.390
05	Tobacco Growing	0.776	0.760	0.743
06	Oilseeds	0.752	0.737	0.722
08	Other Crops	0.616	0.599	0.583
09	Livestock	1.000	0.992	0.985
12	Mining & Quarrying	0.976	0.962	0.948
15	Edible Oils	0.993	0.978	0.962
22	Beverages	0.245	0.214	0.184
31	Threadballs and Other Textiles	0.692	0.670	0.647
42	Fertilizer	1.583	1.558	1.532
44	Paints & Varnishes	0.820	0.802	0.785
45	Soaps & Detergents	1.000	0.983	0.966
47	Plastic Products	0.957	0.943	0.929
50	Glass & Products	0.415	0.401	0.387
51	Non-metal Mineral Products	1.000	0.988	0.975
52	Basic Metals	0.830	0.804	0.777
53	Metal Products	0.938	0.916	0.894
55	Agricultural Machinery	1.002	0.991	0.979
56	Other Non-electrical Machinery	0.878	0.868	0.857
57	Electric Machinery	0.851	0.842	0.832

ACF = 1.0:

	Sector WCF =	1.40	1.15	0.90
01	Wheat	1.415	1.401	1.386
05	Tobacco Growing	0.773	0.757	0.740
06	Oilseeds	0.750	0.734	0.719
08	Other Crops	0.613	0.596	0.580
09	Livestock	0.998	0.991	0.984
12	Mining & Quarrying	0.972	0.959	0.945
15	Edible Oils	0.990	0.975	0.960
22	Beverages	0.238	0.208	0.178
31	Threadballs and Other Textiles	0.688	0.666	0.643
42	Fertilizer	1.574	1.548	1.522
44	Paints & Varnishes	0.816	0.799	0.781
45	Soaps & Detergents	0.997	0.979	0.962
47	Plastic Products	0.954	0.940	0.926
50	Glass & Products	0.412	0.398	0.384
51	Non-metal Mineral Products	0.996	0.984	0.971
52	Basic Metals	0.824	0.797	0.770
53	Metal Products	0.933	0.911	0.889
55	Agricultural Machinery	0.998	0.987	0.976
56	Other Non-electrical Machinery	0.874	0.864	0.854
57	Electric Machinery	0.847	0.838	0.828

ACF = 0.8:

	Sector	WCF = 1.40	1.15	0.90
01	Wheat	1.412	1.397	1.383
05	Tobacco Growing	0.770	0.754	0.737
06	Oilseeds	0.747	0.732	0.716
08	Other Crops	0.610	0.593	0.577
09	Livestock	0.996	0.989	0.982
12	Mining & Quarrying	0.969	0.955	0.942
15	Edible Oils	0.988	0.972	0.957
22	Beverages	0.232	0.202	0.171
31	Threadballs and Other Textiles	0.684	0.661	0.639
42	Fertilizer	1.564	1.538	1.512
44	Paints & Varnishes	0.813	0.795	0.778
45	Soaps & Detergents	0.993	0.976	0.959
47	Plastic Products	0.951	0.937	0.923
50	Glass & Products	0.409	0.395	0.381
51	Non-metal Mineral Products	0.992	0.979	0.967
52	Basic Metals	0.818	0.791	0.764
53	Metal Products	0.928	0.906	0.884
55	Agricultural Machinery	0.994	0.983	0.972
56	Other Non-electrical Machinery	0.871	0.861	0.851
57	Electric Machinery	0.843	0.833	0.824

Note: See note to Table A5.2.

Table A6.1

Accounting Ratios for Various (WCF,ACF) Combinations

Commodity	1	2	3	4	5	6	7	8	9
(1) Wheat	1.416	1.402	1.388	1.413	1.399	1.386	1.411	1.397	1.383
(2) Atta (M)	1.430	1.402	1.375	1.404	1.377	1.349	1.378	1.351	1.323
(3) Rice (P)	2.510	2.510	2.510	2.510	2.510	2.510	2.510	2.510	2.510
(4) Rice (M)	2.132	2.100	2.068	2.103	2.071	2.039	2.075	2.042	2.010
(5) Sugarcane	1.170	1.054	0.937	1.158	1.042	0.925	1.147	1.030	0.914
(6) Cotton	2.420	2.420	2.420	2.420	2.420	2.420	2.420	2.420	2.420
(7) Fertilizer	1.577	1.553	1.529	1.569	1.544	1.520	1.560	1.536	1.512
(8) Sugar (M)	0.682	0.667	0.651	0.680	0.664	0.648	0.677	0.661	0.645
(9) Pulses	1.090	1.031	0.971	1.077	1.017	0.958	1.064	1.004	0.944
(10) Maize	0.614	0.598	0.582	0.612	0.595	0.579	0.609	0.593	0.576
(11) Meat	1.004	0.997	0.991	1.002	0.996	0.989	1.001	0.995	0.988
(12) Milk	0.998	0.991	0.985	0.997	0.990	0.983	0.996	0.989	0.982
(13) Veg.,Fruit & Spices	0.614	0.598	0.582	0.612	0.595	0.579	0.609	0.593	0.576
(14) Edible Oils	0.985	0.970	0.955	0.982	0.967	0.952	0.980	0.965	0.950
(15) Tea	0.965	0.959	0.952	0.964	0.957	0.951	0.963	0.956	0.950
(16) Housing,Fuel& LIght	1.109	1.024	0.939	1.071	0.986	0.901	1.034	0.949	0.864
(17) Clothing	1.273	1.266	1.258	1.268	1.260	1.252	1.262	1.254	1.247
(18) Other Foods	1.007	0.977	0.947	1.002	0.972	0.942	0.997	0.967	0.937
(19) Other Non-Foods	1.020	0.925	0.829	0.990	0.895	0.799	0.960	0.865	0.769
(20) Labour	1.400	1.150	0.900	1.400	1.150	0.900	1.400	1.150	0.900
(21) Capital	1.200	1.200	1.200	1.000	1.000	1.000	0.800	0.800	0.800

Note: Column numbers 1-9 correspond to (WCF,ACF) combinations given by rows 20-21.
Source: Chapter 5.

Table A6.2

Income Distribution and Welfare Weights

(a) Actual Prices:

Income Group (Annual per capita)	No. of Households	% of Total	Cuml. %	Average Expenditure	B
(1) Less than 700	54	5.5	5.5	572.33	1.00
(2) 700 to 900	76	7.7	13.2	816.50	0.70
(3) 900 to 1100	88	8.9	22.1	1004.48	0.57
(4) 1100 to 1400	156	15.8	37.9	1243.99	0.46
(5) 1400 to 2000	250	25.3	63.2	1688.18	0.34
(6) 2000 to 2600	146	14.8	78.0	2273.76	0.25
(7) 2600 to 3200	87	8.8	86.8	2865.61	0.20
(8) 3200 to 4000	60	6.1	92.9	3603.73	0.16
(9) 4000 to 5200	40	4.1	97.0	4529.49	0.13
(10) Over 5200	30	3.0	100.0	8201.34	0.07

(b) Corrected Prices:

Income Group (Annual per capita)	No. of Households	% of Total	Cuml. %	Average Expenditure	B
(1) Less than 700	51	5.2	5.2	572.33	1.00
(2) 700 to 900	65	6.6	11.8	807.21	0.71
(3) 900 to 1100	94	9.5	21.3	1000.98	0.57
(4) 1100 to 1400	152	15.4	36.7	1242.72	0.46
(5) 1400 to 2000	256	25.9	62.6	1685.83	0.34
(6) 2000 to 2600	148	15.0	77.6	2273.07	0.25
(7) 2600 to 3200	86	8.7	86.3	2861.68	0.20
(8) 3200 to 4000	66	6.7	93.0	3605.26	0.16
(9) 4000 to 5200	39	4.0	97.0	4558.09	0.12
(10) Over 5200	30	3.0	100.0	8277.55	0.07

Source: Government of Pakistan (1979).

Table A6.3a

Net Trade Elasticities

	Wheat	Atta(M)	Atta(R)	Rice	S'cane	Cotton	Fert'r	Sugar(M)	Sugar(R)	Pulses
Wheat	2.350	0.000	0.000	0.224	-0.015	-0.421	-1.364	0.013	0.007	0.010
Atta(M)	0.000	-0.277	-0.012	-0.005	0.000	0.000	0.000	-0.008	-0.009	-0.004
Rice(P)	0.641	0.000	0.000	1.920	0.000	-0.462	-1.702	0.000	0.000	0.000
Rice(M)	-0.005	-0.019	-0.012	-0.768	0.011	0.029	-0.028	-0.009	-0.003	-0.011
S'cane	-0.090	0.000	0.000	-0.129	4.383	-0.652	-1.742	0.000	0.000	0.026
Cotton	0.000	0.000	0.000	-0.616	0.000	1.339	-0.722	0.000	0.000	0.000
Fert'r	0.640	0.000	0.000	0.350	0.200	0.370	-1.239	0.000	0.000	0.000
Sugar(M)	-0.053	-0.012	-0.006	0.017	0.014	0.015	-0.043	-0.549	-0.009	-0.008
Pulses	-0.010	-0.008	-0.004	0.009	0.007	0.015	-0.023	-0.006	-0.007	-0.398
Maize	-0.010	-0.008	-0.004	0.009	0.007	0.015	-0.023	-0.006	-0.007	-0.006
Meat	-0.029	-0.040	-0.019	-0.007	0.021	0.042	-0.065	-0.031	-0.033	-0.019
Milk	-0.021	-0.025	-0.012	0.016	0.015	0.030	-0.047	-0.015	-0.017	-0.012
Vetget.	-0.026	-0.029	-0.014	0.020	0.018	0.037	-0.057	-0.022	-0.025	-0.015
EdOil	-0.017	-0.026	-0.013	0.013	0.012	0.026	-0.038	-0.016	-0.018	-0.011
Tea	-0.010	-0.022	-0.011	0.005	0.007	0.014	-0.022	-0.013	-0.014	-0.008
Housing	-0.024	-0.027	-0.017	0.018	0.016	0.034	-0.053	-0.024	-0.026	-0.014
Clothing	-0.019	-0.025	-0.012	0.014	0.013	0.027	-0.042	-0.017	-0.019	-0.007
Oth.Food	-0.015	-0.027	-0.013	0.009	0.010	0.022	-0.033	-0.014	-0.015	-0.011
Oth. NF	-0.032	-0.038	-0.021	0.025	0.023	0.046	-0.072	-0.030	-0.033	-0.019
Labour	-0.258	0.000	0.000	-0.147	-0.169	-0.219	0.114	0.000	0.000	0.000

Table A6.3a continued:

	Maize	Meat	Milk	Veget	EdOil	Tea	Housing	Clothing	OthFd	OthNF
Wheat	0.010	-0.008	0.012	-0.008	0.018	0.008	-0.001	0.024	0.020	-0.044
Atta(M)	-0.004	0.003	-0.010	-0.005	-0.006	-0.002	-0.004	-0.009	-0.002	0.006
Rice(P)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Rice(M)	-0.011	0.009	-0.018	-0.001	-0.017	-0.007	-0.004	-0.023	-0.012	0.029
S'cane	0.026	-0.023	0.026	-0.021	0.042	0.023	-0.002	0.054	0.047	-0.100
Cotton	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fert'r	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sugar(M)	-0.008	0.006	-0.014	-0.001	-0.012	-0.005	-0.003	-0.017	-0.009	0.021
Pulses	-0.006	0.004	-0.008	0.000	-0.008	-0.003	-0.002	-0.011	-0.006	0.015
Maize	-0.398	0.004	-0.008	0.000	-0.008	-0.003	-0.002	-0.011	-0.006	0.015
Meat	-0.019	-1.123	-0.040	-0.012	-0.029	-0.011	-0.012	-0.043	-0.015	0.041
Milk	-0.012	0.010	-0.857	-0.001	-0.019	-0.008	-0.005	-0.027	-0.014	0.034
Veget.	-0.015	0.012	-0.030	-0.955	-0.023	-0.009	-0.008	-0.033	-0.013	0.034
EdOil	-0.011	0.010	-0.022	-0.004	-0.788	-0.007	-0.009	-0.025	-0.011	0.028
Tea	-0.008	0.006	-0.018	-0.005	-0.013	-0.569	-0.005	-0.019	-0.007	0.018
Housing	-0.014	0.011	-0.031	-0.011	-0.021	-0.007	-0.882	-0.031	-0.009	0.027
Clothing	-0.007	0.010	-0.023	-0.004	-0.019	-0.007	-0.006	-0.797	-0.018	0.029
Oth. Fd.	-0.011	0.009	-0.019	-0.002	-0.017	-0.007	-0.005	-0.023	-0.745	0.028
Oth. NF	-0.019	0.015	-0.039	-0.010	-0.030	-0.011	-0.012	-0.043	-0.017	-1.161
Labour	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Note: These elasticities were calculated using demand elasticities from Ahmad and Ludlow (1987).

Table A6.3b

Net Trade Elasticities

	Wheat	Atta(M)	Atta(R)	Rice	S'cane	Cotton	Fert'r	Sugr(M)	Sugr(R)	Meat	Milk	Edoils	OthFd	OthNF
Wheat	2.740	0.000	0.000	0.001	-0.153	-0.426	-1.359	-0.086	0.008	0.180	-0.240	-0.180	-0.030	0.240
Atta(M)	0.000	-0.690	-0.015	0.220	0.000	0.000	0.000	-0.020	-0.012	-0.100	-0.030	0.050	0.130	0.040
Rice(P)	0.641	0.000	0.000	1.920	0.000	-0.462	-1.702	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Rice(M)	0.366	0.427	-0.012	-1.650	0.054	0.019	-0.019	0.084	-0.008	0.290	-0.270	0.300	-0.200	-0.030
S'cane	-0.559	0.000	0.000	-0.830	4.152	-0.627	-1.767	0.000	0.000	-0.419	-0.233	1.020	-0.233	2.959
Cotton	0.000	0.000	0.000	-0.616	0.000	1.339	-0.722	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fert'r	0.640	0.000	0.000	0.350	0.200	0.370	-1.239	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sugar(M)	0.099	-0.031	-0.008	0.252	0.012	0.013	-0.037	-0.420	-0.015	0.015	0.035	-0.275	-0.155	-0.280
Meat	-0.082	-0.097	-0.012	0.142	0.033	0.031	-0.047	0.020	-0.020	-0.465	0.050	0.050	0.085	-0.700
Milk	0.039	-0.035	-0.013	-0.029	0.016	0.029	-0.045	-0.005	-0.020	0.040	-1.000	0.010	-0.005	0.035
EdOils	0.122	0.044	-0.006	0.149	-0.032	0.012	-0.018	-0.180	-0.009	0.070	0.105	-1.555	0.000	0.785
OthFd	0.017	0.044	-0.008	-0.016	0.012	0.017	-0.026	-0.045	-0.012	0.040	0.040	-0.015	-0.370	-0.245
OthNF	-0.034	-0.026	-0.008	0.010	-0.003	0.017	-0.026	-0.035	-0.012	-0.060	-0.015	-0.025	-0.110	-0.825
Labour	-0.258	0.000	0.000	-0.147	-0.169	-0.219	0.114	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Note: These elasticities were calculated using demand elsaticities from Deaton (1991).

Table A6.4

Lambdas and Ranks for Various (WCF,ACF) Combinations

(a) Lambdas:

Commodity WCF=	ACF=1.2 1.4	ACF=1.2 1.15	ACF=1.2 0.9	ACF=1.0 1.4	ACF=1.0 1.15	ACF=1.0 0.9	ACF=0.8 1.4	ACF=0.8 1.15	ACF=0.8 0.9
(1) Wheat	-0.278	-0.285	-0.291	-0.280	-0.286	-0.293	-0.281	-0.288	-0.295
(2) Atta (M)	0.900	0.937	0.977	0.915	0.953	0.994	0.930	0.969	1.012
(3) Atta (R)	0.993	1.020	1.049	1.002	1.029	1.058	1.010	1.038	1.067
(4) Rice	-0.225	-0.225	-0.225	-0.225	-0.226	-0.226	-0.226	-0.226	-0.227
(5) Sugarcane	0.224	0.348	0.772	0.261	0.443	1.473	0.310	0.609	16.148
(6) Cotton	0.745	0.753	0.761	0.744	0.752	0.760	0.744	0.752	0.760
(7) Fertilizer	-0.119	-0.115	-0.112	-0.118	-0.114	-0.110	-0.116	-0.113	-0.109
(8) Sugar (M)	1.216	1.263	1.313	1.228	1.276	1.327	1.241	1.289	1.342
(9) Sugar (R)	1.016	1.041	1.068	1.023	1.049	1.076	1.031	1.057	1.085
(10) Pulses	0.982	1.029	1.081	0.993	1.042	1.095	1.005	1.055	1.109
(11) Maize	1.185	1.203	1.222	1.189	1.208	1.227	1.193	1.212	1.231
(12) Meat	0.995	0.998	1.001	0.995	0.998	1.002	0.995	0.998	1.002
(13) Milk	1.005	1.023	1.042	1.010	1.028	1.047	1.015	1.033	1.052
(14) Veg.,Fruit & Spices	1.577	1.621	1.668	1.586	1.630	1.677	1.594	1.639	1.686
(15) Edible Oils	1.045	1.197	1.401	1.084	1.248	1.471	1.126	1.304	1.549
(16) Tea	1.027	1.048	1.069	1.032	1.053	1.074	1.038	1.059	1.080
(17) Housing,Fuel & Light	0.914	0.987	1.072	0.944	1.022	1.113	0.976	1.059	1.157
(18) Clothing	0.828	0.838	0.849	0.833	0.843	0.854	0.838	0.848	0.859
(19) Other Foods	0.995	1.018	1.043	0.998	1.022	1.047	1.002	1.026	1.052
(20) Other Non-foods	0.974	1.088	1.232	1.007	1.130	1.287	1.043	1.176	1.346

(b) Ranks:

Commodity		ACF=1.2			ACF=1.0			ACF=0.8		
	WCF=	1.4	1.15	0.9	1.4	1.15	0.9	1.4	1.15	0.9
(1) Wheat		3	3	3	3	3	3	3	3	3
(2) Atta (M)		7	7	7	7	7	6	7	7	7
(3) Atta (R)		11	11	11	12	12	10	12	11	10
(4) Rice		2	2	2	2	2	2	2	2	2
(5) Sugarcane		4	4	5	4	4	19	4	4	20
(6) Cotton		5	5	4	5	5	4	5	5	4
(7) Fertilizer		1	1	1	1	1	1	1	1	1
(8) Sugar (M)		19	19	18	19	19	17	19	18	16
(9) Sugar (R)		15	14	12	15	14	12	14	13	12
(10) Pulses		10	13	15	9	13	13	11	12	13
(11) Maize		18	18	16	18	17	15	18	17	15
(12) Meat		13	9	8	10	8	7	9	8	6
(13) Milk		14	12	9	14	11	8	13	10	9
(14) Veg.,Fruit & Spices		20	20	20	20	20	20	20	20	19
(15) Edible Oils		17	17	19	17	18	18	17	19	18
(16) Tea		16	15	13	16	15	11	15	14	11
(17) Housing,Fuel & Light		8	8	14	8	9	14	8	15	14
(18) Clothing		6	6	6	6	6	5	6	6	5
(19) Other Foods		12	10	10	11	10	9	10	9	8
(20) Other Non-foods		9	16	17	13	16	16	16	16	17

Note: Net labour supply responses are assumed to be zero. See note to Tables 6.4 and 6.5.

Table A6.5

Lambdas and Ranks for Various (WCF,ACF) Combinations

(a) Lambdas:

Commodity	ACF=1.2			ACF=1.0			ACF=0.8		
WCF=	1.4	1.15	0.9	1.4	1.15	0.9	1.4	1.15	0.9
(1) Wheat	-0.482	-0.340	-0.262	-0.487	-0.342	-0.264	-0.492	-0.345	-0.265
(2) Atta (M)	0.900	0.937	0.977	0.915	0.953	0.994	0.930	0.969	1.012
(3) Atta (R)	0.993	1.020	1.049	1.002	1.029	1.058	1.010	1.038	1.067
(4) Rice	-0.245	-0.232	-0.221	-0.246	-0.233	-0.221	-0.247	-0.234	-0.222
(5) Sugarcane	0.140	0.258	1.590	0.154	0.307	81.128	0.170	0.379	-1.654
(6) Cotton	0.446	0.600	0.918	0.446	0.600	0.917	0.446	0.600	0.916
(7) Fertilizer	-0.128	-0.118	-0.110	-0.126	-0.117	-0.109	-0.124	-0.115	-0.107
(8) Sugar (M)	1.216	1.263	1.313	1.228	1.276	1.327	1.241	1.289	1.342
(9) Sugar (R)	1.016	1.041	1.068	1.023	1.049	1.076	1.031	1.057	1.085
(10) Pulses	0.982	1.029	1.081	0.993	1.042	1.095	1.005	1.055	1.109
(11) Maize	1.185	1.203	1.222	1.189	1.208	1.227	1.193	1.212	1.231
(12) Meat	0.995	0.998	1.001	0.995	0.998	1.002	0.995	0.998	1.002
(13) Milk	1.005	1.023	1.042	1.010	1.028	1.047	1.015	1.033	1.052
(14) Veg.,Fruit & Spices	1.577	1.621	1.668	1.586	1.630	1.677	1.594	1.639	1.686
(15) Edible Oils	1.045	1.197	1.401	1.084	1.248	1.471	1.126	1.304	1.549
(16) Tea	1.027	1.048	1.069	1.032	1.053	1.074	1.038	1.059	1.080
(17) Housing,Fuel & Light	0.914	0.987	1.072	0.944	1.022	1.113	0.976	1.059	1.157
(18) Clothing	0.828	0.838	0.849	0.833	0.843	0.854	0.838	0.848	0.859
(19) Other Foods	0.995	1.018	1.043	0.998	1.022	1.047	1.002	1.026	1.052
(20) Other Non-foods	0.974	1.088	1.232	1.007	1.130	1.287	1.043	1.176	1.346

Ranks:

Commodity		ACF=1.2			ACF=1.0			ACF=0.8		
	WCF=	1.4	1.15	0.9	1.4	1.15	0.9	1.4	1.15	0.9
(1) Wheat		3	3	3	3	3	3	3	3	3
(2) Atta (M)		7	7	6	7	7	6	7	7	8
(3) Atta (R)		11	11	10	12	12	10	12	11	11
(4) Rice		2	2	2	2	2	2	2	2	2
(5) Sugarcane		4	4	19	4	4	20	4	4	4
(6) Cotton		5	5	5	5	5	5	5	5	6
(7) Fertilizer		1	1	1	1	1	1	1	1	1
(8) Sugar (M)		19	19	17	19	19	17	19	18	17
(9) Sugar (R)		15	14	11	15	14	12	14	13	13
(10) Pulses		10	13	14	9	13	13	11	12	14
(11) Maize		18	18	15	18	17	15	18	17	16
(12) Meat		13	9	7	10	8	7	9	8	7
(13) Milk		14	12	8	14	11	8	13	10	10
(14) Veg.,Fruit & Spices		20	20	20	20	20	19	20	20	20
(15) Edible Oils		17	17	18	17	18	18	17	19	19
(16) Tea		16	15	12	16	15	11	15	14	12
(17) Housing,Fuel & Light		8	8	13	8	9	14	8	15	15
(18) Clothing		6	6	4	6	6	4	6	6	5
(19) Other Foods		12	10	9	11	10	9	10	9	9
(20) Other Non-foods		9	16	16	13	16	16	16	16	18

Note: Net labour supply responses are not assumed to be zero. See notes to Tables 6.4 and 6.5.

Table A6.6

Lambdas for Various Values of ε

Commodity	ε=0		ε=0.5		ε=1.0		ε=2.0		ε=5.0	
	λ	R	λ	R	λ	R	λ	R	λ	R
(1) Wheat	-0.278	3	0.035	3	0.114	3	0.110	10	0.048	16
(2) Atta (M)	0.897	7	0.521	13	0.322	13	0.149	16	0.050	17
(3) Atta (R)	0.991	11	0.593	18	0.385	18	0.199	20	0.081	19
(4) Rice	-0.225	2	-0.113	2	-0.058	2	-0.016	2	0.001	2
(5) Sugarcane	0.763	5	0.400	5	0.224	5	0.083	3	0.010	3
(6) Cotton	0.676	4	0.361	4	0.215	4	0.102	7	0.044	13
(7) Fertilizer	-0.138	1	-0.072	1	-0.040	1	-0.015	1	-0.003	1
(8) Sugar (M)	1.114	18	0.589	16	0.339	15	0.141	13	0.033	11
(9) Sugar (R)	1.012	15	0.589	17	0.373	17	0.188	18	0.079	18
(10) Pulses	0.974	10	0.539	14	0.323	14	0.144	15	0.045	14
(11) Maize	1.182	19	0.659	19	0.400	19	0.194	19	0.097	20
(12) Meat	0.995	12	0.498	9	0.272	10	0.102	8	0.021	6
(13) Milk	1.001	14	0.517	11	0.289	11	0.111	11	0.024	8
(14) Veg.,Fruit & Spices	1.575	20	0.815	20	0.459	20	0.183	17	0.047	15
(15) Edible Oils	1.001	13	0.517	12	0.290	12	0.113	12	0.026	9
(16) Tea	1.097	17	0.586	15	0.340	16	0.143	14	0.037	12
(17) Housing,Fuel & Light	0.905	8	0.465	7	0.261	8	0.106	9	0.031	10
(18) Clothing	0.784	6	0.411	6	0.232	6	0.092	5	0.024	7
(19) Other Foods	1.025	16	0.509	10	0.271	9	0.095	6	0.016	4
(20) Other Non-foods	0.953	9	0.469	8	0.251	7	0.091	4	0.020	5

Note: These results use an alternative set of shadow prices which assume a different method for restoring equilibrium after a price reform, i.e. for some commodities marginal changes in net demand are met through increased production instead of changing net exports. These shadow prices correspond to Case B in Chapter 5.