**The London School of Economics and Political Science**

# The macroeconomic impact of financial reforms: interactions and spillovers

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A thesis submitted to the Department of Economics of the London School of Economics and Political Science for the degree of Doctor of Philosophy, London, July 2011

# Declaration

I certify that the thesis I have presented for examination for the PhD degree of the London School of Economics and Political Science is solely my own work other than where I have clearly indicated that it is the work of others (in which case the extent of any work carried out jointly by me and any other person is clearly identified in it).



I certify that Chapter 4 of this thesis, "Thresholds in the Process of International Financial Integration", was co-authored with M. Ayhan Kose and Eswar S. Prasad. I, Ashley D. Taylor, contributed in excess of 50 percent of the work on this chapter, including the empirical analysis and writing of the text.

ASHLEY D. TAYLOR

10 JULY 2011

# Abstract

How do financial reforms affect the allocation of production within an economy and its long-run macroeconomic performance? How does the impact of financial reforms interact with the effects of other policy reforms or the influence of an economy's structural characteristics? These are the central themes of this thesis.

Chapter 2 examines how financial and trade reforms interact in determining the allocation of production within a general equilibrium heterogeneous firm trade model. While the two reforms have complementary effects on average productivity, the marginal benefits of trade liberalization for wages and household utility are reduced if much reallocative work has been done through a well-functioning financial sector. Financial reforms can spill over internationally via trade channels and greater usage of exports as collateral can enhance the benefits of trade reforms.

Chapter 3 analyzes how domestic and international financial reforms shift production across firms and sectors. Using a modified macro credit multiplier model, changes in credit constraints prompt reallocations in production as firms respond to adjustments in sectoral relative prices and interest rates. Financial reforms generally lead to higher relative investment by more productive firms and to increased aggregate productivity. Intra-sectoral reallocations smooth out the steady state comparative static effects of financial reforms. Structural features of an economy condition the impact of financial reforms. Similarly, the impact of capital account liberalization depends upon the state of domestic financial reforms.

Recent work has highlighted the potential for "threshold" levels of domestic

institutional development above which the potential growth benefits of financial openness offset the associated risks. Chapter 4 provides a wide-ranging empirical analysis of potential threshold conditions using parametric and semi-parametric methods. It finds that there are clearly identifiable thresholds in variables such as financial depth and institutional quality and that the thresholds are lower for foreign direct investment and portfolio equity liabilities compared to those for debt liabilities.

# Acknowledgements

I would like to thank my advisor, Gianluca Benigno, for all his help, guidance and support during my PhD studies. I would also like to thank the students and faculty members of the LSE Macro group for providing a stimulating research environment and the Financial Markets Group research centre, and David Webb and Charles Goodhart in particular, for their hospitality over the years and for providing such an enjoyable place to study. My visit to the IMF to work with Eswar Prasad and Ayhan Kose provided a major boost to my studies and I thank them for all their help and encouragement. I am also very grateful for financial support from the LSE Economics Department and the Economic and Social Research Council (ESRC).

At LSE I was lucky enough to study alongside Christian Fons-Rosen, Ander Perez and Miguel Segoviano. Thanks to Rosanna Chan for her comments and encouragement. I also thank other friends who did not remind me too much of their prior warnings about the long journey this would prove to be. To Sherv I must return your LaTex guide about five years too late. Thanks to my mum, dad and sister Sophie who have always provided such love, support and have not questioned, too often, when it would all be done. Finally, and most importantly, this thesis is dedicated to Louise without whose love, patience and encouragement it would not have been written.

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# Chapter 1

# Introduction

How do financial reforms affect the allocation of production within an economy and its long-run macroeconomic performance? How do the impacts of financial reforms interact with the effects of reforms in other areas, such as in trade policy, or with an economy's structural characteristics? These are the central themes running through the empirical and theoretical analysis in this thesis.

This introduction provides an overview of the issues analyzed in the following three chapters and highlights the interlinkages, and differences, in their motivation and approaches. The final chapter summarizes the main results of the thesis and outlines the potential implications for future work.

The core themes of this thesis are motivated by the insights of the macro and micro empirical literatures on the impact of financial reforms, both domestic and international, on productivity and growth.[1] The theoretical analysis of Chapter 2 and Chapter 3 concerns both the reallocative impacts of financial reforms and their interaction with other reforms or institutional features. In particular, Chapter 2, *Trade and financial sector reforms: interactions and spillovers*, asks how the general equilibrium effects of domestic financial sector and trade reforms interact in

[1] See, for example, the surveys of Levine (2005), Henry (2007) and Kose et al. (2009), and the analysis of the impacts of financial sector reforms on allocative efficiency in Wurgler (2000), Galindo et al. (2007) and Abiad et al. (2008).

influencing aggregate productivity, wages and utility. Chapter 3, *Financial reforms and the reallocation of production: looking across firms and sectors*, switches attention to how the interaction between domestic and international financial sector reforms influences the allocation of production within an economy. Focusing on the second theme, Chapter 4, *Thresholds in the process of international financial integration*, turns to an empirical investigation of the macroeconomic relationship between financial openness and growth and how it is affected by certain "threshold", or conditioning, variables or policies such as domestic financial depth and institutional development.[2] Figure 1.1 provides an overview and comparison of the focus and type of analysis employed in the different Chapters, including the nature of the financial reforms and the interaction variables which are examined.

In terms of the similarities across the theoretical models employed in Chapters 2 and 3, both are modifications of workhorse models in the trade and macro credit multiplier literatures, respectively, in which there are credit-constrained heterogeneous entrepreneurs who produce intermediate goods. In Chapter 2, this involves the introduction of domestic credit constraints into a stripped-down version of Melitz (2003) in which there is a continuum of entrepreneurial productivities. Chapter 3 builds on the macro credit multiplier model of Kiyotaki (1998) which features only high and low productivity entrepreneurs but, since the focus is also on the impact of reforms on inter-sectoral reallocations, the model is extended to two sectors.

In both these theoretical models the focus is on the general equilibrium impact of financial reforms as modeled as a relaxation in credit constraints, i.e. firms can borrow more against their future revenues. While this approach has the advantage of simplicity, as it provides a clear link between borrowing and investment decisions for producers, it is, of course, a relatively narrow dimension of financial reform.

[2] A shortened version of this Chapter was published as Kose et al. (2011) in the *Journal of International Money and Finance*, February, 2011.

**Figure 1.1:** The themes and approaches of the different chapters

| | Macro impact of interest | Type of analysis | Financial reform | Interaction effects |
|---|---|---|---|---|
| **Chapter 2** *Trade and financial sector reforms: interactions and spillovers* | **Aggregate productivity, wages and utility** | **Theoretical**<br>• heterogeneous firm trade model | **Domestic**<br>• relaxation of borrowing constraints | **Between domestic financial reforms and trade liberalization** |
| **Chapter 3** *Financial reforms and the reallocation of production: looking across firms and sectors* | **Aggregate productivity** | **Theoretical**<br>• two-sector heterogeneous entrepreneur credit multiplier macro model | **Domestic and international**<br>• relaxation of borrowing constraints | **Between domestic and international financial reforms** |
| **Chapter 4** *Thresholds in the process of international financial integration* | **GDP growth** | **Empirical**<br>• cross-country panel data analysis | **International financial integration**<br>• level of de facto international capital stocks and flows | **Between international financial integration and a range of institutional factors and policies**<br>• domestic financial depth, trade openness, institutional quality, etc. |

For example, it does not capture a range of features of financial reform which have been highlighted by the recent global financial crisis, such as the introduction of new savings, borrowing or risk-sharing products or the implementation of improvements in supervisory and regulatory structures and procedures.

Nevertheless, using a simple credit multiplier set-up allows a number of empirically motivated modifications to be made in the models of Chapters 2 and 3 to address their respective research questions. Drawing on the empirical literature on the impact of financial frictions on trade, such as Manova (2006) at the sectoral level and Greenaway et al. (2007) at the firm level, Chapter 2 allows the extent to which a firm may borrow against export revenues to differ relative to that for domestic revenues. This may reflect additional organizational or informational problems in recovering export revenues or institutional features, such as requirements to repatriate export revenues. Chapter 3 also allows for a variation in domestic credit multiplies but across intermediate goods sectors, as suggested by empirical evidence on sectoral differences in financing obstacles. Furthermore, while Chapter 3 abstracts from international trade it does allow for international borrowing. Following Aoki et al. (2010), an additional international borrowing constraint is introduced whereby foreign creditors can recover less than domestic creditors in the event of default by the borrower. This differentiation can be thought to reflect greater informational costs or legal restrictions for foreign creditors.

The empirical analysis in Chapter 4 continues with the theme of the macro interactions between the impacts of financial reforms and other policy variables. It builds on the framework proposed in a survey by Kose et al. (2009) that highlights not only the potential indirect benefits of financial integration for growth, for example, via incentives for greater macroeconomic policy discipline or domestic financial market development, but also the scope for certain "threshold" levels of financial and institutional development below which an economy is unlikely to gain the full indirect benefits of international financial integration and to reduce the risks. Indeed,

the global financial crisis has added further fuel to the debate about the merits of financial globalization and the potential trade-offs between its benefits and risks to growth, especially for developing countries. Using panel data for 84 countries over the period 1975-2004, this Chapter provides an in-depth investigation into such potential threshold effects using a range of empirical approaches, both parametric and semi-parametric. Employing a common empirical approach, the analysis examines a host of measures of financial openness, including different types of capital flow, and also looks across a range of potential threshold variables, from domestic financial development through to trade openness and institutional quality. Such cross-country growth regressions have well-known limitations, for example, due to omitted variables and sensitivity to outliers. However, as a first step, they can still be useful in helping to further understanding and to provide useful policy messages related to the potential for threshold conditions in the relationship between financial integration and growth.

# Chapter 2

# Trade and financial sector reforms: interactions and spillovers

## 2.1 Introduction

The efficient allocation of production across firms matters for aggregate total factor productivity (TFP). Distortions which shift resources from more to less productive firms can have a sizeable impact on TFP and hence on average output per worker and welfare. For example, it is estimated that removing such resource misallocations could increase TFP in China by 25-40% and in India by 50-60% (Hsieh and Klenow, 2009).[1] Improvements of such magnitudes are equivalent to substantial reductions in the relative productivity gaps compared to the US, moving relative TFP in both countries from around 40% to 60% of the US level (based on the 2004 aggregate TFP estimates of Jorgenson and Vu, 2007). Many of the wide-ranging structural reforms across developing and transition economies in recent decades have been focused on reducing distortions to the allocation of production. Although

[1]These estimates are derived from a movement to 'US efficiency' based on the distribution of marginal products of capital for plants within sectors. In turn, in a model calibrated to US data, Restuccia and Rogerson (2008) find similar order aggregate TFP effects of distortions to prices faced by individual plants.

reforms to trade and domestic financial sectors are often both key elements of such policy packages, the respective related empirical and theoretical literatures have generally abstracted from the potentially important reallocative effects of contemporaneous reforms in the other sector. Thus, a fundamental policy question of how reforms interact in terms of their impact on aggregate productivity, wages and welfare cannot be addressed.

The objective of this Chapter is to develop a theoretical framework to analyze this issue through adding financial constraints to a two-country (non-symmetric) heterogeneous firm trade model. In order to do so I add a number of novel, empirically relevant, features to a baseline heterogeneous firm trade model adapted from Melitz (2003). The first is to consider intermediate production as owned and operated by heterogeneous entrepreneurs whose borrowing is subject to credit constraints due to agency problems. The second is to allow these agency problems to vary with the composition of the entrepreneur's production between domestic output and exports. This introduces a two-way linkage between a firm's export decision and its financial constraints as suggested by firm-level survey data. I then examine the steady state general equilibrium interactions of the reallocative impacts of trade and domestic financial sector reforms (considered as reductions in variable trade costs and relaxations in credit constraints respectively).

The interaction effects between trade reforms and domestic financial sector reforms appear qualitatively important. On the one hand, trade and domestic financial sector reforms can have complementary effects in increasing the average productivity and size of producing entrepreneurs. If entrepreneurs face less restrictive credit constraints as a result of financial sector reforms then investment can increase more in response to a lowering of variable export costs. With fixed factor supplies, a greater reallocation from low to high productivity entrepreneurs is thus required in order to maintain factor market equilibrium. As a result, the positive effects of trade liberalization on average productivity and producer size are enhanced if domestic

financial sector reforms are more advanced. On the other hand, in such a case the marginal gains for wages and household utility as a result of trade liberalization are reduced. If credit constraints are less restrictive then effective borrowing costs are lower, intermediate prices are reduced and real wages are higher. Thus, the marginal benefits of trade liberalization in lowering prices and increasing real wages are reduced if much reallocative work has already been done through a well-functioning domestic financial sector. In terms of the potential linkage between exports and credit constraints, improvements in the relative ability to pledge exports to creditors amplify the benefits of trade liberalization. A further insight of the Chapter is that even in financial autarky the financial development of not just the domestic economy but also its trading partner can play a role in determining the real wages and the efficiency of domestic production. In particular, domestic financial sector reforms in one economy can be exported via the trade channel putting downward pressure on foreign real wages.

The value added of the approach adopted below is to provide a framework which allows analysis of the macroeconomic implications of reforms in one area, for example the domestic financial sector, conditional on other policy variables, for example the degree of access to international goods markets. Using this modeling approach to assess whether the interactions between these different reform measures have quantitatively important empirical effects is an important next step. In the rest of the Chapter, Section 2.2 first discusses the motivation and related literature. Section 2.3 then provides an overview of the modeling approach focusing on the credit constraints that entrepreneurs face. Section 2.4 provides details of the model with Section 2.5 analyzing the steady state in trade and financial autarky to emphasize the key mechanisms in the model. Section 2.6 then opens up the economies to international goods trade. Section 2.7 concludes including a discussion of further research and empirical implications.

## 2.2 Motivation and related literature

### 2.2.1 Motivation

The modeling approach which I adopt is driven by two main features: first, the importance of addressing firm heterogeneity in any analysis of trade and domestic financial sector reforms and, second, the importance of analyzing the interactions of these two types of reforms. As surveyed in, for example, Bernard et al. (2007a), recent heterogeneous firm models of international trade are motivated by the observation that exporters tend to differ from non-exporters in important ways, for example being larger and more productive. Surveys indicate that only a limited subset of plants export, for example around 20% in the 1991 US Census of Manufactures (Bernard et al., 2003). There is also empirical support for the self-selection of higher productivity firms into exporting rather than a causality running from exporting to higher productivity, eg Clerides et al. (1998). At the same time, financial constraints vary across firms and recent firm-level data suggests that the degree of financial constraints faced by firms depends on their export status. For example, using Spanish data Campa and Shaver (2002) find exporters to be less liquidity constrained whilst for UK data Greenaway et al. (2007) show that being an exporter improves a firm's liquidity and lowers its leverage.[2] This linkage from export status to a firm's financial constraints is in addition to the growing empirical evidence on the effects of financial constraints on export levels and patterns.[3] Indeed, the analysis of Greenaway et al. (2007) suggests that the stronger financial health of exporters can be seen as 'an outcome rather than a determinant of entry' into exporting.

The importance of analyzing the interaction of trade and domestic financial sector reforms can be illustrated by observed patterns of policy indicators or by the joint

[2] Also, using World Bank survey data from developing and emerging economies Beck et al. (2006b) find that the problem of bank corruption as a constraint to finance is less of a problem for exporters.

[3] See, for example, the sector-level analysis in Manova (2006).

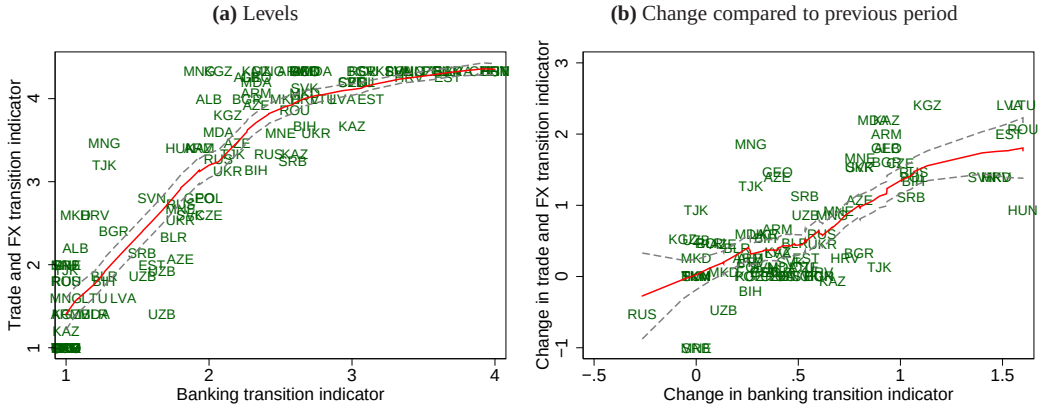
presence of both reforms in many of the policy packages implemented by developing and emerging economies.[4] As an example of the association between the two reforms, Figure 2.1 plots five-year averages for the trade and banking sector transition indicators for Central and Eastern European countries compiled by the European Bank for Reconstruction and Development (EBRD).[5] As expected, the levels of the two policy indicators are positively associated - the second panel highlights the often contemporaneous progress on both trade and financial sector reforms.[6] In addition, reforms in one sector can take place at a range of initial values for policies in the other sector. Indeed, based on a new IMF dataset of de jure reform indicators covering a wider sample of 91 countries over the period 1973-2005, Hauner and Prati (2008) find that trade reforms tend to lead domestic financial reforms. Thus, analysis of trade reforms assuming perfect credit markets would appear to be often inappropriate. Whilst summary indicators of policy stance are clearly not perfect, for example due to the lack of information on enforcement or their aggregate nature, the above patterns serve to highlight the empirical importance of analyzing the potential trade-offs and complementarities in the effects of trade and financial sector reforms. Such analysis can provide insights into the appropriate design of reform packages in individual countries and can also shed light on the political economy implications of different combinations of reforms.

[4]See, for example, the chronology provided by Henry (2000) of reforms across 12 major emerging markets in the 1980s and early 1990s or the analysis of IMF programme conditionalities provided in IMF (2001).

[5]The transition indicators represent an assessment of a country's policies and institutions in each area against specific criteria with scores assigned from 1 to 4.33 such that higher values indicate improvements in the policy areas towards the levels in advanced economies. Appendix 2.A provides further details on the transition indicators and the sample coverage.

[6]As shown in Appendix Figure 2.12, similar associations are present when controlling for country and period fixed effects.

**Figure 2.1:** EBRD transition indicators, 5 year averages: levels and changes




Note: Values of the transition indicators range from 1 to 4.33 with higher values representing standards moving towards those of advanced industrial economies. Averages taken over 1989-1993, 1994-1998, 1999-2003 and 2004-2007 (four year average). Lines represent lowess smoother (locally weighted regression) with 95% confidence intervals.

### 2.2.2 Related literature

This work is related to three main strands of literature. The first concerns the reallocative effects of trade reforms in the presence of heterogeneous productivity firms as analyzed in a growing theoretical literature (see, for example, the theoretical models of Melitz, 2003; Baldwin and Forslid, 2006). In such models trade liberalization increases investment and the demand for labor. With a fixed labor supply this leads to a rise in the minimum productivity of producers, shifts production towards higher productivity firms and results in an increase in average productivity. This reallocative process is supported in empirical studies such as Bernard et al. (2006) in relation to the US, Pavcnik (2002) for Chile and Fernandes (2007) for Colombia.

The second strand of related literature concerns the reallocative effects of financial sector reforms. Theoretical models, such as Almeida and Wolfenzon (2005) and Caselli and Gennaioli (2006), illustrate how domestic financial development (for example, contract enforcement or investor protection) can promote aggregate productivity through reallocating resources to more productive firms.[7] From an

[7] Also, in the context of international financial sector reforms, Aoki et al. (2010) emphasize that

empirical perspective the beneficial impacts of financial sector reforms on allocative efficiency are supported in studies such as Wurgler (2000), Galindo et al. (2007) and Abiad et al. (2008). For example, the latter paper finds domestic financial sector liberalization to be associated with an improvement in the efficiency of the allocation of production (indicated by a fall in the dispersion of Tobin's q) in a sample of emerging economies.[8]

The third strand of related literature concerns the impact of financial frictions on trade. This work builds on the analysis of Kletzer and Bardhan (1987) which provides one of the earliest theoretical papers to emphasize the impact of financial institutions on patterns of comparative advantage. Subsequent empirical papers, most recently using sector-level data, such as Beck (2003), Hur et al. (2006) and Manova (2006), support the view that financial frictions are an important determinant of trade flows. As the trade literature has moved towards heterogeneous firm models such as Melitz (2003) so a number of recent papers have used such frameworks to analyze the role of financial frictions in determining export patterns, for example Chaney (2005), Manova (2006) and Suwantaradon (2008).[9] Chor et al. (2008) extend this approach to consider how financial frictions in host economies affect exporting and foreign direct investment patterns within a three-country model. Whilst based on a similar broad modeling framework, this paper differs from these related papers in a number of important features. First, the focus here is on the general equilibrium macroeconomic effects of the interaction of trade and financial reforms rather than solely the role of financial frictions in determining selection decisions into exporting or foreign direct investment.[10] Second, in line with the empirical evi-

the impact of capital account liberalization in shifting production across high and low productivity entrepreneurs is dependent on the development of the domestic financial sector.

[8]Abiad et al. (2008) also find that trade openness improves the allocation of production across firms but the issue of the interaction of the two reforms is not addressed.

[9]Suwantaradon (2008) highlights how financial frictions lead to selection into exporting and production based on both a firm's net worth and productivity, compared to solely productivity in the standard Melitz set-up.

[10]Related work by Hsu (2006) also examines the productivity effects of trade liberalization in the presence of financial frictions but with symmetric economies and within a different modeling

dence, I allow for two-way interactions between exporting and financial constraints (i.e. exporting decisions play a role in the credit constraints which in turn influences the decision whether to export). Third, I solve for a non-symmetric rather than symmetric equilibrium to allow for the more realistic and policy-relevant case where the level of financial development and trade costs may vary across countries.[11]

## 2.3 Overview of modeling approach

There are two economies in the model, home and foreign, who may trade intermediate goods. The primary feature of the model is the set of heterogenous entrepreneurs in each economy which produce, with varying productivity, intermediate goods using labor inputs.[12] As in the standard set-up of Melitz (2003), depending on her productivity an entrepreneur may choose to produce output for the domestic market or to pay additional costs to access also export markets. However, as the entrepreneur's investment is subject to financial constraints, her production decisions link domestic financial conditions and international trade.

In order to capture the effects of financial frictions on the productive sector I consider intermediate producers as entrepreneurs who maximize their own utility and operate and own their own projects. For simplicity, as in Chaney (2008), I abstract from entry and exit decisions which can be analyzed within the standard Melitz model through the assumption of perfect competition in the productive sector and a fixed cost of entry. Agency problems, such as inalienability of human capital or ex post moral hazard etc., limit a firm's access to finance. The extent of these borrowing constraints may differ with a creditor's nationality. This may be due to

framework based on the transfer of ownership across dynasties.

[11] The three-economy model of Chor et al. (2008) also solves for a non-symmetric equilibrium where two countries in the North are identical whilst the South country is subject to financial frictions. However, in this model Southern producers are restricted to domestic output only and financial frictions only affect fixed costs of production.

[12] It is straightforward to extend the approach to encompass capital or other factor inputs but for simplicity I focus on the labor input case.

different legal systems or different informational and transaction costs. The degree of borrowing constraints may also vary with the type of pledgeable output, namely output for domestic or export markets. This might reflect the differential ability of lenders to recover export output or to monitor exporting activities relative to domestic output or activities respectively.

Agents in each country can access domestic credit markets consisting of one-period risk-free debt contracts (with the underlying contracting problem assumed to yield zero default in equilibrium). Borrowing of one unit of the home consumption good from home creditors at time $t$ requires a gross repayment of $R_{t+1}$ units of the time $t+1$ home consumption good. Similarly, borrowing a unit of time $t$ foreign consumption from foreign creditors requires a gross repayment of $R_{*,t+1}$ of the time $t+1$ foreign consumption good. I now turn to the form of the borrowing constraints.

### 2.3.1 Domestic borrowing constraint

Domestic creditors face costs relative to the entrepreneur in recovering output which has been pledged to them. This may be due to the inalienability of human capital as emphasized in Hart and Moore (1994) or could reflect costs (in terms of output) of recovery when there is ex post moral hazard such as in Aghion et al. (1999) or costs of expropriation in the case of ex ante moral hazard. As in, for example, Kiyotaki (1998) and Aoki et al. (2010), these financial frictions restrict an entrepreneur's borrowing so that debt repayments do not exceed the value to the creditor of pledged output.[13] Creditor recovery costs may differ with the creditor's nationality and the type of pledged receivables:

**Assumption 1** *Creditors in the home economy can recover a fraction* $0 < \theta \leq 1$

[13]Extending the model to add tangible assets, for example, capital or land, to the production function would provide an additional form of collateral that could be pledged to creditors. The creditor's recovery rates on these assets would then affect the optimal ratio of factor inputs. However, if creditors were unable to recover pledged output and could only recover pledged capital or land then financial constraints would only affect relative export to domestic prices if domestic and exporting activities had different production functions.

*of the domestic intermediate output which has been pledged to them by a home entrepreneur. The corresponding fraction for domestic intermediate output pledged by foreign entrepreneurs to foreign creditors is* $0 < \theta^* \leq 1$.

The differential ability of home and foreign lenders to recover domestic outputs pledged by entrepreneurs in their respective economies can be thought to represent both the legal or judicial features of the economy and efficiency of the respective financial systems.

**Assumption 2** *The recovery rate on export output pledged to a domestic creditor is a fraction* $\mu$ *times the recovery rate on domestic output in home and* $\mu^*$ *in foreign with* $\mu\theta \leq 1$ *and* $\mu^*\theta^* \leq 1$.

Assumption 2 is motivated by the firm-level empirical evidence from emerging and developing economies of the linkage between exporting and credit constraints.[14] On the one hand any additional organizational or informational problems in recovering exports may reduce the relative ability of a creditor to recover exports compared to domestic output. On the other hand, certain institutional features, such as requirements to repatriate export revenues, could work in the opposite direction increasing the relative recovery rate on exports. Thus I allow $\mu$ to take values greater than or less than one subject to the restriction that the export recovery rate $\theta\mu$ is bounded in the unit interval (and similarly for $\theta^*\mu^*$).

The creditor will only lend an amount such that gross repayments are less than or equal to the recovery value of output pledged to them. Thus the domestic credit constraint for a home entrepreneur indexed by $\varphi$ can be expressed as:

$$R_{t+1}b_{t+1}(\varphi) \leq rev_{d,t+1}(\theta y_{d,t+1}(\varphi)) + rev_{x,t+1}(\mu\theta y_{x,t+1}(\varphi)) \qquad (2.1)$$

[14]The requirement to pay the additional fixed exporting cost could also, in a situation of hidden information over entrepreneurial productivity, act as a signalling device of higher productivity which could facilitate lending.

where $R_{t+1}b_{t+1}(\varphi)$ are gross repayments made by the entrepreneur in time $t+1$ domestic consumption goods for borrowing $b_{t+1}(\varphi)$ at time $t$. The creditor can recover a fraction $\theta$ of next period's domestic output by the entrepreneur $y_{d,t+1}(\varphi)$. This provides revenues of $rev_{d,t+1}(\theta y_{d,t+1}(\varphi))$ in units of the home consumption good. Similarly $rev_{x,t+1}(\mu\theta y_{x,t+1}(\varphi))$ represents the maximum value to the creditor, in units of the home consumption good, of the pledged export output $y_{x,t+1}(\varphi)$.[15] Thus exporting increases the potential pledgeable output to a creditor but, as detailed below, requires additional investment. In this set-up all investment is subject to the borrowing constraint. In contrast, in Chaney (2005) and Manova (2006) borrowing constraints only affect the financing of exporting costs. However, domestic production costs may also be subject to constraints and, due to the fungibility of funds, applying different constraints to the two types of costs may not be appropriate.[16]

## 2.4 Model

Each economy is populated by two sets of infinitely-lived agents, households and entrepreneurs, of mass $L$ and $M$ respectively ($L^*$ and $M^*$ in foreign).[17] Both sets of agents maximize expected utility over a final consumption good which is produced using intermediate goods. These intermediate goods are themselves produced by entrepreneurs using entrepreneurial and household labor inputs (with entrepreneurs not restricted to working on only their own projects). As mentioned above, agents are able to access domestic credit markets only. In the subsections below I first introduce the final goods and household sectors which provide the con-

[15] The subscripts $d$ and $x$ will be used throughout to denote domestic and exporting variables respectively.

[16] In Antràs and Caballero (2009) financial frictions (which apply in one sector) also apply to all production costs although the nature of revenues does not affect the credit constraint (which in their case limits total investment to a fraction of capital).

[17] Foreign variables are denoted throughout by $^*$.

text for the subsequent analysis of entrepreneurs' optimal decisions.

### 2.4.1 Final goods sector

The non-traded final consumption good in each country is produced using a constant elasticity of substitution (CES) combination of domestic and imported intermediate goods which are produced by home and foreign entrepreneurs respectively. For example, home final good production, $Y_t$ , is given by:

$$Y_t = \left[ \int_{\omega \in \Omega_{d,t}} y_{d,t}(\omega)^{\frac{\sigma-1}{\sigma}} d\omega + \int_{\omega \in \Omega^*_{x,t}} y^*_{x,t}(\omega)^{\frac{\sigma-1}{\sigma}} d\omega \right]^{\sigma/(\sigma-1)} \tag{2.2}$$

where $y_{d,t}(\omega)$ is the home final goods sector demand for an intermediate variety $\omega$ produced by a home entrepreneur; $y^*_{x,t}(\omega)$ is the demand from the home final goods sector for a variety $\omega$ produced by a foreign entrepreneur and exported to home; $\Omega_{d,t}$ denotes the set of available domestically produced intermediate goods in home at time $t$; and, $\Omega^*_{x,t}$ is the set of available intermediate goods in home which were produced by foreign entrepreneurs and exported to home. The elasticity of substitution in production between different intermediate good varieties is $\sigma > 1$. For simplicity I assume that the elasticity of substitution between individual intermediates does not vary between foreign or home intermediates.[18] A corresponding expression holds in the foreign economy with common substitution elasticities in both countries. Due to selection effects into exporting, the set of home-produced inputs available in home, $\Omega_{d,t}$, may differ from the set of home-produced intermediate inputs available in foreign, $\Omega_{x,t}$ (and similarly for the set of foreign produced intermediate inputs available in foreign and home, $\Omega^*_{d,t}$ and $\Omega^*_{x,t}$ respectively).

The final goods technology is open to all agents and takes place under perfect

[18]Relaxing this assumption does not change the results substantively if the elasticity between home and foreign produced intermediates is above unity and less than the elasticity between varieties from the same country. Similarly, I abstract from any bias in final goods production towards home-produced intermediates.

competition. Intermediate goods are purchased to maximize profits given the final consumption good price ($P_t$ at home and $P_t^*$ in foreign) and the prices of individual intermediate goods. Profit maximization yields the standard domestic and export demand schedules for each intermediate good $\omega$ produced in home:

$$\text{Domestic demand: } y_{d,t}(\omega) = \left(\frac{p_{d,t}(\omega)}{P_t}\right)^{-\sigma} Y_t \tag{2.3}$$

$$\text{Export demand: } y_{x,t}(\omega) = \left(\frac{p_{x,t}(\omega)}{P_t^*}\right)^{-\sigma} Y_t^* \tag{2.4}$$

where $p_{d,t}(\omega)$ is the domestic price of variety $\omega$ produced by the home entrepreneur with $p_{x,t}(\omega)$ the price charged for that variety when exported to the foreign country. With zero profits earned on final goods production, the aggregate price indices in home and foreign are given respectively by:

$$P_t = \left[\int_{\omega\in\Omega_{d,t}} p_{d,t}(\omega)^{1-\sigma} d\omega + \int_{\omega\in\Omega_{x,t}^*} p_{x,t}^*(\omega)^{1-\sigma} d\omega\right]^{\frac{1}{1-\sigma}} \tag{2.5}$$

$$P_t^* = \left[\int_{\omega\in\Omega_{d,t}^*} p_{d,t}^*(\omega)^{1-\sigma} d\omega + \int_{\omega\in\Omega_{x,t}} p_{x,t}(\omega)^{1-\sigma} d\omega\right]^{\frac{1}{1-\sigma}}$$

With no money in the model the real exchange rate is equal to the ratio of aggregate prices indices in the foreign and home country, $RER_t = P_t^*/P_t$.

### 2.4.2 Household sector

The representative household in each economy gains utility from consumption of the non-traded final consumption good. In each economy the household labor endowment ($L$ in home and $L^*$ in foreign) is supplied inelastically in the domestic economy and receives a per unit household real wage in terms of the respective

country consumption good ($w_t^l$ in home and $w_t^{l*}$ in foreign). Domestic borrowing by the household (denoted by $b_{t+1}^l$ for the home household ) is chosen to maximize expected utility given wage income and debt repayments. Household sector borrowing is assumed to be unconstrained. Whilst this is clearly an abstraction it greatly simplifies the analysis since the steady state interest rates are then determined from the household euler equation.

The preferences of the home household are given by:

$$U_t^l = \sum_{s=t}^{\infty} \beta^{s-t} \ln\left(c_t^l\right) \tag{2.6}$$

where $\beta$ is the household discount rate (common to home and foreign households) and $c_t^l$ is the household's consumption of the home final good at time $t$. Consumption and gross debt repayments ($R_t b_t^l$ in units of home consumption good) are funded from wage income and new borrowings giving the household sector flow of funds as:

$$c_t^l + R_t b_t^l = w_t^l L + b_{t+1}^l \tag{2.7}$$

The first order conditions with respect to domestic borrowing give standard unconstrained Euler equations (with corresponding equations for the foreign household). With log utility the household consumes a fraction $(1-\beta)$ of wealth in each period (i.e. the return on last period savings plus the discounted present value of future wage income).

### 2.4.3 Entrepreneurial sector

Similar to households, entrepreneurs maximize expected utility over consumption and supply one unit of entrepreneurial labor in each period for which they receive an entrepreneurial real wage ($w_t^e$ in home and $w_t^{e*}$ in foreign). An en-

trepreneur's labor can be supplied to any producer, i.e. it is not restricted to use in the operation of the entrepreneur's own production project.[19] However, a number of crucial characteristics distinguish entrepreneurs from households. First, they have access to an investment project by which they can produce intermediate goods for domestic and export markets. Second, entrepreneurs are heterogeneous in the productivity with which they produce intermediate goods indexed by $\varphi$. The productivity distribution is invariant, with cumulative distribution function $G(\varphi)$ and density function $g(\varphi)$. Third, as discussed in Section 2.3, entrepreneurs face credit constraints which are affected by their choice over investment projects. Finally, entrepreneurs are more impatient than households.

#### 2.4.3.1 Investment projects

In each period the entrepreneur can choose to invest in a variety of projects. First, the entrepreneur may choose not to produce and simply save through domestic savings yielding a gross rate of return of $R_t$. Second the entrepreneur can invest in the production of intermediate goods for the domestic market. Third, the entrepreneur may choose to invest in production for both the domestic and export markets (given the cost structure detailed below an entrepreneur will never produce for export markets only).

Similar to the multiple factor version of Melitz (2003) developed in Bernard et al. (2007b), intermediate goods production by home entrepreneurs requires a composite labor input of entrepreneurial and household labor which incorporates both a per period fixed cost, $f$, and a variable cost equal to $1/\varphi$ per unit of next period output. There is a one period lag in production with next period's output requiring composite labor input today, $l_t(\varphi)$:

[19] Entrepreneurial labor income is required so that those entrepreneurs who do not produce in the steady state and are constrained to zero borrowing have positive consumption levels.

$$l_t(\varphi) = \frac{y_{d,t+1}(\varphi)}{\varphi} + f \tag{2.8}$$

where $y_{d,t+1}(\varphi)$ is next period's production. The composite labor input is a constant returns-to-scale, Cobb-Douglas aggregate over household and entrepreneurial labor inputs, $l_t^l(\varphi)$ and $l_t^e(\varphi)$ respectively:

$$l_t(\varphi) = l_t^l(\varphi)^{\zeta} l_t^e(\varphi)^{1-\zeta} \tag{2.9}$$

where $0 < \zeta < 1$. Cost minimization gives a composite wage $w_t$ which represents the cost per unit of composite labor input, $w_t = \left(w_t^l/\zeta\right)^{\zeta} \left(w_t^e/(1-\zeta)\right)^{1-\zeta}$.

Producers of the final consumption good value a variety of intermediate inputs and so, given the fixed cost, each entrepreneur produces a differentiated intermediate good under monopolistic competition. If the entrepreneur wishes to export she must pay an additional fixed composite labor cost of $f_x$ per period. Exporting also incurs a variable iceberg transportation cost $\tau > 1$ per unit exported. Since the fixed cost of production $f$ is incurred whether or not the firm produces for the domestic market then the firm will always be better off producing for both the domestic and export markets than for the export market alone. In the former case an entrepreneur's total composite labor demand is given by:

$$l_t(\varphi) = \frac{y_{d,t+1}(\varphi)}{\varphi} + \frac{\tau y_{x,t+1}(\varphi)}{\varphi} + f + f_x \tag{2.10}$$

#### 2.4.3.2 Entrepreneurial equity investment

The entrepreneur's cost of composite labor investment in production projects, $w_t l_t(\varphi)$, is financed by borrowings, i.e. external funds, of $b_{t+1}(\varphi)$, and own equity investment, ie internal funds. At time $t$, the entrepreneur's equity investment is equal to her net worth entering the period, $a_t(\varphi)$, plus the entrepreneurial wage

received minus her consumption expenditure $c_t(\varphi)$. Thus the entrepreneur's flow of funds is:

$$a_t(\varphi) - c_t(\varphi) + w_t^e + b_{t+1}(\varphi) = w_t l_t(\varphi) \tag{2.11}$$

An entrepreneur's net worth entering time $t+1$, $a_{t+1}(\varphi)$, is composed of the gross returns on the equity investment made in the previous period, $a_t(\varphi) - c_t(\varphi) + w_t^e$. I define the gross rate of return on this investment realized at time $t+1$ in units of home consumption good as $F_{t+1}(\varphi)$. Thus the transition of net worth is given by:

$$a_{t+1}(\varphi) = F_{t+1}(\varphi)\left(a_t(\varphi) - c_t(\varphi) + w_t^e\right) \tag{2.12}$$

The gross return varies with the entrepreneur's investment choice. Consider the case where the entrepreneur chooses to produce for domestic and export markets. In this case, the gross return represents total real revenues from production minus gross debt repayments:

$$\begin{aligned} a_{t+1}(\varphi) = {} & y_{d,t+1}(\varphi)\,\overline{p}_{d,t+1}(\varphi) + y_{x,t+1}(\varphi)\,\overline{p}_{x,t+1}(\varphi) \\ & - R_{t+1} b_{t+1}(\varphi) \end{aligned} \tag{2.13}$$

where the relative domestic and export prices compared with the aggregate price level in the producer's country of residence are given by $\overline{p}_{d,t}(\varphi) = p_{d,t}(\varphi)/P_t$ and $\overline{p}_{x,t}(\varphi) = p_{x,t}(\varphi)/P_t$ respectively.

Given the flow of funds and the transition of net worth, the entrepreneur must choose how to allocate her net worth state variable $a_t$ between consumption $c_t(\varphi)$ and equity investment to maximize discounted utility:

$$u_t(\varphi) = \sum_{s=t}^{\infty} \delta^{s-t} \ln(c_t(\varphi)) \tag{2.14}$$

The entrepreneurial discount rate, $\delta$, is assumed common across countries with entrepreneurs assumed to be more impatient than households ie $\delta < \beta$ where $\beta$ is the household discount rate.[20] The first order condition with respect to borrowing is:

$$\frac{1}{c_t(\varphi)} = \left( \frac{\delta F_{t+1}(\varphi)}{c_{t+1}(\varphi)} \right) \tag{2.15}$$

Combined with the net worth transition equation this yields the standard results with log utility that current consumption is a fixed fraction $(1-\delta)$ of current wealth (defined as net worth plus the value of future entrepreneurial labor income discounted by gross project returns). Using the Euler equation (Equation 2.15) and net worth transition (Equation 2.12), the entrepreneur's utility maximizing investment project choice is that with the highest return $F_{t+1}(\varphi)$.

#### 2.4.3.3 Optimal investment project choice

The returns from the different investment projects are derived from the entrepreneur's optimal choices over borrowing levels and production levels. This maximization is subject to the flow of funds (Equation 2.11), the net worth transition (Equation 2.12) and definition of the gross equity investment return (Equation 2.13), domestic borrowing constraints (Equation 2.1), the demand from domestic and overseas final goods producers (Equations 2.3 and 2.4 respectively).

For the home entrepreneur, the first order condition with respect to domestic borrowing $b_{t+1}(\varphi)$ is :

[20] A lower effective discount factor for entrepreneurs can equivalently be rationalized by assuming a death probability $\pi$ such that $\delta = \pi\beta$ and that a new generation of entrepreneurs are born each period such that the total population of entrepreneurs remains constant. The assumption of a lower discount rate for entrepreneurs is widely adopted in the related literature on financial constraints to ensure that the entrepreneur can never fully self-finance her investment.

$$1/c_t(\varphi) = \left(\delta/c_{t+1}(\varphi) + \lambda_t^1(\varphi)\right) R_{t+1} \tag{2.16}$$

where $\lambda_t^1(\varphi)$ is the multiplier on the domestic borrowing constraint (with corresponding complementary slackness condition holding).

The first order conditions with respect to domestic production, $y_{d,t+1}(\varphi)$, and export production, $y_{x,t+1}(\varphi)$, give the following relative pricing conditions:[21]

$$\overline{p}_{d,t+1}(\varphi) = \frac{w_t\sigma}{\varphi(\sigma-1)} \frac{1/c_t(\varphi)}{\delta/c_{t+1}(\varphi) + \theta^{\frac{\sigma-1}{\sigma}}\lambda_t^1(\varphi)} \tag{2.17}$$

$$\frac{\overline{p}_{x,t+1}(\varphi)}{\overline{p}_{d,t+1}(\varphi)} = \tau \frac{\delta/c_{t+1}(\varphi) + \theta^{\frac{\sigma-1}{\sigma}}\lambda_t^1(\varphi)}{\delta/c_{t+1}(\varphi) + (\theta\mu)^{\frac{\sigma-1}{\sigma}}\lambda_t^1(\varphi)} \tag{2.18}$$

How do prices differ from the case with no credit constraints? First, credit constraints introduce an additional pricing wedge $v_{t+1}(\varphi) > 1$ over the standard unconstrained marginal cost plus fixed mark-up pricing rule. For example, for domestic production, the unconstrained relative price of a home entrepreneur $\overline{p}_{d,t+1}(\varphi) = \frac{w_t R_{t+1}\sigma}{\varphi(\sigma-1)}$. The additional wedge added to domestic prices due to credit constraints is increasing in the cost of finance and the extent to which the constraint binds and is decreasing with the credit multiplier:

$$v_{t+1}(\varphi) = \left(1 - R_{t+1}\left(1 - \theta^{\frac{\sigma-1}{\sigma}}\right) c_t(\varphi)\lambda_t^1(\varphi)\right)^{-1} \tag{2.19}$$

A similar additional pricing wedge applies to export prices whose value also de-

[21] In the absence of aggregate uncertainty and given the CES demand functions which the entrepreneur faces, the choice of investment in the intermediate output project is equivalent to a decision on relative prices.

pends on the relative recovery rate on export output $\mu$.

Second, compared to the case without credit constraints, export prices differ from domestic prices due not only to the variable trade costs but also the differences in their respective pricing wedges. In turn these pricing wedges depend on the different treatment of export revenues to domestic revenues by creditors.[22]

Given the above optimal decisions of the entrepreneur it is possible to define the different possible values of the gross return $F_{t+1}(\varphi)$ associated with the different investment options. Comparison of these returns yields the optimal entrepreneurial choice between no production (yielding return $F^1_{t+1}(\varphi) = R_{t+1}$); domestic only production (yielding return $F^2_{t+1}(\varphi)$), and; domestic and export production (yielding return $F^3_{t+1}(\varphi)$). Let the set of entrepreneurs in home and foreign be denoted $\Omega$ and $\Omega^*$ respectively. The set of home entrepreneurs who produce goods for domestic final goods producers, $\Omega_{d,t+1}$ (where $\Omega_{d,t+1} \subseteq \Omega$), are the subset for whom $F^2_{t+1}(\varphi) \geq F^1_{t+1}(\varphi)$ and the set who also export to foreign final goods producers, $\Omega_{x,t+1}$ (where $\Omega_{x,t+1} \subseteq \Omega_{d,t+1}$), are those for whom $F^3_{t+1}(\varphi) \geq F^2_{t+1}(\varphi) > R_{t+1}$. The investment decisions of foreign entrepreneurs can be characterized in a similar manner.

### 2.4.4 Aggregate conditions

In equilibrium, in each period market clearing conditions must hold in both economies for domestic entrepreneurial and household labor markets, credit markets, intermediate and final consumption goods markets. Funds market clearing implies that total borrowings within each economy are equal to zero ($B_{t+1} = B^*_{*,t+1} = 0$). For each intermediate good, total demand from final goods producers must equal entrepreneurial production. Final goods consumption also must equal final goods

[22] Interestingly, if export revenues confer a particularly strong financing advantage relative to domestic revenues, i.e. if $\mu$ is relatively high, then it could be the case that "dumping" occurs, i.e. export prices are below domestic prices, despite the presence of iceberg trade costs.

output in each country, ie $C_t = Y_t$ and $C_t^* = Y_t^*$ and the value of final goods output equals the value of inputs (by the zero profit condition for final goods producers). In addition to these market clearing conditions, the home and foreign aggregate pricing equations (Equation 2.5) must be satisfied. Finally, to close the model the balance of payments must be in equilibrium, i.e. with financial autarky net exports must equal zero:

$$NX_t \equiv \int_{\Omega_{x,t}} \overline{p}_{x,t}(\varphi)\, y_{x,t}(\varphi)\, d\varphi - RER_t \int_{\Omega^*_{x,t}} \overline{p}^*_{x,t}(\varphi)\, y^*_{x,t}(\varphi)\, d\varphi = 0 \qquad (2.20)$$

### 2.4.5 Equilibrium definition

To summarize, given household and entrepreneurial debt repayments and production levels entering period t, an equilibrium is defined by a path of aggregate relative prices $\{RER_t, w_t, w_t^*, R_{t+1}, R_{*,t+1}\}$, aggregate quantities $\{Y_t, Y_t^*, C_t, C_t^*, B_{t+1}, B_{*,t+1}^*\}$, individual entrepreneurial investment choices as reflected in intermediate goods relative prices $\{\overline{p}_{d,t+1}(\varphi), \overline{p}_{x,t+1}(\varphi), \overline{p}^*_{d,t+1}(\varphi), \overline{p}^*_{x,t+1}(\varphi)\}$, entrepreneurial credit constraint multipliers $\{\lambda_t^1(\varphi), \lambda_t^{*1}(\varphi)\}$, final goods producer intermediate input demands $\{y_{d,t}(\varphi), y_{x,t}(\varphi), y^*_{d,t}(\varphi), y^*_{x,t}(\varphi)\}$, household and entrepreneurial consumption levels $\{c_t^l, c_t(\varphi), c_t^{*l}, c_t^*(\varphi)\}$ and borrowing by home and foreign households and entrepreneurs $\{b_{t+1}^l, b_{t+1}(\varphi), b_{*,t+1}^{l*}, b_{*,t+1}^*(\varphi)\}$ which are consistent with the optimal choices of households, entrepreneurs and final goods producers described above and which satisfy the above aggregate equilibrium conditions. In the sections below I focus on the properties of the steady state equilibrium given my interest in the long-run impact of the interactions between financial sector and trade reforms.

## 2.5 Domestic financial reforms with trade autarky

In order to illustrate the channels through which domestic financial reforms affect aggregate productivity I first analyze the properties of the steady state equilibrium with financial and trade autarky. Each entrepreneur's productivity is invariant and so, with stable aggregate variables, the entrepreneurial project choice decision (and hence aggregate value of production) will be constant provided each entrepreneur's net worth is stable. In this case, each entrepreneur's consumption is also stable and so aggregate consumption will be stable if household consumption is unchanging. This gives the familiar condition from the household Euler equations $R = R^* = 1/\beta$. Given the assumption that entrepreneurs are more impatient than households then from the entrepreneurial first order conditions all entrepreneurs will be constrained by their respective domestic borrowing constraints. I can now pin down entrepreneurial prices and production decisions which, along with aggregate relative prices, can be used to specify the equilibrium.

### 2.5.1 Entrepreneurial production decisions

Substituting the steady state multiplier on the borrowing constraint $\lambda^1(\varphi) = (1/R - \delta)/c(\varphi) > 0$ into the optimal relative prices expressions (Equations 2.17 and 2.18) gives steady state entrepreneurial relative prices in home (if an entrepreneur produces) of:

$$\overline{p}_d(\varphi) = \frac{w}{\rho\varphi\Theta_d} \tag{2.21}$$

where $\Theta_d = \delta + (\beta - \delta)\theta^{\frac{\sigma-1}{\sigma}}$ and $\rho = (\sigma - 1)/\sigma$. The term $\Theta_d$ can be thought as the reciprocal of the effective borrowing rate faced by entrepreneurs (as credit constraints fall the effective borrowing rate falls to the unconstrained rate of $1/\beta$). Thus, with a common $\theta$, in the steady state the pricing wedges are constant across entrepreneurs. Using the intermediate good demand functions these prices deter-

mine entrepreneurial production levels and revenues.

The comparison between an entrepreneur's gross returns from saving and from production of intermediates for domestic sale gives the familiar condition that the entrepreneur will only produce if her revenues exceed the borrowing costs associated with production. This is the case provided that the entrepreneur's productivity is sufficiently high, $\varphi \geq \overline{\varphi}_d$ where $\overline{\varphi}_d$ is defined by:

$$\overline{p}_d\left(\overline{\varphi}_d\right) y_d\left(\overline{\varphi}_d\right) = \frac{fw}{\left(\beta - \rho\Theta_d\right)} \Leftrightarrow \overline{\varphi}_d^{\sigma-1} = \frac{w^\sigma}{Y} \frac{f\left(\rho\Theta_d\right)^{1-\sigma}}{\left(\beta - \rho\Theta_d\right)} \tag{2.22}$$

Entrepreneurs who have a productivity lower than $\overline{\varphi}_d$ do not produce and, given that their credit constraints still bind, end up in the steady state just consuming their entrepreneurial wage each period. The mass of producing entrepreneurs is given by $M\left(1 - G\left(\overline{\varphi}_d\right)\right)$. Following Melitz (2003), aggregate productivity, $\widetilde{\varphi}\left(\overline{\varphi}_d\right)$, can be defined as a weighted average of the productivities of producing entrepreneurs:[23]

$$\widetilde{\varphi}\left(\overline{\varphi}_d\right) = \left[\frac{1}{1 - G\left(\overline{\varphi}_d\right)} \int_{\overline{\varphi}_d}^{\infty} \varphi^{\sigma-1} g\left(\varphi\right) d\varphi\right]^{1/(\sigma-1)} \tag{2.23}$$

A tightening of the credit multiplier on domestic revenues (i.e. fall in $\theta$) has two partial equilibrium effects on the cutoff through raising the entrepreneur's cost of production and hence price. On the one hand the higher price charged by the entrepreneur reduces revenues, increasing the term $\left(\rho\Theta_d\right)^{1-\sigma}$. On the other hand higher prices are reflected in reduced investment needs and hence repayments (increasing the term $\left(\beta - \rho\Theta_d\right)$). Whilst the former would tend to increase the productivity cutoff the latter may reduce the cutoff. In partial equilibrium, the net effect of these two forces is such that the former effect dominates and the partial derivative of

[23] As detailed in Melitz (2003), $\widetilde{\varphi}\left(\overline{\varphi}_d\right)$ is the weighted harmonic mean of producing entrepreneurs' productivities with the weights given by their relative output shares.

the domestic productivity cutoff with respect to the domestic financial development $\theta$ is negative:

$$\frac{\partial \overline{\varphi}_d}{\partial \theta} = -\frac{\overline{\varphi}_d (1-\theta)(\beta-\delta)^2}{\Theta_d (\beta - \rho\Theta_d)} < 0$$

Note that these comparative statics ignore the general equilibrium effect of financial development on the cutoff via aggregate prices and quantities. This is an important omission since, as shown below, the general equilibrium effect will tend to mean that higher financial development leads to a higher domestic production productivity cutoff.

### 2.5.2 Properties of the steady state autarky equilibrium

Using the properties of the intermediate demand functions, the autarky equilibrium can be defined by a system of five equations in the real wage, domestic interest rate, domestic production cutoff, aggregate borrowing and final goods output. The corresponding equations are the household Euler equation, the productivity cutoff definition, labor and credit market clearing conditions and the aggregate pricing equation.

**Proposition 1** *In financial and trade autarky, there exists a unique steady state equilibrium in home referenced by relative prices $\{w, R\}$, the domestic production cutoff $\{\overline{\varphi}_d\}$ and aggregate quantities $\{Y, B\}$ from which all other endogenous variables can be derived. With domestic financial sector reforms (i.e. increases in the credit multiplier $\theta$) the steady state comparative statics are as follows:*

- *Average productivity of intermediate output rises through a reallocation of production towards more productive firms as the domestic production productivity cutoff, $\overline{\varphi}_d$, increases.*
- *Real wages increase.*

- *Aggregate consumption of the final good rises.*

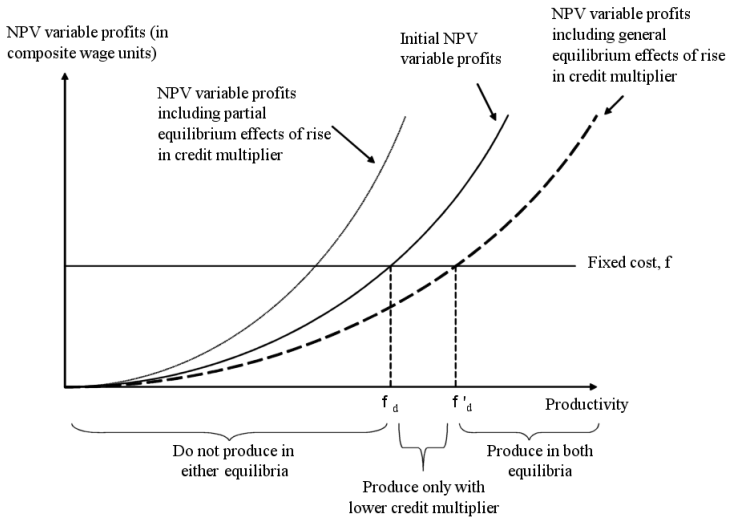
**Proof.** See Appendix 2.B.1. ■

Thus by adding a simple credit constraint within this heterogeneous firm model, financial sector reforms increase real wages and average productivity through a reallocative process very similar to that emphasized in relation to trade liberalization. With households unconstrained, all the reallocative work is done by the wage rate and labor markets.[24] If the credit multiplier is relaxed then, for a given wage, entrepreneurs lower their prices, increasing revenues and profits. The rise in $\theta$ has an intensive margin effect increasing investment of existing producers. Ceteris paribus, in partial equilibrium there would also be an extensive margin effect since, with profits higher, more firms are induced to produce (see Figure 2.2). However, with lower prices and more varieties the real wage rate rises. This reduces revenues and raises costs. With profits reduced, lower productivity firms exit production. As illustrated in Figure 2.2, the overall effect is an increase in the productivity required for entrepreneurs to make positive profits from domestic production.[25] Equivalently for labor market clearing to hold the mass of producing firms must fall if the rise in $\theta$ induces greater labor demand across firms. Although the variety of intermediate inputs falls and the wage rises, the beneficial effects on unit costs of higher $\theta$ and higher average productivity lead to an overall rise in final goods production and consumption.

[24]The comparative static results for average productivity and real wages with respect to the credit multiplier are similar to those in Aoki et al. (2010) when the credit constraint binds. However, in their model, with households also constrained, as the credit multiplier rises there is adjustment of the real interest rate as well as the real wage.

[25]Interestingly, in the model of Chor et al. (2008) the effect of a rise in financial development for a country affected by credit constraints is to reduce the productivity cut-off for domestic production. This is because in their set-up the wage rate is pinned down by the exogenous productivity of a homogenous good sector. Thus, absent the general equilibrium wage effects, there is no requirement for the productivity cut-off to rise to ensure that labor market clearing still holds. Instead there is an adjustment via the free-entry condition in their model whereby the level of aggregate demand in the economy must fall to ensure that the value of entry is still equal to the exogenously determined entry cost.

**Figure 2.2:** Impact of credit multiplier $\theta$ on entrepreneurial production in trade autarky




## 2.6 Domestic financial reforms with trade openness

The two economies are now open to trade in goods and entrepreneurs can choose whether to export intermediates in addition to selling them to domestic final goods producers.

### 2.6.1 Entrepreneurial production decisions

When the economies are open to trade the relative price of exports to domestic output for a given entrepreneur is defined as follows:

$$\frac{\overline{p}_x(\varphi)}{\overline{p}_d(\varphi)} = \frac{\tau\Theta_d}{\Theta_x} \tag{2.24}$$

where $\Theta_x = \delta + (\beta - \delta)(\mu\theta)^{\frac{\sigma-1}{\sigma}}$ is the reciprocal of the effective borrowing rate when export output is pledged as collateral. Compared to the standard model, the relative price of exports now depends not just on the trade costs but on how export and domestic pledged output are treated by domestic creditors. If the relative

pledgeabilty of export output, $\mu$, rises then the relative price of export to domestic sales falls. As the overall domestic financial development rises the relative price of exports rises if $\mu < 1$, i.e. if the fall in the pricing wedge is greater for domestic production, and falls if $\mu > 1$.

Again the comparison between an entrepreneur's gross returns to domestic production versus those for domestic and export production gives a productivity cutoff $\overline{\varphi}_x$ above which the additional revenues from exporting as well as producing for domestic sales exceed the additional costs. The exporting productivity cutoff is defined by:

$$\overline{p}_x\left(\overline{\varphi}_x\right) y_x\left(\overline{\varphi}_x\right) = \frac{f_x w}{\left(\beta - \rho\Theta_x\right)} \Leftrightarrow \overline{\varphi}_x^{\sigma-1} = \frac{w^\sigma RER^{-\sigma}}{Y^*} \frac{f_x \left(\tau/\rho\Theta_x\right)^{\sigma-1}}{\left(\beta - \rho\Theta_x\right)}$$

The partial equilibrium effect of greater overall financial development $\theta$ and the ability to lend against export output, $\mu$, is to reduce $\overline{\varphi}_x$, i.e. increase the propensity of intermediate producers to export. The ratio of the exporting to domestic production cutoff is given by:

$$\left(\frac{\overline{\varphi}_x}{\overline{\varphi}_d}\right)^{\sigma-1} = \frac{\tau^{\sigma-1} f_x}{f} \frac{RER^{-\sigma} Y}{Y^*} \left(\frac{\Theta_d}{\Theta_x}\right)^{\sigma-1} \left(\frac{\beta - \rho\Theta_d}{\beta - \rho\Theta_x}\right) \tag{2.25}$$

The relative magnitudes of the exporting to domestic only productivity cutoff (and hence the likelihood of exporting given domestic production) can be decomposed into three terms. First, as variable and relative fixed trade costs increase, i.e. as $\tau^{\sigma-1} f_x / f$ rises, the relative level of the exporting cutoff increases. Second, the terms $\frac{RER^{-\sigma} Y}{Y^*}$ reflect the relative scale of demand from foreign compared to domestic final goods producers. The higher relative foreign demand the lower the cutoff ratio $\overline{\varphi}_x / \overline{\varphi}_d$. The third term, reflecting financial constraints in the pledging of both

domestic and export output, is the novel feature compared to the related literature.

Focusing on this third effect, if the relative ability of creditors to recover exports compared to domestic output, $\mu$, rises then the partial equilibrium effect is to increase the propensity of producers to export. However, the impact of changes in overall financial development, $\theta$, is ambiguous. This is because, in contrast to Chaney (2005) and Manova (2006), domestic production is also subject to credit constraints. Thus, a rise in $\theta$ will reduce both the domestic and export production cutoffs in partial equilibrium. For $\mu$ less than one, a rise in overall financial development from a low level initially will tend to increase the relative exporting cutoff since it has a greater effect on the domestic production cutoff. As financial development rises the elasticity of the relative cutoff with respect to $\theta$ falls. If the relative recovery rate $\mu$ is greater than one then the effects are in the opposite directions.

In line with firm-level empirical evidence which suggests a partitioning of producing firms into exporters and non-exporters I focus on situations where $\overline{\varphi}_x/\overline{\varphi}_d > 1$. Given this ordering of the production cutoffs, home entrepreneurs can be partitioned into those who do not produce ($\varphi < \overline{\varphi}_d$), those who produce for domestic markets only ($\overline{\varphi}_d \leq \varphi < \overline{\varphi}_d$) and those who produce for export as well as domestic markets ($\overline{\varphi}_x \leq \varphi$). Similar expressions can be derived in foreign for $\overline{\varphi}_d^*$ and $\overline{\varphi}_x^*$. The average productivity of intermediate production with trade, $\widetilde{\varphi}_T$, can be expressed as a weighted sum of the average productivity of domestic production, $\widetilde{\varphi}(\overline{\varphi}_d)$, and export production, $\widetilde{\varphi}(\overline{\varphi}_x)$, where the weights take into account the relative mass of exporters to total producers and the relative level of export production (including iceberg trade costs) to domestic production for a given entrepreneur.[26]

[26] See Appendix 2.C.1 for details.

### 2.6.2 Properties of non-symmetric financial autarky steady state equilibrium

The symmetric case can be shown to be unique without the need for specific distributional assumptions. However, given that financial reforms in particular are undertaken in a domestic economy without the need for corresponding reforms in trading partners, it is of more interest to focus on the non-symmetric equilibrium. Following the related literature I adopt the empirically plausible Pareto distribution for the numerical solutions where $G(\varphi) = 1 - (\varphi_{\min}/\varphi)^a$ with $\varphi_{\min} > 0$ the lower-bound productivity and $a$ is the distribution shape parameter.[27] Under this distributional assumption the non-symmetric steady state equilibrium under financial autarky is uniquely defined.

**Proposition 2** *In financial autarky with entrepreneurial productivity following a Pareto distribution, there exists a unique steady state equilibrium with costly goods trade which can be uniquely defined by a system of thirteen equations in relative prices* $\{w, w^*, R, R^*, RER\}$*, domestic market production and exporting cutoffs* $\{\overline{\varphi}_d, \overline{\varphi}_x, \overline{\varphi}_d^*, \overline{\varphi}_x^*\}$ *and aggregate quantities* $\{Y, Y^*, B, B^*\}$ *from which all other endogenous variables can be derived. The corresponding equations are the home and foreign household euler equations, the definitions of the four productivity cutoffs, labor and credit market clearing conditions at home and abroad, the balance of payments condition (ie balanced trade given financial autarky) and the two countries' aggregate pricing equations.*

**Proof.** See Appendix 2.B.2. ■

[27] For simplicity the shape parameter $a$ is common across countries (although the lower bound productivity can be different across countries). Helpman et al. (2004) illustrate the empirical fit of the Pareto distribution and note that the assumption that $a > \sigma - 1$ is required to ensure finite variances of revenues.

#### 2.6.2.1 Numerical parameter values

In the numerical examples below I focus solely on the impact of differences in credit multipliers between countries with all other parameters identical. For the production and productivity distribution parameters I follow Bernard et al. (2007b) in setting the elasticity of substitution between different varieties $\sigma = 3.8$ based on the estimates from US data of Bernard et al. (2003), the shape parameter of the Pareto distribution at $a = 3.4$ and the minimum productivity $\varphi_{\min} = 0.2$. The discount factors of households and entrepreneurs are set at $\beta = 0.96$ and $\delta = 0.92$ respectively (yielding a steady state annual real interest rate of 4%). The share of household labor costs in total labor costs is set at $\zeta = 0.985$ following Bernanke et al. (1999) since entrepreneurial production rather than their labor income is the focus of the model. For simplicity the fixed costs of domestic and export production are set equal to one composite labor unit in both countries. Labor endowments are identical across countries with the masses of labor and entrepreneurs which rescale the results set at $L = L^* = 100$ and $M = M^* = 20$ giving an export propensity of producers of around 30% when variable trade costs $\tau = 1.4$.[28] This compares, for example, to estimates of around 21% of plants in the 1991 US Census of Manufactures Bernard et al. (2003). In developing economies, Aitken et al. (1997) find that around 27% of a 1986 and 1989 sample of Mexican manufacturing plants were exporters whilst the samples of Clerides et al. (1998) have 35% of Moroccan plant as exporters (1984-1991), 9.5% of Colombian plants (1981-1991) and a comparable number of 23% for Mexican plants (1986-1990).

#### 2.6.2.2 Impact of reforms to home financial sector

Before considering trade and financial reform interactions I first illustrate how home financial sector reforms affect both the home and the foreign economy for

[28] Such trade costs are of similar order to the 44% estimate of border-related trade barriers in the representative trade costs outlined in Anderson and van Wincoop (2004).

given trade costs. This aids understanding of the mechanisms through which the different reform policies interact. I compare the steady state equilibria with goods trade (subject to symmetric iceberg trade costs $\tau = \tau^* = 1.4$) under different values of home financial development (i.e. varying the credit multipliers $\theta$ and $\mu$) with foreign credit multipliers constant at $\theta^* = 0.5$ and $\mu^* = 1$.

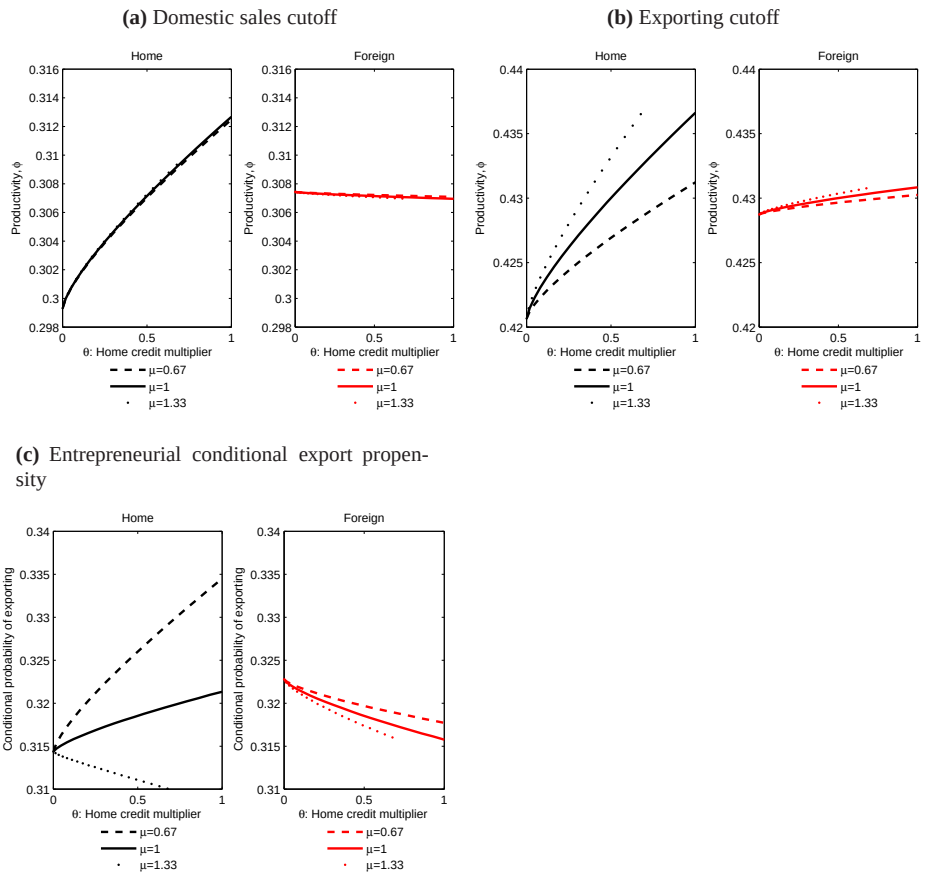
**Entrepreneurial propensity to produce and export** As illustrated in Figure 2.3, as the home credit multipliers rise the domestic production productivity cutoff in home rises via the same channels as in autarky (i.e. increasing investment via the intensive margin with the resulting real wage rise increasing costs and causing lower productivity firms to drop out of production).[29] The higher wage costs also cause the export production productivity cutoff in home to rise. In the foreign economy the impact of changes in $\theta$ all take place via the trade channel. In particular in this general equilibrium set-up home financial development affects not just home export propensity (which has been emphasised in, for example, Chaney, 2005; Manova, 2006) but also the export propensities of foreign firms, as is also the case in the three-country analysis of Chor et al. (2008).

In the home economy the rise in $\theta$ affects the export propensity (i.e. the ratio $\overline{\varphi}_x/\overline{\varphi}_d$) through two channels. The first is an ambiguously signed partial equilibrium effect via the relative financing constraints on domestic and export revenues. The second effect is general equilibrium via the real exchange rate reducing the relative demand for foreign relative to home intermediates. In the home economy the net effect in this illustration is that the propensity to export increases with home financial development if the relative pledgeability of export output $\mu$ is high but falls with $\theta$ for high $\mu$. In the foreign economy it is only the general equilibrium effect that is at work with a rise in home financial development causing a fall in

[29] It can also be shown analytically that the domestic production productivity cutoff in the home economy rises with an increase in the relative pledgeability of exports, $\mu$.

relative demand for foreign intermediates resulting in a reduction in the foreign entrepreneurs' propensity to export. This reduces overall labor demand and the domestic production cutoff in foreign falls slightly to ensure market clearing. Whilst these results are illustrative they indicate a potential channel through which the financial development in one economy can spill over to the production and export patterns of trading partners.

**Figure 2.3:** Impact of home overall financial development on entrepreneurial production cutoffs and propensity to export

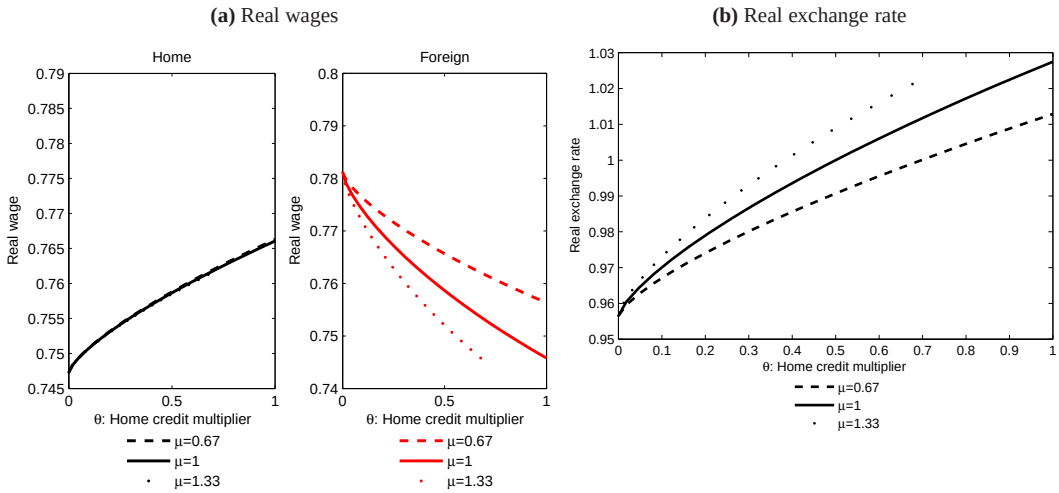



Note: Home and foreign identical except credit multipliers. Foreign credit multipliers constant at $\theta^* = 0.5$ and $\mu^* = 1$. Variable iceberg trade cost $\tau = \tau^* = 1.4$. The varying lengths of the plots against $\theta$ for different values of $\mu$ reflect the restriction that $\mu\theta \leq 1$ as detailed in Assumption 2.

**Real wages and real exchange rate** As in the trade autarky case the home real wage rises with the home credit multiplier (Figure 2.4), i.e. the home final good price falls. This reflects a combination of lower mark-ups for existing producers

and a rise in the average productivity of domestic and imported inputs which more than offset the reduction in varieties of inputs. In the foreign economy, the direct mark-up effect is not present with the result being that the lower variety of imports contributes to a fall in the foreign real wage as the home credit multiplier increases. Thus the real exchange rate rises with the home credit multipliers as home and foreign final goods prices fall and rise respectively.

**Figure 2.4:** Impact of home overall financial development on composite real wages and real exchange rate under financial autarky

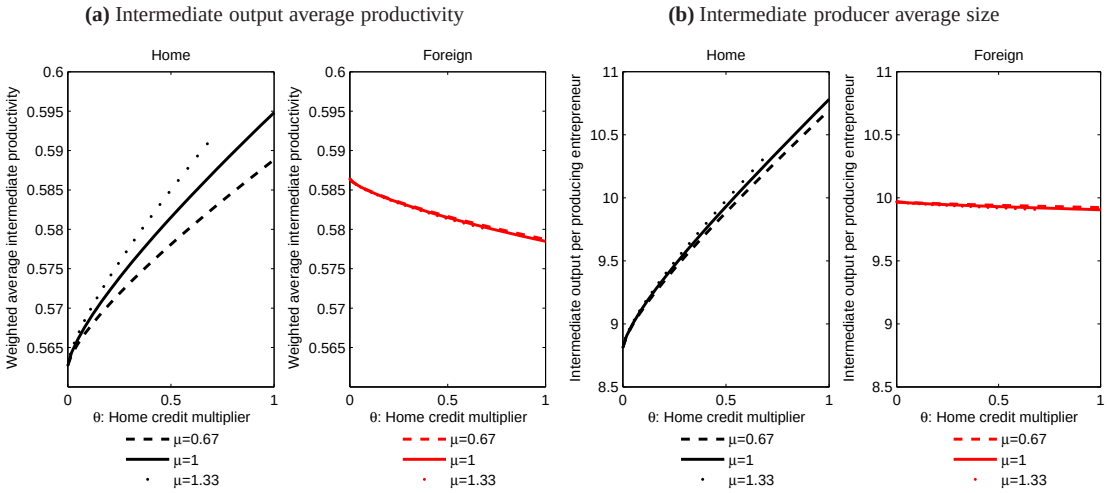



Note: Home and foreign identical except credit multipliers. Foreign credit multipliers constant at $\theta^* = 0.5$ and $\mu^* = 1$. Variable iceberg trade cost $\tau = \tau^* = 1.4$.

**Intermediate output productivity and firm size** As the home credit multiplier rises lower productivity domestic producers and exporters exit in the home economy. This increases the weighted average home productivity of intermediate goods producers and the average size of producing entrepreneurs (Figure 2.5). In the foreign economy there is a slight fall in the aggregate intermediate productivity and firm size reflecting the slight decrease in the domestic production cutoff.

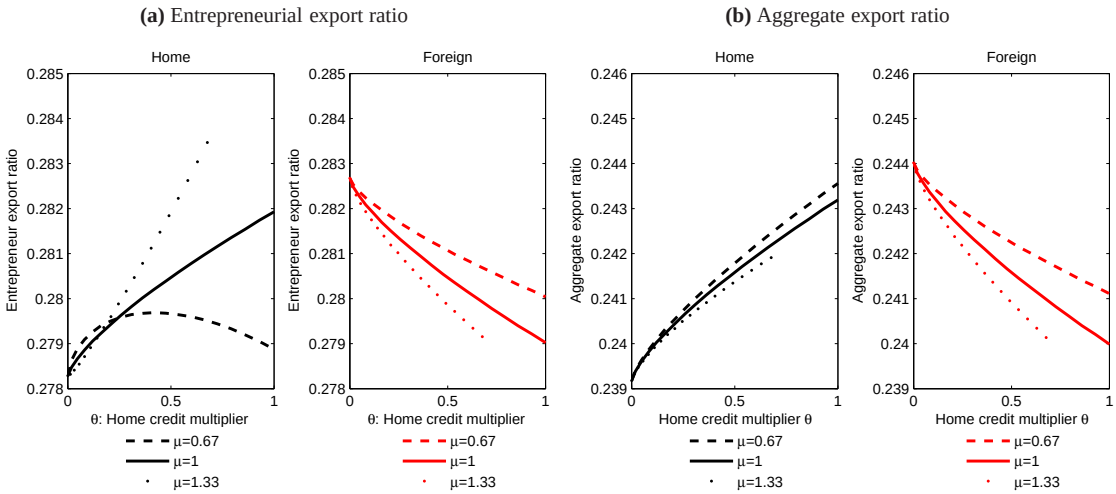
**Exports** From the properties of the demand functions for intermediate inputs, the relative value of exports to total intermediate sales (both in units of domestic final consumption good) at the entrepreneurial level is a function of the exporting

**Figure 2.5:** Impact of home overall financial development on intermediate output productivity and average size of producing entrepreneurs




Note: Home and foreign identical except credit multipliers. Foreign credit multipliers constant at $\theta^* = 0.5$ and $\mu^* = 1$. Variable iceberg trade cost $\tau = \tau^* = 1.4$.

**Figure 2.6:** Impact of home overall financial development on firm- and aggregate-level export to total intermediate revenue ratios under financial autarky




Note: Revenues in units of domestic consumption good. Home and foreign identical except credit multipliers. Foreign credit multipliers constant at $\theta^* = 0.5$ and $\mu^* = 1$. Variable iceberg trade cost $\tau = \tau^* = 1.4$.

and domestic production cutoffs and is identical across entrepreneurs. For a home entrepreneur this ratio is given by:

$$exrat = \left(1 + \frac{f\left(\beta - \rho\Theta_x\right)}{f_x\left(\beta - \rho\Theta_d\right)}\left(\frac{\overline{\varphi}_x}{\overline{\varphi}_d}\right)^{\sigma-1}\right)^{-1} \tag{2.26}$$

The impact of changes in $\theta$ on a home entrepreneur's export ratio combines two effects. First there is the impact on $\overline{\varphi}_x/\overline{\varphi}_d$ which, as detailed in Equation 2.25, embodies relative demand from home and foreign final goods producers, financing differences between exports and domestic revenues and trade costs. Second, there is the impact on relative net profits per variable unit sold between export and domestic sales (i.e. $\left(\beta - \rho\Theta_x\right) / \left(\beta - \rho\Theta_d\right)$). The overall effect depends on the relative ability of entrepreneurs to pledge exports compared to domestic output to creditors. In the home economy, the illustrations suggest that an entrepreneur's export ratio increases with $\theta$ if $\mu$ is high enough but has an inverted U-shaped response if $\mu$ is relatively low as illustrated in Figure 2.6. Changes in home $\theta$ only affect a foreign entrepreneur's export ratio in financial autarky via the impact on the propensity to export, i.e. via the direct trade channel. With the foreign propensity to export falling (ie $\overline{\varphi}^*_x/\overline{\varphi}^*_d$ rising) with $\theta$ this implies a decrease in a foreign entrepreneur's export ratio as its trading partner's financial development improves.

In the home economy the positive intensive margin effect on exports of improved home financial development combines with a generally positive extensive margin effect (for all but high levels of relative pledgeability of exports $\mu$) to give an overall increase in the ratio of aggregate intermediate exports to total sales. In the foreign economy, the ratio of aggregate intermediate exports to total sales falls as $\theta$. This reflects both an intensive margin effect (through lower relative demand from home final goods producers for foreign intermediate exports) and an extensive margin effect through the rise in the exporting production cutoff.

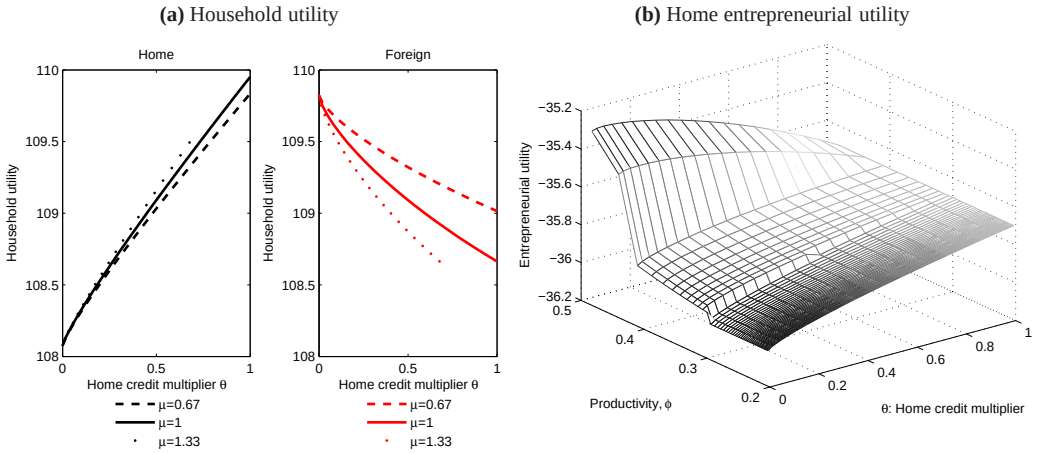
**Household and entrepreneurial utility** Household steady state consumption is dependent upon household wage income and the net return on steady state household savings (which, from domestic funds market clearing, are defined by aggregate entrepreneurial borrowing). Thus the effects of changes in home financial development on household utility can be split into a household wage effect and entrepreneurial borrowing effects. The latter can be categorized as a direct pledging effect whereby a rise in $\theta$ for given revenues will increase entrepreneurial borrowing capacity, an intensive margin effect on output via the wage and an extensive margin effect on the mass of producing and exporting entrepreneurs who are able to borrow. In the home economy a rise in $\theta$ leads to a rise in wages and a positive direct pledging effect which more than offsets the extensive margin effects of higher production cutoffs and thus increases household utility (Figure 2.7). In the foreign economy, with financial autarky, there is no direct pledging effect from changes in $\theta$ and the wage effect via the trade channel leads to a fall in household utility.

Turning to entrepreneurs, the steady state consumption of non-producing entrepreneurs, who are constrained and hence cannot borrow, is equal only to their entrepreneurial wage income. The consumption of producing entrepreneurs depends on both their entrepreneurial wage income and their profits from total sales (which are increasing in entrepreneurial productivity).[30] Focusing on the home economy, as $\theta$ rises wages increase which unambiguously increases the utility of non-producing entrepreneurs. However, for given productivity, higher $\theta$ implies lower profits from production as wages and production costs rise. Thus, for low productivity entrepreneurs utility rises with $\theta$ but for higher productivity producing entrepreneurs the negative profit effect more than outweighs the positive income effect and utility falls with $\theta$ (see Figure 2.7). This feature can be viewed as similar in nature to the interest group theory proposed by Rajan and Zingales (2003) whereby

[30] Appendix 2.C.2 provides further details on the composition of entrepreneurial steady state utility.

incumbent producers may oppose financial sector reforms because it reduces their profits.

**Figure 2.7:** Impact of home overall financial development on steady state utility under financial autarky




Note: Home and foreign identical except credit multipliers. Foreign credit multipliers constant at $\theta^* = 0.5$ and $\mu^* = 1$. Variable iceberg trade cost $\tau = \tau^* = 1.4$.

#### 2.6.2.3 Interaction of reforms to trade and to the domestic financial sector

Having illustrated how changes in home financial development affect both the home and foreign economy in the presence of trade I now turn to the interaction of financial sector and trade reforms. In particular I consider the level and marginal effects on the home economy of symmetric changes in the iceberg variable trade costs and how these effects vary with the home credit multipliers (with the foreign credit multipliers set at $\theta^* = 0.5$ and $\mu^* = 1$).[31] In doing so it is convenient to define a trade freeness measure $TF = \tau^{1-\sigma}$ which lies between zero and one with $TF = 0$ as $\tau$ tends to infinity and $TF = 1$ for $\tau = 1$.

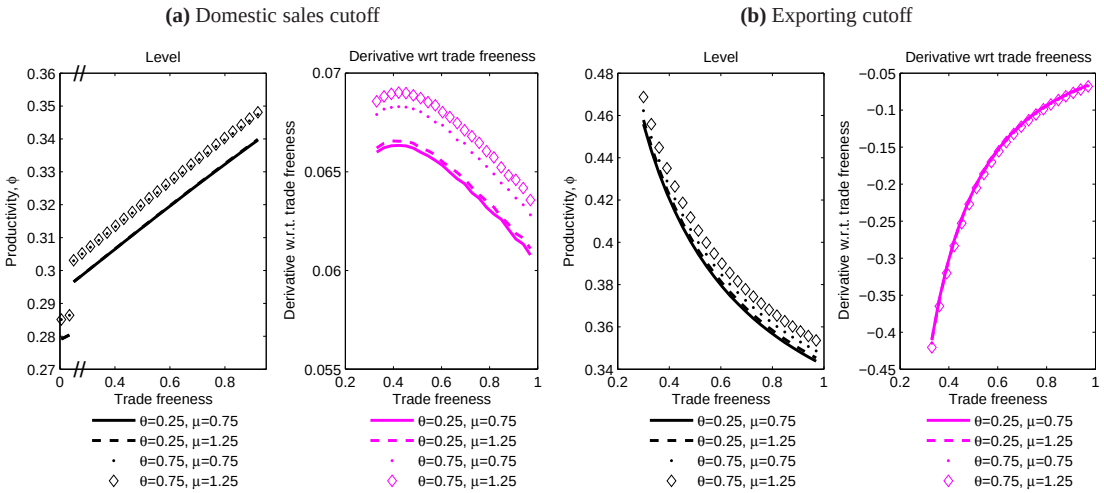
**Home entrepreneurial propensity to produce and export: trade liberalization**

For given credit multipliers, the impact of trade liberalization between two economies

[31] Although asymmetric changes in trade costs can be analyzed within the model I focus on symmetric changes in trade costs to reflect, for example, the implementation of bilateral trade agreements involving common tariff liberalization or the effect of common reductions in transport costs.

who are already open to trade follows a similar pattern to that in the original Melitz (2003) setup. A rise in trade freeness leads to a rise in the domestic production cutoff, a fall in the exporting cutoff and rise in the propensity of producers to export in both countries. However, as illustrated in Figure 2.8, the magnitude of the marginal impact on the domestic production cutoff of these changes in trade freeness appears to increase with home financial development. When home financial development is relatively high the intensive and extensive margin effects of trade liberalization on labor demand are amplified, leading to a greater required rise in the domestic production cutoff to ensure labor market clearing. Whilst the marginal fall in export prices through trade liberalization is reduced at higher levels of financial development the marginal impact on overall labor demand is higher due to the looser borrowing constraint. Although not illustrated, as in the standard model, greater trade freeness increases export propensity and aggregate- and firm-level export ratios. The impact of the level of the credit multiplier is of unclear direction.

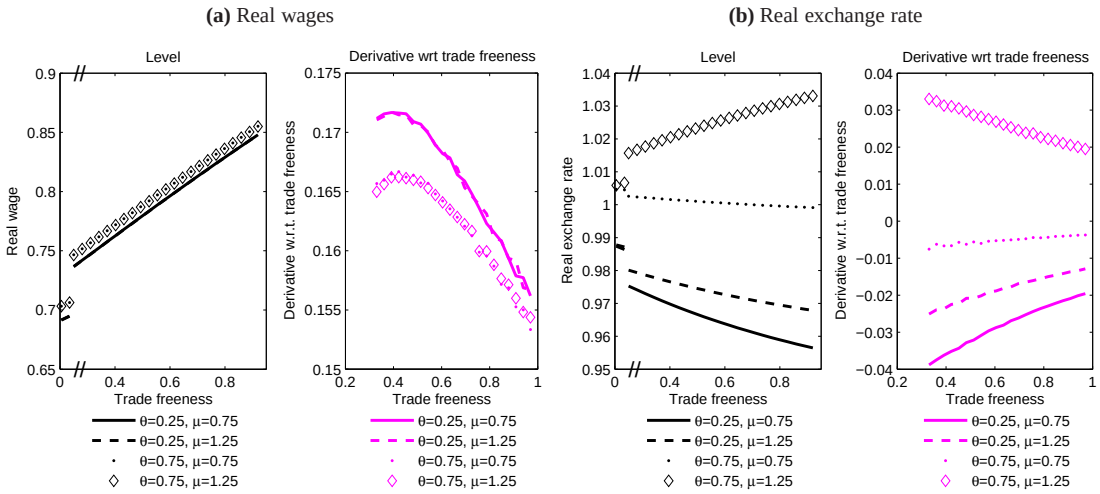
**Figure 2.8:** Impact of symmetric changes in variable trade costs on home entrepreneurial production cutoffs




Note: Home and foreign identical except overall credit multipliers $\theta$ and $\theta^*$. Foreign credit multipliers constant at $\theta^* = 0.5$ and $\mu^* = 1$.

**Home real wages and real exchange rate: trade liberalization** Trade liberalization increases the variety of imported inputs used in final goods production. Whilst the rise in the domestic production cutoff reduces the variety of domestic inputs they are on average of a higher productivity. The net effect is a fall in the aggregate price level and increase in home real wages. The real wage gains from trade opening appear to be greater if overall financial sector development is lower and, for given $\theta$, if the relative pledgeability of export output is higher (Figure 2.9). The intuition is that with $\theta$ high the aggregate price level at home is relatively low and thus the less the impact of any additional fall in prices due to the trade liberalization. The rise in trade freeness also increases the real wage in the foreign economy with the marginal impact also greater if home financial development is relatively low. The interplay of these two relative price changes suggests that if home development is lower than that in foreign then the real exchange rate is less than one and is falling with greater trade freeness.

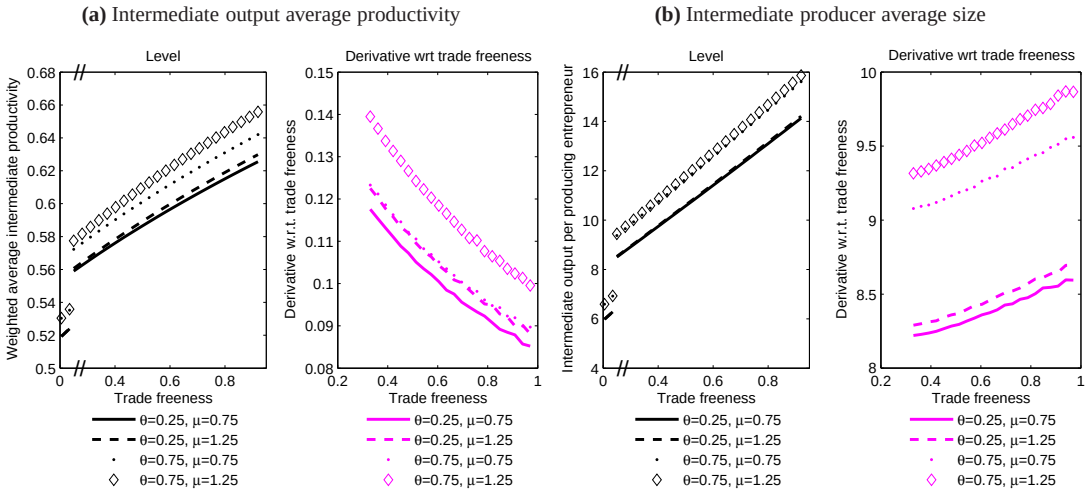
**Figure 2.9:** Impact of symmetric changes in variable trade costs on home composite real wages and the real exchange rate




Note: Home and foreign identical except overall credit multipliers $\theta$ and $\theta^*$. Foreign credit multipliers constant at $\theta^* = 0.5$ and $\mu^* = 1$.

**Home intermediate output productivity and firm size: trade liberalization** Additional labor demand stimulated by increasing investment in export production as trade freeness rises leads to a rise in the domestic production productivity cutoff. This contributes to a rise in intermediate productivity and average size of producing entrepreneurs (Figure 2.10). Reflecting the corresponding greater marginal effect of trade liberalization on the domestic production productivity cutoff these effects are enhanced at higher levels of financial development (and at higher levels of relative export pledgeability for given $\theta$). Thus, in contrast with their impact on real wages trade and financial sector reforms appear to have complementary effects on aggregate productivity and firm-size.

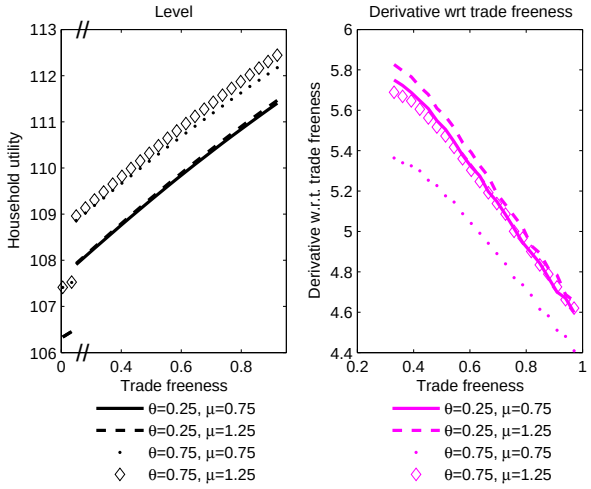
**Figure 2.10:** Impact of symmetric changes in variable trade costs on home intermediate productivity and average size of producing entrepreneurs




Note: Home and foreign identical except overall credit multipliers $\theta$ and $\theta^*$. Foreign credit multipliers constant at $\theta^* = 0.5$ and $\mu^* = 1$.

**Home household and entrepreneurial utility: trade liberalization** In terms of household utility, lower trade costs increase wage income. They also affect household saving (i.e. constrained entrepreneurial borrowing) via intensive and extensive margin effects on total pledgeable output for exporters and domestic producers. As $\theta$ rises the real wage gains fall whilst the extensive margin effects increase (as the

**Figure 2.11:** Impact of symmetric changes in variable trade costs on steady state home household utility under financial autarky




Note: Home and foreign identical except overall credit multipliers $\theta$ and $\theta^*$. Foreign credit multipliers constant at $\theta^* = 0.5$ and $\mu^* = 1$.

change in cutoffs rises). Overall, these effect combine to reduce the benefits to household utility from trade opening as $\theta$ rises for given $\mu$ (see Figure 2.11). This result is intuitive - using one policy tool, ie trade opening, to improve the allocation of production leads to less utility gain for consumer households if the resource allocation is more efficient in the first place through stronger financial development. However, the utility gains from trade liberalization are enhanced if, for given $\theta$, the relative ability to pledge export output compared to domestic output is increased.

Although not illustrated, for a given level of financial development, the utility of entrepreneurs increases with trade openness. Entrepreneurial wage income rises whilst producers gain from increased demand and a greater propensity to export (despite the rise in production costs through higher wages). In terms of the interaction of trade reforms and financial reforms, the picture is somewhat complex combining the relative effects on both wages and intensive and extensive productive margins. However, the utility loss for higher productivity entrepreneurs in moving from low to higher financial development (i.e. increasing $\theta$) which was illustrated in Figure 2.7 appears to be reduced when trade openness is higher. This is consistent

with the interest group theory of financial development outlined in Rajan and Zingales (2003) whereby the opposition of incumbent producers to financial reforms is weakened when an economy is open to international trade.[32]

## 2.7 Conclusions

This Chapter provides a tractable extension of a two-economy heterogeneous firm model to incorporate financial constraints affecting both domestic and export production. In doing so it enables analysis of trade and domestic financial sector policy changes across countries in a non-symmetric setting and provides some important insights into the mechanisms through which the two reforms can reallocate production within the two economies, their potential similarities and their interactions. In particular, numerical illustrations suggest that on the one hand domestic financial sector reforms, in facilitating greater investment, can enhance the marginal effects of trade liberalization in increasing average productivity and firm size. On the other hand, at higher levels of financial development the marginal benefits of trade liberalization in reducing aggregate prices and raising real wages and household utility may be reduced. The numerical illustrations also highlight the role of exports as collateral in amplifying the benefits of trade liberalization and the channels through which domestic financial sector reforms may be transmitted to trading partners.

The analysis of the macroeconomic impact of the interactions of trade and domestic financial sector reforms within a general equilibrium heterogeneous firm setting provides a novel addition to the existing theoretical literature and is complementary to a growing empirical literature on the impact of financial constraints on trade and FDI. However, it also highlights the need for additional empirical research

[32]Rajan and Zingales also argue that opposition to domestic financial reforms will be reduced when the economy is open to international finance, a feature from which the current model abstracts.

on the quantitative significance of these interaction effects since, as noted by Banerjee and Duflo (2005), the question of whether there are potential gains from adding multiple sources of inefficiency to models to explain productivity differences across countries is dependent upon their empirical relevance. The evidence from existing studies on these interactions is limited. At the macro level, Chang et al. (2009) provide support for the complementary effects of financial development and trade openness on growth. At the firm-level, Topalova (2004), for example, considers whether the impact on productivity of trade reforms in India varies across states by financial depth and finds that although the point estimates are similar in states with high or low credit to GDP they are only significant in the former. Further empirical analysis on the interaction of the reallocative effects of trade and financial reforms and their joint impact on aggregate productivity levels is of particular interest. A focus for future work is thus to extend the model to a multi-sector set-up to derive empirically testable predictions on the effects of reform interactions to be applied to sectoral data on average firm-size and labor productivity. In addition to these important empirical steps there is the potential to modify the model to address other policy relevant issues. For example, to extend the analysis beyond the steady state in order to examine the transitional impact of reforms or to incorporate the potential reallocative effects of international financial liberalization emphasized by Aoki et al. (2010).

## 2.A Appendix: EBRD transition indicators

Full details of the EBRD transition indicator score methodology are available at www.ebrd.com. The transition indicators cover up to 29 Eastern European and former Soviet Union economies from 1989 to 2007: Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, FYR Macedonia, Georgia, Hungary, Kazakhstan, Kyrgyz Republic, Latvia, Lithuania, Moldova, Mongolia, Montenegro, Poland, Romania, Russian Federation, Serbia, Slovak Republic, Slovenia, Tajikistan, Turkmenistan, Ukraine, and Uzbekistan.

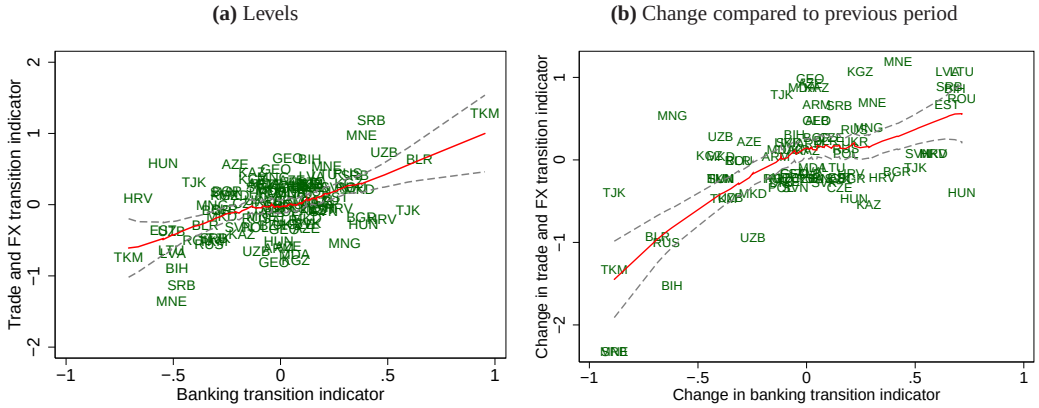
The transition indicator scores are based on a judgement made on an economy's progress relative to defined classifications. Scores range from 1 (little change from centrally planned economy) through to 4+ (defined as 4.33) which represents norms of advanced industrial economies. Trade measure also includes restrictions to current account convertibility. In addition to the banking sector measure indicated in the figures below there is also an indicator for non-bank financial institutions and securities markets.

The trade and foreign exchange (FX) indicator ranges from a value of 1 through to 4+ (graded by the EBRD as 4.33) with "1: Widespread import and/or export controls or very limited legitimate access to foreign exchange; 2: Some liberalization of import and/or export controls; almost full current account convertibility in principle, but with a foreign exchange regime that is not fully transparent (possibly with multiple exchange rates); 3: Removal of almost all quantitative and administrative import and export restrictions; almost full current account convertibility; 4: Removal of all quantitative and administrative import and export restrictions (apart from agriculture) and all significant export tariffs; insignificant direct involvement in exports and imports by ministries and state-owned trading companies; no major non-uniformity of customs duties for non-agricultural goods and services; full and current account convertibility; 4+: Standards and performance norms of advanced

industrial economies: removal of most tariff barriers; membership in WTO."

The corresponding definitions for the banking reform and interest rate liberalization transition indicator are "1: Little progress beyond establishment of a two-tier system; 2: Significant liberalization of interest rates and credit allocation; limited use of directed credit or interest rate ceilings; 3: Substantial progress in establishment of bank solvency and of a framework for prudential supervision and regulation; full interest rate liberalization with little preferential access to cheap refinancing; significant lending to private enterprizes and significant presence of private banks; 4: Significant movement of banking laws and regulations towards BIS standards; well-functioning banking competition and effective prudential supervision; significant term lending to private enterprizes; substantial financial deepening; 4+: Standards and performance norms of advanced industrial economies: full convergence of banking laws and regulations with BIS standards; provision of full set of competitive banking services."

**Figure 2.12:** EBRD transition indicators, 5 year averages: levels and changes after removing country and period fixed effects




Note: Values of the transition indicators range from 1 to 4.33 with higher values representing standards moving towards those of advanced industrial economies. Averages taken over 1989-1993, 1994-1998, 1999-2003 and 2004-2007 (four year average). Plots indicate residuals from regressions controlling for country and period fixed effects. Lines represent lowess smoother (locally weighted regression) with 95% confidence intervals.

## 2.B Appendix: Proofs

### 2.B.1 Steady state equilibrium with trade and financial autarky - Proof of existence and uniqueness

The steady state equilibrium in home can be defined by the following system of five equations in relative prices $\{w, R\}$, domestic market production cutoff $\{\overline{\varphi}_d\}$ and aggregate quantities $\{Y, B\}$ from which all other endogenous variables can be derived:

1. Household Euler equation: $R = 1/\beta$
2. Domestic production cutoff: $\overline{\varphi}_d^{\sigma-1} = \frac{w^\sigma}{Y} \frac{f(\rho\Theta_d)^{1-\sigma}}{(\beta-\rho\Theta_d)}$
3. Funds market clearing: $B = 0$
4. Labor market clearing: $L^\zeta M^{-\zeta}/f = H\left(\Theta_d, \overline{\varphi}_d\right)$ where $H\left(\Theta_d, \overline{\varphi}_d\right) = \frac{\rho\Theta_d}{\beta-\rho\Theta_d} A\left(\overline{\varphi}_d\right) + 1 - G\left(\overline{\varphi}_d\right)$ and $A\left(\overline{\varphi}_d\right) = \int_{\overline{\varphi}_d}^{\infty} \left(\varphi/\overline{\varphi}_d\right)^{\sigma-1} g\left(\varphi\right) d\varphi$. $H\left(\Theta_d, \overline{\varphi}_d\right)$ is increasing in $\Theta_d$ and decreasing in $\overline{\varphi}_d$.
5. Aggregate Pricing equation: $w^{\sigma-1} = M\left(\rho\Theta_d\right)^{\sigma-1} \int_{\overline{\varphi}_d}^{\infty} \varphi^{\sigma-1} g\left(\varphi\right) d\varphi$

To prove existence and uniqueness of the equilibrium first consider the labor market clearing condition. $H\left(\Theta_d, \overline{\varphi}_d\right)$ is continuously differentiable (provided $g'\left(\overline{\varphi}_d\right)$ is defined) and tends to zero as $\overline{\varphi}_d \to \infty$ and tends to infinity as $\overline{\varphi}_d \to 0$. There is thus a unique value of $\overline{\varphi}_d$ for which the labor market clearing condition holds. Substituting the equilibrium value of $\overline{\varphi}_d$ into the aggregate pricing equation uniquely defines the real wage. The domestic production cutoff then uniquely defines final goods output $Y$. The real interest rate and aggregate borrowing are defined by the euler equation and funds market clearing respectively.

Comparative statics with respect to $\theta$:

- $\frac{\partial \overline{\varphi}_d}{\partial \theta} > 0$: From the labor market clearing condition, using the implicit function theorem the equilibrium cutoff value can be shown to be increasing in $\theta$.

- $\frac{\partial w}{\partial \theta} > 0$: Using the definition of the real wage from the aggregate pricing equation and the expression for $\partial \overline{\varphi}_d / \partial \theta$ it can be shown that the real wage is increasing in $\theta$.

- $\frac{\partial Y}{\partial \theta} > 0$: In the productivity cutoff equation substitute in for wages from the aggregate pricing equation. Using the labor market clearing condition with some manipulation one obtains final goods output as a function of $\overline{\varphi}_d$ independent of $\theta$ giving $\partial Y / \partial \theta \propto \partial \overline{\varphi}_d / \partial \theta > 0$.

### 2.B.2 Non-symmetric steady state equilibrium with financial autarky - Proof of existence and uniqueness

Using the fact that $\frac{\overline{p}_d(\varphi_d) y_d(\varphi_d)}{\overline{p}_d(\varphi'_d) y_d(\varphi'_d)} = \left(\frac{\varphi}{\varphi'}\right)^{\sigma-1}$ plus the domestic production productivity cutoff then $\overline{p}_d(\varphi_d) y_d(\varphi_d) = \left(\frac{\varphi}{\overline{\varphi}_d}\right)^{\sigma-1} \frac{fw}{(\beta - \rho \Theta_d)}$. Similar expressions can be used to define exporting revenues in relation to $\overline{\varphi}_x$ and also for variable labor demand. The steady state equilibrium can be defined by the following system of thirteen equations in relative prices $\{w, w^*, R, R^*, RER\}$, domestic market production and exporting cutoffs $\{\overline{\varphi}_d, \overline{\varphi}_x, \overline{\varphi}^*_d, \overline{\varphi}^*_x\}$ and aggregate quantities $\{Y, Y^*, B, B^*\}$ from which all other endogenous variables can be derived:

Household Euler equations:

$$R = 1/\beta; \; R^* = 1/\beta \tag{2.27}$$

Domestic production cutoff definitions:

$$\overline{\varphi}_d^{\sigma-1} = \frac{w^\sigma}{Y} \frac{f\left(\rho\Theta_d\right)^{1-\sigma}}{\left(\beta - \rho\Theta_d\right)} \tag{2.28}$$

$$\overline{\varphi}_d^{*^{\sigma-1}} = \frac{w^{*^\sigma}}{Y^*} \frac{f^*\left(\rho\Theta_d^*\right)^{1-\sigma}}{\left(\beta - \rho\Theta_d^*\right)} \tag{2.29}$$

Relative cutoffs $\overline{\varphi}_x/\overline{\varphi}_d^*$ and $\overline{\varphi}_x^*/\overline{\varphi}_d$ (which cancel out foreign and domestic final goods production):

$$\left(\frac{\overline{\varphi}_x}{\overline{\varphi}_d^*}\right)^{\sigma-1} = \left(\frac{RER\, w^*}{w}\right)^{-\sigma} \Upsilon \tag{2.30}$$

$$\left(\frac{\overline{\varphi}_x^*}{\overline{\varphi}_d}\right)^{\sigma-1} = \left(\frac{RER\, w^*}{w}\right)^{\sigma} \Upsilon^* \tag{2.31}$$

where:

$$\Upsilon \equiv \frac{f_x}{f^*}\left(\frac{\tau\Theta_d^*}{\Theta_x}\right)^{\sigma-1}\left(\frac{\beta - \rho\Theta_d^*}{\beta - \rho\Theta_x}\right);\ \Upsilon^* \equiv \frac{f_x^*}{f}\left(\frac{\tau^*\Theta_d}{\Theta_x^*}\right)^{\sigma-1}\left(\frac{\beta - \rho\Theta_d}{\beta - \rho\Theta_x^*}\right)$$

Composite labor market clearing conditions:

$$\overline{\varphi}_d^{-a} = \Gamma_1 - \Gamma_2\overline{\varphi}_x^{-a} \tag{2.32}$$

$$\overline{\varphi}_d^{*^{-a}} = \Gamma_1^* - \Gamma_2^*\overline{\varphi}_x^{*^{-a}} \tag{2.33}$$

where:

$$\Gamma_1 \equiv \frac{L^\zeta M^{-\zeta}}{\left(1 + k\rho\Theta_d/\left(\beta - \rho\Theta_d\right)\right) f\varphi_{\min}^a}; \Gamma_2 \equiv \frac{f_x\left(1 + k\rho\Theta_x/\left(\beta - \rho\Theta_x\right)\right)}{f\left(1 + k\rho\Theta_d/\left(\beta - \rho\Theta_d\right)\right)}$$

with $k = a/(a - \sigma + 1)$. $\Gamma_1^*$ and $\Gamma_2^*$ are correspondingly defined using foreign variables.

Funds market clearing conditions:

$$B = B^* = 0 \tag{2.34}$$

Balance of trade conditions:

$$RER = \frac{w}{w^*}\left(\frac{\overline{\varphi}_x^*}{\overline{\varphi}_x}\right)^a \Xi \tag{2.35}$$

where $\Xi \equiv \frac{Mf_x(\beta-\rho\Theta_x^*)}{M^* f_x^*(\beta-\rho\Theta_x)}\left(\frac{\varphi_{\min}}{\varphi_{\min}^*}\right)^a$.

Aggregate pricing equations in home and foreign respectively:

$$1 = w^{1-\sigma}\overline{\varphi}_d^{\sigma-1-a}\Psi_1 + (RER\, w^*)^{1-\sigma}\,\overline{\varphi}_x^{*\sigma-1-a}\Psi_2 \tag{2.36}$$

$$1 = w^{*1-\sigma}\overline{\varphi}_d^{*\sigma-1-a}\Psi_1^* + (RER/\, w)^{\sigma-1}\,\overline{\varphi}_x^{\sigma-1-a}\Psi_2^* \tag{2.37}$$

where:

$$\Psi_1 \equiv (\rho\Theta_d)^{\sigma-1}\, kM\varphi_{\min}^a;\ \Psi_2 \equiv (\rho\Theta_x^*/\tau^*)^{\sigma-1}\, kM^*\varphi_{\min}^{*a}$$

$$\Psi_1^* \equiv (\rho\Theta_d^*)^{\sigma-1}\, kM^*\varphi_{\min}^{*a};\ \Psi_2^* \equiv (\rho\Theta_x/\tau)^{\sigma-1}\, kM\varphi_{\min}^a$$

Noting that the labor market clearing conditions define the domestic productivity cutoffs as functions of exporting cutoffs in each country and using the balance of trade condition to substitute out for $RER$ the relative cutoff equations define a system in the two exporting cuts:

$$\left(\frac{\overline{\varphi}_x}{\left(\Gamma_1^* - \Gamma_2^*\overline{\varphi}_x^{*-a}\right)^{-1/a}}\right)^{\sigma-1} = \left(\left(\frac{\overline{\varphi}_x^*}{\overline{\varphi}_x}\right)^a \Xi\right)^{-\sigma} \Upsilon \tag{2.38}$$

$$\left(\frac{\overline{\varphi}_x^*}{\left(\Gamma_1-\Gamma_2\overline{\varphi}_x^{-a}\right)^{-1/a}}\right)^{\sigma-1}=\left(\left(\frac{\overline{\varphi}_x^*}{\overline{\varphi}_x}\right)^a\Xi\right)^{\sigma}\Upsilon^* \tag{2.39}$$

Each of these equations describe an upward sloping locus in $\{\overline{\varphi}_x^*,\overline{\varphi}_x\}$. Dividing the two equations gives a downward sloping curve which can be shown to intersect (2.38) uniquely at positive values of the two exporting cutoffs. As mentioned I focus on the case for which $\overline{\varphi}_x/\overline{\varphi}>1$ and $\overline{\varphi}_x^*/\overline{\varphi}^*>1$ which implies that parameter values must satisfy $\Upsilon\Upsilon^*>1$.

For the equilibrium values of $\overline{\varphi}_x$ and $\overline{\varphi}_x^*$ the wages can be uniquely obtained from the aggregate pricing equations (again once the real exchange rate has been substituted in):

$$w^{*^{\sigma-1}}=\left(\Gamma_1^*-\Gamma_2^*\overline{\varphi}_x^{*-a}\right)^{1-\frac{\sigma-1}{a}}\Psi_1^*+\left(\left(\frac{\overline{\varphi}_x^*}{\overline{\varphi}_x}\right)^a\Xi\right)^{\sigma-1}\overline{\varphi}_x^{\sigma-1-a}\Psi_2^* \tag{2.40}$$

$$w^{\sigma-1}=\left(\Gamma_1-\Gamma_2\overline{\varphi}_x^{-a}\right)^{1-\frac{\sigma-1}{a}}\Psi_1+\left(\left(\frac{\overline{\varphi}_x^*}{\overline{\varphi}_x}\right)^a\Xi\right)^{1-\sigma}\overline{\varphi}_x^{*^{\sigma-1-a}}\Psi_2 \tag{2.41}$$

Domestic production cutoffs can be obtained from the labor market clearing conditions given the equilibrium values of $\overline{\varphi}_x$ and $\overline{\varphi}_x^*$ which combined with equilibrium wages then determine equilibrium output from the domestic production productivity cutoffs. From these variables all other individual steady state choice variables can be determined. Given the existence of a unique equilibrium the model can be solved numerically using standard techniques.

## 2.C Appendix: Trade steady state

### 2.C.1 Weighted average productivity

As in Melitz (2003) the home average productivity of intermediate production with trade, $\widetilde{\varphi}_T$, can be defined as a weighted harmonic mean over of productivity levels reflecting the additional production (inclusive of iceberg transport costs) of those firms who choose to export. The productivity levels are weighted by an entrepreneur's output relative to the domestic output of the average productivity level.$y_d\left(\widetilde{\varphi}_T\right)$.

$$\begin{aligned}\widetilde{\varphi}_T^{-1} = & \frac{1}{1+\pi_x}\left[\frac{1}{1-G\left(\overline{\varphi}_d\right)}\int_{\overline{\varphi}_d}^{\infty}\frac{y_d\left(\varphi\right)}{y_d\left(\widetilde{\varphi}_T\right)}\varphi^{-1}g\left(\varphi\right)d\varphi\right] \\ & +\frac{\pi_x}{1+\pi_x}\left[\frac{1}{1-G\left(\overline{\varphi}_d\right)}\int_{\overline{\varphi}_d}^{\infty}\frac{\tau y_x\left(\varphi\right)}{y_d\left(\widetilde{\varphi}_T\right)}\varphi^{-1}g\left(\varphi\right)d\varphi\right]\end{aligned} \tag{2.42}$$

where $\pi_x = \frac{1-G(\overline{\varphi}_x)}{1-G(\overline{\varphi}_d)}$ is the conditional probability of a producer exporting. This expression can be simplified using the definitions of $\widetilde{\varphi}\left(\overline{\varphi}_d\right)$ and $\widetilde{\varphi}\left(\overline{\varphi}_x\right)$ from Equation 2.23 plus the relation between output levels $y_d\left(\varphi\right)/y_d\left(\varphi^{'}\right) = \left(\varphi/\varphi^{'}\right)^{\sigma}$ and between relative export to domestic output:

$$\begin{aligned}\widetilde{\varphi}_T^{\sigma-1} &= \frac{1}{1+\pi_x}\left[\widetilde{\varphi}\left(\overline{\varphi}_d\right)^{\sigma-1} + \pi_x\frac{\tau y_x\left(\widetilde{\varphi}\left(\overline{\varphi}_x\right)\right)}{y_d\left(\widetilde{\varphi}\left(\overline{\varphi}_x\right)\right)}\widetilde{\varphi}\left(\overline{\varphi}_x\right)^{\sigma-1}\right] \\ &= \frac{1}{1+\pi_x}\left[\widetilde{\varphi}\left(\overline{\varphi}_d\right)^{\sigma-1} + \pi_x\tau^{1-\sigma}RER^{\sigma}\frac{Y^*}{Y}\widetilde{\varphi}\left(\overline{\varphi}_x\right)^{\sigma-1}\right]\end{aligned} \tag{2.43}$$

Thus, if the two economies are non-symmetric, the weighted productivity includes a relative demand term $RER^{\sigma}Y^*/Y$ reflecting the differences in demand for intermediates from export and domestic markets.

## 2.C.2 Entrepreneurial utility

In the steady state, an entrepreneurs utility $u(\varphi) = \ln(c(\varphi)) / (1-\delta)$ where the steady state consumption level is equal to:

$$c(\varphi) = w^e + (1-\delta) a(\varphi) \tag{2.44}$$

The entrepreneur's steady state net worth is given by:

$$a(\varphi) = y_d(\varphi) \overline{p}_d(\varphi) + y_x(\varphi) \overline{p}_x(\varphi) - Rb(\varphi) \tag{2.45}$$

If the entrepreneur does not produce then, as she has no collateral, her borrowing is zero and she consumes all her wage income, i.e. $a = 0$. If the entrepreneur producers then her borrowing is pinned down by the binding borrowing constraint and so her net worth is given by:

$$\begin{aligned} a(\varphi) &= \left(1 - \theta^{\frac{\sigma-1}{\sigma}}\right) y_d(\varphi) \overline{p}_d(\varphi) + \left(1 - (\mu\theta)^{\frac{\sigma-1}{\sigma}}\right) y_x(\varphi) \overline{p}_x(\varphi) \\ &= \left(\frac{\varphi}{\overline{\varphi}_d}\right)^{\sigma-1} \frac{fw}{(\beta - \rho\Theta_d)} \left[\left(1 - \theta^{\frac{\sigma-1}{\sigma}}\right) + \left(1 - (\mu\theta)^{\frac{\sigma-1}{\sigma}}\right) \frac{f_x(\beta - \rho\Theta_d)}{f(\beta - \rho\Theta_x)} \left(\frac{\overline{\varphi}_d}{\overline{\varphi}_x}\right)^{\sigma-1}\right] \end{aligned}$$

# Chapter 3

# Financial reforms and the reallocation of production: looking across firms and sectors

## 3.1 Introduction

How do financial sector reforms affect the efficiency of the allocation of production across firms and across sectors within an economy? How do the reallocative impacts of domestic versus international financial reforms differ? This paper develops a simple theoretical model to examine these questions, building on a workhorse macroeconomic model of credit constrained investment.

The recent global financial crisis and economic downturn has sparked renewed interest in the macro-financial linkages between household, corporate and banking sector financing conditions and real macroeconomic activity. Over the past two decades a vast literature has developed on the amplification and propagation of macroeconomic shocks through their impact on the balance sheets of banks and the non-bank private sector (see, for example, Bernanke et al., 1999). Much of this literature was motivated by the experience of the Great Depression and the role of

financial factors in other economic downturns, such as in the Asian financial crisis of the late 1990s. In parallel, studies examining the fundamental question of why income levels differ across countries have increasingly focused on how inefficiencies in the allocation of production within an economy can be first order determinants of total factor productivity (TFP) differentials (Syverson, 2010). Financial factors are one type of such micro-economic distortions that can limit the efficiency of the allocation of production.[1] Building on a standard macro model of credit constraints, but focusing on the reallocative effects of financial reforms, this Chapter bridges these two literatures with the objective of analyzing the general equilibrium mechanisms by which domestic and international financial reforms affect the allocation of production. As such it also aims to provide insights for the still challenging empirical investigation of these effects.

To enable the examination of *inter-sectoral*, as well as *inter-firm*, reallocation effects of *domestic and international* financial reforms, three empirically motivated features are added to a baseline macro model of credit-constrained investment developed from Kiyotaki (1998). First, the model is adapted to a multi-sector set-up. Second, credit constraints are allowed to vary across sectors, i.e. firms' ability to pledge revenues differs across their sector of production. Third, international borrowing constraints are added to the model to allow examination of liberalization of access to international financing. The credit constraints within the model are interpreted as financial reform variables which can be adjusted by the authorities, for example, through regulations on collateral requirements, or which are altered through technological or institutional changes (for example, changes in information gathering, monitoring or bankruptcy costs).

[1] For example, Abiad et al. (2008) find that financial liberalization leads to greater allocative efficiency across firms while Wurgler (2000) finds that more developed capital markets tend to be associated with allocation of greater investment to sectors which are faster growing. Indeed, this reallocative effect may outweigh the role of financial reforms in facilitating a rise in aggregate investment. For example, Tressel et al. (2009) find that in middle-income economies the primary impact of financial reforms is on aggregate TFP rather than increased investment.

Within the model, the individually optimal investment decisions of firms adjust to changes in their ability to borrow against future revenues. These partial equilibrium decisions lead to general equilibrium adjustments in relative prices, namely relative prices across intermediate goods sectors and the domestic interest rate, in order to maintain equilibrium between the demand and supply of funds for investment. These relative price changes lead to two reallocation mechanisms - *inter-sectoral* and *inter-firm* - in response to financial reforms (i.e. when credit constraints are relaxed). As credit constraints are relaxed, the resultant changes in firms' incentives to invest depend on their productivity, leading to reallocations across firms, and on the sector of investment, shifting incentives to move production across sectors.

The degree of financial reform in the economy thus determines how production is allocated across firms and sectors. For example, as the recovery rate rises, the benefit of greater leverage boosts the investment of productive entrepreneurs more than that of the unproductive. As a result their share in total investment rises and there is an intra-firm reallocation of investment towards the productive, raising aggregate productivity (in line with the empirical evidence of Abiad et al., 2008). At higher levels of the recovery rate, the rise in investment by the productive pushes up the domestic interest rate until the unproductive find that their return from producing falls to a level at which they prefer instead only to lend to the productive. At lower levels of the recovery rate, the overall demand for investment funds falls, and relative prices and the domestic interest adjust. Unproductive firms now find it worthwhile to produce as well as to lend.

Relative to the single-sector model of Kiyotaki (1998), the additional intra-sectoral mechanism in the model smooths out comparative static adjustments in interest rates or productivity in response to financial reforms since now relative prices across sectors, as well as the domestic interest rate, also adjust to maintain equilibrium. But, on the whole the comparative statics are of a similar direction.

For example, the domestic interest rate is non-decreasing with the recovery rate, broadly similar to empirical patterns.

The structural characteristics of an economy act as conditioning factors in determining the equilibrium allocation of production for a given level of financial reform. They also influence the impact of financial reforms, i.e. there is the potential for reform complementarities.[2] These structural characteristics include the dispersion in productivity across entrepreneurs and the idiosyncratic uncertainty they face in their productivity. The latter could be thought of as stability of the business environment in terms of the risk of government expropriation of returns or other firm-level political and regulatory risks. The empirical literature finds similar factors to be important. Tressel et al. (2009), for example, find that property rights play a key role in explaining the impact of financial, and trade, reforms in developing economies. The model also points to the importance of not only the level of the aggregate credit multiplier in determining the efficiency of the allocation of production but also the difference in the credit multiplier across sectors. If this dispersion is high then in general the magnitude of the impact of financial reforms on productivity and other endogenous variables is lower.

The key features of the domestic autarky economy on the whole carry over into the more complex case of allowing for international borrowing. However, closed form solutions are not always possible due to the additional complexity introduced by the international borrowing constraint. Equilibria are still partitioned by the domestic recovery rate and policy complementarities continue to determine the impact of financial reforms. The impact of financial reforms, both domestic and international, again depends on the interaction of the direct effect of the changes in leverage and the general equilibrium effects of changes in the domestic interest rate and relative prices. The relative impact of capital account liberalization on these transmis-

[2]This is in line with the "thresholds effects" view of Kose et al. (2009), as outlined in Chapter 4, on the growth impact of financial integration.

sion channels depends upon the state of domestic financial reforms. For example, the leverage benefits of a relaxation in international credit constraints will be greater at higher levels of the overall domestic credit multiplier, or pledgeability. However, the relationship between changes in the degree of pledgeability and movements in sectoral relative prices and real interest rates is non-monotonic.[3] As a result the comparative statics for capital account liberalization are often non-ambiguous.

The impact of international financial liberalization can also vary quite markedly from that in which sectoral reallocations are switched off. For example, in the single sector model, at low levels of recovery rates, the domestic interest rate is pinned down to the productivity of the unproductive entrepreneurs and does not change with financial liberalization, either domestic or international. In contrast, when sectoral reallocations are allowed, return equalization of the unproductive may require a rise in domestic interest rates upon international liberalization.

The structure of the remainder of this Chapter is as follows. Section 3.2 draws out the main linkages with the related theoretical and empirical literature. Section 3.3 highlights the key features of the model with Section 3.4 detailing the set-up. As a baseline, Section 3.5 uses the domestic autarky setting to explore the potential for non-linearities in the impacts of financial reforms and the roles of policy complementarities. Section 3.6 then examines the impact of financial reforms when the economy is opened up to international financial flows and, finally, Section 3.7 concludes.

## 3.2 Related literature

The focus on the reallocative impact of domestic and international financial sector reforms in this paper is related to four key strands of literature. As mentioned above, the first is the broad macro theoretical literature on the impact of finan-

[3] As with the real wages and interest rates in Aoki et al. (2010).

cial frictions, including, for example, Kiyotaki and Moore (1997); Bernanke et al. (1999); Matsuyama (2008, 2007). In particular this model is based on the stripped down credit multiplier model of Kiyotaki (1998) which is one of the main building blocks of recent DSGE models incorporating credit constraints.

The second strand is the growing literature examining the role of distortions to the allocation of production as a determinant of aggregate productivity. These include, for example, recent theoretical papers such as Restuccia and Rogerson (2008) and the empirical work of Hsieh and Klenow (2009) (for a review see, for example, Syverson, 2010). Within this literature a number of papers examine different channels through which contracting institutions determine TFP growth through the production allocation channel including, for example, Caselli and Gennaioli (2006), Buera et al. (2010) and Barseghyan and DiCecio (2008).

The third strand of related literature is a set of recent theoretical papers focusing on the impact of capital account liberalization within models of financially constrained production. Depending on their focus these papers adopt a range of empirically motivated modeling structures. For example Aoki et al. (2010) and Aoki et al. (2009), on which this Chapter builds, incorporate labor market adjustments in response to financial reforms, abstracting from the sectoral reallocations within this Chapter. The work of Antràs and Caballero (2009) focuses on the interaction between international trade and capital flows within a model which incorporates both labor and capital and variation in domestic financial frictions across sectors. However, they abstract from reallocations across heterogeneous firms and make no distinction between domestic and international borrowing constraints.

The final related, and motivating, area of literature is the vast empirical literature on financial reforms and growth and productivity (see, for example, Levine, 2005, for a review). This includes papers looking at the interaction between international financial liberalization and growth (such as Henry, 2007; Kose et al., 2009) and the reallocative effects of domestic financial reforms. For example, the impact of

domestic financial liberalization on the efficiency of the allocation of production has been examined at both the sector-level, for example in Wurgler (2000), and the firm-level, for example by Abiad et al. (2008) and Galindo et al. (2007).

## 3.3 Key features of the model

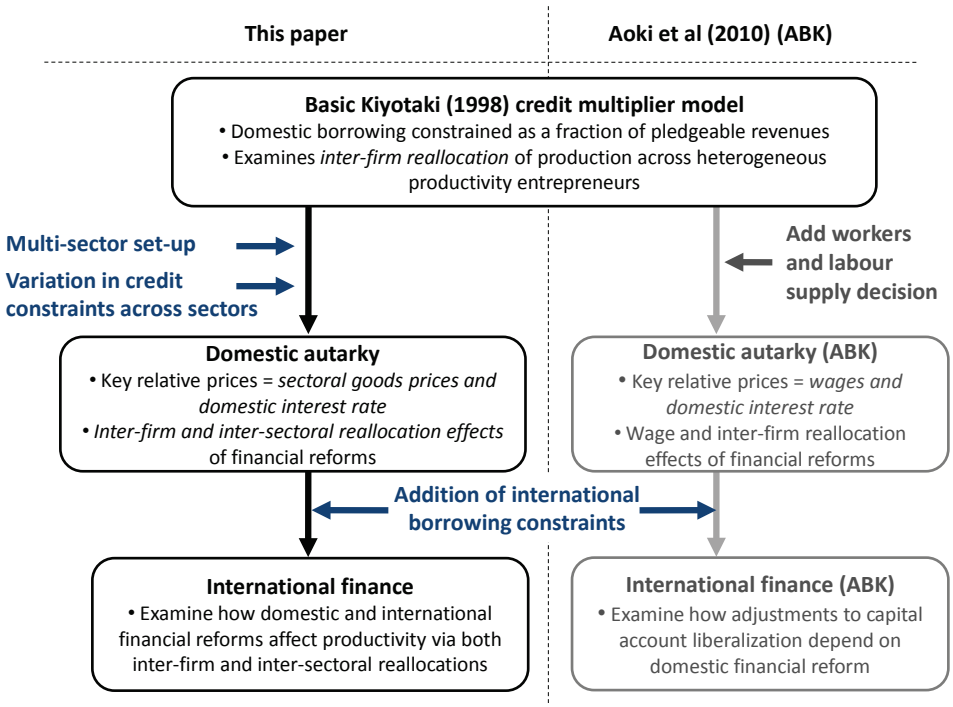
The model builds upon the basic credit multiplier model of Kiyotaki (1998) which looks at the *inter-firm* reallocation effects of *domestic* financial reforms. Entrepreneurs with heterogeneous productivities invest in this period using their own retained equity and borrowed funds in order to produce goods in the next period. However, due to the inalienability of the entrepreneur's human capital associated with the investment project, creditors can only recover a fraction of next period's pledged revenues if they take over the project in the event of default. As a result, an entrepreneur can only borrow a fraction, or credit multiplier, of next period's pledged revenues.[4]

In partial equilibrium, for the same amount of own equity investment, a higher productivity entrepreneur can produce more next period and so can pledge greater revenues to, and borrow more from, creditors than a less productive one. In general equilibrium, the interest rate will equalize the supply and demand of domestic funds. More productive entrepreneurs will borrow from the lower productivity types who earn more from lending than producing themselves. As the credit multiplier varies so the allocation of investment and production across entrepreneurs by their productivity changes, leading to an adjustment in aggregate productivity.

Three key, empirically-motivated, features are added to this basic model to enable the examination of *inter-sectoral*, as well as *inter-firm*, reallocation effects of *domestic and international* financial reforms - (i) a multi-sector set-up, (ii) allowing

[4] As in Tirole (2006) a Hart-Moore credit constraint based on inalienability of human capital of the entrepreneur can be translated into a corresponding constraint motivated by moral hazard or costly-state verification.

**Figure 3.1:** The key features of the model




for the variation in credit constraints across sectors, and (iii) the addition of international borrowing constraints. Figure 3.1 highlights these features, illustrating how the model builds on Kiyotaki (1998) and departs from the approach taken in the related work of Aoki et al. (2010).

First, to allow for inter-sectoral reallocations, entrepreneurs are able to produce in two intermediate goods sectors which are then combined into a final good. The relative prices of these intermediates, which are affected by financial reforms, help to determine the allocations of production across both entrepreneurs and across sectors.[5]

Second, in order to examine the impact of changes in access to international finance as well as domestic financial reforms, entrepreneurs are able to borrow from

[5]Along with the domestic interest rate, it is this relative price which leads to reallocations in production rather than movements in the relative wage (and domestic interest rate) in the one-sector, two factor, model of Aoki et al. (2010).

abroad. Investment decisions are made subject to both an international and an overall borrowing constraint, and the ability to pledge revenues to foreign relative to domestic creditors differs as in Aoki et al. (2009), Aoki et al. (2010) and Iacoviello and Minetti (2006). In particular, foreign creditors are assumed to be in a weaker position to extract revenues from a project which they take over in the event of default. This could be, for example, for reasons of higher transaction costs, informational disadvantage or regulatory or legal factors.[6] Senior domestic creditors will restrict their lending so that total borrowing repayments are at most equal to the revenues they can extract from the project if they take it over.

Third, the credit multiplier on next period revenues differs across intermediate goods sectors.[7] There is strong empirical support to suggest that there are sectoral differences in financing obstacles.[8] For example, Beck et al. (2006a) find sectoral dummies have significant coefficients in regressions of the degree of self-reported financing obstacles in a sample of over 10,000 firms across 80 countries surveyed in 1999 and 2000 by the World Bank Business Environment Survey.

There are a number of intuitive rationales for variations in credit multipliers across sectors. Perhaps the most simple is that policies, whether for political economy or regulatory reasons, may target different sectors. For example, this could be in the form of directed credit towards certain sectors, or indeed politically-motivated credit to individual firms. Legal and regulatory costs or treatment, such as capital adequacy requirements or loan-to-value ratios, may also vary across sectors (as, for example, under the Basel II capital adequacy rules), feeding through into variations in credit multipliers across sectors.[9]

[6] See, for example, Iacoviello and Minetti (2006), for an overview of reasons why foreign lenders may have relatively limited liquidation ability.

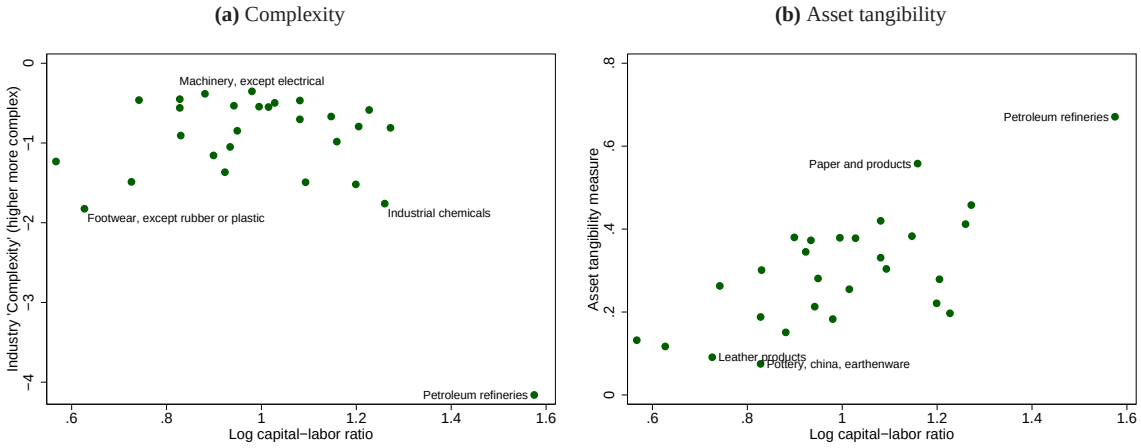
[7] To keep the model simple, this is the only difference between two sectors and so is needed to make the addition of a sectoral set-up have meaning.

[8] Variations in borrowing constraints across sectors are also seen in, for example, the models of Matsuyama (2008) and the aforementioned model of Antràs and Caballero (2009).

[9] In reality, to add further complexity, there may also be regional variations in contracting institutions or legal costs within an economy. For example, within regions in India, World Bank (2009) finds that contract enforcement costs (as a percentage of the value of the claim) vary from around

A second rationale for differential credit multipliers across sectors relates to the inalienability of entrepreneurial human capital as emphasized by Hart and Moore (1994) and employed in the macro models of Kiyotaki and Moore (1997) and Kiyotaki (1998). An entrepreneur's human capital input may be easier to replace in one sector than in an other. For example, this could be due to the complexity of the production process. Figure 3.2 illustrates the variation in measures of the "complexity" of different industries proxied by the dispersion of intermediate inputs (based on US data). The more complex a project, the more difficult it may be to replace the entrepreneur in the event of default, or to monitor the project, and hence the lower the credit multiplier on next period's revenues up to which the creditor would be willing to lend.

**Figure 3.2:** Potential rationale for variations in financial constraints across sectors - differences in "complexity" and asset tangibility across sectors




Note: Data for US 3-digit SIC manufacturing industries. Asset tangibility measure from Braun and Larrain (2005) is the industry median of the ratio of net property, plant and equipment to total assets by U.S.-publicly listed firms during the 1986–1995 period. Capital-labor and "complexity" measure from Cowan and Neut (2007) based on the 1992 US input-output tables. The complexity measure is constructed as the negative of the Herfindahl index of intermediate inputs used by an industry (i.e. the less concentrated the intermediate inputs used the more "complex" the industry).

A third related rationale concerns differences in production structures. For example, sectors differ in their levels of tangible assets which can be pledged to creditors (see the US industry variation in Figure 3.2). Although in the model of this

17-18% in Patna and in Hyderabad through to 34% and 39% respectively in New Delhi and Mumbai.

Chapter the production structure is linear in investment (which depreciates 100% between periods) there is a clear read across to a more complex production structure taking into account different capital-labor ratios and asset tangibility across sectors.

The following section details the set-up of the model in terms of entrepreneurs' objectives, technology and options to invest and borrow. It then outlines the equilibrium conditions for individual entrepreneurs (i.e. determined by the optimal return from her investment and borrowing choices) and the aggregate market clearing conditions.

## 3.4 Model

### 3.4.1 Set-up

There is a mass one of entrepreneurs who make investments to produce two types of intermediate goods and who consume a final consumption good. An entrepreneur indexed by $i$ maximises discounted log utility:

$$U_t(i) = E_t \sum_{s=t}^{\infty} \beta^{s-t} \ln(c_t(i)) \tag{3.1}$$

where $\beta$ is the discount rate and $c_t(i)$ is the entrepreneur's consumption of the final good at time $t$.

The final good, which is the numeraire, is used for consumption as well as investment and is produced from a simple constant returns to scale Cobb-Douglas technology combining the two intermediate goods. Final goods technology is open to all agents and takes place under perfect competition. Aggregate output of the final good, $Y_t$, can thus be expressed as a function of aggregate production in the

two intermediate sectors, $Y_{1,t}$ and $Y_{2,t}$ respectively:

$$Y_t = Y_{1,t}^{\gamma} Y_{2,t}^{1-\gamma} / (\gamma^{\gamma} (1-\gamma)^{1-\gamma}) \tag{3.2}$$

where $0 < \gamma < 1$ indicates the relative weight in production of the final good of the two intermediates. The relative demand schedules for each intermediate good are standard and the relative price of the intermediates is given by:

$$1 = p_{1,t}^{\gamma} p_{2,t}^{1-\gamma} \tag{3.3}$$

**Differentiation in productivity across firms** The intermediate goods are produced with a linear production technology which is identical across the two intermediate goods sectors $j \in \{1, 2\}$. With no aggregate uncertainty, the intermediate output of an entrepreneur in period $t+1$ is given by a linear combination of an entrepreneur's investment input and her productivity at time $t$, $\varphi_t(i)$, i.e. $y_{j,t+1}(i) = \varphi_t(i)\, i_{j,t}(i)$. Without loss of generality an individual entrepreneur who makes an investment does so in one sector or the other in a given period.[10] The intermediate good produced in sector $j$ has price $p_{j,t}$.

Productivity varies across entrepreneurs and, while there is no aggregate uncertainty, individual entrepreneurs face shocks to their productivity which follow a Markov process between a high and a low state (with productivities $\varphi_p$ and $\varphi_u$ respectively, $\varphi_p > \varphi_u$).[11] As in Kiyotaki (1998), the transition probabilities are such that $Prob(\varphi_{t+1}(i) = \varphi_p | \varphi_t(i) = \varphi_p) = 1-\delta$ and $Prob(\varphi_{t+1}(i) = \varphi_u | \varphi_t(i) = \varphi_u) = 1 - n\delta$. The transitions between states are assumed to be restricted in the following

[10] This could be, for example, due to an infinitesimally small additional fixed cost of producing in more than one sector. As shown below, the production choices will be identical for entrepreneurs with the same productivity levels. Thus a formulation in which entrepreneurs of a given productivity level choose one production sector or the other yields identical output levels to the formulation assuming that all entrepreneurs with a given productivity level split their output between the two sectors if they choose to produce in both sectors.

[11] The expectations operator is now dropped for notational convenience.

manner:

**Assumption 3** *The likelihood of an entrepreneur moving between high and low productivity states is such that* $\delta + n\delta < 1$.

This plausible assumption is consistent with the average likelihood of a productivity transition between periods being less than one in every two periods. This is in line with assumptions in the related literature (see the discussion of parameter values in Section 3.4.3 below). This assumption allows us to focus on stable steady state equilibria. In such equilibria, the fraction of productive entrepreneurs is equal to $n/(1+n)$.

**Variation in borrowing constraints across sectors** Overall borrowing at time $t$ by an entrepreneur $i$ is subject to the constraint that total repayments to foreign and domestic creditors, respectively $b_{j,t+1}(i)$ and $b^*_{j,t+1}(i)$, are limited to a fraction $\theta_{j,t+1}$, of the expected value of the agent's output in sector $j$ at $t+1$ (i.e. the value that the creditor can recover if they take over the project). Due to difficulties in enforcing contracts or operating projects across international boundaries, foreign borrowing is restricted to be a fraction $\psi_{t+1}\theta_{j,t+1}$ of the value of the output at $t+1$ where $\psi_{t+1}$ is less than one and, for simplicity, is assumed to be identical across sectors (Assumption 4). Thus the overall and international borrowing constraints are respectively:

$$b_{t+1}(i) + b^*_{t+1}(i) \leq \theta_{j,t+1} p_{j,t+1} y_{j,t+1}(i) \tag{3.4}$$

$$b^*_{t+1}(i) \leq \psi_{t+1}\theta_{j,t+1} p_{j,t+1} y_{j,t+1}(i) \tag{3.5}$$

**Assumption 4** *The relative recovery rate by foreign creditors compared to the domestic lead creditor is common across sectors and is equal to* $0 \leq \psi_{t+1} < 1$.

The borrowing constraints are assumed to differ depending on the sectors in which the agent produces such that revenues in sector two have a lower degree of pledgeability than in sector one:

**Assumption 5** *The recovery rate by the domestic lead creditor is higher in sector one than in sector two, i.e.* $0 < \theta_{1,t} = \theta_t \leq 1$ *and* $0 < \theta_{2,t} = \kappa\theta_t \leq 1$ *where* $0 \leq \kappa < 1$.

A further assumption on the credit multiplier and relative productivities is required to ensure that the additional return earned by productive entrepreneurs who produce and borrow is greater than or equal to the return earned by unproductive entrepreneurs on saving or producing.

**Assumption 6** $\varphi_u \geq \theta_{j,t+1}\varphi_p$

**An entrepreneur's flow of funds** The entrepreneur's flow of funds is given by:

$$c_t(i) + i_{j,t}(i) = a_t(i) + \frac{b_{t+1}(i)}{R_{t+1}} + \frac{b^*_{t+1}(i)}{R^*_{t+1}}$$

where $R_{t+1}$ is the domestic interest rate from period $t$ to $t+1$ and $R^*_{t+1}$ is the corresponding interest rate on foreign borrowing. The supply of funds at the foreign interest rate is assumed to be perfectly elastic.[12] An entrepreneur's net worth is equal to the value of her intermediate goods output (realized due to last period's investment input) minus total repayments to foreign and domestic creditors:

$$a_t(i) = p_{j,t}y_{j,t}(i) - b_t(i) + b^*_t(i)$$

[12]This is a convenient simplification. Adding a more realistic debt elastic risk premium on top of the foreign interest rate, either at the level of the firm or in aggregate, could be an interesting avenue for future research using a similar model but would add considerable complexity to the set-up.

### 3.4.2 Equilibrium conditions

Given her debt repayments and production levels entering period $t$, each entrepreneur will choose her investment in production, $i_{j,t}(i)$, her foreign and domestic borrowing and consumption levels, $b_{t+1}(i)$ and $b^*_{t+1}(i)$ respectively, to maximize discounted log utility over final goods consumption $c_t(i)$ subject to her state (described by her productivity and her net worth $a_t(i)$), the production technology, borrowing constraints, her flow of funds and aggregate prices.

With log utility the entrepreneur will consume a fraction $(1-\beta)$ of her net worth $a_t(i)$ in each period. Thus the investment from own equity that an entrepreneur makes is equal to $\beta a_t(i)$. The key question is therefore how can an entrepreneur maximise the return earned on this investment through her production and borrowing choices?

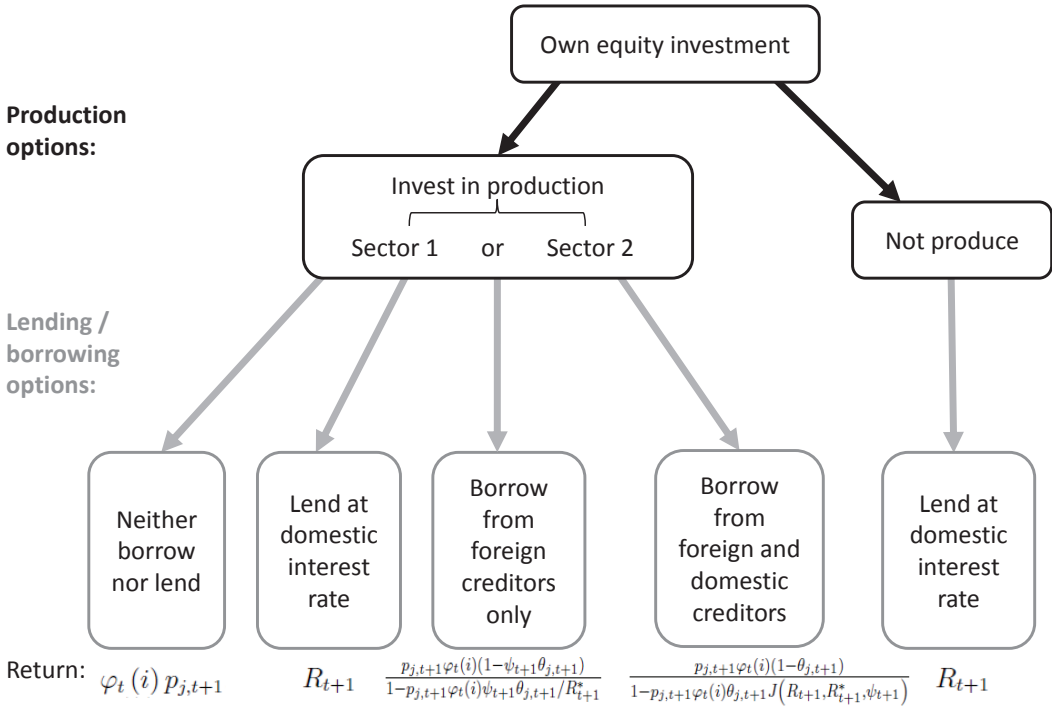
#### 3.4.2.1 Production and borrowing options

Given prices for output next period and the cost of borrowing, the rate of return earned by an entrepreneur from period $t$ to $t+1$, $R_{t+1}(\varphi_t(i))$, is dependent upon her investment and borrowing decisions. An entrepreneur will only produce if the return is at least equal to the opportunity cost of investing in production, i.e. the return that could be earned on lending out her funds. This opportunity cost is the domestic interest rate since, as there is no constraint on lending to foreigners, it must be the case that the domestic interest rate is greater than or equal to the foreign interest rate.[13] Thus, $R_{t+1} \geq R^*_{t+1}$ and the entrepreneur, if she borrows, will first borrow from abroad up to the limit of the international borrowing constraint and then borrow from domestic creditors.

The options available to an entrepreneur can thus be summarized as follows. First, simply lend domestically (given that the domestic interest rate is higher than

[13] If the foreign interest rate is above the domestic interest rate then all entrepreneurs would decide to invest abroad and there would be no funds for domestic investment and hence no consumption.

**Figure 3.3:** Entrepreneur production and borrowing options




the foreign) and receive interest rate $R_{t+1}$. An entrepreneur might not produce and lend or also lend in the case that she produces (in which case her return from production must equal $R_{t+1}$). Second, choose to produce in sector $j$ but using only internal equity funding, yielding a rate of return of $p_{j,t+1}\varphi_t(i)$. Third, produce in sector $j$ but finance via her own equity and borrowing from foreign creditors only. The fourth option is to produce in sector $j$ and borrow from both domestic and foreign creditors. If this option is chosen then the return from production must be higher than the domestic interest rate and hence the overall borrowing constraint will bind.

The respective returns of these different production and borrowing combinations are illustrated in Figure 3.3. The maximum rate of return from period $t$ to $t+1$ earned by an entrepreneur with productivity level $\varphi_t(i)$ is thus defined by:

$$R_{t+1}\left(\varphi_t\left(i\right)\right)=\max\left\{R_{t+1},\ \max_{j\in\{1,2\}}\left\{\begin{array}{c}\varphi_t\left(i\right)p_{j,t+1},\\ \frac{p_{j,t+1}\varphi_t(i)(1-\psi_{t+1}\theta_{j,t+1})}{1-p_{j,t+1}\varphi_t(i)\psi_{t+1}\theta_{j,t+1}/R^*_{t+1}},\\ \frac{p_{j,t+1}\varphi_t(i)(1-\theta_{j,t+1})}{1-p_{j,t+1}\varphi_t(i)\theta_{j,t+1}J\left(R_{t+1},R^*_{t+1},\psi_{t+1}\right)}\end{array}\right\}\right\} \quad (3.6)$$

where $J\left(R_{t+1},R^*_{t+1},\psi_{t+1}\right)\equiv\psi_{t+1}/R^*_{t+1}+\left(1-\psi_{t+1}\right)/R_{t+1}$.

The partial equilibrium impact of domestic financial reforms, as proxied by a rise in $\theta$, is thus to increase returns for those entrepreneurs who borrow since it allows greater leverage. This benefit is increasing in the productivity of an entrepreneur, since a higher productivity allows, ceteris paribus, for higher leverage levels. As returns from production are increasing in productivity so the productive entrepreneurs will always produce in equilibrium. The market interest rate is set by the indifference of unproductive entrepreneurs between producing or lending to the productive, i.e. $R_{t+1}\left(\varphi_u\right)=R_{t+1}$.

**Borrowing decisions** The productive will always borrow to produce since their return from doing so is above that of the unproductive and therefore always greater than or equal to the domestic interest rate. Since total net domestic borrowing of entrepreneurs is equal to zero, productive entrepreneurs will borrow domestically from the unproductive. Unproductive entrepreneurs will not borrow domestically but, if they produce, they will borrow from abroad up to the binding international borrowing constraint since the foreign interest rate is less than or equal to their return from production (the domestic interest rate). Furthermore, if the productive are constrained in their borrowing then their returns are greatest when borrowing from both domestic and foreign creditors because the marginal benefit of the extra leverage for next period's revenues exceeds the additional repayment.

**Decisions to invest in production in intermediate goods sectors** A necessary condition for an entrepreneur to invest in production in a sector today is that the marginal benefit from equity investment in terms of the value of next period's marginal output is greater than or equal to the marginal opportunity cost of the investment, i.e. $\varphi_p p_{j,t+1} \geq R_{t+1}$. If the productive entrepreneur is constrained then, borrowing from both home and abroad, she would earn a positive excess return from producing in sector $j$ if the intermediate price earned next period is sufficiently high relative to the interest rates:

$$p_{j,t+1}\varphi_p > R_{t+1} / \left(1 + \psi_{t+1}\theta_{j,t+1}\left(R_{t+1}/R^*_{t+1} - 1\right)\right)$$

This price cut-off for the productive falls with their productivity and, in partial equilibrium, is decreasing in the credit multiplier $\theta$. This reflects the net benefit of the higher leverage (with the returns from the higher investment outweighing the rise in repayments associated with increased borrowing). An entrepreneur is indifferent between producing in one or the other sectors when her returns are equalised.

#### 3.4.2.2 Equilibrium production combinations

In an unconstrained equilibrium, only the productive will produce and will do so in both sectors. But, what productive combinations may occur in borrowing constrained equilibria?

First, given the structure of final production, both intermediate goods must be produced in an equilibrium. Second, due to their higher relative productivities, productive entrepreneurs always produce (in at least one sector). Third, any combination of relative prices and interest rate which yields return equalization across sectors for the productive means that return equalization for the unproductive cannot hold (and vice versa). In particular, for a given interest rate, the price in sector two required to equalize returns across sectors is higher for the productive than the

unproductive.[14] This means that if the productive produce in both sectors then the unproductive will produce, if in any sectors, in sector two and if the unproductive are producing in both sectors then the returns for the productive are higher in sector one.[15]

There are therefore four possible production combinations which may occur in a credit-constrained equilibrium (see Appendix Figure 3.8). In Case A interest rates are relatively high and the unproductive do not find it worthwhile to invest in production. The productive invest in both sectors. If the domestic interest rate falls and the relative price of intermediate sector two rises sufficiently high, it becomes worthwhile for the unproductive to produce. This leads to Case B in which the productive entrepreneurs invest in both sectors and the unproductive entrepreneurs invest in sector 2. If the interest rate falls further and the relative price in sector two also declines then the productive entrepreneur's return from producing in sector 2 may fall below that in sector 1. In this range, Case C, the productive entrepreneurs invest in sector one and the unproductive entrepreneurs do so in sector 2. Finally, the interest rate may be sufficiently low that it is worthwhile for the unproductive to move also into production in section 1. This leads to a Case D in which the productive entrepreneurs invest in sector one and the unproductive entrepreneurs invest in both sectors.[16]

For the purposes of defining the equilibrium, denote by $\chi^p_{j,t}$ and $\chi^u_{j,t}$ the share of productive and unproductive entrepreneurs respectively who invest in sector $j$. Thus, $1 \geq \chi^p_{1,t} = 1 - \chi^p_{2,t} > 0$ while for the unproductive $1 > \chi^u_{1,t} \geq 0$ and

[14] This is because the lower credit multiplier in sector two has a greater detrimental effect on the relative returns of the productive (due to their higher leverage and because they borrow from home and abroad). Thus, to compensate and maintain return equalization across intermediate sectors for the productive, the price in sector two must be higher than for that required for return equalization across sectors for the unproductive.

[15] See Appendix 3.B.1 and Appendix Figure 3.8 which illustrates the production options for given intermediate prices and the domestic interest rate.

[16] Thus, in comparison to Aoki et al. (2010), since entrepreneurs have the choice to produce in two different sectors, there are now three possible equilibria in which both the productive and unproductive entrepreneurs produce rather than one in their single sector set-up.

$1 \geq \chi^u_{2,t} \geq 0$ and the share who do not invest, $1 - \chi^u_{1,t} - \chi^u_{2,t}$, is either zero or one.

#### 3.4.2.3 Entrepreneurial returns

Given these four possible constrained equilibria cases, the domestic interest rate and conditions for production of the unproductive are defined as:

$$R_{t+1} = R_{t+1}(\varphi_u) \geq \max_{j \in \{1,2\}} \left\{ \frac{p_{j,t+1}\varphi_u (1 - \psi_{t+1}\theta_{j,t+1})}{1 - p_{j,t+1}\varphi_u \psi_{t+1}\theta_{j,t+1}/R^*_{t+1}} \right\}$$

$$\text{and } 0 = \chi^u_{j,t} \left\{ R_{t+1} - \frac{p_{j,t+1}\varphi_u (1 - \psi_{t+1}\theta_{j,t+1})}{1 - p_{j,t+1}\varphi_u \psi_{t+1}\theta_{j,t+1}/R^*_{t+1}} \right\} \text{ for } j \in \{1,2\} \tag{3.7}$$

$$\left(1 - \chi^u_{1,t} - \chi^u_{2,t}\right)\left(\chi^u_{1,t} + \chi^u_{2,t}\right) = 0 \tag{3.8}$$

The productive entrepreneur will always invest in sector 1. Her borrowing constraints will bind if her return is greater than the domestic interest rate:

$$R_{t+1}(\varphi_p) = \frac{p_{1,t+1}\varphi_p (1 - \theta_{t+1})}{1 - p_{1,t+1}\varphi_p \theta_{t+1} J\left(R_{t+1}, R^*_{t+1}, \psi_{t+1}\right)} \geq R_{t+1} \tag{3.9}$$

The productive entrepreneurs only invest in sector 2 in Cases A and B, i.e. when their returns are equalized across sectors. In cases C and D the return for the productive in sector one exceeds that in sector two and hence $\chi^p_{1,t} = 1$. Productive returns and the share of productive entrepreneurs operating in sector one are thus linked as follows:

$$R_{t+1}(\varphi_p) \geq \frac{p_{1,t+1}\varphi_p (1 - \kappa\theta_{t+1})}{1 - p_{1,t+1}\varphi_p \theta_{t+1} J\left(R_{t+1}, R^*_{t+1}, \psi_{t+1}\right)} \text{ and}$$

$$0 = \left(1 - \chi^p_{1,t}\right)\left\{ R_{t+1}(\varphi_p) - \frac{p_{1,t+1}\varphi_p (1 - \kappa\theta_{t+1})}{1 - p_{1,t+1}\varphi_p \theta_{t+1} J\left(R_{t+1}, R^*_{t+1}, \psi_{t+1}\right)} \right\} \tag{3.10}$$

The proportional excess return of the productive over the unproductive, denoted

$x_t$, is defined as follows:

$$x_t = \left(R_{t+1}\left(\varphi_p\right) - R_{t+1}\right)/R_{t+1} \geq 0 \tag{3.11}$$

#### 3.4.2.4 Aggregate conditions

In equilibrium, market clearing conditions must hold in each period for domestic credit markets, intermediate and final consumption good markets. Credit market clearing implies that total domestic borrowing repayments are equal to zero:

$$B_{t+1} \equiv B^p_{t+1} + B^u_{t+1} = 0 \tag{3.12}$$

where $B^p_{t+1}$ and $B^u_{t+1}$ are total domestic borrowing repayments by productive and unproductive entrepreneurs respectively (where the unproductive, as domestic lenders, have negative repayments). The total level of repayments of foreign borrowing $B^*_{t+1}$ is limited by the foreign borrowing constraints aggregated across entrepreneurs:

$$B^*_{t+1} \leq \psi_{t+1}\theta_{t+1}\left(p_{1,t+1}\left(\varphi_p I^p_{1,t} + \varphi_u I^u_{1,t}\right) + \kappa p_{2,t+1}\left(\varphi_p I^p_{2,t} + \varphi_u I^u_{2,t}\right)\right) \tag{3.13}$$

which binds if $R_{t+1} > R^*_{t+1}$.

In order to provide a convenient expression for total investment levels denote the share of net worth of productive entrepreneurs in total net worth at time $t$ as $s_t$, where:

$$s_t = \left(\varphi_p\left(p_{1,t}I^p_{1,t-1} + p_{2,t}I^p_{2,t-1}\right) - B^{p,*}_t\right)/Z_t \tag{3.14}$$

The share of net worth at time $t$ of those productive entrepreneurs investing in sector

one is therefore given by $\chi^p_{1,t} s_t$.

The maximum constrained investment of entrepreneurs can be derived from substituting their flow of funds equation into the binding borrowing constraints. The total equity investment made by each entrepreneur is equal to $\beta$ times their net worth. Total own equity investment in sector 1 by the productive is therefore $\beta \chi^p_{1,t} s_t Z_t$ with a corresponding expression for sector two. Total investment of productive entrepreneurs in sector $j$ is given by:

$$I^p_{j,t} \leq \frac{\beta \chi^p_{j,t} s_t Z_t}{1 - \varphi_p p_{j,t+1} \theta_{j,t+1} J\left(R_{t+1}, R^*_{t+1}, \psi_{t+1}\right)} \text{ for } j \in \{1, 2\} \tag{3.15}$$

which holds with equality if $R_{j,t+1}(\varphi_p) > R_{t+1}$, i.e. if the overall borrowing constraint binds. A similar expression can be derived for the unproductive investment in sector 1 from their foreign borrowing constraint (with their investment in sector 2 derived as a residual from aggregate investment):

$$I^u_{1,t} \leq \frac{\beta \chi^u_{1,t} (1 - s_t) Z_t}{1 - \varphi_u p_{1,t+1} \psi_{t+1} \theta_{t+1} / R^*_{t+1}} \tag{3.16}$$

which binds when $R_{1,t+1}(\varphi_u) = R^*_{t+1}$.

Total demand for each intermediate good from final goods producers must equal entrepreneurial production. The relative demands for intermediates from the final goods producer implies:

$$\frac{\varphi_p I^p_{1,t-1} + \varphi_u I^u_{1,t-1}}{\varphi_p I^p_{2,t-1} + \varphi_u I^u_{2,t-1}} = \frac{\gamma}{(1-\gamma)} \left(\frac{p_{2,t}}{p_{1,t}}\right) \tag{3.17}$$

Final goods market clearing gives: $Y_t + \frac{B^*_{t+1}}{R^*_{t+1}} = C^p_t + C^u_t + I_t + B^*_t$ where $C^p_t$ and $C^u_t$ indicate total consumption of productive and unproductive entrepreneurs respectively at time $t$.

Total investment $I_t$ is the sum of investment by productive and unproductive

entrepreneurs in different sectors:[17]

$$I_t \equiv I^p_{1,t} + I^p_{2,t} + I^u_{1,t} + I^u_{2,t} \tag{3.18}$$

Summing the flows of funds across all entrepreneurs, and using the domestic market clearing condition, provides the expression for aggregate net worth, $Z_t = p_{1,t}Y_{1,t} + p_{2,t}Y_{2,t} - B^*_t = Y_t - B^*_t$. Substituting in this expression and optimal consumption into the goods market clearing condition gives:

$$\frac{B^*_{t+1}}{R^*_{t+1}} + \beta Z_t = I_t \tag{3.19}$$

In addition to these market clearing conditions, the aggregate pricing equation must be satisfied (Equation 3.3).

In terms of the dynamics of net worth, irrespective of the sector in which they decide to produce, the unproductive entrepreneurs earn a return of $R_{t+1}$ with the productive entrepreneurs earning a return of $(1 + x_t) R_{t+1}$. Thus the transition of aggregate net worth is given by:

$$Z_{t+1} = \beta Z_t \left(s_t \left(1 + x_{t+1}\right) R_{t+1} + \left(1 - s_t\right) R_{t+1}\right) = \left(1 + s_t x_{t+1}\right) R_{t+1} \beta Z_t \tag{3.20}$$

The growth rate of net worth $g_{t+1} \equiv Z_{t+1}/Z_t$ therefore depends on the savings rate and the returns to investment aggregated over productive and unproductive entrepreneurs. In period $t + 1$, the net worth of productive entrepreneurs reflects the returns of those who remain productive between $t$ and $t + 1$ and the returns of unproductive who invested at time $t$ who become productive at time $t + 1$ :

[17] Aggregate productivity can then be defined as final goods output at time $t$ over total investment at time $t - 1$:
$TFP_t = \left(\varphi_p I^p_{1,t-1} + \varphi_u I^u_{1,t-1}\right)^{\gamma} \left(\varphi_p I^p_{2,t-1} + \varphi_u I^u_{2,t-1}\right)^{1-\gamma} / \left(\gamma^{\gamma} \left(1 - \gamma\right)^{1-\gamma} I_{t-1}\right)$.

$$s_{t+1}Z_{t+1} = \beta Z_t R_{t+1}\left(s_t\left(1-\delta\right)\left(1+x_t\right)+\left(1-s_t\right)n\delta\right)$$

Thus the transition of the share of net worth held by the productive is given by:

$$s_{t+1} = \frac{s_t\left(1-\delta\right)\left(1+x_t\right)+\left(1-s_t\right)n\delta}{\left(1+s_t x_t\right)} \tag{3.21}$$

It will also prove useful to define, $X_t$, as the net worth share-weighted excess return of the productive, i.e., $X_t \equiv s_t x_t$.

#### 3.4.2.5 Equilibrium definition

Given initial levels of investment ($I^p_{1,t-1}$, $I^u_{1,t-1}$, $I^p_{2,t-1}$, $I^u_{2,t-1}$), aggregate net worth $Z_t$ and the productive entrepreneurs' net worth share $s_t$, the equilibrium dynamics of the economy are described by a path for relative prices, interest rates, excess returns, the allocation of productive entrepreneurs across sectors, entrepreneurial net worths, investment levels, and foreign borrowings ($p_{1,t}$, $p_{2,t}$, $R_{t+1}$, $R_{t+1}\left(\varphi_p\right)$, $x_{t+1}$, $\chi^p_{1,t}$, $\chi^u_{1,t}$, $\chi^u_{2,t}$, $I^p_{1,t}$, $I^p_{2,t}$, $I^u_{1,t}$, $I^u_{2,t}$, $I_t$, $B^*_{t+1}$, $s_{t+1}$, $Z_{t+1}$) that satisfy the following equations: the relative demands for intermediates (Equation 3.17); the aggregate pricing equation (Equation 3.3); the definitions of $R_{t+1}\left(\varphi_p\right)$ and $x_{t+1}$ (Equations 3.9 and 3.11 respectively); the condition for return equalization across sectors for the productive entrepreneur (Equation 3.10); the condition for the domestic interest rate to be greater than or equal to the returns earned by the unproductive with maximum leverage and the sectoral conditions for production (Equation 3.7 for each sector and (Equation 3.8); the upper bound on investment of the productive in sectors 1 and 2 (Equation 3.15 for each sector) and on the investment of the unproductive in sector 1 (Equation 3.16); goods market clearing (Equation 3.19); the definition of aggregate investment (Equation 3.18); the aggregate international borrowing constraint (Equation 3.13); the transition of aggregate net worth (Equation 3.20); the transition for the share of net worth held by the productive (Equation 3.21). In each

period this gives 16 equations in 16 unknowns.

### 3.4.3 Parameter values

Where possible, closed form solutions are derived for steady state comparative statics. Graphical illustrations and, when necessary, numerical solutions require baseline parameter values which, on the whole, are set to follow those of Aoki et al. (2010). A range of sensitivity analysis is conducted around the baseline values.

High productivity entrepreneurs are assumed to produce $1.2$ units of output for every unit of investment, i.e. $\varphi_p = 1.2$, while the productivity of low productivity entrepreneurs is $\varphi_u = 1.05$. As noted by Aoki et al. (2010) this is somewhat lower than the ratio of 75th to 25th of plant level productivity in the US of around $1.3$. It is also below comparative ratios of $2.5$ and $2.3$ found by Hsieh and Klenow (2009). The baseline parameters for the idiosyncratic shocks to productivity are set at $n = 0.1$ and $\delta = 0.15$. Taking each period as a year this means that the probability of a productive entrepreneur receiving an adverse shock in a year is $15\%$ and the probability of a favorable productivity shock for an unproductive entrepreneurs is $1.5\%$. This implies a steady state share of productive agents of $9\%$ who expect to remain with high productivity for $6.7$ years (i.e. $1/\delta$). These parameter values satisfy Assumption 3 which allows us to focus on steady state equilibria and are also in line with the related literature.[18] The discount factor $\beta$ is set at $0.96$ which, combined with the high productivity parameters, implies that in autarky net worth growth reaches up to 15 percent in the unconstrained equilibrium. The parameters

[18]For example, in a model with transfer of talent across finite-lived generations, Caselli and Gennaioli (2006) set transition probabilities to match evidence on intergenerational correlation of talent (as proxied by IQs) and the fraction of talented managers. This gives a calibrated value for the likelihood of a talented individual having talented offspring of $0.46$ and of an untalented individual having untalented offspring of $0.96$. Translated into the current set-up, this would be equivalent to setting $\delta + n\delta = 0.58$. Note, however, that these are the transition probabilities across generations. In a model using the transition of productivity across years for a given individual, the symmetric transition probabilities used by Eisfeldt and Rampini (2006) are $0.25$, i.e. states change every four years, which is also broadly in line with the assumption.

for the relative weight in final goods production of the sector one intermediate and for the relative credit multiplier in sector two are set at $\gamma = 0.7$ and $\kappa = 0.9$ respectively to provide some, but not extreme, differentiation across sectors. Finally, as in Aoki et al. (2010) the baseline value for $\psi$ is one half (i.e. foreign creditors are assumed only to be able to recover half the net project value that domestic creditors) and the foreign real interest rate is set at $4\%$.

## 3.5 Domestic financial reforms with a closed capital account

Before moving to the set up with a liberalized capital account, this section highlights the key features of the model equilibria in the baseline case of financial autarky, focusing on the two reallocation mechanisms at play during financial reforms, i.e. *inter-sectoral* and *inter-firm*. The discussion below first considers the nature of the equilibria in the model and then the comparative statics of financial reforms on the steady state equilibria, including conditioning factors and reform complementarities.

### 3.5.1 Recovery rates and the partitioning of equilibria

The different types of potential competitive equilibria are partitioned by the value of the state variable, namely the share that productive entrepreneurs have in total net worth $s_t$. This is because $s_t$ determines the returns from different production and borrowing choices through expectations of relative prices in the next period and the domestic interest rate (Proposition 3). Since the level of recovery rates in the economy influences these returns, the cut-offs for the state variable can be expressed as a function of $\theta_{t+1}$.[19]

[19] See Appendix Figure 3.9 for a graphical illustration.

**Proposition 3** *For given model parameters, the type of equilibria at time $t$ is uniquely determined by the state variable of the share of the productive entrepreneurs in total net worth entering the period, $s_t$:*

- $s_t > s_A(\theta_{t+1})$*: unconstrained equilibria with only productive investing in production.*
- $s_B(\theta_{t+1}) < s_t \leq s_A(\theta_{t+1})$*: constrained equilibria (A) in which only the productive invest in production (in both sectors).*
- $s_C(\theta_{t+1}) < s_t \leq s_B(\theta_{t+1})$*: constrained equilibria (B) in which the productive invest in production in both sectors and the unproductive also invest in production in sector two only.*
- $s_D(\theta_{t+1}) < s_t \leq s_C(\theta_{t+1})$*: constrained equilibria (C) in which the productive only invest in production in sector one and the unproductive invest in production in both sectors.*
- $s_t \leq s_D(\theta_{t+1})$*: constrained equilibria (D) in which the productive invest in production in sector one and the unproductive in sector 2.*

**Proof.** See Appendix 3.B.2. ■

The channel through which the state variable affects these relative prices is through the investment decision of entrepreneurs. For example, if there is a rise in the share of net worth held by the productive, i.e. $s_t$ rises, then the partial equilibria effect would be for the productive entrepreneurs to increase their investment via two mechanisms. First, their own equity investment relative to $Z_t$ (i.e. $\beta s_t$) would increase directly. Second, increasing their own equity investment would increase expected revenues next period, which can be pledged to facilitate greater borrowing to finance investment. But, if $s_t$ rises there is a lower share of domestic net worth available for domestic lending by the unproductive, pushing up the interest rate. To

maintain a given pattern of returns associated with an equilibrium (e.g. productive return equalization in the example of a case A equilibria) relative prices of intermediates must adjust.[20] This general equilibria adjustment in relative prices and the interest rate can have two reallocative effects. First, it will affect the incentives to invest of high and low productivity firms differently leading to a reallocation of production across firms. Second it will lead to a change in the incentives to produce in different sectors. The overall effect is to reduce borrowing as a share of total net worth in the economy.

For given $s_t$ and $\theta_{t+1}$, the unique value of $s_{t+1}$ is given by the transition Equation 3.21. The model steady states are stable and unique and can be partitioned by the level of recovery rates within the economy.[21]

**Proposition 4** *In the financial autarky steady state, there are five possible types of locally stable equilibria partitioned by the level of recovery rates, $\theta$, which correspond to the different production combinations outlined in Proposition 3.*

- $\theta > \theta_A$*: unconstrained equilibria with only the productive entrepreneurs investing in production in both sectors.*
- $\theta_B < \theta \leq \theta_A$*: constrained equilibria type (A);*
- $\theta_C < \theta < \theta_B$*: constrained equilibria type (B);*
- $\theta_D < \theta \leq \theta_C$*: constrained equilibria type (C);*
- $\theta \leq \theta_D$*: constrained equilibria type (D).*

**Proof.** See Appendix 3.B.3. ■

[20] Similarly in Kiyotaki (1998) the interest rate adjusts while in Aoki et al. (2010) both the domestic interest rate and the other relative price in their model, i.e. wages, adjust.

[21] Although not the focus of this Chapter, transitional dynamics may also differ markedly depending on the nature of the constrained steady state with jumps to the new steady state for type A and C equilibria and smoother, concave, transitional dynamics for type B and D.

### 3.5.2 Domestic financial reforms and the reallocation of investment across firms and sectors

In domestic autarky closed form solutions for the comparative statics of financial reforms can be derived as detailed in Proposition 5 (and as illustrated in Appendix Figure 3.10).

**Proposition 5** *The comparative statics of financial reform in the autarky constrained steady state equilibria are such that:*

1. *the domestic interest rate:* $\partial R/\partial\theta \geq 0$ *(*$= 0$ *in Case D);*

2. *relative intermediate prices:* $\partial(p_2/p_1)/\partial\theta < 0$ *in Case A,* $> 0$ *in Cases B and C and* $= 0$ *in Case D*

3. *the share of net worth of the productive and their excess returns:* $\partial s/\partial\theta \geq 0$*,* $\partial x/\partial\theta \geq 0$ *in Case B and D (*$< 0$ *in Cases A and C);*

4. *the growth rate of aggregate net worth* $\partial g/\partial\theta = \beta((1+X)\,\partial R/\partial\theta + R\partial X/\partial\theta) > 0$ *in Cases A, B, D and* $\gtrless 0$ *in Case C*

5. *the share of productive entrepreneurs investing in production in sector 1:* $\partial\chi_1^p/\partial\theta < 0$ *for* $0 < \chi_1^p < 1$ *(i.e. Cases C and D);*

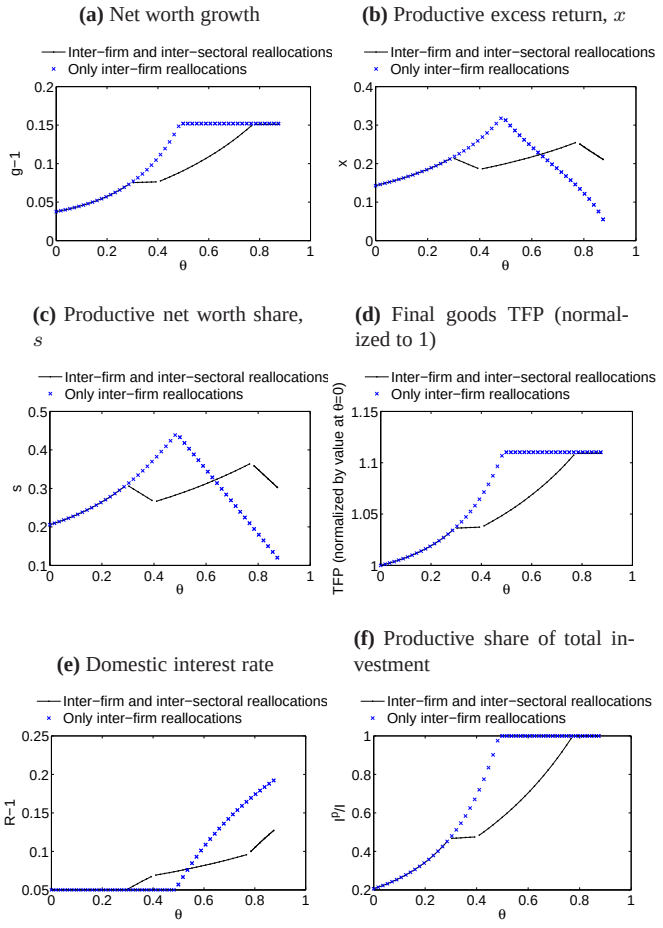
6. *investment levels:* $\partial I_1^p/\partial\theta > 0$ *in Cases B, C and D and* $\gtrless 0$ *in Case A,* $\partial I_2^p/\partial\theta > 0$ *for* $I_2^p > 0$ *(i.e. Cases A and B),* $\partial I_1^u/\partial\theta > 0$ *for* $I_1^p > 0$ *(i.e. Case D) and* $\partial I_2^u/\partial\theta < 0$ *for Cases B and C and* $< 0$ *for Case D.*

**Proof.** See Appendix 3.B.4. ■

Looking across steady states, the reallocation in production in response to domestic financial reforms (as proxied by increases in pledgeability of revenues, $\theta$) when the economy is financially constrained involves movements in resources across

sectors and between productive and unproductive firms. To illustrate the two reallocative channels the steady state comparative statics of this model can be compared to those of the model of Kiyotaki (1998) in which sectoral reallocations are switched off (Figure 3.4).

**Figure 3.4:** Domestic financial reforms and the steady state impact of reallocations across firms and sectors - the autarky case




Note: Base parameters are $\gamma = 0.7$;$\kappa = 0.8$;$\theta = 0.7$;$\varphi_p = 1.2$;$\varphi_u = 1.05$; $n = 0.1$; $\delta = 0.15$; $\beta = 0.96$. Model with inter-firm and inter-sectoral reallocations is the base model. The model without sectoral reallocations is adapted from Kiyotaki (1998).

As the recovery rate $\theta$ rises, the greater leverage benefits boost the investment of the productive entrepreneurs more than that of the unproductive. As a result their share in total investment rises, i.e. as in Kiyotaki (1998) there is an intra-firm reallocation of investment towards the productive, raising aggregate productivity (in

line with the empirical evidence of Abiad et al., 2008).

The nature of the intra-sectoral reallocations in response to financial reforms depends on the constrained equilibria type. These reallocations reflect two channels. The first is the direct impact through the partial equilibrium increase in relative returns in sector one due to its higher relative recovery rate. The second effect is through the adjustment in relative prices.

Except for in Case D where the unproductive produce in both sector, in constrained equilibria, the rise in investment induced due to a rise in the recovery rate leads to an increase in the domestic interest rate so as to maintain funds market equilibrium in which available credit is a fixed share of investment to net worth. In Case D the direct impact of a higher $\theta$ induces a reallocation of investment of the unproductive towards sector two since the investment of the productive in sector one rises and the relative outputs across the two sectors is held constant by the fixed relative price.

In the equilibria other than Case D, relative prices of intermediate goods also adjust in response to changes in the domestic recovery rate $\theta$. For example, when the productive produce in both sectors and the unproductive do not produce (i.e. case A), a rise in the interest rate dampens relative returns in sector one (given the greater pledgeability of that sector) and so the relative price of sector two falls. But, the return effect dominates and the share of productive entrepreneurs in sector one falls and the overall share of investment in that sector. In the cases where the unproductive also produce the rise in the domestic interest must be accompanied by a rise in the price of sector two in order that their return indifference is maintained.[22] In case B when the productive also produce in both sectors, this induces a rise in the investment, and in the share of entrepreneurs, of the productive in sector two, crowding out the unproductive. But the direct effect of the rise in $\theta$ on production in sector one dominates resulting in a rise in the share of investment in sector one. In

[22]Recall that in these cases $R = p_2\varphi_u$

case C, while there is no shift in the number of producers in each sector the direct effect on relative returns of the rise in $\theta$ also dominates the impact of the relative price adjustment and the overall share of investment in sector one rises.

The additional intra-sectoral mechanism in this model smooths out the adjustment process relative to that in Kiyotaki (1998). But, on the whole the comparative statics are in a similar direction. For example, the domestic interest rate is non-decreasing with $\theta$ (Figure 3.4). The improvement in pledgeability increases the ability to borrow and hence relative prices must adjust to dampen the potential rise in borrowing and maintain the fixed share of investment to net worth. This requires a rise in the domestic interest rate in all equilibria but type D, in which the interest rate is pinned down to the productivity of the unproductive entrepreneur. The non-decreasing relationship from the model is broadly similar to empirical patterns (see Figure 3.5).

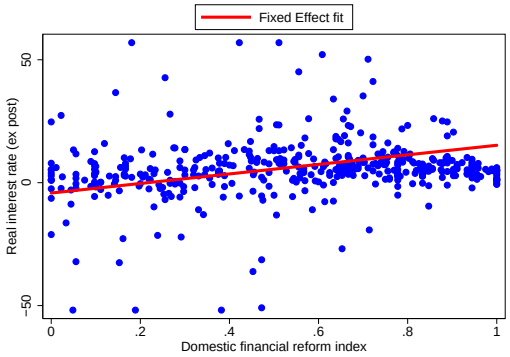
The positive real interest rate effect is one of two channels through which changes in pledgeability affect the steady state growth rate of aggregate net worth. The second is the potentially offsetting (Cases A and C) or magnifying (Cases B and D) reduction in the importance of the excess returns of the productive entrepreneurs, $X$. The overall effect of a rise in $\theta$ on the growth rate of aggregate net worth is positive in all but Case C for which it is ambiguous.

### 3.5.3 Conditioning factors, reform complementarities

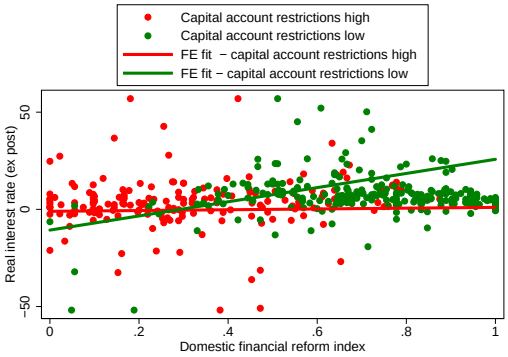
Structural characteristics act as conditioning factors, determining the type of equilibria for a given level of financial reform. They also influence the impact of domestic financial reforms, i.e. there may be reform complementarities. These structural characteristics include the dispersion in productivity across entrepreneurs and the idiosyncratic uncertainty they face in their productivity, which could be thought of as a risk of government expropriation of returns or idiosyncratic political

**Figure 3.5:** Real lending interest rates (ex post) and financial reforms (five-year averages, 1973-2003)

**(a)** Full sample




**(b)** Sample split by degree of capital account liberalization




Note: Nominal lending interest rate deflated by CPI inflation. Index of domestic financial reforms is the overall reform index of Abiad et al. minus restrictions on international capital flows (with the resultant index rescaled to lie between zero and one where a higher value is less restrictions). Capital account restrictions classed as high if over 0.5 (again corresponding index from Abiad et al. rescaled to lie between zero and one) and low otherwise. Regressions include period and country fixed effects.

Source: Abiad et al. (2010), World Bank World Development Indicators and author's calculations.

and regulatory risk. The empirical literature finds similar factors to be important. For example, Tressel et al. (2009) find that "variation in the quality of property rights helps explain the heterogeneity of the effectiveness of financial and trade reforms in developing countries. The evidence suggests that sufficiently developed property rights are a precondition for reaping the benefits of economic reform".

The likelihood of the economy being in different steady state equilibria depends crucially on the structural parameter values. The closed form comparative statics of the recovery rate cut-offs for the different equilibria types are given in Proposition 8 in the Appendix and in Appendix Figure 3.11. For example, if the difference in credit constraints across sectors is sufficiently high, i.e. $\kappa$ relatively low, or the share of productive entrepreneurs relatively low, then the cut-off for $\theta$ above which lies the range for the unconstrained steady state may be greater than 1, i.e. the unconstrained state is not possible.

Similarly, an economy is more likely to be in the unconstrained equilibrium if

there is a higher steady state share of productive entrepreneurs and if the divergence between the credit multipliers in the two sectors is lower. The likelihood that the unproductive produce is decreasing in the share of productive entrepreneurs ($n$) and their relative productivity differential ($\varphi_p/\varphi_u$) and increasing in the probability that the productive suffer an adverse productivity shock ($\delta$, for given $n$). It may also be the case that the cutoffs do not lie within the possible range for $\theta$.

The potential for reform complementarities implies, for example, that the impact of financial reforms depends on the dispersion of credit multipliers across sectors. If this dispersion is high, i.e. a lower $\kappa$, the marginal impact of changes in $\theta$ on the domestic borrowing potential, and hence the change in relative prices through the aggregate investment constraint, is lower and as a result in general the magnitude of the impact of financial reforms on the key endogenous variables is reduced. In line with the empirical results of Tressel et al. (2009) cited above, a more stable business environment, as proxied by a lower probability of adverse productivity shocks for the productive entrepreneur ($\delta$ falls), also plays a role in determining the impact of financial reforms. The partial derivative of the reform impact with respect to $\delta$ varies but in general at lower levels of $\theta$ the marginal impact of financial reforms is higher if the probability of adverse shocks to the productive is lower.

## 3.6 Allowing for capital account liberalization

The key features of the domestic autarky economy carry over into the set-up allowing for international borrowing. This includes the partitioning of equilibria by the domestic recovery rate and the role of policy complementarities in determining the impact of financial reforms. However, closed form solutions are not always possible due to the additional complexity introduced by the international borrowing

constraint.[23] Numerical solutions are required in many cases and the continuity of the ranges of $\theta$ for the different equilibria and the non-ambiguity of the comparative static results are no longer guaranteed.

Proposition 6 sets out the different possible steady state equilibria in the international finance case. The possibility of interest rate equalization is restricted to equilibria in which only the productive produce. In the cases that the unproductive entrepreneurs also produce, the steady state equilibria are only defined for $R > R^*$ since if the international borrowing constraint does not bind then there are insufficient equations for the number of endogenous variables.

**Proposition 6** *With financial integration, there are six possible types of unique steady state equilibria, all locally stable, which may exist.*

- *Unconstrained equilibria - For $\theta > \theta_{A,IF} > \theta_A$, the entrepreneurs are unconstrained and only the productive entrepreneurs produce, in both sectors, and they borrow from home and abroad.*

- *Type A without interest rate equalization (denoted $_{A,IF,R>R^*}$) - The productive entrepreneurs produce only and the international borrowing constraint (IBC) binds, i.e. $R > R^*$, if $\theta$ is in the set:*

$$A_{IF,R>R^*} = \left\{ \theta \in [0, \varphi_u/\varphi_p) : \begin{array}{c} \theta \leq \theta_{A,IF} \;\; R_{A,IF,R>R^*}(\theta) > R^* \\ R_{A,IF,R>R^*}(\varphi_u)(\theta) < R_{A,IF,R>R^*}(\theta) \end{array} \right\}.$$

  *where $\theta_{A,IF}$ is the upper bound for the range of values for which $X_A^{IF}(\theta)$ is positive.*

- *Type A with interest rate equalization (denoted $_{A,IF,R=R^*}$) - Only the produc-*

[23] In particular, with international finance the ratio of investment to net worth is no longer an exogenous constant.

*tive entrepreneurs produce and* $R_{A,IF,R=R^*}(\theta) = R^*$ *if* $\theta$ *is in the set:*

$$A_{IF,R>R^*} = \{\theta \in [0, \varphi_u/\varphi_p) : X_{A,IF,R>R^*}(\theta) \geq 0 \quad R_{A,IF,R=R^*}(\varphi_u)(\theta) < R^*\}.$$

- *Type B (denoted* $_{B_{IF}}$*): The IBC binds and the productive produce in both sectors and the unproductive in sector two only. The relevant set for* $\theta$ *is defined by:*

$$B_{IF} = \left\{ \theta \in [0, \varphi_u/\varphi_p) : \begin{array}{c} X_{B,IF}(\theta) \geq 0 \;\; R_{B,IF}(\theta) > R^* \\ \overline{I}^u_{B,IF,2}(\theta) > 0 \;\; 1 > \chi^p_{B,IF}(\theta) \end{array} \right\}$$

- *Type C (denoted* $_{C_{IF}}$*): The IBC binds with the productive producing in sector one and the unproductive in sector two if* $\theta$ *lies in the following set:*

$$C_{IF} = \left\{ \theta \in [0, \varphi_u/\varphi_p) : \begin{array}{c} \theta \leq \theta_{C,IF} \;\; R_{C,IF,1}(\varphi_p)(\theta) > R_{C,IF,2}(\varphi_p)(\theta) \\ R_{C,IF}(\theta) > R^* \;\; R_{C,IF,2}(\varphi_u)(\theta) > R_{D,IF,1}(\varphi_u)(\theta) \end{array} \right\}$$

*where* $\theta_{C,IF}$ *is the upper bound for the range of values for which* $X^{IF}_C(\theta)$ *is positive (with* $\theta_{C,IF} > \theta_C$*).*

- *Type D (denoted* $_{D_{IF}}$*): The productive produce in sector one and the unproductive in both sectors with the IBC binding. The relevant set for* $\theta$ *is:*

$$D_{IF} = \left\{ \theta \in [0, \varphi_u/\varphi_p) : \begin{array}{c} X_{D,IF}(\theta) \geq 0 \;\; \overline{I}^u_{D,IF,1}(\theta) > 0 \;\; \overline{I}^u_{D,IF,2}(\theta) > 0 \\ R_{D,IF,1}(\varphi_p)(\theta) > R_{D,IF,2}(\varphi_p)(\theta) \;\; R_{D,IF}(\theta) > R^* \\ R_{D,IF,1}(\varphi_u)(\theta) = R_{D,IF,2}(\varphi_u)(\theta) \end{array} \right\}$$

**Proof.** See Appendix 3.B.6. ■

Numerical solutions illustrate that the influence of structural conditioning factors on the type of equilibria is on the whole in a similar direction to that in autarky

(see Appendix Figure 3.12). For example, increasing the probability of adverse productivity shocks to the productive, i.e. increasing $\delta$, increases the range over which the unproductive produce in both sectors, leading to the lowest TFP. In addition, for some parameter values there may not exist a steady state equilibrium.

The impact of financial reforms, both domestic and international, again depends on the interaction of three different effects: the direct leverage effect and general equilibrium changes in the domestic interest rate and relative prices. The relative magnitude of these effects due to capital account liberalization depends upon the state of domestic financial reforms. The leverage benefits of a relaxation in international credit constraints, $\psi$, will be greater at higher levels of overall pledgeability. In contrast the price and real interest rate impacts vary with $\theta$.[24] This differential nature of the relationship between the domestic interest rate and domestic financial reforms by the level of capital account liberalization is also suggested in the available data (Figure 3.5).

As a result the comparative statics for capital account liberalization may be ambiguous.[25] However, it can be shown that capital account liberalization increases the excess return for productive entrepreneurs and their share of net worth (Proposition 7).

**Proposition 7** *International financial reforms: In each type of steady state in which the international borrowing constraint is not binding, for given $\theta$, opening up the capital account through loosening the restrictions on foreign borrowing (i.e. increasing $\psi$) increases the productive entrepreneurs' excess return and share of net worth relative to their value in autarky. This is due to the additional leverage possi-*

[24] As with the real wage and interest rate impact in Aoki et al. (2010).

[25] The sensitivities of the key variables to domestic financial reforms, i.e. changes in $\theta$, are in general in a similar direction to in the autarky case (see Appendix Figure 3.13). However, the additional complexity of the model means that in some cases they are now ambiguous or differ in direction to those in financial autarky. For example, with international finance, the domestic interest rate the equilibria in which the unproductive produce in both sectors (type D) is now decreasing in $\theta$ (whereas it is constant in the Case D autarky equilibrium).

*ble through foreign borrowing. The sensitivity of the domestic interest rate to a rise in $\psi$ varies across steady states. In case A with the IBC binding $R = R^*$ but the sensitivity is ambiguous for $R > R^*$ (and also in Case C). In Case B the interest rate rises with capital account liberalization but falls in Case D.*

**Proof.** See Appendix 3.B.6. ■

As in the autarky case we again can compare this model to one with only inter-firm reallocations.[26] Numerical illustrations highlight that the impact of international financial liberalization can vary quite markedly from that in which sectoral reallocations are switched off.

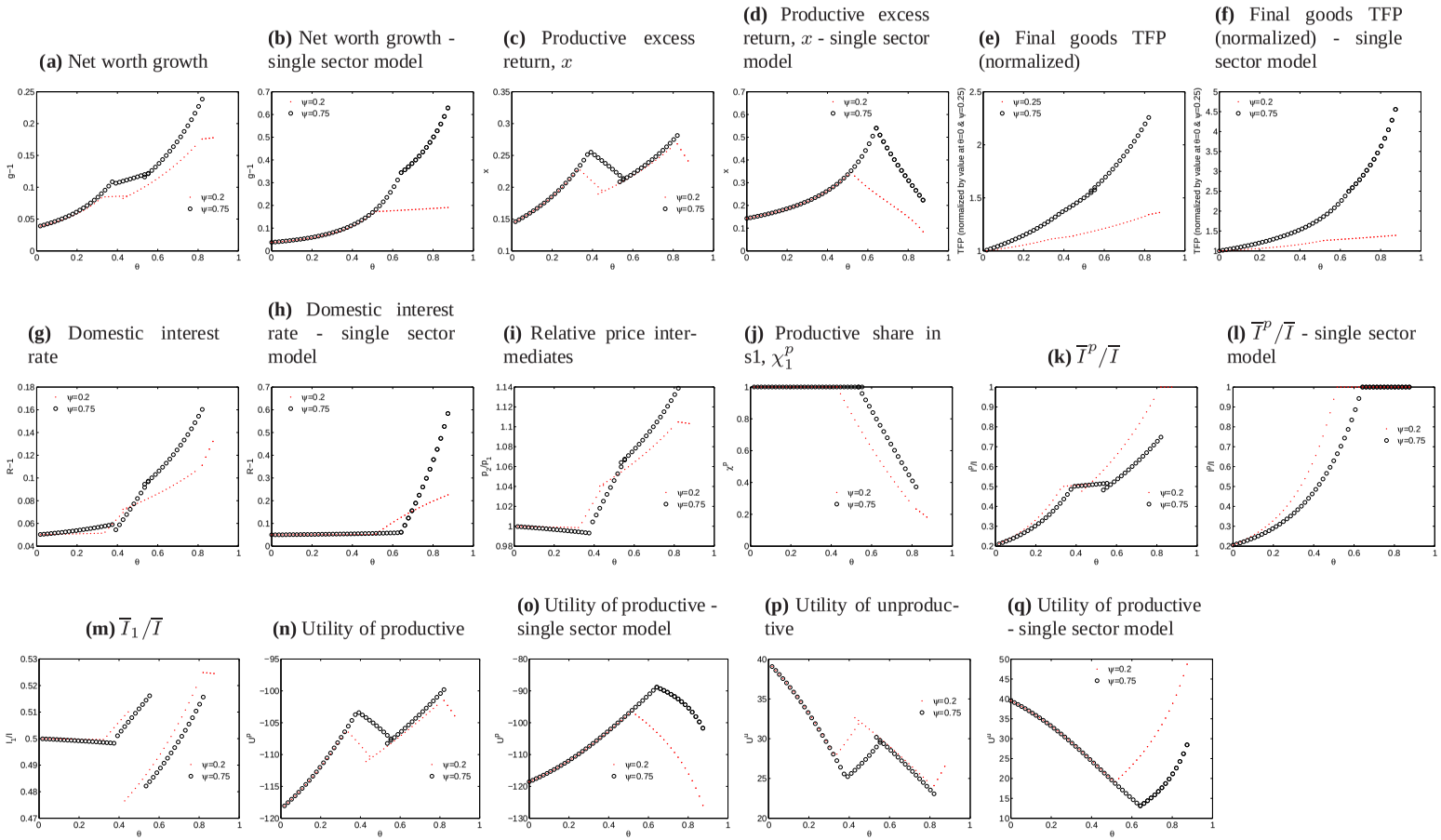
This is seen for example in the response of the domestic interest rate and the excess return of productive entrepreneurs (Figure 3.6). For very high levels of domestic recovery rates, with only the productive producing, the leverage benefits of an increased ability to borrow from abroad boosts the returns in sector one more than in sector two (given the higher pledgeability in that sector). Relative prices in sector two must rise to maintain return equalization for the productive. The domestic interest rate rises as the increased demand for funds for investment more than offsets the increased availability of funds from abroad. This channel is similar to the baseline one-sector model. However, with two sectors, productive entrepreneurs also shift into sector one since the leverage benefit of the liberalization for this sector more than offsets the reduction in relative returns due to the fall in sector one's relative price. Although the rise in the domestic interest rate induces a greater share of unproductive investment in total investment, the overall effect of the higher production for both productive and unproductive is to increase TFP. At middle levels of domestic financial development, greater international financial liberalization can lead to a fall in domestic interest rates. The relaxation of the overall borrowing constraint has a greater impact on the supply of funds requiring a fall in the domestic

[26] This is based on the numerical steady state solutions of an extension of the baseline model of Kiyotaki (1998) to add international borrowing constraints as described in Section 3.4.

interest rate to maintain market clearing for investment funds. At lower levels of domestic financial reforms, return equalization of the unproductive may require a rise in domestic interest rates upon international liberalization. In contrast, in the single sector model the domestic interest rate is here pinned down to the productivity of the unproductive entrepreneurs.

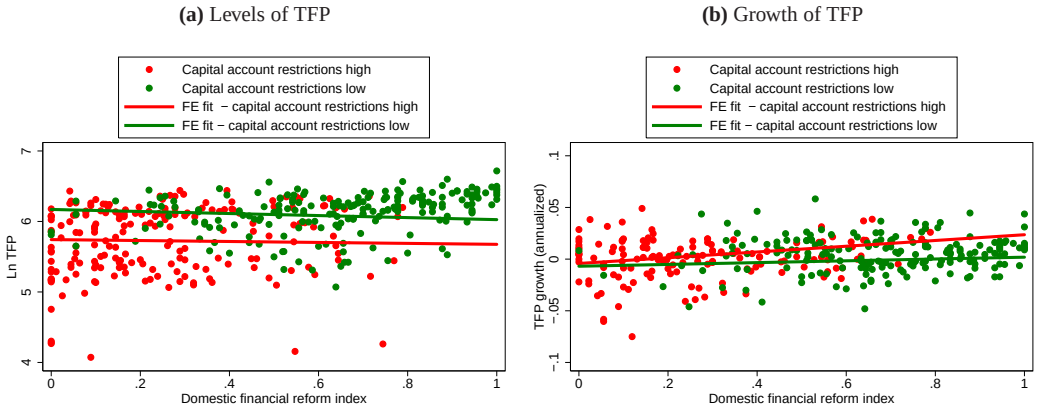
Thus, in general, both domestic and international financial reforms lead to higher interest rates as the ability to borrow for investment rises. Production shifts towards productive entrepreneurs and across sectors in response to the relative price movements and aggregate productivity rises. This is broadly in line with the stylized facts which show a higher level of TFP as domestic financial reforms rise (see Figure 3.7). But, once the role of structural factors, for example, firm-level uncertainty and relative productivity, is taken into account (as proxied by country fixed effects in Figure 3.7) the relationship between TFP and financial reforms is more ambiguous.

**Figure 3.6:** Steady state reallocations across firms and sectors due to international financial liberalization




Note: Base parameters are $\gamma = 0.7$; $\kappa = .8$; $\theta = 0.7$; $\varphi_p = 1.2$; $\varphi_u = 1.05$; $n = 0.1$; $\delta = 0.15$; $\beta = 0.96$; $R_f = 1.04$. Single-sector model is Kiyotaki (1998) extended with the addition of international borrowing constraints as described in Section 3.4. Comparative statics of $s$ are same pattern as $x$.

**Figure 3.7:** TFP and financial reform indices (five-year averages, 1973-2003)




Note: TFP estimates taken from Klenow and Rodriguez-Clare (2005) and financial reform index data from Abiad et al. (2010) and Tressel and Detragiache (2008). Index of domestic financial reforms is the overall reform index of Abiad et al. minus restrictions on international capital flows (with the resultant index rescaled to lie between zero and one where a higher value is less restrictions). Capital account restrictions classed as high if over 0.5 (again corresponding index from Abiad et al. rescaled to lie between zero and one) and low otherwise. Regressions include period and country fixed effects.

## 3.7 Conclusions

This Chapter has set out a simple extension of a stripped down version of a standard credit multiplier model used in the macro literature to examine the inter-sectoral and inter-firm reallocation effects due to domestic and international financial reforms. Financial factors affect the domestic interest rate through adjustments in constrained investment demand. In turn the relative prices necessary for firms to produce must adjust to offset changes in their cost of finance. This provides an alternative channel of relative price adjustment to the wages channel which is emphasized by Aoki et al. (2010).

The non-linearities in the impacts of domestic and international financial reforms, and the role of conditioning factors, fit with the nuanced empirical evidence on the impact of financial reforms on TFP and growth. However, this advantage must be set against the clearer analysis of patterns of propagation and amplifica-

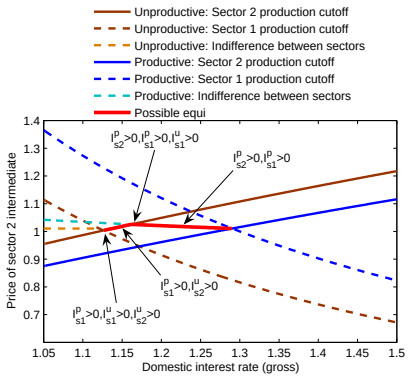
tion of shocks that can be achieved through using more standard one-sector credit multiplier models.

Nevertheless this relatively simple model has the potential to be used for a range of further research questions. The first is to examine the nature of the transitional dynamics in response to liberalization of domestic financial reforms and capital account liberalization. Indeed, the initial motivation for this research project was to provide such a theoretical framework to take to the sectoral empirical data. The second set of questions is how the results are sensitive to modifications of the set up. For example, the production structure could be expanded to include labor and capital (which in a model of constant returns and fixed labor supply would pin down the steady state growth rate).[27] Another interesting extension is to follow the approach of Matsuyama (2007) where the productivity in each sector varies as well as the credit multiplier. This may be intuitive since, for example, a potentially high return sector may also be one in which it is harder for a creditor to take over and operate efficiently in the case of default. Finally, the framework could be used to explore the political economy of financial reforms, along the lines of Rajan and Zingales (2003). For example, the different credit multipliers across sectors may be used to highlight the macro impact of directed credit policies on productivity, which is perhaps of increasing interest given the increased role of the state in many financial sectors due to the global financial crisis.

[27] At a first pass the main results of the model would seem to go through when adding a simple labor side but adding wage elastic labor supply would require additional assumptions, for example, on the labor elasticity parameter, to pin down unique steady states for a given $\theta$.

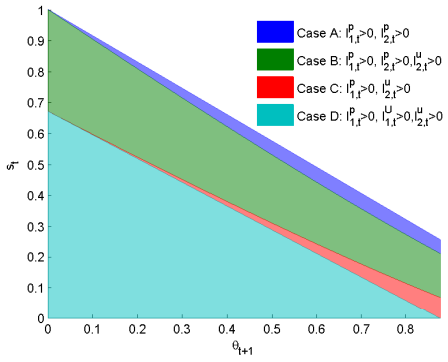
# 3.A Appendix: Additional figures

**Figure 3.8:** Entrepreneurial investment options for given domestic interest rates and next period intermediate prices



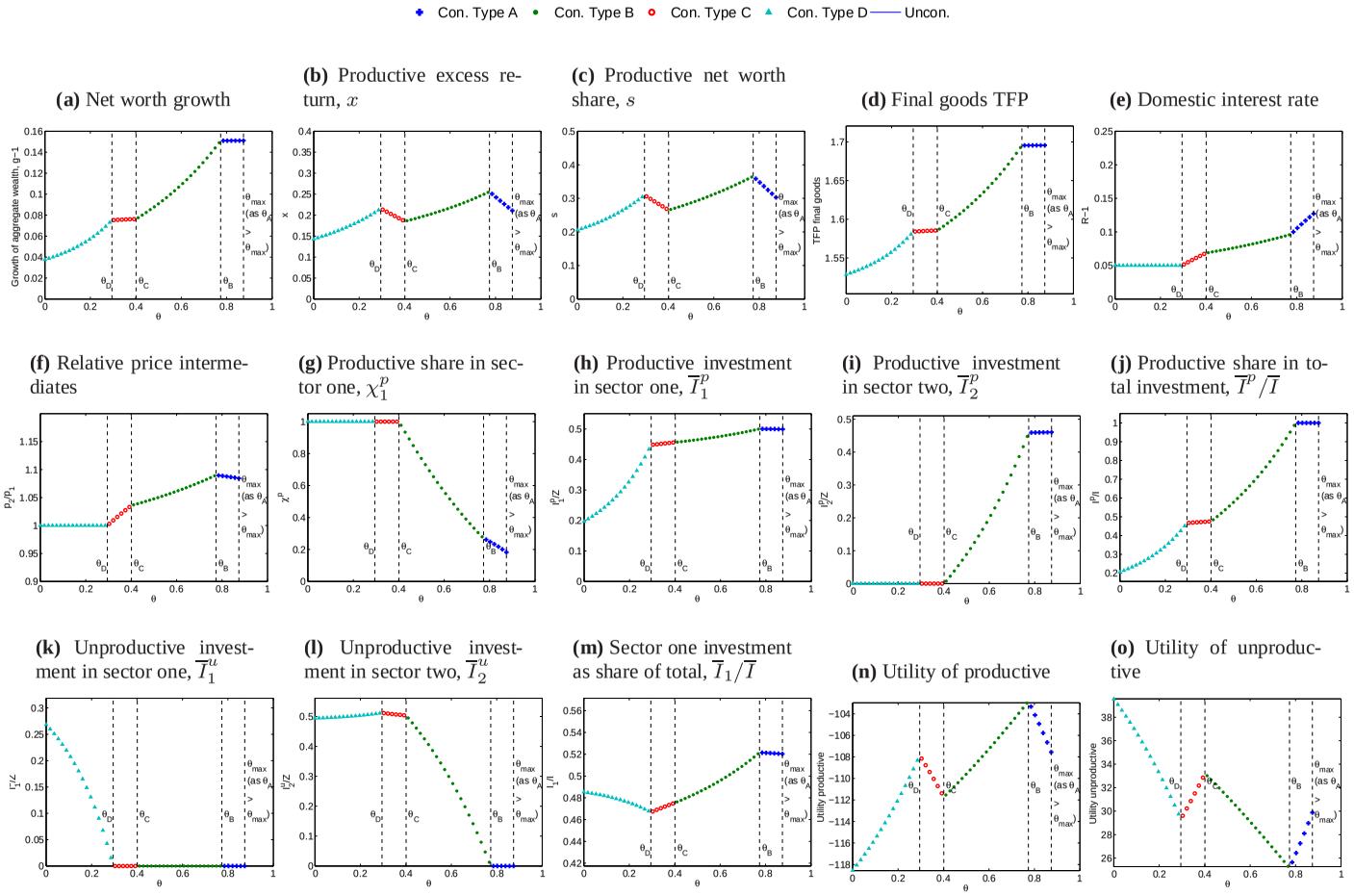

Note: Illustrative parameters are $R_f = 1.05; \gamma = 0.7; \kappa = .8; \theta = 0.7; \psi = 0.5; \varphi_p = 1.2; \varphi_u = 1.1;\ n = 0.1; \delta = 0.15$.

**Figure 3.9:** The different autarky equilibria possible for values of the state variable $s_t$ by value of the credit multiplier $\theta_t + 1$



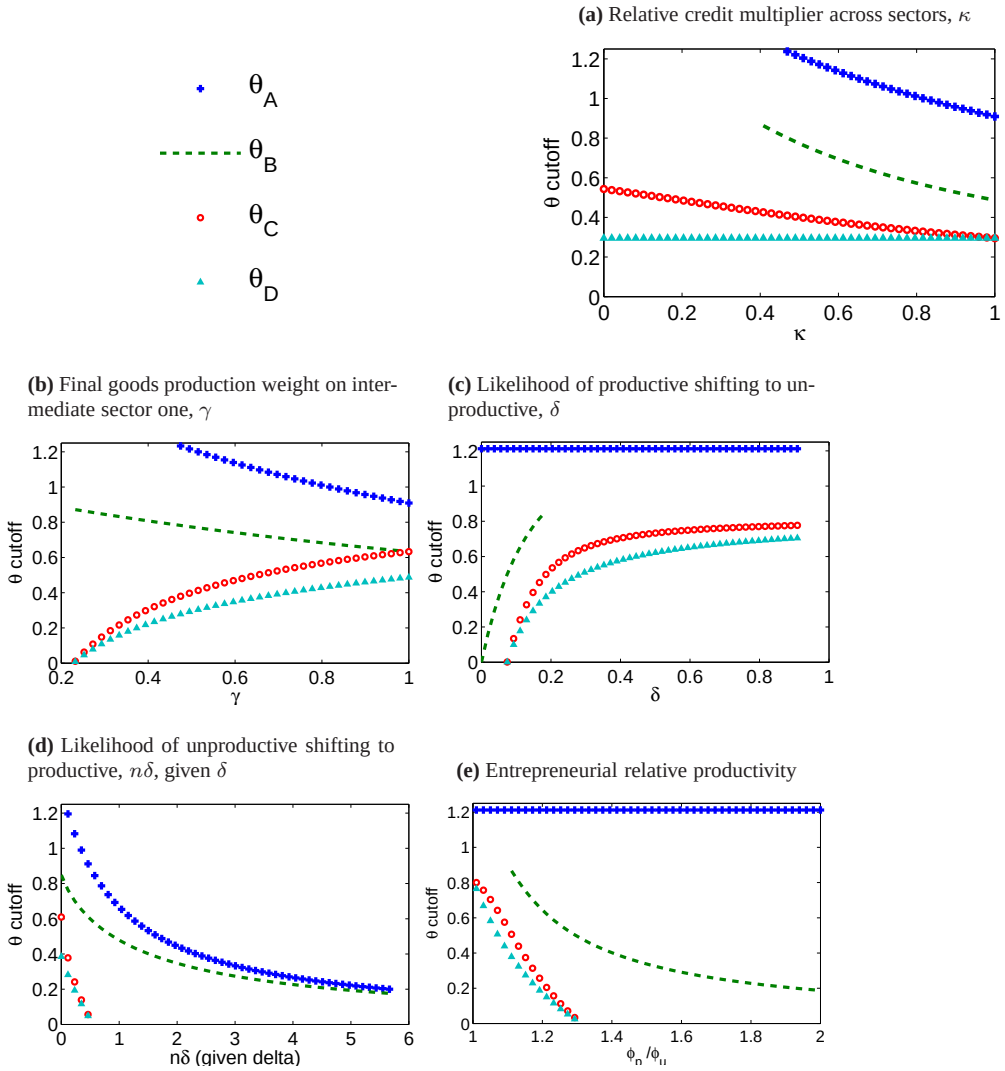

Note: Base parameters are $\gamma = 0.7; \kappa = .8; \varphi_p = 1.2; \varphi_u = 1.05; n = 0.1; \delta = 0.15; \beta = 0.96$.

**Figure 3.10:** Impact of domestic financial reforms on autarky steady state




Note: Key indicates type of equilibria (Con. is constrained equilibria). Base parameters are $\gamma = 0.7; \kappa = 0.8; \theta = 0.7; \varphi_p = 1.2; \varphi_u = 1.05$; $n = 0.1; \delta = 0.15$; $\beta = 0.96$.

**Figure 3.11:** The role of conditioning factors in determining the range of autarky equilibria cut-offs




**(a)** Relative credit multiplier across sectors, $\kappa$

**(b)** Final goods production weight on intermediate sector one, $\gamma$

**(c)** Likelihood of productive shifting to unproductive, $\delta$

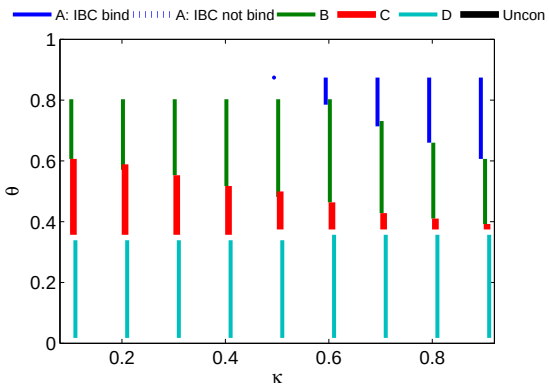
**(d)** Likelihood of unproductive shifting to productive, $n\delta$, given $\delta$

**(e)** Entrepreneurial relative productivity

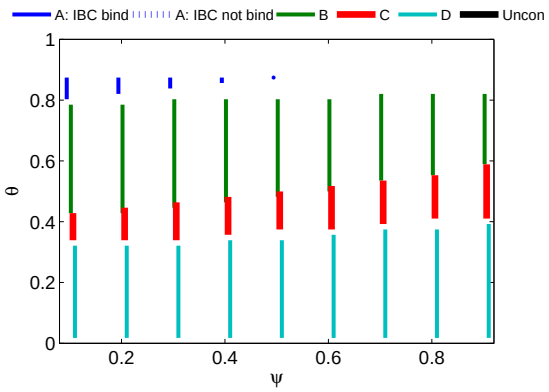
Note: Unless indicated base parameters are $\gamma = 0.7; \kappa = 0.8; \theta = 0.7; \varphi_p = 1.2; \varphi_u = 1.05$; $n = 0.1$; $\delta = 0.15$; $\beta = 0.96$.

**Figure 3.12:** The role of conditioning factors in determining the range of international finance steady state equilibria

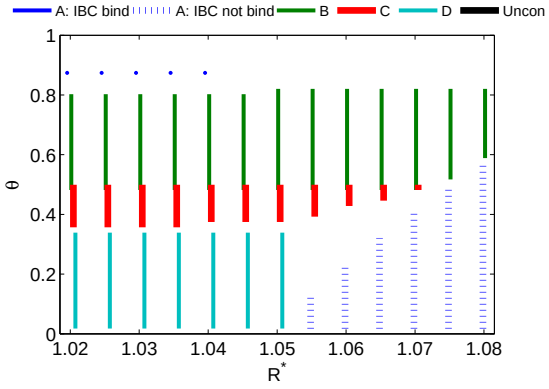
**(a)** Relative credit multiplier across sectors, $\kappa$



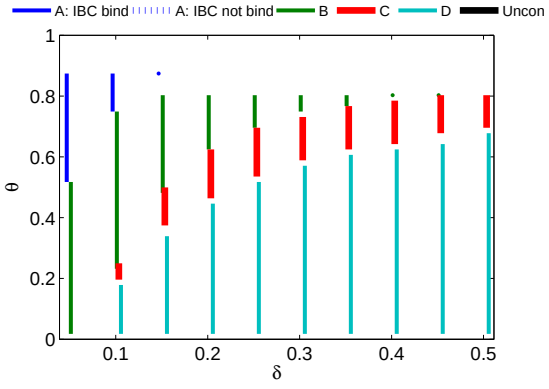

**(b)** Relative international credit multiplier, $\psi$



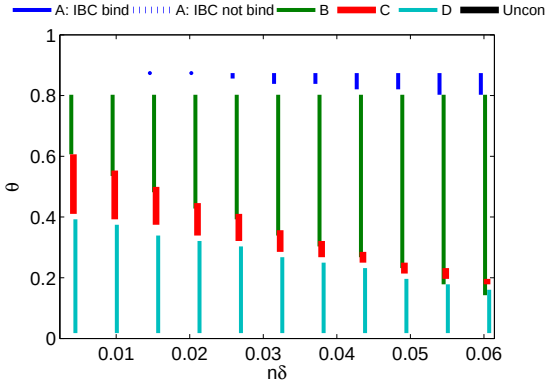

**(c)** International interest rate, $R^*$



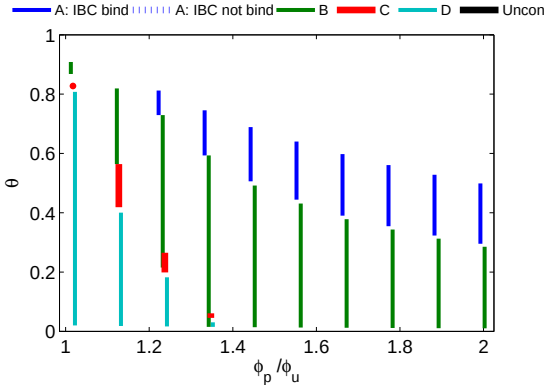

**(d)** Likelihood of productive shifting to unproductive, $\delta$




**(e)** Likelihood of unproductive shifting to productive, $n\delta$, given $\delta$

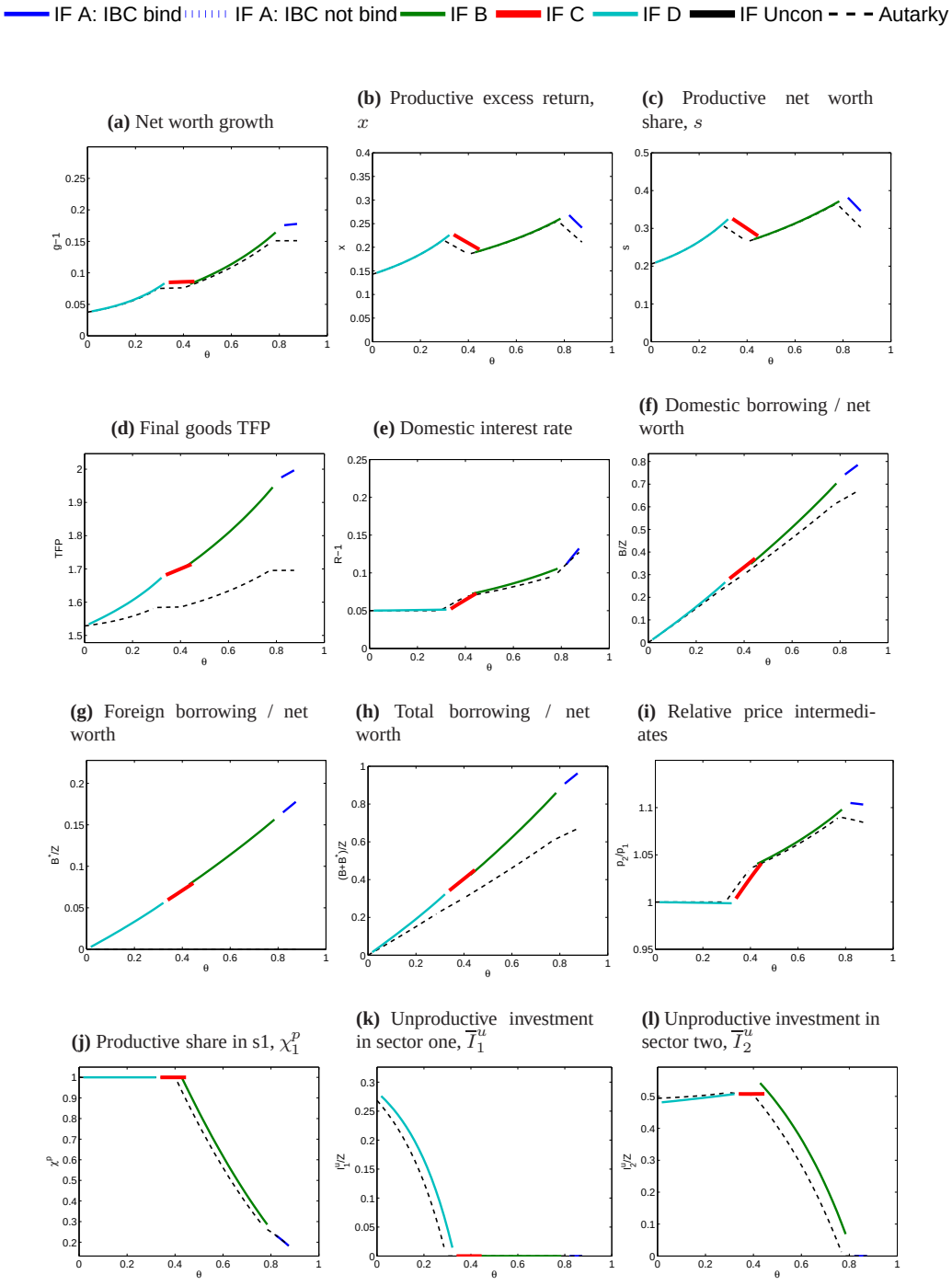



**(f)** Entrepreneurial relative productivity




Note: Key indicates type of equilibria (Con. is constrained equilibria). Base parameters are $\gamma = 0.7$;$\kappa = 0.8$;$\theta = 0.7$;$\psi = 0.5$;$\varphi_p = 1.2$;$\varphi_u = 1.05$; $n = 0.1$;$\delta = 0.15$;$\beta = 0.96$;$R_f = 1.04$.

**Figure 3.13:** Domestic financial reforms with international finance - steady state comparative statics




Note: Key indicates type of equilibria (Con. is constrained equilibria). Base parameters are $\gamma = 0.7$;$\kappa = 0.8$;$\theta = 0.7$;$\psi = 0.5$;$\varphi_p = 1.2$;$\varphi_u = 1.05$; $n = 0.1$;$\delta = 0.15$; $\beta = 0.96$;$R_f = 1.04$.

## 3.B Appendix: Proofs

### 3.B.1 Equilibrium production combinations

In an unconstrained equilibria, the domestic interest rate is pinned down by the productivity of the productive. Only the productive will produce. To identify the productive combinations in a constrained equilibrium note that (i) given the structure of final production it must be the case that both intermediate goods are produced; (ii) due to their higher relative productivities and returns from production, the productive must always produce in at least one sector; (iii) return equalization cannot hold for both the productive and unproductive (since for any intermediate price and domestic interest rate the returns of the productive are higher than the unproductive); (iv) if return equalization holds for the productive the unproductive prefer, if they produce at all, to produce in sector two; (v) if return equalization holds for the unproductive then the productive must produce in sector one.

The last two points can be seen from examining the conditions for return equalization. Return equalization for a constrained productive entrepreneur occurs along the following locus in $(p_{2,t+1}, R_{t+1})$ space:

$$p_{2,t+1} - \frac{(1-\theta_{t+1})\, p_{1,t+1}\left(p_{2,t+1}\right)}{1-\kappa\theta_{t+1} - p_{1,t+1}\left(p_{2,t+1}\right)\varphi_p\left(1-\kappa\right)\theta_{t+1} J\left(R_{t+1}, R^*_{t+1}, \psi_{t+1}\right)} = 0 \tag{3.22}$$

Denoting the left-hand side by $\Gamma^p(p_{2,t+1}, R_{t+1})$, the implicit value of $p_{2,t+1}$ defined by $\Gamma^p = 0$ is downward sloping in $R_{t+1}$. If $p_{2,t+1}$ is above (below) this locus then the productive would prefer to produce in sector two (one) only. Return equalization for a constrained unproductive entrepreneur pins down a unique value of $p_{2,t+1}$ given $R^*_{t+1}$ such that:

$$p_{2,t+1} - \frac{(1-\psi_{t+1}\theta_{t+1})\, p_{1,t+1}\left(p_{2,t+1}\right)}{1-\kappa\psi_{t+1}\theta_{t+1} - p_{1,t+1}\left(p_{2,t+1}\right)\varphi_u\left(1-\kappa\right)\theta_{t+1}\psi_{t+1}/R^*_{t+1}} = 0 \tag{3.23}$$

If $p_{2,t+1}$ is above (below) this unique value then the unproductive would prefer to produce in sector two (one) only. It can be shown that this unique value is less than the value of $p_{2,t+1}$ given by evaluating $\Gamma^p(p_{2,t+1}, R_{t+1})$ at $R_{t+1} = R^*_{t+1}$, i.e. the price in sector two required to equalize returns across sectors is higher for the productive than the unproductive. This is because the lower credit multiplier in sector two has a greater detrimental effect on the returns of the productive (due to their higher leverage and because they borrow from home and abroad). Thus, to compensate and maintain return equalization for the productive, the price in sector two must be higher than that required for return equalization for the unproductive. This implies that if return equalization holds for the productive the unproductive prefer, if they produce at all, to produce in sector two. If return equalization holds for the unproductive then the productive must produce in sector one.

The above five restrictions mean that there are four possible production combinations for the constrained equilibria:

- If constrained return equalization holds for the productive then the productive produce in both sectors. The unproductive may or may not choose to produce but if they do so they would produce in sector two. This gives two constrained productive combinations, type A and B respectively.

- If the productive prefer to produce in sector one only, then the unproductive must produce in sector two. If the unproductive returns are equalized across sectors then they may produce in sector two only, a type C equilibria, or in both sectors, a type D equilibria.

If the productive prefer to produce in sector two only, then the price in sector two is such that the unproductive would also prefer to produce in sector two. Thus this cannot be an equilibria as the intermediate goods must be produced in both sectors.

## 3.B.2 Proof of Proposition 3

The dynamics of the system can be described by the non-linear difference equation in $s_{t+1} = f(s_t)$ and the transition of $Z_{t+1} = (1 + s_t x_t) R_{t+1} \beta Z_t$. Below we define $\rho_{t+1} \equiv p_{2,t+1}/p_{1,t+1}$ and normalize aggregate quantities by $Z_t$ (denoting normalized variables by an upper bar) and drop the time subscript on other parameters (excluding $\theta_{t+1}$).

### 3.B.2.1 Constrained Equilibria Type A

Return equalization pins down $\rho_{t+1}$ in terms of $R_{t+1}$. Given $R_{t+1}$ and $s_t$, constrained investment demands and the aggregate investment equation determine the productive entrepreneurs' investment in each sector and their distribution across sectors. The relative demands for goods can then be used to determine $R_{t+1}$.

The constrained investment equations for each sector are given by:

$$\overline{I}^p_{1,t} = \frac{\beta \chi^p_{1,t} s_t \rho_{t+1} (1-\kappa)}{(1-\theta_{t+1})(1-\kappa\rho_{t+1})}$$
$$\overline{I}^p_{2,t} = \frac{\beta s_t \left(1-\chi^p_{1,t}\right)(1-\kappa)}{(1-\kappa\theta_{t+1})(1-\kappa\rho_{t+1})} = \overline{I}^p_{1,t} \frac{\left(1-\chi^p_{1,t}\right)(1-\theta_{t+1})}{\chi^p_{1,t}\rho_{t+1}(1-\kappa\theta_{t+1})}$$

Plugging these expressions into the equation for relative demands for intermediate output in the following period gives $\chi^p_{1,t} = \gamma(1-\theta_{t+1}) / (1-\Omega\theta_{t+1})$ where $\Omega(\kappa,\gamma) \equiv \kappa + \gamma(1-\kappa)$. Using these expressions relative prices as an increasing function of $s_t$ can be pinned down from the goods market/investment clearing condition ($\beta = \overline{I}^p_{1,t} + \overline{I}^p_{2,t}$):

$$1 = \frac{s_t(1-\kappa)(1-\rho_{t+1}\kappa)}{(1-\Omega\theta_{t+1})((1-\gamma)+\gamma\rho_{t+1})} \Leftrightarrow \rho_{t+1} = \frac{1-\Omega\theta_{t+1}-(1-\gamma)(1-\kappa)s_t}{\gamma(1-\kappa)s_t + \kappa(1-\Omega\theta_{t+1})}$$

The excess return of the productive can be expressed in terms of relative prices and hence $s_t$ and is decreasing in the latter.

$$x_t(s_t) = \frac{1 - \Omega\theta_{t+1} - s_t}{\Omega\theta_{t+1} s_t}$$

When this expression is plugged into the difference equation we obtain $s_{t+1} = (1-\delta)(1-\Omega\theta_{t+1}) + n\delta\Omega\theta_{t+1}$, i.e. $s_{t+1}$ jumps immediately to the SS value.

If this equilibria is to exist then $x_t(s_t) \geq 0$, i.e. $s_t \leq s_A(\theta_{t+1}) \equiv (1 - \Omega\theta_{t+1})$. Above this range the productive are unconstrained. A further condition is that the unproductive do not find it worthwhile to invest, i.e. $R_{t+1}(s_t) > p_{2,t+1}(s_t)\varphi_u$. With some manipulation this gives the following condition:

$$s_t > \frac{(1 - \Omega\theta_{t+1})(\varphi_u - \kappa\theta_{t+1}\varphi_p)}{(1 - \Omega\theta_{t+1})\varphi_u - \gamma(1-\kappa)\theta_{t+1}\varphi_p} \equiv \underline{s}_A(\theta_{t+1}) > s_A(\theta_{t+1})$$

So, if $\underline{s}_A(\theta_{t+1}) < s_t \leq s_A(\theta_{t+1})$ then an equilibria of type A is possible.

### 3.B.2.2 Constrained Equilibria type B

In this equilibria, the productive produce in both sectors and the unproductive in sector two. $R_{t+1}$ and $\rho_{t+1}$ are thus determined by the conditions for the return equalization for the productive and $R_{t+1} = p_{2,t+1}\varphi_u$. The excess return of the productive is equal to $x_t = (\varphi_p - \varphi_u)/(\varphi_u - \kappa\theta_{t+1}\varphi_p)$. This gives a concave function for the transition equation $s_{t+1} = f(s_t)$ with a positive gradient around the steady state of less than one. Investment levels $\overline{I}^p_{1,t}, \overline{I}^p_{2,t}, \overline{I}^u_{2,t}$ and $\chi^p_{1,t}$ are determined by the two equations for constrained intermediate investment by the productive, the relative demand for intermediates and goods market clearing condition. The share of productive investing in sector one can be shown to be decreasing in $s_t$ :

$$\chi^p_{1,t}(s_t) = \frac{\gamma(1-\theta_{t+1})((\varphi_p - \varphi_u) + (\varphi_u - \kappa\theta_{t+1}\varphi_p)/s_t)}{\varphi_p(1 - \kappa\theta_{t+1})}$$

For this equilibria to exist $s_t$ must be above a lower bound so that $\chi^p_{1,t} < 1$:

$$s_t > \underline{s}_B(\theta_{t+1}) \equiv \frac{\gamma(1-\theta_{t+1})(\varphi_u - \kappa\theta_{t+1}\varphi_p)}{\varphi_p(1-\kappa\theta_{t+1}) - (\varphi_p - \varphi_u)\gamma(1-\theta_{t+1})}$$

The upper bound of the range for this equilibria is determined by the condition that $\overline{I}^u_{2,t} > 0$ (since it can be shown that the derivative of productive investment with respect to $s_t$ is positive). This upperbound is equal to the lower bound of case A, i.e. $s_B(\theta_{t+1}) = \underline{s}_A(\theta_{t+1})$ (since in both cases the unproductive investment is zero, $R_{t+1} = p_{2,t+1}\varphi_u$ and return equalization holds for the productive) where $\underline{s}_B(\theta_{t+1}) < s_B(\theta_{t+1})$. So if $\underline{s}_B(\theta_{t+1}) < s_t \leq s_B(\theta_{t+1})$ then an equilibria of type B is possible with $s_{t+1} = f(s_t)$ which is a concave function with a unique fixed point.

### 3.B.2.3 Constrained Equilibria type C

The productive produce in sector one and the unproductive in sector two. The domestic interest rate is determined by $R_{t+1} = p_{2,t+1}\varphi_u$. Again, constrained investment levels can be plugged into the investment/goods market clearing condition to give an expression for $\rho_{t+1}(s_t)$ and the excess return of the productive can then be defined as a decreasing function of $s_t$:

$$x_t(s_t) = \frac{\varphi_p - \rho_{t+1}(s_t)\varphi_u}{\rho_{t+1}(s_t)\varphi_u - \theta_{t+1}\varphi_p} = \frac{\gamma(1-\theta_{t+1}) - s_t}{s_t(1-\gamma(1-\theta_{t+1}))}$$

As in case A when this expression is plugged into the difference equation we obtain a constant value for $s_{t+1} = (1-\delta)\gamma(1-\theta_{t+1}) + n\delta$. The condition for this equilibria to exist are that the excess return of the productive is greater than or equal to zero ($\varphi_p \geqslant \rho_{t+1}(s_t)\varphi_u$ and $\rho_{t+1}(s_t)\varphi_u > \theta_{t+1}\varphi_p$ which is greater than one by Assumption 6), the unproductive do not have an incentive to produce in sector one, i.e. $\rho_{t+1}(s_t) > 1$, and that the return for the productive from producing in sector one is greater than in sector two. It is the latter two conditions that are binding. The lower bound for $s_t$ is defined as follows:

$$\rho_{t+1}(s_t) > 1 \Leftrightarrow s_t > \underline{s}_C(\theta_{t+1}) = \frac{\gamma(\varphi_u - \theta_{t+1}\varphi_p)}{(1-\gamma)\varphi_p + \gamma\varphi_u}$$

The upperbound is defined by the condition $x_t(\rho_{t+1}(s_t)) > (\varphi_p - \varphi_u)/(\varphi_u - \kappa\theta_{t+1}\varphi_p)$ which is equivalent to the following restriction on $s_t$:

$$s_t \leq s_C(\theta_{t+1}) \equiv \frac{\gamma(1-\theta_{t+1})(\varphi_u - \kappa\theta_{t+1}\varphi_p)}{\varphi_p(1-\kappa\theta_{t+1}) - (\varphi_p - \varphi_u)\gamma(1-\theta_{t+1})} = \underline{s}_B(\theta_{t+1})$$

So, if $\underline{s}_C(\theta_{t+1}) < s_t \leq s_C(\theta_{t+1})$ then an equilibria of type C is possible with $s_{t+1} = (1-\delta)\gamma(1-\theta_{t+1}) + n\delta$.

#### 3.B.2.4 Constrained Equilibria type D

Relative intermediate goods prices are equal and $R = \varphi_u$. The excess return of the productive is equal to $x_t = \frac{\varphi_p - \varphi_u}{\varphi_u - \theta_{t+1}\varphi_p}$ and, as in case B, the transition equation $s_{t+1} = f(s_t)$ is an upward sloping concave function with an absolute gradient around the steady state of less than one. The investment levels are linear functions of $s_t$ determined by the constrained investment of the productive, the goods market clearing condition and relative demand for intermediates. If investment of the unproductive in sector 1 is to be positive then the share of net worth of the productive must be low enough, which implies the following condition:

$$s_t < s_D(\theta_{t+1}) = \frac{\gamma(\varphi_u - \theta_{t+1}\varphi_p)}{\gamma\varphi_u + (1-\gamma)\varphi_p} = \underline{s}_C(\theta_{t+1})$$

### 3.B.3 Proof of Proposition 4

#### 3.B.3.1 Proof of stability of autarky steady state equilibria

The first order difference non-linear equation defining the transition of the dynamics of the economy is:

$$s_{t+1} = f(s_t) = \frac{s_t\,(1-\delta)\,(1+x_t) + (1-s_t)\,n\delta}{(1+s_t x_t)} \tag{3.24}$$

where from the previous proof in Section 3.B.2 depending on the equilibria, $x_t$ is a constant or a function of $s_t$. In a steady state equilibria $s^{ss} = f(s^{ss})$. Taking a first order expansion around the equilibria we have $s_{t+1} = f(s^{ss}) + f'(s^{ss})(s_t - s^{ss})$ where $|f'(s^{ss})| < 1$ is the condition for local (asymptotic) stability. In the equilibria in which $x_t$ is a function of $s_t$ (i.e. equilibria of type A or type C) then it can be shown that $s_{t+1}$ is equal to a constant. In those equilibria (type B and D) in which $x_t$ is a constant then local stability also holds since:

$$\begin{aligned} f'(s^{ss}) &= \frac{(1-\delta-n\delta)\,(1+x)}{(1+s^{ss}x)^2} \\ &= \frac{(1-\delta-n\delta)\,(1+x)}{(1+s^{ss}x)\,((1-\delta-n\delta)\,(1+x) + n\delta x + n\delta/s)} \end{aligned}$$

which is positive and less than one, given Assumption 3 that $1 > n + n\delta$.

### 3.B.3.2 Partitioning of steady state equilibria by $\theta$

Applying the results from Section 3.B.2 we can derive the steady state equilibria conditions (where steady state values are denoted with no time subscript).

**Range for Type A equilibria:** $\theta_B < \theta \leq \theta_A$ In this steady state we have $s_A = (1-\delta)\,(1-\Omega\theta) + n\delta\theta$ and $x_A = \frac{\delta(1-\theta\Omega(1+n))}{\theta\Omega(1-\delta-\theta\Omega(1-\delta(1+n)))}$. Two conditions define the range of $\theta$ for Case A in which productive returns are equalized and unproductive do not invest. First, productive entrepreneurs are constrained and receive non-negative excess returns from investing: $x_A \geq 0$. Second, the unproductive do not find it worthwhile to invest.

From Section 3.B.2 the first condition requires $s \leq s_A(\theta) \equiv (1-\Omega\theta)$ which

implies that $\theta \leq ((1+n)\Omega)^{-1} \equiv \theta_A$. The second condition requires $R > p_2\varphi_u$ which is equivalent to $\frac{1+x(\theta)}{1+\theta\kappa x(\theta)} < \varphi_p/\varphi_u$ where the LHS is increasing in $\theta$. Thus the lower bound for $\theta$ for steady state equilibria of Type A is given by $\theta > \theta_B$ where $\theta_B$ can be implicitly defined by:

$$\frac{\delta(1-\theta_B\Omega(1+n))}{1-\delta-\theta_B\Omega(1-\delta(1+n))} - \frac{\varphi_p-\varphi_u}{\varphi_u-\kappa\theta_B\varphi_p} = 0$$

**Range for Type B equilibria:** $\theta_C < \theta \leq \theta_B$ In the Type B equilibria, from the previous proof in Section 3.B.2, we have $x_B(\theta) = (\varphi_p-\varphi_u)/(\varphi_u-\kappa\theta\varphi_p)$. Defining $X \equiv sx$, then rearranging Equation 3.20, we obtain the unique steady state solution for $X_B(\theta)$

$$0 = X_B^2 + (\delta(1+n) - (1-\delta)x_B(\theta))X_B - n\delta x_B(\theta)$$

If $x_B(\theta) > 0$ the solution to the above quadratic equation has one positive and one negative root (from Viète's formula). The positive root is increasing in $x_B$ and $X_B'(\theta) > 0$. We can also show that $s_B(\theta)$ is increasing in $x_B$ and hence $ds_B/d\theta > 0$.

Three equations define $p_{2_B}$, $p_{1_B}$ and $R_B$: unproductive entrepreneurs' indifference between saving and investing, i.e. $R = p_2\varphi_u$; return equalization for the productive; the aggregate pricing equation relating $p_{2_B}$ and $p_{1_B}$. The first two equations give relative prices as follows:

$$\frac{p_{2_B}(\theta)}{p_{1_B}(\theta)} = 1 + \frac{(\varphi_p-\varphi_u)(1-\kappa)\theta}{\varphi_u(1-\kappa\theta)} > 1$$

From Section 3.B.2 we can obtain an expression for the share of the productive operating in sector one which is decreasing in $\theta$:

$$\chi_1^p(\theta) = \frac{\gamma(1-\theta)((\varphi_p-\varphi_u)+(\varphi_u-\kappa\theta\varphi_p)/s_B(\theta))}{\varphi_p(1-\kappa\theta)}$$

This steady state equilibria will occur in the range of parameter values for which the following conditions must be satisfied:

- The productive entrepreneur is constrained and earns a positive return from investing i.e. $x_B \geq 0$. This is satisfied since Assumption 6 holds.

- The productive entrepreneur has positive production in both sectors ($\chi_{1B}^{p}(\theta) < 1$). Thus we can define a lower bound of $\theta$ for case B, $\theta_C$, such that $\chi_{1B}^{p}(\theta_C) = 1$:

$$1 = \frac{\gamma(\varphi_p - \varphi_u)(1-\theta_C)(1+1/X_B(\theta_C))}{\varphi_p(1-\theta_C\kappa)}$$

- The unproductive entrepreneurs find it worthwhile to invest in sector two, i.e. $\bar{I}_2^u(\theta) > 0$. The cut-off at which $\bar{I}_2^u(\theta) = 0$ provides the upperbound on the range of $\theta$ for case B (which is the lower bound for case A since in both cases the same relative prices hold and the unproductive do not produce). This upperbound $\theta_B \in (0, \varphi_u/(\varphi_p\kappa))$ can be shown to be defined uniquely by:

$$1 + 1/X_B(\theta_B) = \frac{\varphi_p(1-\kappa\theta_B)}{(\varphi_p - \varphi_u)(1-\theta_B\Omega)}$$

where $\theta_B > \theta_C$.

**Range for Type C equilibria:** $\theta_D < \theta \leq \theta_C$ From Section 3.B.2, in steady state equilibrium $s_C(\theta) = (1-\delta)\gamma(1-\theta) + n\delta$ and we have the following positive solution for $X_C$ :

$$X_C = \delta\left(\frac{1}{\Lambda(\theta)} - (1+n)\right)$$

where $\Lambda(\theta) \equiv (1-\gamma(1-\theta))$, $X_C'(\theta) < 0$ and $X_A > X_C$. The excess return of the productive entrepreneurs is given by:

$$x_C(\theta) = \frac{\delta(1-\Lambda(\theta)(1+n))}{1-\delta-\Lambda(\theta)(1-\delta(1+n))}$$

If we define $h(R) \equiv \varphi_p p_1(R)/R$ then $p_{2C}/p_{1C} = R_C/\varphi_u$can be expressed in terms of the excess return of the productive $h(\theta) = \frac{1+x_C(\theta)}{1+\theta x_C(\theta)}$. From the relative demand equation we then have:

$$\frac{p_{2C}}{p_{1C}} = \frac{1-\gamma}{\gamma}\frac{\varphi_p}{\varphi_u}\left(\frac{X_C(\theta)}{h(R)-1-X_C(\theta)}\right)$$

The conditions for Case C are as follows:

- The productive entrepreneurs are constrained and earn a positive excess return from investing in sector one: $X_C \geq 0$, $x_C \geq 0$

- The return of productive entrepreneurs in sector two is less than in sector one. This implies that $x_C(\theta) > \frac{\varphi_p-\varphi_u}{\varphi_u-\kappa\theta\varphi_p} > 0$. Since $x_C$ is decreasing in $\theta$ this upperbound on $\theta$ for the equilibrium of type C binds relative to the condition above that $x_C \geq 0$. The cutoff $\theta_C$ is defined by:

$$\frac{\varphi_p-\varphi_u}{\varphi_u-\kappa\theta_C\varphi_p} = \frac{\delta(1-\Lambda(\theta_C)(1+n))}{1-\delta-\Lambda(\theta_C)(1-\delta(1+n))}$$

  This is equivalent to $x_B(\theta_C) = x_C(\theta_C)$. This is also the lower bound for case B since at this value of $\theta$ in both equilibria production by the productive entrepreneur would be in sector one only and the excess return is identical.

- The unproductive find it worthwhile to invest in sector two, i.e. , $\varphi_u p_{2C} = R_C$, and $\overline{I}_2^u > 0$ which holds from the relative demand expression.

- The unproductive do not find it worthwhile to invest in sector one. This requires that $p_2 > p_1$. Using the above expression for relative prices and substi-

tuting in for $x_C$ as a function of $X_C$ we obtain the following condition:

$$X_C(\theta) < \frac{\gamma(\varphi_p - \varphi_u)}{\varphi_p(1-\gamma) + \gamma\varphi_u}$$

As $X_C$ is decreasing in $\theta$, the lower bound for the type C equilibria is such that $\theta_D$ i.e. $\theta > \theta_D$ where $\theta_D$ is defined by equality of the above expression, or equivalently, $x_C(\theta_D) = (\varphi_p - \varphi_u) / (\varphi_u - \theta_D\varphi_p)$ (since this is the expression for $x_C$ when $p_2 = p_1$and $p_{2C}/p_{1C} = R_C/\varphi_u$).

**Range for case D:** $\theta \leq \theta_D$ From Section 3.B.2 in steady state equilibrium $s_D(\theta)$ is defined by the steady state solution of Equation 3.20 when $x_D(\theta) = \frac{\varphi_p - \varphi_u}{\varphi_u - \theta\varphi_p}$. The conditions for a Case D equilibrium are as follows:

- The productive entrepreneur is constrained and earns a positive return from investing in sector one: $x_D > 0$ which holds by Assumption 6 on relative productivities.

- The return of the productive entrepreneur in sector two is less than in sector one, $\frac{\varphi_p - \varphi_u}{\varphi_u - \theta\varphi_p} > \frac{\varphi_p - \varphi_u}{\varphi_u - \kappa\theta\varphi_p}$ which holds since $\kappa < 1$.

- The unproductive find it worthwhile to invest in sector two and sector one and have positive investment in both. The necessary pricing conditions hold. From the investment demand equations, goods market clearing and relative demand expression we can solve for investment levels such that $\bar{I}^u_{2D}(\theta) = (1-\gamma)\beta(1 + X_D(\theta)) > 0$ and $\overline{I}^u_{1D}(\theta) = \beta\gamma\left(1 - \frac{X_D(\theta)((1-\gamma)\varphi_p + \gamma\varphi_u)}{(\varphi_p - \varphi_u)\gamma}\right)$. Thus the upper bound value for $\theta$ for this type of equilibria is defined by $\overline{I}^u_{1D}(\theta) > 0$, i.e. if $\theta < \theta_D$ where

$$X_D(\theta_D) = \frac{\gamma(\varphi_p - \varphi_u)}{\varphi_p(1-\gamma) + \gamma\varphi_u}$$

With $X_D$ increasing in $\theta$, there is a positive solution for this cutoff iff $\varphi_p(1-\gamma) > \varphi_u\gamma$.

### 3.B.4 Proof of Proposition 5

**Type A steady state equilibria** From Section 3.B.3 $\partial s_A/\partial\theta < 0$, $\partial x_A/\partial\theta < 0$ and $\chi^p_{1A} = \gamma(1-\theta)/(1-\theta\Omega)$ and so is decreasing in $\theta$. From the definition of the excess returns of the productive and return equalization, relative prices ($\rho_A = p_{2_A}/p_{1_A}$) can be expressed as a function of $\theta$:

$$\rho_A(\theta) = (1+\theta x_A(\theta))(1+\kappa\theta x_A(\theta))^{-1}$$

i.e. $\rho_A(\theta)$ is increasing in $\theta x(\theta)$ which in turn is decreasing in $\theta$, i.e.$\rho'_A(\theta) < 0$. From the aggregate pricing equation this gives $p'_{2_A}(\theta) < 0$. From the goods market clearing condition $\overline{I}^p_1 + \overline{I}^p_2 = \beta$ and from the relative demand for intermediates $\overline{I}^p_1/\overline{I}^p_2 = \rho_A(\theta)\gamma/(1-\gamma)$ which is decreasing in $\theta$ and hence $\overline{I}^p_1$ ($\overline{I}^p_2$) is decreasing (increasing) in $\theta$.

Defining $\lambda = \varphi_p p_2/R$ then rearranging we have $\lambda = \frac{1+x_A(\theta)}{1+\kappa\theta x_A(\theta)}$ and so, using the expression for relative prices we obtain the following solution for $R_A$ which is increasing in $\theta$ :

$$R_A(\theta) = \varphi_p(1+\kappa\theta x_A(\theta))^{1-\gamma}(1+\theta x_A(\theta))^{\gamma}(1+x_A(\theta))^{-1}$$

The steady state growth in aggregate net worth is given by $g_A = (1+X_A)R_A\beta$. Using the expressions for $R_A$ and $(1+X_A)$ we obtain:

$$g_A = \beta\varphi_p(1+\kappa\theta x_A(\theta))^{1-\gamma}(1+\theta x_A(\theta))^{\gamma}(1+\theta\Omega x_A(\theta))^{-1}$$

Taking logs and differentiating we can show that $g_A$ is decreasing in $\theta x_A(\theta)$ and hence increasing in $\theta$.

**Type B steady state equilibria** From Section 3.B.3 we can see that $\rho_B(\theta)$ is increasing in $\theta$. Thus $p'_{2_B}(\theta) > 0$, $p'_{1_B}(\theta) < 0$ and $R_B(\theta) = p_{2_B}(\theta)\varphi_u$ is also increasing in $\theta$. The excess return for the productive is given by $x_B = (\varphi_p - \varphi_u)/(\varphi_u - \kappa\theta\varphi_p)$ and is increasing in $\theta$ and hence $s'_B(\theta) > 0$ and $X'_B(\theta) > 0$. The steady state growth rate in aggregate net worth $g_B = (1 + X_B) R_B\beta$ therefore increases with $\theta$. The equilibrium value of $\chi^p_{1B}(\theta) = \frac{\gamma(\varphi_p-\varphi_u)(1-\theta)(1+1/X_B(\theta))}{\varphi_p(1-\theta\kappa)}$ is decreasing in $\theta$. Plugging in relative prices and $\chi^p_{1B}(\theta)$ into the investment equation we obtain the following expressions for investment by the productive which are both increasing in $\theta$ (and hence $\overline{I}^u_{2B}$ is decreasing in $\theta$):

$$\overline{I}^p_{1B}(\theta) = \frac{\gamma\beta(\varphi_u(1-\theta) + \varphi_p\theta(1-\kappa))(1 + X_B(\theta))}{\varphi_p(1-\theta\kappa)}$$
$$\overline{I}^p_{2B}(\theta) = \frac{\beta(1-\chi^p_{1B}(\theta))X_B(\theta)\varphi_u}{(\varphi_p - \varphi_u)}$$

**Type C steady state equilibria** From Section 3.B.3 we can see that $s_C$, $X_C$ and $x_C$ are decreasing in $\theta$. Expressing $h \equiv \varphi_p p_1/R$ as function of $x_C$ we obtain:

$$h = \frac{1 + x_C}{1 + \theta x_C} = \frac{\gamma(1-\theta)}{\theta + \delta(1-\theta)(\gamma\delta + n\delta(1-\gamma))}$$

where $h'_C(\theta) < 0$. Since $p_{2C}\varphi_u = R_C$ this means that $p'_2(\theta) > 0$, $p'_1(\theta) < 0$ and $R'_C(\theta) > 0$. Plugging the expressions for $R_C$ and $X_C$ as functions of $x_C$ into the growth of aggregate net worth gives the following expression whose partial derivative with respect to $\theta$ is ambiguous:

$$g_C = \beta\varphi_p^\gamma\varphi_u(1 + x_C(\theta))^{1-\gamma}(1 + \theta x_C(\theta))^\gamma(1 + (1 - \gamma(1-\theta))x_C(\theta))^{-1}$$

In Type C equilibria, $\chi^p_{1C} = 1$. From the goods market clearing condition $\overline{I}^u_{2C} =$

$\beta - \overline{I}^p_{1C}$ and from relative demand for intermediates $\frac{1-\gamma}{\gamma}\left(\frac{p_{1C}}{p_{2C}}\right) = \frac{\varphi_u \bar{I}^u_{2C}}{\varphi_p \bar{I}^p_{1C}}$ and so $\overline{I}^u_{2C}$ ($\overline{I}^p_{1C}$) is decreasing (increasing) in $\theta$.

**Type D steady state equilibria** In Type D equilibria, $\chi^p_{1D} = 1$, $p_{2D} = p_{1D} = 1$ and $R_D = \varphi_u$. The excess returns of the productive are given by $x_D = \frac{\varphi_p - \varphi_u}{\varphi_u - \theta\varphi_p}$ and are increasing in $\theta$ and hence so is $s_C$. The growth of net worth is also increasing in $\theta$ as $X_D$ increases with $\theta$. The constrained investment by the productive is increasing in $\theta : \overline{I}^p_{1D}(\theta) = \beta X_D(\theta)\varphi_u / (\varphi_p - \varphi_u)$. From the goods market clearing condition and the relative demand expression the investment of the unproductive in sector two is given by $\bar{I}^u_{2D}(\theta) = (1-\gamma)\beta(1 + X_D(\theta))$ and is increasing in $\theta$. Hence the investment of the unproductive in sector one falls with $\theta$.

### 3.B.5 Sensitivity of equilibria cutoffs in autarky

**Proposition 8** *The sensitivity of the autarky equilibria cutoffs is such that:*

1. *$\theta_A$ is decreasing in $n$, $\kappa$ and $\gamma$. For a given $\theta$, an economy is more likely to be in the unconstrained equilibrium if there is a higher steady state share of productive entrepreneurs, if the divergence between the credit multipliers in the two sectors is lower and if the relative weight on the sector one intermediate in the final good production is higher.*

2. *The cut-off $\theta_B$ above which the unproductive entrepreneurs do not produce is also decreasing in the share of productive entrepreneurs, $n$, the lack of dispersion in credit multipliers across sectors, $\kappa$, and the weight on the sector one intermediate good in final goods production, $\gamma$. In addition, for given $\theta$, the likelihood that the steady state is one in which the unproductive do not produce is increasing in the relative productivity differential, $\varphi_p/\varphi_u$, and decreasing in the probability that the productive suffer an adverse productivity shock, $\delta$.*

3. *The cut-off $\theta_C$ below which the productive only invest in sector one is decreasing in $\varphi_p/\varphi_u$, $\gamma$, $\kappa$ and the share of the productive in steady state (i.e. rises with $n$) and increasing in the probability of an adverse shock for the productive $\delta$.*

4. *The upper-bound for Case D, $\theta_D$, in which the unproductive entrepreneur produces in both sectors whilst the productive just produces in sector two, $\theta_D$, is also increasing in $\gamma$ and decreasing in $n$. $\theta_D$ is also decreasing in the relative productivity differential of entrepreneurs and increasing in the probability that the productive suffer an adverse productivity shock, $\delta$.*

**Proof.**

- The comparative statics of $\theta_A \equiv \left((1+n)\left(\kappa+\gamma\left(1-\kappa\right)\right)\right)^{-1}$ are clear from its definition.

- The cut-off $\theta_B$ is defined by:

$$\frac{\delta\left(1-\theta_B\Omega\left(1+n\right)\right)}{1-\delta-\theta_B\Omega\left(1-\delta\left(1+n\right)\right)}-\frac{\varphi_p-\varphi_u}{\varphi_u-\kappa\theta_B\varphi_p}=0$$

  The LHS is decreasing in $\theta_B$. Thus $\theta_B$ is decreasing in $\gamma$, decreasing in $\kappa$, decreasing in $\varphi_p/\varphi_u$, decreasing in $n$ and increasing in $\delta$.

- Comparative statics of $\theta_C \equiv 1-\frac{n}{(1+n)\gamma}$ are clear from its definition.

- The cut-off $\theta_D$ is defined by:

$$\frac{\delta\left(1-\Lambda\left(\theta_D\right)\left(1+n\right)\right)}{1-\delta-\Lambda\left(\theta_D\right)\left(1-\delta\left(1+n\right)\right)}-\frac{\varphi_p-\varphi_u}{\varphi_u-\theta_D\varphi_p}=0$$

  $\theta_D$ is increasing in $\gamma$ and $\delta$ and decreasing in $\varphi_p/\varphi_u$ and $n$.

■

### 3.B.6 Proof of Proposition 6 and Proposition 7

The following sections outline the properties of the international financial steady state equilibria providing the proofs for the partitioning results in Proposition 6 and the comparative statics in Proposition 7. In the cases B to D where unproductive entrepreneurs do produce, it can be shown that the equilibrium is only defined for $R > R^*$. If the IBC does not bind then there are insufficient equations for the number of endogenous variables. This means that there are now five possible constrained equilibria types - Type A with $R > R^*$, Type A with $R = R^*$, Type B, Type C and Type D.

#### 3.B.6.1 Case A International Finance

The constrained equilibrium with only the productive investing is pinned down by 11 equations in 11 unknowns: $p_2$, $p_1$, $\bar{I}$, $\overline{I}_1^p$, $\overline{I}_2^p$ , $\chi_1^p$, $\overline{B}^*$, $x$,$X$, $R$, $g$. For a given $R$, relative prices can be solved from the aggregate pricing equation and return equalisation for productive entrepreneurs. The quantities $\bar{I}$, $\overline{I}_1^p$, $\overline{I}_2^p$ , $\chi_1^p$, $\overline{B}^*$ can then be solved using the equations for the relative demand for intermediates, intermediate investment in the two sectors, goods market clearing and definition of total investment. This leaves the international borrowing constraint (IBC) to pin down the domestic interest rate as greater than or equal to $R^*$.

For a given interest rate the price of intermediate good one is determined by return equalisation plus the aggregate pricing equation:

$$\Psi_1 \equiv 1 - \kappa\theta - p_1\varphi_p\left(1-\kappa\right)\theta J\left(R, R^*, \psi\right) - \left(1-\theta\right)p_1/p_2\left(p_1\right) = 0$$

where, by the implicit function theorem, $\partial p_1/\partial R > 0$. Plugging in the investment levels of the productive into the relative demand expression we obtain the same

expression as in autarky for $\chi_1^p = \gamma(1-\theta)/(1-\theta\Omega)$ (since international finance does not change the relative credit multiplier across sectors). Using this result and the expressions for constrained investment we can then express the international borrowing constraint as follows:

$$\frac{X}{x(1-\theta\Omega)}(1-\psi\theta\Omega + x\theta\Omega(1-\psi)) \leq 1 \text{ holds with equality if } R > R^*$$

**Case A with binding international borrowing constraint** In this case two equations uniquely define equilibrium $x$ and $X$, namely the binding international borrowing constraint and the steady state solution for the difference equation in $s$ and $x$ which can be expressed as $F(x,X) = X^2 + (\delta(1+n) - (1-\delta)x)X - n\delta x = 0$. The solutions are decreasing in $\theta$ and increasing in $\psi$:

$$X = \delta\left(\frac{1-\theta\Omega\psi}{\theta\Omega(1-\psi)} - (1+n)\right)$$
$$x = \frac{\delta(1-\theta\Omega\psi)(1-\theta\Omega(1+n(1-\psi)))}{\theta\Omega((1-\delta)(1-\theta\Omega) + n\delta\theta\Omega(1-\psi))}$$

From the definition of $s$ we have $s$ is increasing in $X$ and hence $s$ is decreasing in $\theta$ and increasing in $\psi$:

$$s = \frac{(1-\delta)(1-\theta\Omega) + \theta\Omega n\delta(1-\psi)}{(1-\psi\theta\Omega)}$$

Substituting the aggregate pricing equation into the return equalization condition and the definition of $x$ we can uniquely determine $p_1$ and $R$ from the following two equations:

$$\varsigma_1(p_1, R, \theta, \psi) \equiv 1 - \kappa\theta - p_1\varphi_p(1-\kappa)\theta J(R, R^*, \psi) - \frac{(1-\theta)p_1}{p_2(p_1)} = 0 \quad (3.25)$$

$$\varsigma_2(p_1, R, \theta, \psi) \equiv p_1\frac{\varphi_p}{R}(1-\theta) - (1+x(\theta))(1-p_1\varphi_p\theta J(R, R^*, \psi)) = 0 \quad (3.26)$$

Both equations can be shown to be upward sloping in $(p_1, R)$ space. Using standard comparative static results the partial derivative of the equilibrium value of $R$ with respect to $\theta$ is given by:

$$\frac{\partial R}{\partial \theta} = \frac{\frac{\partial \varsigma_2}{\partial p_1}\frac{\partial \varsigma_1}{\partial \theta} - \frac{\partial \varsigma_1}{\partial p_1}\frac{\partial \varsigma_2}{\partial \theta}}{\frac{\partial \varsigma_1}{\partial p_1}\frac{\partial \varsigma_2}{\partial R} - \frac{\partial \varsigma_1}{\partial R}\frac{\partial \varsigma_2}{\partial p_1}} = \frac{(+)(-) - (-)(+)}{(-)(-) - (+)(+)}$$

Thus whether the domestic interest rate increases or decreases with $\theta$ depends upon the relative sensitivities of $p_1$ and $R$, defined by the two loci, to $\theta$. The denominator of $\partial R/\partial \theta$ can be shown to be positive and so $R$ increases with $\theta$ if $\frac{\partial p_1}{\partial \theta}_{\varsigma_1=0} < \frac{\partial p_1}{\partial \theta}_{\varsigma_2=0}$, i.e. if the fall in $p_1$ required to ensure return equalisation across sectors when $\theta$ changes is of greater magnitude than the price fall as a result in the fall in the excess return of the productive. Similar results hold for $\partial R/\partial \psi$ which is also therefore ambiguous. With $X$ decreasing with $\theta$ and $R$ ambiguous then $g'(\theta)$ is ambiguous.

**Range of $\theta$ for Case A with binding international borrowing constraint** For this case to occur we require that $X(IF, CaseA\ IBC\ bind) \geq 0$, that $R > R^*$ and that the unproductive do not find it worthwhile to invest.

The first condition is satisfied by:

$$\theta \leq \frac{1}{\Omega(1 + n(1 - \psi))} = \theta_A^{IF}$$

This cutoff is increasing in $\psi$ (and hence greater than the corresponding cutoff in autarky) and decreasing in $n$, $k$ and $\gamma$. This is also the binding constraint for $x_A \geq 0$. For $\theta$ above this value entrepreneurs are unconstrained and only the productive produce.

As the sensitivity of $R$ to $\theta$ is ambiguous, the range of values of $\theta$ for which $R > R^*$ may not be continuous or may be empty. The value of $\theta$ for which $R = R^*$, $\widehat{\theta}_{IF}$, is implicitly defined by the following equation:

$$\varsigma_1^{\dagger}(\widehat{\theta}_{IF}) \equiv \frac{\left(1+\kappa\widehat{\theta}_{IF}x\left(\widehat{\theta}_{IF}\right)\right)}{1+\widehat{\theta}_{IF}x\left(\widehat{\theta}_{IF}\right)} - \left(\frac{R^*\left(1+x\left(\widehat{\theta}_{IF}\right)\right)}{\varphi_p\left(1+\widehat{\theta}_{IF}x\left(\widehat{\theta}_{IF}\right)\right)}\right)^{1/(1-\gamma)} = 0$$

As $\varsigma_1^{\dagger}(\widehat{\theta}_{IF})$ is a continuous function then it can be shown that if $R^* < \varphi_p$ there exists at least one solution for $\widehat{\theta}_{IF}$ between 0 and $\theta_A^{IF}$.

The unproductive if she did produce would do so in sector two. The condition that her return from production must be less than the domestic interest rate is given by:

$$R_{A,IF,R>R^*}(\varphi_u)(\theta) < R_{A,IF,R>R^*}(\theta) \Rightarrow \frac{p_2\varphi_u(1-\psi\kappa\theta)}{1-p_2\varphi_u\psi\kappa\theta/R^*} < R$$

As with the case of the sensitivity of $R$ to $\theta$ the sensitivity of $R(\varphi_u)$ to $\theta$ is also ambiguous.

**Case A if international borrowing constraint does not bind** In this case $R = R^*$ and $p_1$ is uniquely defined by return equalization for the productive across sectors with $p_1'(\theta) < 0$ and $p_1'(\psi) = 0$ . $x$ is defined as a function of $p_1$ and the exogenous parameters:

$$x(R=R^*) = \frac{1-p_1/p_2(p_1)}{\theta(p_1/p_2(p_1)-\kappa)}$$

where $x'(\theta) \propto p_1'(\theta)(1-\theta) + p_1\left(\frac{p_1\varphi_p\theta}{R}-1\right) \propto \kappa(1-\theta) + \frac{p_1}{p_2(p_1)}\frac{(1-\theta)\gamma}{(1-\gamma)} > 0$. We can thus obtain the value for $X$ from $F(x,X)=0$ where $X'(\theta)>0$, $s'(\theta)>0$ and $s'(\theta)>0$.

This case occurs in the range for which $X(IF, CaseA\ IBC\ not\ bind) > 0$ and $R(\varphi_u)(IF, CaseA\ IBC\ not\ bind) > R^*$

**Range of $\theta$ for Case A with non-binding international borrowing constraint**

The conditions for this equilibria are that $X_{A,IF,R>R^*}(\theta) \geq 0$ and that the unproductive prefer not to production. The first condition requires that $\theta$ be less than the value at which $1 = p_1/p_2(p_1)$. The second condition is that $R_{A,IF,R=R^*}(\varphi_u)(\theta) < R^*$. This range is defined by the values of $\theta$ for which:

$$\frac{p_2(\theta)\varphi_u(1-\psi\kappa\theta)}{1-p_2\varphi_u\psi\kappa\theta/R^*} < R^*$$

### 3.B.6.2 Case B International Finance

The domestic interest rate and intermediate price $p_1$ are determined by return equalisation for productive and return indifference for the unproductive:

$$\Psi_1 \equiv 1-\kappa\theta-p_1\varphi_p(1-\kappa)\theta J(R,R^*,\psi)-(1-\theta)p_1/p_2(p_1)=0$$
$$\Psi_2 \equiv 1-p_2\varphi_u\left(\frac{1-\psi\kappa\theta}{R}+\frac{\psi\kappa\theta}{R^*}\right)=0$$

These two equations give a two loci in $(p_1, R)$ the intersection of which determines the equilibrium value. From the second equation we obtain $p_1(R,\theta,\psi)$ where $p'_{1,R} < 0$, $p'_{1,\theta} > 0$ and $p'_{1,\psi} > 0$. Substituting into the first equation, we obtain the unique value of $R$ which is increasing in $\theta$ and in $\psi$.

Substituting in the solutions for prices and domestic interest rate into the excess return of the productive we obtain:

$$1+x_B^{IF} = \left[\frac{\varphi_u-\kappa\theta\varphi_p}{\varphi_p(1-\kappa\theta)}-\frac{(\varphi_p-\varphi_u)\psi\kappa\theta(R/R^*-1)}{\varphi_p(1-\kappa\theta)}\right]^{-1} > (1+x_B)$$

Thus $x$ is increasing in both $\theta$ and $\psi$. From the expression for $x$ we can determine $X$ and $s$ which have similar comparative statics with respect to $\theta$ and $\psi$ from

$F(x, X) = 0$.

Given $x, X$, prices and the domestic interest rate we can pin down the quantities as the solution of five linear equations (relative demand, binding IBC, goods market clearing, investment of the productive in each sector) in five unknowns.

$$A \begin{bmatrix} \bar{I}_1^p \\ \bar{I}_2^p \\ \bar{I}_2^u \\ \chi_1^p \\ \overline{B}^* \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ \beta \\ 0 \\ \beta X/x \end{bmatrix}$$

where $A$ is defined by:

$$A = \begin{bmatrix} (1-\gamma) p_1 \varphi_p & -\gamma p_2 \varphi_p & (1-\gamma) p_1 \varphi_u & 0 & 0 \\ p_1 \varphi_p & \kappa p_2 \varphi_p & \kappa p_2 \varphi_u & 0 & -(\psi \theta R^*)^{-1} \\ 1 & 1 & 1 & 0 & -1/R^* \\ A_1 & 0 & 0 & -\beta X/x & 0 \\ 0 & A_2 & 0 & \beta X/x & 0 \end{bmatrix}$$

where $A_1 \equiv 1 - \varphi_p p_1 \theta J(R, R^*, \psi)$ and $A_2 \equiv 1 - \varphi_p p_2 \kappa \theta J(R, R^*, \psi)$.

**Range of $\theta$ for Case B with binding international borrowing constraint** This equilibria will occur in the range of $\theta$ for which productive net worth weighted excess returns are greater than zero, i.e. $X_{B,IF}(\theta) \geq 0$ (requiring $\theta$ above a certain value) and for which the domestic interest rate exceeds the foreign rate (again requiring $\theta$ to be above a certain value), the unproductive produce in sector two and the share of productive producing in sector one is less than unity, i.e. $R_{B,IF}(\theta) > R^*$, $\overline{I}^u_{B,IF,2}(\theta) > 0$ and $1 > \chi^p_{B,IF}(\theta)$. Given the complexity of the solutions to these conditions it is unclear whether they form a continuous non-empty range for $\theta$.

### 3.B.6.3 Case C International Finance

We have $\chi_1^p = 1$ and $\chi_1^u = 0$, $\chi_2^u = 1$. Return indifference for the unproductive pins down $p_2$ as an increasing function of $R$. Using the constrained investment level of the productive, the relative demand expression and the goods market clearing condition we can, with some manipulation, obtain an expression for the international borrowing constraint defined in terms of $x$ and $X$.

$$1 = \frac{X}{x\left(1-\theta\right)}\left(E_1 + x\left(E_1 - 1 + \theta\right)\right)$$

where $E_1 \equiv 1 - \psi\theta + \frac{1-\gamma}{\gamma}\frac{\varphi_u(1-\psi\kappa\theta)}{\varphi_p}$. Combining this with the equation $F(x, X) = 0$ gives a system in $X$ and $x$ which can be solved uniquely. The solution for $X$ is given by:

$$X = \delta\left(\frac{E_1}{E_1 - 1 + \theta} - 1 - n\right)$$

and can be shown to be decreasing in $\theta$ and increasing in $\psi$ (and hence so are $x$ and $s$). Given the value of $x$ we can solve for $R$ as a function $p_1$ from the definition of $x$ and then substituting this into the return indifference for the production we obtain the following implicit solution for $p_1$:

$$0 = J_1 \equiv p_2\left(p_1\right)\varphi_u - \frac{p_1\varphi_p\left(1 - \psi\theta + x\theta\left(1-\psi\right)\right)}{\left(1+x\right)\left(1-\psi\kappa\theta\right) - \frac{p_1\varphi_p\psi\theta}{R^*}\left(1 - \kappa + x\left(1-\theta\kappa\right)\right)}$$

where $\partial J_1/\partial p_1 < 0$. As $p_1$ tends to zero $J_1$ tends to infinity. As $p_1$ tends to $\frac{R^*(1+x)(1-\psi\kappa\theta)}{\varphi_p\psi\theta(1-\kappa+x(1-\theta\kappa))}$ then $J_1$ tends to minus infinity. Thus there is a unique equilibrium value of $p_1$ from which we can derive $p_2$ and then $R$ from return indifference for the unproductive:

$$p_2\left(p_1\left(\theta\right)\right)\varphi_u = \left(\frac{1-\psi\kappa\theta}{R} + \frac{\psi\kappa\theta}{R^*}\right)^{-1}$$

The sensitivity of the domestic interest rate to $\theta$ is ambiguous. Given relative prices, domestic interest rate and $s$ we can obtain investment levels and foreign borrowing.

**Range of $\theta$ for Case C with binding international borrowing constraint** This equilibrium falls in the range of $\theta$ for which $X_{C,IF} \geq 0$, the productive prefers to produce in sector one than sector two ($R_{C,IF,1}\left(\varphi_p\right)\left(\theta\right) > R_{C,IF,2}\left(\varphi_p\right)\left(\theta\right)$), the unproductive prefers to produce in sector two than sector one ($R_{C,IF,2}\left(\varphi_u\right)\left(\theta\right) > R_{D,IF,1}\left(\varphi_u\right)\left(\theta\right)$) and the domestic interest rate exceeds the foreign rate ($R_{C,IF}\left(\theta\right) > R^*$). The first condition is equivalent to the condition that:

$$\theta \leq \theta_{C,IF} = \frac{\gamma\varphi_p - n\left(1-\gamma\right)\varphi_u}{\gamma\varphi_p\left(1+n\left(1-\psi\right)\right) - n\left(1-\gamma\right)\psi\kappa\varphi_u}$$

where $\theta_A^{IF} > \theta_C^{IF}$ and $\theta_C^{IF} > \theta^{IF}$

### 3.B.6.4 Case D International Finance

Productive entrepreneurs invest in sector one only, i.e. $\chi_{1D}^p = 1$, and the unproductive entrepreneurs invest in both sectors. The unproductive returns are equalized across sectors and are equal to $R$. This gives a unique solution for $p_1$ implicitly defined by:

$$\Lambda \equiv p_2\left(p_1\right) - \frac{\left(1-\psi\theta\right)p_1}{1-\kappa\psi\theta - p_1\varphi_u\left(1-\kappa\right)\theta\psi/R^*} = 0$$

$p_1$ is increasing in $R^*$, $\theta, \psi$ and $\kappa$. From the unproductive's return indifference, the domestic interest rate can then be expressed as function of $p_1$ and is decreasing in $R^*$, $\theta$ and $\psi$ (and ambiguous in $\kappa$).

Substituting the relative prices and domestic interest rate into the definition of the excess returns of the productive gives the following expression:

$$1+x=\frac{\varphi_p\left(\frac{p_1}{p_2(p_1)}-\kappa\right)}{\frac{\varphi_u(1-\kappa)}{(1-\theta)}\left(1-\frac{p_1\varphi_p\psi\theta}{R^*}\right)-\frac{\varphi_p(1-\psi)\theta}{(1-\theta)}\left(\frac{p_1}{p_2(p_1)}-\kappa\right)}$$

It can be shown that $x$ is increasing in $\theta$ through both the direct effect and the indirect effect on $p_1$ (and hence $X$ and $s$ are also increasing in $\theta$). Similarly $x$ is increasing in $\psi$ through the direct and indirect effects. Given relative prices, $R$, $x$ and $X$ the investment levels and foreign borrowing can then be pinned down.

**Range of $\theta$ for Case D with binding international borrowing constraint** The conditions for Case D to be the steady state constrained equilibrium are that the net worth share weighted excess returns of the productive are non-negative (i.e. $X_{D,IF}(\theta) \geq 0$), the unproductive have positive production in both sectors with their returns equalized across sectors (i.e. $\overline{I}^{u}_{D,IF,1}(\theta) > 0$ $\overline{I}^{u}_{D,IF,2}(\theta) > 0$ and $R_{D,IF,1}(\varphi_u)(\theta) = R_{D,IF,2}(\varphi_u)(\theta)$), that the productive prefer to produce in sector 1 (i.e. $R_{D,IF,1}(\varphi_p)(\theta) > R_{D,IF,2}(\varphi_p)(\theta)$ ) and that the domestic interest rate exceeds the foreign ($R_{D,IF}(\theta) > R^*$).

# Chapter 4

# Thresholds in the process of international financial integration

## 4.1 Introduction

The worldwide financial crisis has dramatically driven home the downside risks of financial globalization. Many emerging market and developing economies had to grapple with surges of capital inflows earlier in this decade. Sharp reversals were then seen during the crisis as financial linkages served as a channel for the global financial turmoil to reach their shores. More recently capital inflows to emerging markets have been resurgent, bringing their own policy challenges. These experiences have re-ignited the fierce debate about the merits of financial globalization and its implications for growth and volatility, especially for developing countries.[1]

In theory, financial globalization should facilitate efficient international allocation of capital and promote international risk sharing. These benefits should be much greater for developing countries. These countries are relatively capital scarce and labor rich, so access to foreign capital should help them increase investment

[1] As an example, in the wake of the financial crisis, IMF staff have re-evaluated the appropriateness of capital controls and indicated that they may be a legitimate part of the policy mix in response to surges in capital inflows (see, for example, Ostry et al., 2010).

and grow faster. Developing countries also have more volatile output growth than advanced industrial economies, which makes their potential welfare gains from international risk sharing much greater.

However, the empirical literature has not been able to conclusively establish the growth and stability benefits of financial integration. In particular, cross-country studies have not yielded robust evidence that financial openness has a positive effect on growth. Studies using microeconomic (firm- or industry-level) data or those that look at specific events such as equity market liberalizations do detect significant growth effects, but it remains an open question whether these effects scale up when one considers the more general concept of financial openness and its effects on growth. Moreover, for developing countries with low to intermediate levels of financial openness, there is equally sparse evidence that financial integration has delivered its other presumed benefit–improved risk sharing and better consumption smoothing.

Kose et al. (2009) survey this extensive literature and propose an alternative framework for analyzing the macroeconomic implications of financial globalization in order to pull together the different strands of evidence. These authors point out that in theory financial globalization should catalyze domestic financial market development, improve corporate and public governance, and provide incentives for greater macroeconomic policy discipline. Such indirect benefits may be more important than the traditional financing channel emphasized in previous analyses. Indeed, recent work stimulated by the phenomenon of global current account imbalances suggests that developing countries that are more open to certain types of financial flows but overall are less reliant on foreign capital and finance more of their investment through domestic savings have on average experienced better growth performance.[2]

A major complication, however, is that there seem to be certain "threshold" lev-

[2]See Aizenman et al. (2007), Gourinchas and Jeanne (2007) and Prasad et al. (2007).

els of financial and institutional development that an economy needs to attain before it can get the full indirect benefits and reduce the risks of capital account liberalization. It has generally been the case that industrial countries—which typically have better institutions, more stable macro policies, and deeper financial markets than developing countries—have been the main beneficiaries of financial globalization. This has led many authors to argue that developing countries should focus on building up their institutional capacity and strengthening their financial markets before opening up their capital accounts (e.g., Rodrik and Subramanian, 2009). How to balance these considerations against the potential benefits to be gained from financial integration is a pressing policy question, now that developing countries again face difficult choices about whether and how to liberalize capital account transactions further.

Framing the issue this way generates a set of pointed questions that are relevant for translating academic analysis of financial globalization into implications for policies toward capital account liberalization. How can countries improve the benefit-risk trade-off associated with integration into international capital markets? Is there a well-defined threshold level of economic characteristics beyond which the trade-off improves and makes opening of the capital account beneficial and less risky for a developing country?

There is a substantial theoretical and empirical literature, mostly of recent vintage, suggesting that financial sector development, institutional quality, trade openness, and the stability of macroeconomic policies all play important roles in realizing the benefits of financial openness. For instance, a deep and well-supervised financial sector is essential for efficiently intermediating foreign finance into productive investments. It can also be helpful in reducing the adverse effects of capital flow volatility. Similarly, countries with better institutions (less corruption and red tape, better corporate and public governance) attract relatively more FDI and portfolio equity flows, which are more stable than debt flows and are also more likely

to promote indirect benefits. The existing literature points to the existence of such threshold effects but lacks a unifying framework that can be used to interpret the results and derive policy implications.

Our main contribution is to provide a unified empirical framework for studying the concept of thresholds in the process of financial integration and for analyzing the policy implications of this framework for the process of capital account liberalization. We then provide a new set of results on thresholds in different dimensions using a common empirical approach. In the process, we tackle a number of complex measurement issues that need to be dealt with in order to provide more coherence to the existing literature. We also make a modest methodological contribution by showing how to adapt semiparametric estimation techniques to estimate key interaction relationships in growth regressions in a flexible manner.

We report some initial progress on framing and addressing a more difficult set of practical questions directly related to various policy choices. For instance, what are the confidence intervals around different threshold conditions? This is important for determining the policy relevance of the estimated thresholds and for identifying zones that are clearly hazardous or clearly safe for undertaking financial opening. We take an agnostic approach towards various measurement issues on which there is no consensus in the literature, including how best to measure financial development and financial openness. We also try to account for possible differences in threshold conditions across different types of cross-border flows.

Based on an analysis of data over a period of three decades prior to the recent financial crisis, we find that there are indeed clearly identifiable thresholds in variables such as financial depth and institutional quality. Although there are differences in the results we obtain from various methodologies and the confidence intervals tend to be large, some of the key thresholds are fairly precisely estimated and have practical empirical content. We also find that the thresholds are lower for foreign direct investment and portfolio equity liabilities compared to those for debt

liabilities.

We begin, in Section 4.2, by reviewing some of the existing literature and providing a synthesis that enables us to map out some of the key issues that need to be addressed in analyzing threshold effects. In Section 4.3, we tackle a number of measurement issues, including how to measure financial openness and the different threshold variables. In Section 4.4, we discuss the empirical strategy to get at the issue of thresholds. Our basic results, including some stylized facts to motivate the more detailed analysis, are in Section 4.5. In Section 4.6, we conduct a variety of sensitivity tests on our baseline results. We then present a number of extensions in Section 4.7. We conclude, in Section 4.8, by highlighting the main findings and discussing their policy implications.

## 4.2 Synthesis of Theory and Evidence

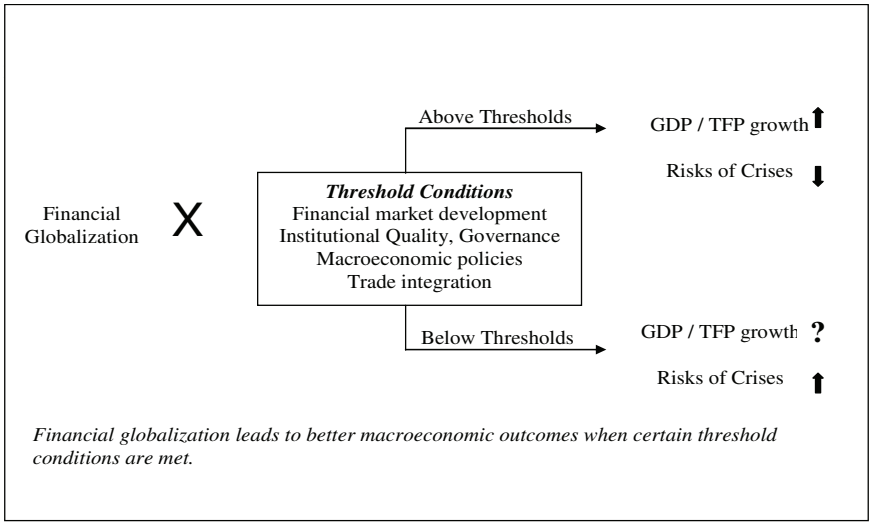
In prior research, a number of avenues have been explored to reconcile the strong theoretical prediction that financial integration should boost long-run growth in developing economies with the weak empirical evidence. Some authors have argued that countries that do not have the right initial conditions can experience growth surges due to financial integration but they inevitably experience crises, which pulls down their long-run growth. Others have argued that countries that lack certain structural features are not able to derive the full benefits of financial integration even if they can escape crises.[3]

Kose et al. (2009) synthesize these two lines of argument into a framework that characterizes variables that influence the relationship between financial integration and growth as a set of "threshold conditions." Figure 4.1 schematically depicts this framework and lists the main threshold conditions. These include an economy's structural features–the extent of financial sector development, institutional quality,

[3]For a comprehensive review of the related literature see Appendix Tables 4.9 to 4.13.

and trade integration–and also the macroeconomic policy framework.

**Figure 4.1:** Thresholds in the Process of Financial Integration




Source: Kose et al. (2009).

In theory, financial development enhances the growth benefits of financial globalization and reduces vulnerability to crises. Domestic and international collateral constraints play a particularly important role in financially underdeveloped low-income economies where access to arm's length financing is limited. A number of recent studies show how, in different theoretical settings, the interaction of these constraints can lead to unpredictable and possibly adverse effects of capital account liberalization.[4] Shifts in the direction of capital flows can induce or exacerbate boom-bust cycles in developing countries that lack deep financial sectors (Aghion and Banerjee, 2005). Moreover, mismanaged domestic financial sector liberalizations have been a major contributor to crises associated with financial integration (Mishkin, 2006).

Cross-sectional studies generally find significant positive interaction effects between foreign direct investment (FDI) and financial depth (ratio of private credit to

[4]See Caballero and Krishnamurthy (2001); Aghion et al. (2004); Mendoza et al. (2007); Aoki et al. (2010).

GDP) on growth (see Appendix Tables 4.9 and 4.10). However, the implied financial depth thresholds for obtaining a positive coefficient on financial openness vary substantially within and across studies. For example, across Hermes and Lensink (2003), Alfaro et al. (2004), and Carkovic and Levine (2005) the estimated credit to GDP thresholds vary from 13 percent to 48 percent. There are mixed results from studies where financial depth is interacted with other financial openness measures. Bekaert et al. (2005) and Hammel (2006) find higher growth following equity market liberalizations in countries with higher private credit, stock market turnover and stock market capitalization, respectively (see also Bekaert et al., 2009; Mukerji, 2009). Using broader measures of financial openness, Prasad et al. (2007) find evidence of high/low interaction effects among non-industrial countries (see also Klein and Olivei, 2001; Chinn and Ito, 2006; Masten et al., 2008) but Kraay (1998) and Arteta et al. (2003) do not.

The quality of corporate and public governance, the legal framework, the level of corruption, and the degree of government transparency can affect the allocation of resources in an economy. Some authors argue that precursors of crises such as flawed macroeconomic and structural policies can also be traced back to weak institutions (Acemoglu et al., 2003). Since capital inflows make more resources available, the quality of institutions matters more for financially open economies. Post-mortems of the Asian financial crisis have pinned a large portion of the blame on crony capitalism that reflected corruption and weak public governance (Haber, 2002; Krueger, 2002). Indeed, an intermediate degree of financial openness with selective capital controls may be most conducive to crony capitalism, as it gives politically well-connected firms preferential access to foreign capital (Johnson and Mitton, 2003). Weak protection of property rights in poor countries means that foreign financing may not be directed to long-gestation, investment-intensive, and low-initial profitability projects (including infrastructure) where such financing could be particularly useful given domestic financing constraints (Rajan and Zingales, 1998).

Bekaert et al. (2005) and Chang et al. (2009) find interaction effects between institutional quality and financial openness in promoting growth but Kraay (1998) and Quinn and Toyoda (2008) do not (see Appendix Table 4.11). Klein (2005) finds that only intermediate levels of institutional quality are associated with a positive correlation between growth and capital account liberalization, hinting at the possibility of nonlinear threshold effects. Countries with better corporate and public governance receive more of their inflows in the form of FDI and portfolio equity; these are more stable than debt flows and also confer more of the indirect benefits of financial integration (Wei, 2001). Some authors have used a country's level of income as a proxy for overall institutional development and interacted that with financial openness (see Appendix Table 4.12). Edwards (2001) and Edison et al. (2004) find evidence of a positive linear interaction and an inverted U-shaped relationship, respectively. However, Arteta et al. (2003), Carkovic and Levine (2005) and Quintin et al. (2008) do not find robust evidence of such relationships.

Trade openness reduces the probability of crises associated with financial openness and mitigates the costs of crises if they do occur. Economies that are more open to trade have to undergo smaller real exchange rate depreciations for a given current account adjustment, face less severe balance sheet effects from depreciations and, as a result, are less likely to default on their debt. This makes them less vulnerable to sudden stops and financial crises (Calvo et al., 2004; Cavallo and Frankel, 2008). Trade integration puts an economy in a better position to continue servicing its debt and export its way out of a recession (Edwards, 2004). Eichengreen (2001) note that financial integration without trade integration could lead to a misallocation of resources as capital inflows may go to sectors in which a country doesn't have a comparative advantage (also see Aizenman and Noy, 2008).

Capital account liberalization is more likely to be successful if it is supported by good fiscal, monetary and exchange rate policies. Weak or incompatible policies can increase the risk of crises from an open capital account. For instance, the combi-

nation of a fixed exchange rate and an open capital account has been implicated in a number of currency crises (Obstfeld and Rogoff, 1995; Wyplosz, 2004). Similarly, managing capital inflows can be especially complicated in developing economies with large fiscal deficits and procyclical fiscal policy (Ishii et al., 2002; Calvo et al., 2004; IMF, 2007). These findings have been used to argue that capital account liberalization can serve as a commitment device for sound macroeconomic policies (Bartolini and Drazen, 1997; Gourinchas and Jeanne, 2007). Arteta et al. (2003) report evidence of threshold effects related to macro policies in generating positive growth effects of financial openness. Mody and Murshid (2005) find that better macro policies enhance the impact of financial openness on investment growth.

In summary, there is a substantial theoretical and empirical literature that serves as a basis for positing the existence of threshold conditions. However, this literature is disparate and does not provide clear guidance about the precise nature of the threshold relationship or how one would translate the theory into a reduced-form empirical framework. Some models suggest the existence of nonlinear threshold effects but the form of nonlinearity is not clear.

The empirical literature has reported many interesting results but the robustness of these results and the estimated thresholds vary widely. Moreover, each of these studies typically focuses on one conditioning variable and one indicator of financial openness, and most of them use a simple linear interaction specification. The extent to which countries satisfy different potential thresholds or the trade-offs between different threshold variables has not been examined, nor has the economic significance of the threshold levels. Finally, the potentially wide confidence intervals around the thresholds have not been emphasized. Thus, while there is a great deal of evidence that threshold conditions matter, the existing literature is not organized around a consistent framework, making it difficult to draw policy conclusions about capital account liberalization.

## 4.3 Measurement and Data

In this section, we discuss our approach to several key measurement issues and present our dataset. We take an agnostic approach to some of the complex measurement issues. Our approach will be to pick baseline measures of certain variables and then conduct extensive robustness tests of those baseline results using alternative measures. A detailed description of the variables in our dataset, as well as their sources, are presented in Appendix 4.A.

There is an important distinction between traditional de jure measures of openness, i.e., restrictions on capital account transactions, and de facto openness. Capital controls are the relevant policy tool, but there can be differences in their degree of enforcement over time. Besides, when analyzing how financial openness influences growth, what matters is how much an economy is actually integrated into international capital markets.

We use as our baseline measure of financial openness the sum of a country's total stocks of external assets and liabilities, expressed as a ratio to nominal GDP. This is a summary measure of a country's total exposure to international financial markets. We also look at stocks of liabilities—cumulated measures of inflows into a country—that may be most relevant for developing economies as well as various measures of gross and net flows. In some of our analysis, we also look at de jure capital account openness based on an indicator of the proportion of years in which the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER) indicates the absence of capital account restrictions. For each of the threshold categories, we have to choose an appropriate measure that is conceptually sound and for which data are available for our broad sample of countries.

a. Financial depth: We use the ratio of private credit to GDP as a proxy for financial depth, recognizing that this is a narrow definition of financial development. We also examine a range of alternative measures of de facto financial depth

and development, such as the sum of stock market capitalization and credit to GDP, the ratio of M2 to GDP etc., as well as institutional measures such as creditors' rights.

b. Institutional quality: The World Bank Governance Indicators (WBGI) cover six aspects of institutional quality: voice and accountability; political instability and violence; government effectiveness; regulatory quality; rule of law; and control of corruption Kaufmann et al. (2005). We use a simple average of these six indices as a proxy for aggregate institutional quality. These data are available only from 1996 and show strong persistence across time for each country; hence, we use the average of the available data as a fixed institutional variable.

c. Regulation: We use an index of the rigidity of labor regulations from the International Finance Corporation's Doing Business Database. It captures an economy's ability to adapt to changing business conditions, including financial flows. These data are available only from 2003, so we use the average for each country as a fixed regulation variable.

d. Trade openness: We use the sum of exports and imports of goods and services, expressed as a ratio to GDP. We also include a measure of policy openness to trade, defined as the proportion of years for which the trade regime is an open one, as defined by Wacziarg and Welch (2008).

e. Macro policies: The monetary and fiscal policy stances are measured by the degree of variation in consumer price inflation and the average ratio of government revenue to expenditure, respectively, over the relevant period. Whilst these macroeconomic outcomes are subject to exogenous shocks, their measurement over five-year periods can provide a broad indication of the policy stance.

f. Overall development: We use the level of initial per capita GDP (either at the beginning of the sample or the initial year of each five-year period measure).

Our dataset comprises a total of 84 countries. We do not include the transition economies of Eastern Europe since their data for the pre-transition years are suspect and we need longer time series for our analysis. We also exclude small economies (population under 1 million) and a number of poor economies for which data availability, especially on capital flows, is limited. The dataset covers the period 1975-2004, giving us a maximum of six non-overlapping five year-averaged observations for each country. When presenting basic stylized facts, we group the countries into industrial (21), emerging market (21), and other developing countries (42) (see Appendix Table 4.7). The emerging market countries are those from the group of non-industrial countries that are most financially open.[5] This group accounts for the vast majority of capital flows (either net inflows or gross inflows plus outflows) into or out of the non-industrial countries. In the formal empirical analysis, we do not use these coarse distinctions; instead, we directly control for the level of development and the degree of financial openness. Our econometric analysis includes the full sample of countries as it is based on a framework that should be consistent across industrial and developing countries. Indeed, for identifying threshold effects, it is best to include as many countries as possible at different stages of development.

## 4.4 Empirical Strategy

We now discuss some issues that we need to confront in our formal empirical analysis and describe how we tackle them. Our empirical framework builds on standard cross-country growth regressions as we are interested in capturing thresh-

[5]The countries in the group of emerging markets roughly correspond to those included in the MSCI Emerging Markets Index. The main differences are that we drop the transition economies because of limited data availability and add Singapore and Venezuela.

old effects at the national level.[6] Our focus is on medium- and long-run growth rather than business cycle and other short-run fluctuations. Hence, we use five-year averages of the underlying data for our baseline results. Business cycles are more persistent in developing economies than in industrial ones but a five-year window is a reasonable compromise for filtering out cycles in both types of countries (Agenor et al., 2000; Aguiar and Gopinath, 2007). Time averages of the annual data also smooth out year-to-year fluctuations in variables such as capital flows. We use two broad categories of cross-country econometric models to investigate potential thresholds in the relationship between financial openness and growth. Both methods attempt to explain a country's growth over a five-year period, $\Delta \mathrm{y}_{\mathrm{it}}$, as a function of a set of standard controls for growth models, $\mathrm{x}_{it}$ , country and time period specific effects, $\delta_i$ and $\gamma_t$ respectively, financial openness, $FO_{it}$ , and its relationship with a threshold variable, $TH_{it}$:

$$\Delta \mathrm{y}_{it} = f(\mathrm{x}_{it}, FO_{it}, TH_{it}, \delta_i, \gamma_t) + \varepsilon_{it}$$

where $i$ indexes the country and $t$ the time period, and $\varepsilon_{\mathrm{it}}$ is an idiosyncratic error term.

The first approach we consider is parametric - a standard linear dynamic panel data model with various interaction functions between the threshold and financial openness variables. The second approach is a semi-parametric one - a partial linear model wherein the relationship between growth and the standard controls plus fixed effects is assumed to be linear but the relationship between growth and the financial openness and threshold variables is modeled as a nonparametric function.

[6] We are aware of concerns of authors such as Durlauf et al. (2005) about cross-country growth regressions. Our view is that, despite their limitations, these regressions can help develop some useful policy messages related to threshold conditions for financial integration.

### 4.4.1 Parametric approach

The dynamic linear panel data model is of the following form:

$$\Delta \mathrm{y}_{it} = \delta_i + \gamma_t + \mathrm{x}'_{it}\theta + g(FO_{it}, TH_{it}) + \varepsilon_{it}$$

where $\theta$ is a vector of coefficients on the set of standard controls and where the vector of standard controls $\mathrm{x}_{it}$ includes the initial income per capita levels. A key empirical issue is how to define the thresholds relationship in the function $g(FO_{it}, TH_{it})$. Based on the literature cited earlier, we explore three specific parametric assumptions for this function:[7]

a A linear interaction between financial openness and the threshold variable:

$$g(FO_{it}, TH_{it}) = \beta_{FO} FO_{it} + \beta_{TH} TH_{it} + \beta_{FOTH} FO_{it} TH_{it}$$

This approach tests if the level of a particular variable affects the marginal effect of financial openness on growth in a linear manner.

b A quadratic interaction that allows for nonlinear effects of the threshold variable:

$$\begin{aligned} g(FO_{it}, TH_{it}) &= \beta_{FO} FO_{it} + \beta_{TH} TH_{it} + \beta_{FOTH} FO_{it} TH_{it} \\ &\quad + \beta_{THsq} TH_{it}^2 + \beta_{FOTHsq} FO_{it} TH_{it}^2 \end{aligned}$$

This allows for the possibility that, beyond a certain level, the threshold variable becomes more or less important in determining the marginal effect of

[7] These are among the most widely used parametric specifications in the literature. Other approaches include interactions of capital account openness with cubic terms in institutional quality, with a quadratic spline or with quantile dummies for institutional quality such as in Klein (2005).

financial openness on growth.

c A high-low cut-off based on the sample median of a threshold variable:

$$\begin{aligned} g(FO_{it}, TH_{it}) &= \beta_{FO} FO_{it} + \beta_{FOTHhigh} \mathbf{D}(TH_{it} > THmedian_t) \\ &\quad + \beta_{TH} TH_{it} \end{aligned}$$

where $\mathbf{D}(TH_{it} > THmedian_t)$ is an indicator variable that takes the value of 1 if the threshold variable for a country is above the median value for all countries in that time period.

This approach sets the threshold exogenously and provides a simple way of testing if the level of a particular variable matters in terms of the quantitative effect of openness on growth outcomes. We also examine the impact of varying the high-low cut-off to check the appropriateness of the median approach.[8]

The interpretation of reduced-form growth regressions is typically bedevilled by concerns about endogeneity and the direction of causality. For instance, capital may flow disproportionately to fast-growing economies, making financial integration dependent on growth rather than the reverse. Similarly, financial development and growth may both be driven by common factors such as the legal or broader institutional frameworks. It is difficult to come up with convincing and effective instruments to deal with these issues. Hence, we use system generalized method of moments (GMM) techniques for dynamic panels to get around these problems. This involves estimating a system comprising a first-differenced equation to eliminate country fixed effects and an additional equation in levels. Appropriately lagged values of levels and first-differences, respectively, can then be used as instruments

[8] An alternative approach would be to use sample-splitting methodologies to endogenously determine the threshold (Hansen, 2000). Unfortunately, however, such models cannot be applied to the dynamic panel approach that we employ.

in these equations to address endogeneity concerns. This approach is increasingly being used in a variety of related contexts.[9] In addition to the system GMM estimation we also provide basic fixed effects estimates as a consistency check.

### 4.4.2 Semi-parametric approaches

Next, we turn to a nonparametric technique that allows us to model in a more flexible manner the relationship between growth, on the one hand, and the financial openness and threshold variables on the other. To keep the model tractable, we assume that the relationship between growth and the standard controls plus fixed effects is linear as before. The resulting semiparametric model is written as follows:

$$\Delta \mathrm{y}_{it} = \delta_i + \gamma_t + \mathrm{x}'_{it}\theta + h(FO_{it}, TH_{it}) + \varepsilon_{it}$$

where we estimate the parametric coefficients and the nonparametric relationship $\mathrm{h}(\mathrm{FO}_{\mathrm{it}}, \mathrm{TH}_{\mathrm{it}})$.

A few recent papers in the growth literature have used partial linear models to examine the relationship between growth and a regressor of interest. For example, Banerjee and Duflo (2003) examine the nonparametric effects of inequality on growth while Imbs and Rancière (2007) look at the relationship between external debt and growth. However, these papers focus on the relationship between growth and a nonparametric function of a single variable rather than a function of two variables as is the case with the interaction effects we consider.

Yatchew (1998, 2003) provides a detailed guide to a variety of methods that can be employed to estimate the parametric coefficients and a multidimensional non-

[9] See Bond et al. (2001), for a detailed technical discussion of its application to empirical growth models. In related work, Chang et al. (2009) use this methodology to explore linear interaction effects of institutional features and trade openness. Aghion et al. (2009) look at interaction effects between financial development and the exchange rate regime. Roodman (2006, 2008) provides a detailed review of the practical implementation of this methodology in a manner that obviates potential concerns related to its somewhat mechanical application and small sample problems.

parametric function such as $h(FO_{it}, TH_{it})$.[10] In particular, as in Banerjee and Duflo (2003) and Imbs and Rancière (2007), we focus on the Robinson (1988) double residuals approach. This involves two stages. First, nonparametric regressions of growth and each of the other control variables on financial openness and the threshold variable are estimated to give $\mathrm{E}(\Delta \mathrm{y}_{it}|FO_{it}, TH_{it})$ and $\mathrm{E}(\mathrm{z}_{it}|FO_{it}, TH_{it})$ where $z_{it}$ denotes the matrix of $\mathrm{x}_{it}$ plus the fixed effects with corresponding vector of coefficients $\kappa$. Various nonparametric estimation methodologies can be employed, for example local regression or kernel estimation. The residuals from these regressions are then used to estimate the parametric coefficients $\kappa$ using an OLS regression:

$$\begin{aligned} \Delta \mathrm{y}_{it} - \mathrm{E}(\Delta \mathrm{y}_{it}|FO_{it}, TH_{it}) &= \Delta \mathrm{y}_{it} - \mathrm{E}(\mathrm{z}_{it}|FO_{it}, TH_{it})'\kappa - h(FO_{it}, TH_{it}) \\ &= (\mathrm{z}_{it} - \mathrm{E}(\mathrm{z}_{it}|FO_{it}, TH_{it}))'\kappa + \varepsilon_{it} \end{aligned}$$

These OLS estimates of $\hat{\kappa}$ can then be used to construct an expression for the residual growth with the estimated parametric effects removed:

$$\Delta \mathrm{y}_{it} - \mathrm{z}'_{it}\kappa \approx h(FO_{it}, TH_{it}) + \varepsilon_{it}$$

The nonparametric form of $h(FO_{it}, TH_{it})$ can be estimated using standard methods such as local regression. For details on the required assumptions and convergence properties, see Robinson (1988) and Yatchew (2003). We use OLS regressions in the different stages of the partial linear estimation, with time and country fixed effects included where appropriate.[11]

The use of semi-parametric methods allows for a more flexible examination of

[10] See also Yatchew and No (2001) for estimation of a partial linear model with two variables entering the nonparametric expression. We implement these partial linear estimations using S-plus coding following the examples in Yatchew (2003).

[11] As discussed below, in the case of the non time-varying institutional quality index we do not include country dummies in the nonparametric estimation.

the nature of threshold effects in the relationship between financial openness and growth than is possible with parametric approaches. However, there are trade-offs among different approaches. For example, the flexibility of the semi-parametric estimates comes with other assumptions, such as that of a linear relationship for other control variables and the choice of the nature of the nonparametric estimation approach. More importantly, nonparametric relationships are somewhat more difficult to interpret and to translate into policy implications.

A key issue concerns the significance and empirical content of the estimated thresholds. To have policy relevance, our analysis requires more than just a demonstration of statistically significant conditional correlations between certain variables and growth. We need to construct confidence intervals around our estimates of the marginal effects of openness on growth, conditional on a particular level of a given threshold variable. We also need to know if the magnitudes of the threshold effects are economically significant and if the estimated thresholds lie within the range of the sample used in the estimation (otherwise, the thresholds would be of little practical value in terms of understanding differential growth outcomes).

## 4.5 Basic Results

We motivate our empirical analysis by documenting a set of stylized facts for data averaged over the full sample period. We then present our baseline econometric results that rely on a finer temporal breakdown of the data. As much of the existing literature has analyzed the interaction between financial openness and financial development, we will focus our initial exposition on the latter as a threshold variable in order to illustrate our framework.

### 4.5.1 Stylized facts

We begin by exploring if there are obvious threshold effects in the data. For this exercise, we limit the sample to non-industrial countries split into two groups—emerging markets (EMs) and other developing countries (ODCs). Our interest is in whether, within each of these groups, the levels of certain variables are associated with differences in average growth rates. Table 4.1 compares unconditional and conditional growth rates over the period 1975-2004 for countries that are above or below the within-group sample medians for different variables that have been posited as threshold variables. After sorting countries within each group by these group-specific thresholds, we then report cross-sectional averages within each cell.

There are three main results that can be gleaned from this table. First, EMs, which are more integrated into international capital markets than ODCs, have a higher average growth rate than ODCs over the period 1975-2004, but this effect becomes smaller when we control for other standard variables that influence growth. Second, unconditional growth rates in EMs are greater for those countries with higher (within-group above-median) levels of the illustrative threshold indicators for financial depth, trade openness, institutional quality, regulation and macro policies, although this difference is not always statistically significant. These effects are less pronounced in ODCs, except that the institutional quality threshold is even more important for ODCs than for EMs. The picture is less clear when looking at overall development and financial openness as threshold variables. Growth rates are higher for countries with lower initial GDP per capita, reflecting convergence effects. In both groups, growth rates are higher for countries with lower relative financial openness.

Third, for conditional growth rates the patterns are less pronounced, although the positive association of growth with higher values of certain threshold variables persists (e.g., private credit, trade, reduced regulation and lower inflation variability

**Table 4.1:** Long-term Growth in Emerging Markets and Other Developing Countries

| | | Unconditional growth (% per annum) | | Conditional growth (% per annum) | |
|---|---|---|---|---|---|
| | | **EM** | **ODCs** | **EMs** | **ODCs** |
| Overall | | 2.284<br>(1.937) | 0.820<br>(0.650) | 0.441<br>(0.533) | -0.159<br>(-0.043) |
| Splitting sub-samples: | | | | | |
| By private credit to GDP | High | 3.158<br>(3.113) | 0.656<br>(0.451) | 0.733<br>(0.673) | -0.255<br>(-0.197) |
| | Low | 1.490<br>(1.410) | 0.983<br>(0.877) | 0.176<br>(0.503) | -0.064<br>(0.139) |
| Difference in means | | 1.668* | -0.327 | 0.557 | -0.191 |
| By average WBGI institutional quality index | High | 2.416<br>(1.878) | 1.217<br>(0.853) | 0.394<br>(0.418) | 0.369<br>(0.127) |
| | Low | 2.165<br>(1.937) | 0.422<br>(0.451) | 0.483<br>(0.633) | -0.688<br>(-0.117) |
| Difference in means | | 0.251 | 0.795* | -0.089 | 1.057** |
| By trade openness | High | 2.923<br>(3.017) | 1.074<br>(0.710) | 0.644<br>(0.583) | 0.129<br>(0.127) |
| | Low | 1.704<br>(1.096) | 0.566<br>(0.493) | 0.256<br>(0.503) | -0.448<br>(-0.094) |
| Difference in means | | 1.218 | 0.508 | 0.388 | 0.577 |
| By rigidity of employment index | Less rigid | 2.958<br>(2.440) | 0.787<br>(0.493) | 0.563<br>(0.533) | -0.012<br>(-0.094) |
| | More rigid | 1.544<br>(1.253) | 0.790<br>(0.927) | 0.306<br>(0.568) | -0.344<br>(-0.168) |
| Difference in means | | 1.414 | -0.003 | 0.257 | 0.333 |
| By st. dev of CPI inflation | Low | 3.381<br>(3.365) | 1.509<br>(1.542) | 1.074<br>(0.968) | 0.398<br>(0.379) |
| | High | 1.078<br>(1.147) | 0.215<br>(0.346) | -0.255<br>(-0.242) | -0.841<br>(-0.810) |
| Difference in means | | 2.303*** | 1.294*** | 1.329*** | 1.239*** |
| By initial GDP per capita | High | 1.105<br>(1.085) | 0.798<br>(1.034) | -0.166<br>(-0.098) | 0.146<br>(0.276) |
| | Low | 3.357<br>(3.155) | 0.842<br>(0.493) | 0.993<br>(0.968) | -0.464<br>(-0.506) |
| Difference in means | | -2.253*** | -0.044 | -1.159** | 0.611 |
| By de jure financial openness (IMF measure) | High | 1.537<br>(1.211) | 0.730<br>(0.452) | 0.048<br>(-0.098) | 0.026<br>(-0.043) |
| | Low | 2.964<br>(2.431) | 0.901<br>(0.927) | 0.799<br>(0.813) | -0.327<br>(-0.183) |
| Difference in means | | -1.427 | -0.171 | -0.751 | 0.353 |
| By de facto gross financial openness | High | 1.502<br>(1.262) | 0.738<br>(0.853) | 0.036<br>(-0.248) | -0.163<br>(0.009) |
| | Low | 2.995<br>(2.440) | 0.902<br>(0.493) | 0.810<br>(0.660) | -0.155<br>(-0.094) |
| Difference in means | | -1.493* | -0.164 | -0.774 | -0.008 |

Note: The numbers shown are average annual growth rates (medians are shown in parentheses below the means). The symbols *, ** and *** indicate statistical significance at the 10 percent, 5 percent and 1 percent levels, respectively, of a t-test of mean equality across sub-samples. High/low sub-samples are defined relative to medians within groupings. See Appendix Table 4.7 for definition of emerging market (EM) and other developing country (ODC) sub-samples and Appendix Table 4.8 for variable definitions. Conditional growth indicates residuals from a cross-section regression of growth on log initial GDP per capita, average investment to GDP, average years of schooling and average population growth rate.

among EMs). Table 4.1 also suggests that the difference between the growth rates of EMs and ODCs is generally more pronounced at higher levels of the threshold variables (except for institutional quality, GDP per capita and financial openness). These stylized facts are suggestive of systematic threshold or conditioning effects in the relationship between financial openness and growth. We now turn to a more formal empirical analysis of these effects.

### 4.5.2 Basic empirical analysis

Our regression analysis is based on five-year averages of the underlying annual data. We begin with a limited set of controls that have been identified in the literature as being relatively robust determinants of long-term per capita GDP growth—initial income (at the start of each five-year period), which picks up convergence effects; the level of investment to GDP; a proxy for human capital; and population growth. We report the results of baseline growth regressions using these controls in the first panel of Table 4.2. The first column shows the results of OLS regressions with country fixed effects (FE). The population growth rate does not seem to matter for medium-term growth. However, when we switch to generalized method of moments (GMM) estimation to deal with endogeneity issues (column 2), only the level of investment remains statistically significant. Nevertheless, we retain these four controls in the first stage of our analysis. FE and GMM are the two basic specifications that we will build upon in our further analysis.[12]

[12]Both specifications always include time effects to capture common factors affecting growth across all countries in each five-year period.

**Table 4.2:** Interactions of Private Credit and Gross Financial Openness to GDP

| | [1] Base | | [2] With FO | | [3] High/low interaction | | [4] Linear interaction | | [5] Quadratic interaction | |
|---|---|---|---|---|---|---|---|---|---|---|
| | FE | Sys GMM | FE | Sys GMM | FE | Sys GMM | FE | Sys GMM | FE | Sys GMM |
| Ln initial income per capita | -0.2769 | -0.0505 | -0.3028 | -0.0529 | -0.3122 | -0.1028 | -0.3096 | -0.0762 | -0.3196 | -0.0847 |
| | [0.0560]*** | [0.0657] | [0.0460]*** | [0.0533] | [0.0473]*** | [0.0483]** | [0.0468]*** | [0.0530] | [0.0479]*** | [0.0484]* |
| Av investment to GDP | 0.8079 | 0.9852 | 0.8029 | 0.942 | 0.7534 | 0.8505 | 0.7521 | 0.9384 | 0.6835 | 0.9112 |
| | [0.3064]*** | [0.2806]*** | [0.3110]** | [0.3097]*** | [0.3126]** | [0.2842]*** | [0.3243]** | [0.2862]*** | [0.3025]** | [0.2946]*** |
| Years schooling | 0.0286 | -0.0022 | 0.0305 | 0.0039 | 0.0301 | 0.0196 | 0.0301 | 0.0108 | 0.0252 | 0.011 |
| | [0.0140]** | [0.0193] | [0.0143]** | [0.0168] | [0.0145]** | [0.0161] | [0.0145]** | [0.0161] | [0.0148]* | [0.0143] |
| Pop growth | 4.7321 | -0.9328 | 4.8012 | -0.1238 | 4.7648 | -0.9325 | 4.7266 | -0.8469 | 4.7277 | -1.9786 |
| | [3.1908] | [1.7681] | [3.1706] | [2.6259] | [3.1514] | [2.0722] | [3.2036] | [2.2271] | [3.1587] | [3.1068] |
| Gross FO to GDP | | | -0.0008 | -0.005 | -0.0371 | -0.0612 | -0.0191 | -0.0057 | -0.0825 | -0.0724 |
| | | | [0.0082] | [0.0074] | [0.0169]** | [0.0221]*** | [0.0187] | [0.0228] | [0.0277]*** | [0.0325]** |
| Private credit to GDP (PC) | | | | | -0.0241 | -0.0627 | -0.0147 | -0.0145 | -0.1687 | -0.2476 |
| | | | | | [0.0358] | [0.0394] | [0.0410] | [0.0596] | [0.0986]* | [0.1535] |
| Gross FO*high PC | | | | | 0.0380 | 0.0628 | | | | |
| | | | | | [0.0160]** | [0.0215]*** | | | | |
| Gross FO*PC | | | | | | | 0.0174 | 0.0018 | 0.1761 | 0.2024 |
| | | | | | | | [0.0152] | [0.0195] | [0.0518]*** | [0.0814]** |
| PC squared | | | | | | | | | 0.0798 | 0.157 |
| | | | | | | | | | [0.0436]* | [0.0832]* |
| FO* PC squared | | | | | | | | | -0.0845 | -0.115 |
| | | | | | | | | | [0.0242]*** | [0.0464]** |
| Constant | 2.1202 | 0.41 | 2.3375 | 0.3923 | 2.4632 | 0.8071 | 2.4252 | 0.5727 | 2.6252 | 0.7355 |
| | [0.4557]*** | [0.4255] | [0.3676]*** | [0.3350] | [0.3815]*** | [0.3137]** | [0.3802]*** | [0.3393]* | [0.3915]*** | [0.3319]** |
| Observations | 460 | 460 | 457 | 457 | 456 | 456 | 456 | 456 | 456 | 456 |
| Adj R-squared | 0.2915 | | 0.3131 | | 0.3259 | | 0.3149 | | 0.338 | |
| AR2 test p-value | | 0.3191 | | 0.2498 | | 0.2323 | | 0.3333 | | 0.4474 |
| Hansen p-value | | 0.264 | | 0.3873 | | 0.4966 | | 0.406 | | 0.5246 |

Note: All specifications include period dummies which are not reported. Standard errors in parentheses. The symbols *, **, *** indicate significance 10%, 5 % and 1% levels, respectively. FE: country fixed effects with robust standard errors clustered by country. GMM system (sys GMM) estimation: Two step using Windmeijer standard errors with small sample correction and control variables treated as endogenous (instrumented using 2nd lag).

#### 4.5.2.1 Financial depth as a threshold

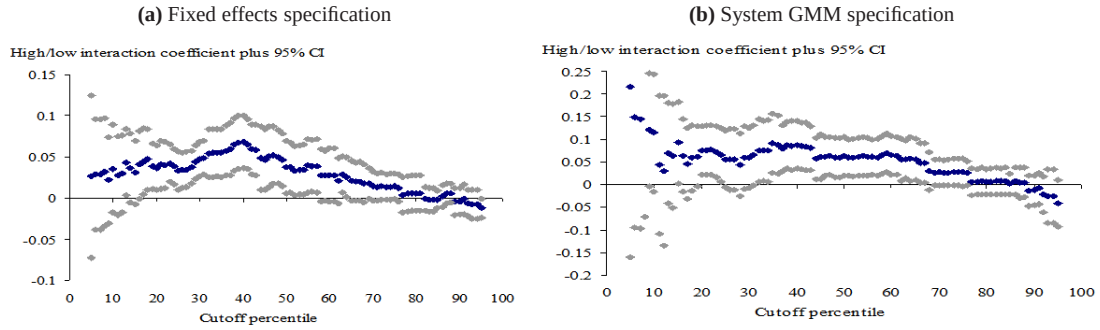
In panel 2 of Table 4.2, we include a broad measure of de facto financial openness. As is typical in the literature, we find that the correlation between financial integration and growth is weak or even slightly negative. This highlights the key discrepancy between theory and evidence on the growth effects of financial integration. Consider a simple exercise where we look at whether the correlation is different between countries with high and low levels of financial depth (above or below the sample median). The third panel of Table 2 shows that there is a striking difference. When we interact the indicator for a high degree of financial depth with the financial openness variable, the coefficient on the interaction term is strongly positive and nearly the same in magnitude as the negative coefficient on the financial openness variable itself. In other words, the overall effect of financial openness is negative for economies with comparatively low levels of financial depth and slightly positive but insignificant for those with higher levels.[13] Repeating the experiment using different percentiles of the financial depth variable rather than the median as the cutoff yields similar positive significant interaction coefficients for cutoffs from the 15th to the 60th percentile with FE estimates and from the 30th to the 65th percentile with GMM estimates (see Figure 4.2).

In panel 4, we allow for a linear interaction term between domestic financial depth and financial openness. Neither the coefficient on financial openness nor the one on the interaction term is significantly different from zero. The level of financial depth does not seem to matter for the correlation between financial openness and growth. Could this non-result be driven by the fact that, once a country has attained a certain level of financial depth, further improvements don't matter that much?

In panel 5, we allow for an additional interaction of financial openness with the square of the financial depth variable. The coefficients on both the linear and

[13]The median levels of financial development that determine the high-low cutoffs are calculated separately for each period.

**Figure 4.2:** High/Low Interaction Coefficients for Gross Financial Openness and Private Credit to GDP at Different Sample Splits




Note: Specifications include base controls of Panel 3 of Table 4.2. Percentile cutoffs calculated for each period on the basis of the distribution of private credit observations in that period.

quadratic interactions are now strongly significant in both the FE and GMM estimates, with the first coefficient being positive and the second negative in both cases. That is, greater financial depth leads to an improvement in the growth effects of financial integration but only up to a certain level of financial depth.

Where is the threshold and is it an economically reasonable one? We can calculate the level of the threshold, for a given level of credit to GDP, from the interaction terms. The overall financial openness coefficient in this case takes an inverted U-shape as the threshold variable rises. It is thus possible to calculate the cutoffs at which its sign changes. Based on the FE estimates, the threshold level below which the marginal effect of financial openness on growth is negative corresponds to a credit to GDP ratio of $71$ percent ($-0.0825 + 0.1761 * 0.71 - 0.0845 * 0.71^2 = 0$). Above this level, the coefficient is positive before turning negative for credit to GDP above $137$ percent. Based on the GMM estimates, the corresponding threshold levels are credit to GDP ratios of $50$ percent and $126$ percent, respectively. For reference, the median levels of credit to GDP for industrial countries, EMs and ODCs are $0.71$, $0.32$ and $0.19$, respectively (calculated across all period-country observations for each group).

With both estimation methods, the vast majority (over 90%) of ODC observations lie below the lower threshold and have a negative financial openness co-

efficient. For emerging and industrial economies, a much higher fraction of observations lie between the lower and upper thresholds and have a positive financial openness coefficient: about two-fifths for emerging economies and four-fifths for industrial countries (relative to the GMM-based threshold). Thus, the threshold level seems plausible and of practical relevance for developing countries contemplating capital account liberalization. In the remaining discussion, we focus on the lower threshold, which is the relevant one for developing and emerging economies.[14]

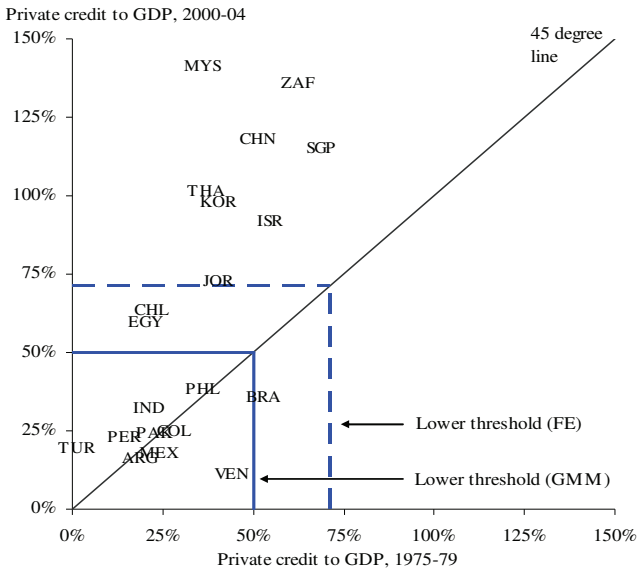
Since the threshold we have derived is static, it is interesting to see how different groups of countries are doing relative to this threshold over time.[15] In 1975-79, the proportion of countries in each group above the GMM-based lower threshold (private credit to GDP ratio of 0.50) was as follows: industrial countries—62 percent; emerging markets—25 percent; and ODCs—2 percent. By 2000-04, the proportions had increased to 100 percent, 48 percent and 14 percent, respectively. Figure 4.3 shows how the credit to GDP ratio has changed for each of the emerging market countries from 1985-89 to 2000-04, and how these levels match up against the estimated FE and GMM thresholds. For most of the emerging markets, the data points lie above the 45-degree line, implying increases in financial depth over time by this measure. The fraction of emerging markets above the GMM threshold rises from 25% in 1975-79 to 48% in 2000-04, while the number above the FE threshold goes from 0% to 38%. It is worth noting that a country like China comes out looking very good by this measure despite the weaknesses in its financial sector, which is dominated by state-owned banks. This is a useful reminder of the potential pitfalls

[14]The upper threshold is an artifact of the quadratic specification. We experimented with the inclusion of higher order polynomials of the threshold variable (and corresponding interactions with financial openness). The coefficients on the higher order terms were usually not statistically significant but their magnitudes generally showed a flattening out of (rather than a decline in) the implied marginal effect of financial openness on growth at high levels of the threshold variable. This is another reason why we focus on the lower threshold.

[15]An important issue here is whether the thresholds themselves change over time. This is not an easy question to address in an empirical framework that uses cross-country data and, therefore, comes up against obvious data limitations. We leave this for future work and note that our exercise here is meant only to be illustrative of the empirical content of the thresholds concept.

of using a particular uni-dimensional measure of financial development. And of course the worldwide crisis that first hit the U.S. and then spread to other industrial countries has shown that financial depth is not equivalent to financial stability.

**Figure 4.3:** Average Private Credit to GDP Relative to Estimated Thresholds: Emerging Market Economies, 1975-79 and 2000-04




Note: Thresholds taken from quadratic interaction specification in Table 4.2, Panel 5.

#### 4.5.2.2 Robustness of financial depth threshold

We test the sensitivity of our baseline results for the financial depth threshold in a number of ways. First, we use a different set of basic controls and redo the regressions in Table 4.2. We retain log initial income and the education variable, and add the following controls—trade openness, CPI inflation, and the logarithm of the number of phone lines per capita (a proxy for the level of infrastructure). We do not present the results here, but they were quite similar in terms of the signs and magnitudes of the coefficients of interest. The implied upper and lower thresholds from the FE specification with quadratic interactions are private credit to GDP ratios of 63 percent and 148 percent, respectively (compared to 71 percent and 137 percent based on the results in Table 4.2). For the GMM specification the results are such

that, while the estimated overall financial openness coefficient retains an inverted U-shape, it remains positive and does not cut the x-axis.

Second, we use an alternative measure of financial depth—the sum of private credit and stock market capitalization as a ratio to GDP. Unfortunately, given the absence of stock markets in many of the developing countries, especially in the early years of the sample, the sample drops to about half the original size. In the specification with quadratic interactions, the estimated coefficients on the interaction terms have the same sign as in our baseline, but they are smaller and not statistically significant. Given the low levels of stock market development in ODCs and, until recently, in emerging markets as well, this broader measure of financial depth does not seem to be useful for constructing thresholds.

Third, we check if the results are driven by the choice of countries in our sample. We test for robustness to the exclusion of three groups of countries (dropping one group at a time): (i) OPEC countries (Algeria, Ecuador, Indonesia, Iran, Kuwait, UAE and Venezuela); (ii) offshore financial centers (Ireland, Panama, Singapore); and (iii) countries hit by the Asian financial crisis (Indonesia, Korea, Malaysia, Philippines and Thailand). The results with the high-low interactions and linear interactions were broadly similar when we excluded these sub-samples. Table 4.3 shows that the signs and magnitudes of the coefficients, as well as the implied thresholds, are relatively stable when we drop each of these groups of countries, suggesting that the results are not being driven by outliers or any specific group of countries.

Fourth, we go back to the original financial depth variable but look at alternative measures of financial openness (FO). The threshold value of private credit to GDP is almost unchanged when we use the stock of gross external liabilities as a ratio to GDP—rather than the sum of external assets and liabilities–as the measure of FO (0.51 in the GMM estimates, which is almost identical to the baseline result from Table 4.2).

Fifth, we consider different growth time windows for the analysis to examine how the results are sensitive to the choice of a five-year window. The usage of five-year periods is common in the related literature since it increases the number of observations, allowing for the usage of the GMM technique, and provides an indication of medium-run growth determinants. However, the period cut-offs are arbitrary, determined by the choice of the length of each period and the overall sample size, and may catch countries at different stages of their growth and financial integration dynamics (e.g. post- or pre-crisis).[16] Due to the reduced number of periods with longer sample lengths this sensitivity analysis focuses on the fixed effect results. The inverted U-shape pattern of the quadratic interaction between credit-to-GDP and gross financial openness remains with the different windows (see Appendix Table 4.14). The upper and lower thresholds for credit-to-GDP between which the overall financial openness coefficient is positive are of similar order of magnitude (with the lower cut-off ranging from around 40 to 90 percent of GDP and the upper from around 140 to 170 percent). The significance levels are however weaker, although less so for the 10-year window. This sensitivity of results to the specification of the growth windows is likely to be a generic issue of importance to the wider literature using similar approaches to this Chapter.

[16] An alternative empirical strategy is therefore to focus on growth around an increase in financial integration, i.e. adopt an event study approach. However, as discussed, identifying the appropriate liberalization event is itself a difficult choice, for example due to the distinction between the various de jure measures of financial account liberalization and their enforcement.

**Table 4.3:** Sub-sample Sensitivities: Private Credit and Gross Financial Openness to GDP Interaction Coefficients

| | | [1] Full sample | | [2] Ex OPEC | | [3] Ex OFCs | | [4] Ex Asian crisis countries | |
|---|---|---|---|---|---|---|---|---|---|
| | | FE | Sys GMM | FE | Sys GMM | FE | Sys GMM | FE | Sys GMM |
| **A. No interaction** | Gross FO | -0.0008 | -0.0050 | -0.0007 | -0.0041 | -0.0235 | -0.0267 | 0.0000 | -0.0040 |
| | | [0.0082] | [0.0074] | [0.0080] | [0.0071] | [0.0080]*** | [0.0138]* | [0.0081] | [0.0074] |
| **B. High/low interaction** | Gross FO | -0.0371 | -0.0612 | -0.0404 | -0.0482 | -0.0632 | -0.0586 | -0.045 | -0.0499 |
| | | [0.0169]** | [0.0221]*** | [0.0169]** | [0.0196]** | [0.0163]*** | [0.0231]** | [0.0177]** | [0.0200]** |
| | Gross FO*high PC | 0.038 | 0.0628 | 0.042 | 0.0513 | 0.0415 | 0.0355 | 0.0472 | 0.0521 |
| | | [0.0160]** | [0.0215]*** | [0.0164]** | [0.0188]*** | [0.0138]*** | [0.0231] | [0.0176]*** | [0.0198]** |
| **C. Linear interaction** | Gross FO | -0.0191 | -0.0057 | -0.0157 | -0.0026 | -0.0526 | -0.0479 | -0.0204 | -0.0027 |
| | | [0.0187] | [0.0228] | [0.0179] | [0.0188] | [0.0161]*** | [0.0231]** | [0.0187] | [0.0222] |
| | Gross FO*PC | 0.0174 | 0.0018 | 0.0147 | -0.0002 | 0.0258 | 0.0188 | 0.0194 | -0.0002 |
| | | [0.0152] | [0.0195] | [0.0144] | [0.0156] | [0.0119]** | [0.0155] | [0.0159] | [0.0198] |
| | PC cutoff for positive overall gross FO coeff. | >1.10 | >3.22 | >1.07 | n.a. | >2.04 | >2.55 | >1.05 | n.a. |
| **D. Quadratic interaction** | Gross FO | -0.0825 | -0.0724 | -0.0789 | -0.0653 | -0.0958 | -0.0658 | -0.0893 | -0.0746 |
| | | [0.0277]*** | [0.0325]** | [0.0269]*** | [0.0294]** | [0.0267]*** | [0.0488] | [0.0281]*** | [0.0365]** |
| | Gross FO*PC | 0.1761 | 0.2024 | 0.1722 | 0.1844 | 0.1507 | 0.0673 | 0.1927 | 0.2195 |
| | | [0.0518]*** | [0.0814]** | [0.0512]*** | [0.0799]** | [0.0542]*** | [0.1002] | [0.0532]*** | [0.0957]** |
| | Gross FO* PC squared | -0.0845 | -0.115 | -0.0835 | -0.1048 | -0.0639 | -0.0246 | -0.0924 | -0.1251 |
| | | [0.0242]*** | [0.0464]** | [0.0241]*** | [0.0457]** | [0.0244]** | [0.0494] | [0.0247]*** | [0.0551]** |
| | PC cutoffs at which overall gross FO coeff. is zero:[a] | 0.711 | 0.500 | 0.688 | 0.492 | n.a. | n.a. | 0.694 | 0.461 |
| | | 1.372 | 1.260 | 1.375 | 1.268 | n.a. | n.a. | 1.391 | 1.294 |
| | % observations above lower cutoff | | | | | | | | |
| | Industrial countries | 60% | 80% | 62% | 80% | n.a. | n.a. | 62% | 81% |
| | Emerging economies | 21% | 42% | 25% | 46% | n.a. | n.a. | 20% | 43% |
| | Other developing countries | 1% | 10% | 1% | 8% | n.a. | n.a. | 1% | 12% |

Note: a Cutoff is not available if the overall FO coefficient estimated as a function of the threshold variable does not have a quadratic root. All specifications include base controls in Table 4.2 and period dummies, which are not reported. Standard errors in parentheses. The symbols *, **, *** indicate significance 10%, 5 % and 1% levels, respectively. FE: country fixed effects with robust standard errors clustered by country. GMM system (sys GMM) estimation: Two step using Windmeijer standard errors with small sample correction and control variables treated as endogenous (instrumented using 2nd lag).

### 4.5.3 Breaking down the nature of financial integration

The literature on financial flows makes a distinction between FDI and portfolio equity flows, on the one hand, and debt on the other. It is generally believed that the former types of flows generate more of the indirect benefits of financial integration and also have fewer risks than debt. Does the composition of external liabilities (or flows) influence the threshold level of financial depth? Here we obtain a very interesting result (Table 4.4). When we measure FO as the stock of FDI plus portfolio equity liabilities, the threshold is lower (credit to GDP ratios of 58 percent and 34 percent for the FE and GMM estimates, respectively). By contrast, when we use debt liabilities, the threshold is much higher (credit to GDP ratios of 75 percent and 55 percent for the FE and GMM estimates, respectively). That is, the risks of financial integration seem to be lower when it takes the form of FDI or portfolio equity liabilities. When debt liabilities constitute the primary form of financial integration, the level of financial depth necessary for financial integration to have growth benefits is much higher. The results with flows are more mixed (Table 4.5). Using total inflows, the signs of the interaction effects are such that the overall financial openness coefficient has a U-shape as credit to GDP rises, the reverse of the results with the stock measures of openness. Again, there is a dramatic difference between the results when using FDI plus portfolio equity inflows versus debt inflows. In the former case, the inverted U-shape of the overall financial openness coefficient remains (although insignificant using GMM estimates). By contrast, the results with debt inflows correspond to those for total inflows (as expected, given the high share of debt to total inflows). In this case, the impact of financial openness on growth is estimated to be positive for lower or particularly high levels of financial depth but negative at intermediate levels. This result is consistent with models of potential instability induced by greater capital inflows in economies at an intermediate level of financial development (Aghion et al., 2004).

**Table 4.4:** Interaction Coefficients with Private Credit to GDP and Different Financial Openness Measures: Stock Measures (relative to GDP)

| | | [1] Gross measure | | [2] Total liabilities | | [3] FDI + portfolio equity | | [4] Debt liabilities | |
|---|---|---|---|---|---|---|---|---|---|
| | | FE | Sys GMM | FE | Sys GMM | FE | Sys GMM | FE | Sys GMM |
| **A. No interaction** | FO | -0.0008 | -0.005 | -0.0174 | -0.0202 | 0.0352 | 0.0051 | -0.0366 | -0.031 |
| | | [0.0082] | [0.0074] | [0.0168] | [0.0175] | [0.0272] | [0.0315] | [0.0177]** | [0.0237] |
| **B. High/low interaction** | FO | -0.0371 | -0.0612 | -0.0722 | -0.1025 | -0.1764 | -0.2233 | -0.0839 | -0.1231 |
| | | [0.0169]** | [0.0221]*** | [0.0205]*** | [0.0286]*** | [0.1135] | [0.1756] | [0.0213]*** | [0.0332]*** |
| | FO*high PC | 0.038 | 0.0628 | 0.0619 | 0.1066 | 0.2205 | 0.2518 | 0.0574 | 0.1248 |
| | | [0.0160]** | [0.0215]*** | [0.0189]*** | [0.0303]*** | [0.1119]* | [0.1819] | [0.0189]*** | [0.0367]*** |
| **C. Linear interaction** | FO | -0.0191 | -0.0057 | -0.0672 | -0.0362 | 0.021 | 0.1107 | -0.0792 | -0.0581 |
| | | [0.0187] | [0.0228] | [0.0253]*** | [0.0315] | [0.1032] | [0.1234] | [0.0268]*** | [0.0247]** |
| | FO*PC | 0.0174 | 0.0018 | 0.0591 | 0.024 | 0.0114 | -0.084 | 0.0692 | 0.0477 |
| | | [0.0152] | [0.0195] | [0.0256]** | [0.0305] | [0.0777] | [0.0985] | [0.0357]* | [0.0502] |
| | PC cutoff for positive overall FO coefficient | >1.10 | >3.22 | >1.14 | >1.31 | n.a. | <1.97 | >1.14 | >-0.31 |
| **D. Quadratic interaction** | FO | -0.0825 | -0.0724 | -0.1495 | -0.1341 | -0.3502 | -0.1694 | -0.1454 | -0.159 |
| | | [0.0277]*** | [0.0325]** | [0.0330]*** | [0.0402]*** | [0.1622]** | [0.2421] | [0.0381]*** | [0.0366]*** |
| | FO*PC | 0.1761 | 0.2024 | 0.3258 | 0.3715 | 0.8555 | 0.6364 | 0.3125 | 0.4258 |
| | | [0.0518]*** | [0.0814]** | [0.0792]*** | [0.1014]*** | [0.2794]*** | [0.4204] | [0.1048]*** | [0.1202]*** |
| | FO* PC squared | -0.0845 | -0.115 | -0.1596 | -0.2099 | -0.4381 | -0.3969 | -0.1585 | -0.249 |
| | | [0.0242]*** | [0.0464]** | [0.0413]*** | [0.0602]*** | [0.1288]*** | [0.1994]** | [0.0548]*** | [0.0715]*** |
| | PC cutoffs at which overall FO coefficient zero: | 0.711 | 0.500 | 0.697 | 0.505 | 0.584 | 0.337 | 0.752 | 0.551 |
| | | 1.372 | 1.260 | 1.345 | 1.264 | 1.369 | 1.266 | 1.220 | 1.159 |
| | % observations above lower cutoff | | | | | | | | |
| | Industrial countries | 60% | 80% | 62% | 80% | 71% | 91% | 56% | 75% |
| | Emerging economies | 21% | 42% | 22% | 42% | 33% | 58% | 17% | 37% |
| | Other developing countries | 1% | 10% | 1% | 9% | 5% | 20% | 1% | 7% |

Note: All specifications include base controls in Table 4.2 and period dummies, which are not reported. Standard errors in parentheses. The symbols *, **, *** indicate significance 10%, 5 % and 1% levels, respectively. FE: country fixed effects with robust standard errors clustered by country. GMM system (sys GMM) estimation: Two step using Windmeijer standard errors with small sample correction and control variables treated as endogenous (instrumented using 2nd lag).

**Table 4.5:** Interaction Coefficients with Private Credit to GDP and Different Financial Openness Measures: Flow Measures (relative to GDP)

| | | [1] Gross flows | | [2] Total inflows | | [3] FDI + port. eq. inflows | | [4] Debt inflows | |
|---|---|---|---|---|---|---|---|---|---|
| | | FE | Sys GMM | FE | Sys GMM | FE | Sys GMM | FE | Sys GMM |
| **A. No interaction** | FO | 0.0539 | 0.0277 | 0.1025 | 0.1343 | 0.3307 | 0.3683 | 0.0911 | 0.173 |
| | | [0.0368] | [0.0440] | [0.0808] | [0.0616]** | [0.0916]*** | [0.1962]* | [0.0919] | [0.1203] |
| **B. High/low interaction** | FO | 0.3931 | 0.1229 | 0.8829 | 0.9599 | -0.1891 | 0.1585 | 0.9959 | 1.4456 |
| | | [0.2046]* | [0.6629] | [0.2255]*** | [0.5288]* | [0.6742] | [1.6524] | [0.1858]*** | [0.5775]** |
| | FO*high PC | -0.3495 | -0.0659 | -0.8278 | -0.8475 | 0.5464 | 0.2146 | -0.9642 | -1.3112 |
| | | [0.2049]* | [0.6572] | [0.2305]*** | [0.5197] | [0.6829] | [1.7114] | [0.1901]*** | [0.5558]** |
| **C. Linear interaction** | FO | 0.1447 | 0.189 | 0.3186 | 0.4339 | 0.9633 | 2.0915 | 0.456 | 0.6122 |
| | | [0.1168] | [0.2165] | [0.2057] | [0.3120] | [0.8197] | [1.2152]* | [0.2332]* | [0.3992] |
| | FO*PC | -0.1038 | -0.1269 | -0.2997 | -0.3059 | -0.6054 | -1.5512 | -0.582 | -0.6076 |
| | | [0.0929] | [0.1724] | [0.2214] | [0.2691] | [0.7299] | [1.0439] | [0.3666] | [0.5376] |
| | PC cutoff for positive overall FO coefficient | <1.39 | <0.26 | <1.06 | <10.12 | <1.59 | <12.35 | <0.78 | <0.99 |
| **D. Quadratic interaction** | FO | 0.2085 | -0.2087 | 0.9311 | 0.9015 | -1.1963 | -0.4571 | 1.1183 | 1.706 |
| | | [0.2317] | [0.4957] | [0.3238]*** | [0.6844] | [1.1833] | [2.0809] | [0.2762]*** | [0.7045]** |
| | FO*PC | -0.2824 | 0.6634 | -2.0279 | -1.7388 | 6.1905 | 6.5172 | -2.5299 | -3.8141 |
| | | [0.5078] | [0.9660] | [0.8380]** | [1.8620] | [2.5132]** | [5.4541] | [0.6619]*** | [1.8492]** |
| | FO* PC squared | 0.108 | -0.3839 | 1.0608 | 0.8488 | -4.2428 | -5.0065 | 1.2849 | 1.9293 |
| | | [0.2636] | [0.4801] | [0.4637]** | [1.0722] | [1.3188]*** | [3.2263] | [0.3488]*** | [1.1016]* |
| | PC cutoffs at which overall FO coefficient zero: % observations above lower cutoff | n.a. | 0.41 | 0.77 | n.a. | 0.23 | 0.07 | 0.67 | 0.68 |
| | | n.a. | 1.31 | 1.15 | n.a. | 1.23 | 1.23 | 1.30 | 1.29 |
| | Industrial countries | n.a. | 87% | 50% | n.a. | 98% | 100% | 64% | 63% |
| | Emerging economies | n.a. | 50% | 16% | n.a. | 78% | 98% | 25% | 24% |
| | Other developing countries | n.a. | 14% | 1% | n.a. | 48% | 88% | 2% | 2% |

Note: Port. eq. denotes portfolio equity. All specifications include base controls in Table 4.2 and period dummies, which are not reported. Standard errors in parentheses. The symbols *, **, *** indicate significance 10%, 5 % and 1% levels, respectively. FE: country fixed effects with robust standard errors clustered by country. GMM system (sys GMM) estimation: Two step using Windmeijer standard errors with small sample correction and control variables treated as endogenous (instrumented using 2nd lag).

## 4.6 Alternative Thresholds

Our focus has so far been on the financial depth threshold. We now examine threshold effects based on a range of other indicators suggested by the discussion of theoretical models in Section 4.2. We maintain the FE and GMM specifications as our benchmarks and focus on the quadratic interaction specifications.

The first panel of Table 4.6 repeats the results for the financial depth variable. The second panel looks at a composite measure of institutional quality (IQ). Many authors have argued that IQ is a crucial determinant of growth and volatility, especially crises (e.g., Acemoglu et al., 2003). There is indeed a clear threshold effect that we can identify; the interactions of financial openness with the level and squared level of the IQ variable are statistically significant. All of the industrial country observations (five-year averages) exceed the estimated threshold, while only 29 percent of emerging market observations and about 20 percent of ODC observations do. By this measure, most developing countries are below the level of IQ at which the marginal benefits of increasing financial openness become apparent.

We also looked at some of the constituents of the composite measure of institutional quality—level of corruption, cost of enforcing debt contracts etc.—but could not identify any strong threshold effects based on these components of the IQ indicator (results not shown). The level of per capita income (on an internationally comparable basis) is often seen as a composite index that proxies for a variety of factors that have been found to boost growth. But there is no clear threshold effect based on this variable.

We can identify a threshold based on trade openness (the ratio of the sum of imports and exports to GDP) but the estimated threshold is so high that few countries meet this threshold. We also experimented with a policy measure of trade openness (results not reported here). The relevant interaction coefficients were significant in the FE regressions but not in GMM. We also looked at thresholds based

on a measure of structural policies—labor market flexibility—and two measures of macro policies—inflation volatility and the ratio of government revenues to expenditures. There are a number of significant interaction terms in the regressions with these variables, but they are in general not robust, so we choose not to focus on the implied thresholds.

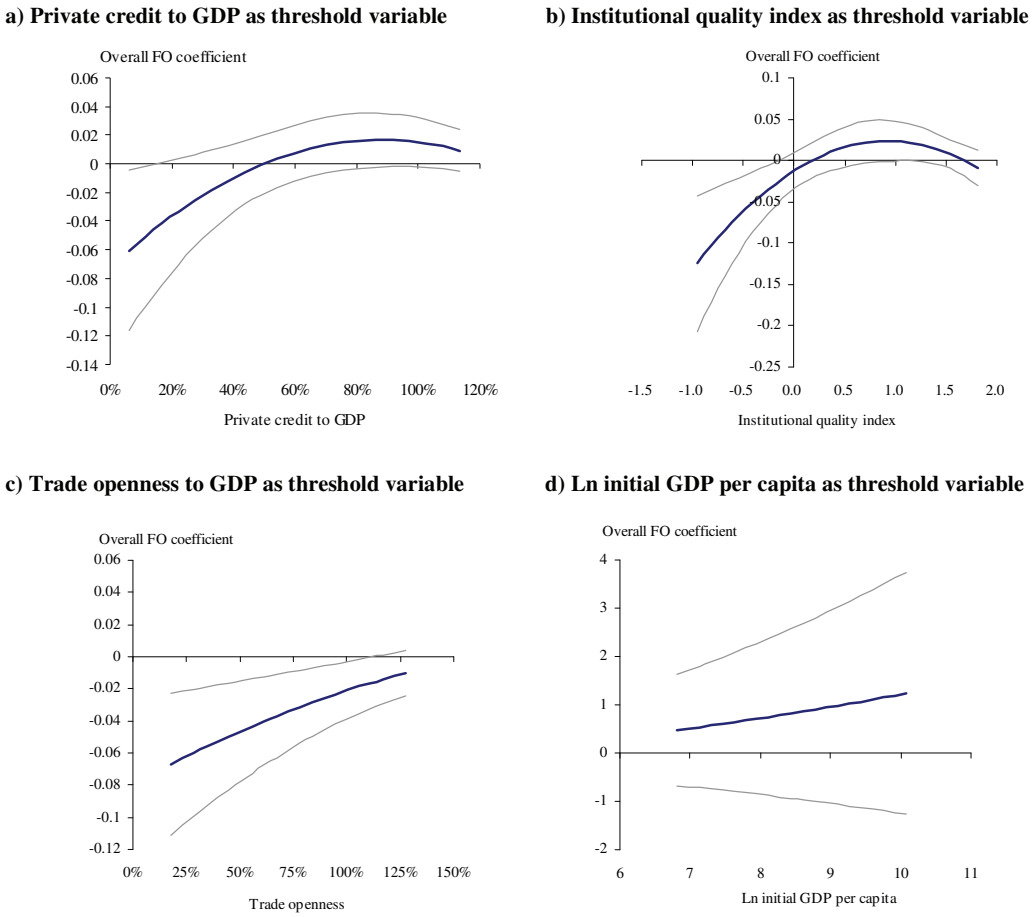
To visually examine how the estimated thresholds look for a few key variables, Figure 4.4 plots the overall (including interactions) financial openness coefficient estimates against different values of the relevant threshold variable. Private credit and IQ illustrate the inverted U-shaped relationship, with the standard error bands often encompassing zero but still leaving some empirical content in this threshold measure. When we use trade openness or the log of initial income, the threshold effects are essentially linear in the relevant range.

**Table 4.6:** Alternative Threshold Variables: Interaction Coefficients with Gross Financial Openness to GDP)

| | | [1] Private credit to GDP as threshold | | [2] Institutional quality index as threshold | | [3] Trade openness to GDP as threshold | | [4] Ln initial GDP per capita as threshold | |
|---|---|---|---|---|---|---|---|---|---|
| | | FE | Sys GMM | FE | Sys GMM | FE | Sys GMM | FE | Sys GMM |
| **A. High/low interaction** | Gross FO | -0.0371 | -0.0612 | -0.0657 | -0.0773 | -0.0155 | -0.0618 | -0.0383 | -0.0774 |
| | | [0.0169]** | [0.0221]*** | [0.0196]*** | [0.0396]* | [0.0083]* | [0.0254]** | [0.0146]** | [0.0322]** |
| | Gross FO*high threshold | 0.038 | 0.0628 | 0.0721 | 0.0782 | 0.0143 | 0.0598 | 0.0419 | 0.0794 |
| | | [0.0160]** | [0.0215]*** | [0.0208]*** | [0.0396]* | [0.0074]* | [0.0247]** | [0.0161]** | [0.0327]** |
| **B. Linear interaction** | Gross FO | -0.0191 | -0.0057 | -0.0282 | -0.0148 | -0.0156 | -0.0302 | -0.1171 | -0.266 |
| | | [0.0187] | [0.0228] | [0.0154]* | [0.0197] | [0.0102] | [0.0189] | [0.0785] | [0.1185]** |
| | Gross FO*threshold variable | 0.0174 | 0.0018 | 0.0236 | 0.0113 | 0.0077 | 0.0154 | 0.0121 | 0.0263 |
| | | [0.0152] | [0.0195] | [0.0099]** | [0.0106] | [0.0048] | [0.0122] | [0.0079] | [0.0117]** |
| | Threshold cutoff for positive FO coefficient | >1.10 | >3.22 | >1.19 | >1.31 | >2.02 | >1.97 | >9.64 | >10.12 |
| **C. Quadratic interaction** | FO | -0.0825 | -0.0724 | -0.0179 | -0.0121 | -0.0386 | -0.0795 | -1.3559 | -1.7303 |
| | | [0.0277]*** | [0.0325]** | [0.0084]** | [0.0108] | [0.0137]*** | [0.0262]*** | [0.7836]* | [1.2973] |
| | Gross FO*threshold variable | 0.1761 | 0.2024 | 0.0724 | 0.0779 | 0.0342 | 0.0733 | 0.289 | 0.3637 |
| | | [0.0518]*** | [0.0814]** | [0.0256]*** | [0.0262]*** | [0.0161]** | [0.0249]*** | [0.1769] | [0.3019] |
| | Gross FO* threshold variable squared | -0.0845 | -0.115 | -0.0339 | -0.0421 | -0.0056 | -0.0147 | -0.0153 | -0.0191 |
| | | [0.0242]*** | [0.0464]** | [0.0152]** | [0.0155]*** | [0.0042] | [0.0055]*** | [0.0098] | [0.0172] |
| | Threshold cutoffs at which overall FO coeff. zero: | 0.711 | 0.500 | 0.285 | 0.171 | 1.496 | 1.602 | 8.569 | -6.129 |
| | | 1.372 | 1.260 | 1.848 | 1.681 | 4.633 | 3.368 | 10.368 | 3.827 |
| | % observations above lower cutoff | | | | | | | | |
| | Industrial countries | 60% | 80% | 100% | 100% | 2% | 2% | 100% | 100% |
| | Emerging economies | 21% | 42% | 29% | 29% | 7% | 6% | 49% | 100% |
| | Other developing countries | 1% | 10% | 17% | 21% | 2% | 1% | 22% | 100% |

Note: All specifications include base controls in Table 4.2 and period dummies, which are not reported. Standard errors in parentheses. The symbols *, **, *** indicate significance 10%, 5 % and 1% levels, respectively. FE: country fixed effects with robust standard errors clustered by country. GMM system (sys GMM) estimation: Two step using Windmeijer standard errors with small sample correction and control variables treated as endogenous (instrumented using 2nd lag).

**Figure 4.4:** Overall Financial Openness Coefficient Against Alternative Threshold Variables (based on GMM estimation)

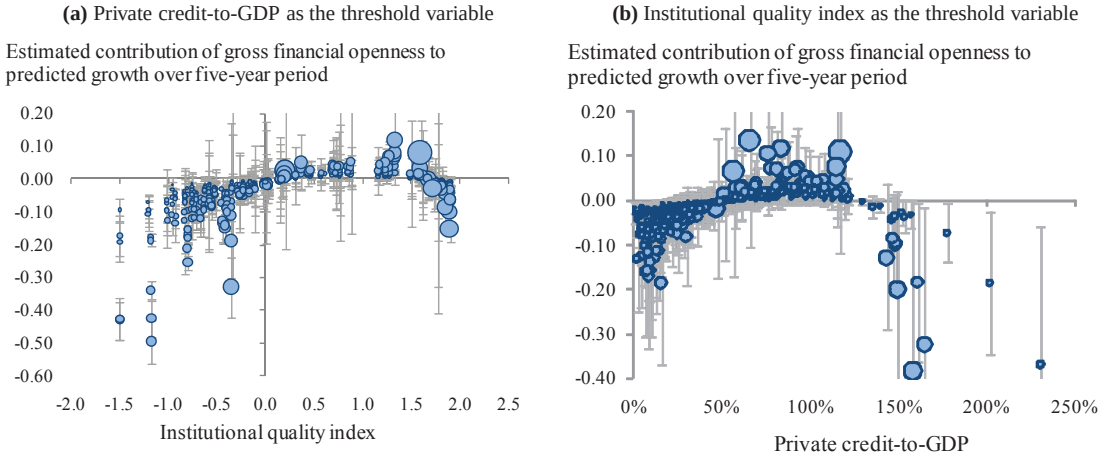



Note: See Table 4.6 for estimation details. The lighter lines indicate 95 percent confidence intervals.

To examine the overall estimated contribution of financial openness to the predicted level of growth, the overall financial openness coefficient estimates must be combined with the level of financial openness. Figure 4.5 plots these overall growth contributions over the five-year periods for the quadratic specifications using private credit and institutional quality as the threshold variables. It also indicates the extent of financial openness for the different observations. Given the estimating equation, the level of gross financial openness amplifies the estimated growth contribution, with the sign determined by the level of the threshold variable. For example, an ob-

servation with values of credit-to-GDP and financial openness to GDP at their 90th percentile levels (around 100 and 250 percent of GDP respectively) would give an overall growth contribution of around 0.04. But, for those with a negative overall financial openness coefficient, the negative contribution to growth can be of even greater magnitude, at both the low and high ranges for private credit. Similar magnitude contributions to growth are found when institutional quality is used as the threshold variable. When considering these estimates, the size of the confidence intervals must also be noted, along with the difficulty within cross-country growth regressions in attributing causality given the difficulty in adequately controlling for endogeneity.

**Figure 4.5:** Overall estimated contribution of gross financial openness to predicted growth over five-year periods




Note: Size of circles proportional to level of gross financial openness to GDP. Vertical bars indicate 95% confidence intervals. Estimate growth contribution is equal to $FO_{it} * (\beta_{FO} + \beta_{FOTH} TH_{it} + \beta_{FOTHsq} TH_{it}^2)$ . Plots based on coefficient estimates from the GMM specifications with quadratic interaction terms (see Tables 4.2 and 4.6 for details).

The analysis in this section suggests that, at a first pass, the results for financial and institutional development are more supportive of the presence of threshold effects. Other variables we have looked at also hint at threshold effects, particularly for high/low interactions, although the estimates from other specifications are less

robust and not always statistically significant.[17]

## 4.7 Results Based on Semi-parametric Approaches

We now explore the relationship between financial openness and growth using the semi-parametric methods outlined in Section 4.4. To illustrate these methods, we first start with a univariate nonparametric specification in the partial linear setup. That is, we look at the potential nonlinear relationship between growth and financial openness itself. We then examine interaction effects between financial openness and various threshold variables.

### 4.7.1 Semiparametric estimation of the effects of financial openness on growth

The regressions of growth against the baseline controls plus gross financial openness to GDP indicate an insignificant negative coefficient on the latter from both the FE and system GMM estimation (Table 4.4). However, unconditional plots suggest that the level and shape of the relationship between financial openness and growth vary by quintile of financial openness (Appendix Figure 4.11). To investigate this in more detail, we employ the partial linear model with the gross financial openness variable alone entering the specification nonparametrically.[18]

First, we run a regression to eliminate the baseline parametric effects (including country and time fixed effects) from the growth data.[19] Figure 4.6 plots growth

[17] We also experimented with using the IMF AREAER de jure measure of financial openness as a threshold variable in place of the de facto measure. The coefficient on gross financial openness is positive at higher levels of financial openness, although the coefficient is significant only in the fixed effect estimates.

[18] Whilst this section focuses on the potential non-linear relationship between the stock measures of financial openness and growth, similar considerations also apply to flow measures. Indeed the importance of non-linearities may be even greater for the latter given the likely higher instability of flow measures for many countries.

[19] Note that the baseline parametric effects exclude the indirect influence of the financial openness on these variables.

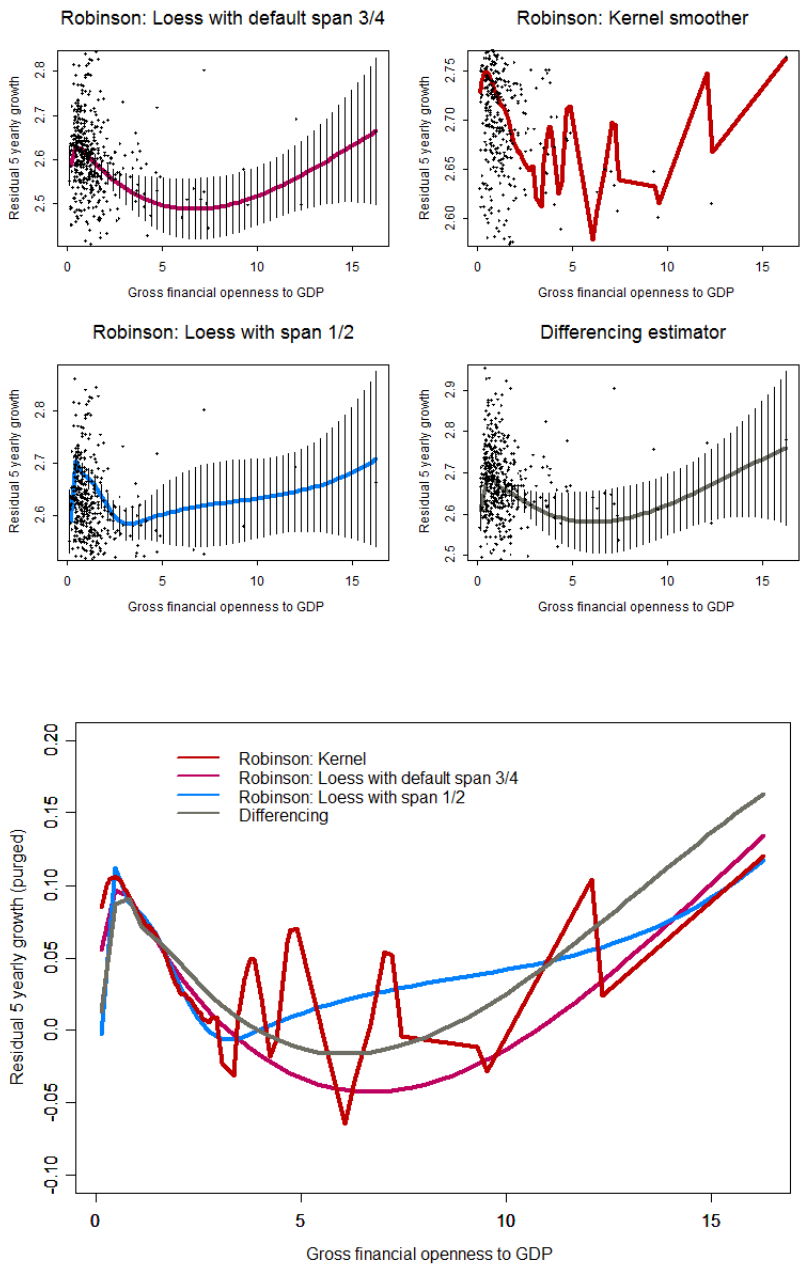
residuals from this regression against the gross financial openness variable. Next, we use nonparametric methods to estimate the form of the relationship between these two variables. Specifically, we employ the Robinson residual method, first using local regression with two different spans (the percentage of data points included in the local regression) and then a kernel estimator (with a triangular kernel) as the nonparametric technique. We also use the alternative "differencing approach" described by Yatchew (1998, 2003) and Yatchew and No (2001).[20] If we demean the growth estimates from the first-stage parametric regressions, we obtain "purged" or demeaned growth residual values that illustrate the nonparametric relationship at the mean of the parametric variables (Yatchew, 2003). These different relationships are illustrated in the bottom panel of Figure 4.6.

These plots illustrate a similar pattern in the results from different approaches, with an increasing relationship between growth and financial openness at low levels of the latter, which then turns negative and reverts to being positive at the highest levels of financial openness. However, the estimated relationship becomes insignificant as financial openness rises. The plots also highlight the potential roles of outliers on financial openness in influencing the results and the relatively large confidence intervals attached to the point estimates. The variations in the effects across financial openness values may contribute to the overall negative insignificant coefficient in the standard linear parametric estimation.

We replicated the above analysis for different measures of financial openness. As with the parametric results, there are marked differences across these measures. For example, the stock of FDI and portfolio equity liabilities, which has a positive but insignificant linear coefficient in the parametric setup (see Table 4.4), has a relationship that is broadly flat at positive values of the demeaned growth residuals

[20]This involves the removal of the non-parametric function by taking the difference in the dependent variable relative to its nearest neighbour by the similarity of linear control variables. Once the non-parametric function has been removed the linear coefficients are estimated. The resultant fitted values are then used to obtain residuals which can then be used to estimated the non-parametric function, for example, by locally-weighted regression techniques.

**Figure 4.6:** Gross Financial Openness and Growth Residuals




Note: The plots illustrate the relationship between five-year growth rates–once standard controls and dummy variables have been controlled for (excluding the indirect effect of gross financial openness on these controls)–and gross financial openness. A nonparametric relationship is then estimated and illustrated on the graph with 95% confidence intervals indicated by vertical lines. Four alternative methods are illustrated. Three employ the Robinson double residual estimator including local regression estimator (loess) using various spans of the observations and a kernel smoother. The final one employs the differencing estimator described above. The lower panel looks across methods and employs "purged" or demeaned growth residual values, i.e. when growth estimates from the first-stage parametric regressions are demeaned, to illustrate the nonparametric relationship at the mean of the parametric variables.

and then increases with the financial openness measure. In contrast, the relationship of the debt measure with the demeaned growth residuals has a marked downward slope above a certain value of debt (see the discussion of Imbs and Rancière, 2007, of the external debt Laffer curve).

### 4.7.2 Semiparametric interactions between financial openness and threshold variables

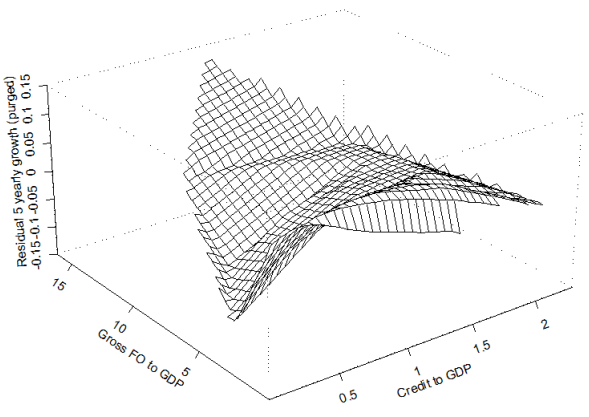
The double residuals approach is applied in a similar manner when looking at interaction effects, i.e., when both financial openness and a threshold variable enter nonparametrically. As before, we first obtain growth residuals by eliminating the baseline parametric effects. To conduct the nonparametric smoothing, we then focus on the local regression estimator.[21]

Unconditional plots of growth against financial openness reveal patterns that vary by the level of credit to GDP (Appendix Figure 4.12). At low levels of credit to GDP, the relationship tends to be negative, then moving towards a flat relationship at higher levels of credit to GDP. Using the double residual approach with a local regression span of 0.75, the estimated nonparametric relationship between growth residuals and financial openness is illustrated in Figure 4.7.[22] This figure is similar to Figure 4.6 but, rather than showing the univariate nonparametric relationship between growth residuals and financial openness, it shows the multivariate relationship of growth residuals with financial openness and the credit to GDP ratio. Thus, it represents one nonparametric approach to illustrating the interaction between financial openness and a threshold variable in their relationship with growth residuals. For relatively low levels of credit to GDP and low levels of financial openness, the estimated relationship between growth and financial openness is indeed negative.

[21] This fits a local quadratic regression including the threshold and financial openness variables, their squares and cross-products. Insightful Corporation (2007) has details on local regression procedures.

[22] The results were not greatly sensitive to alternative local regression spans.

**Figure 4.7:** Double Residual Nonparametric Interaction Effects (Credit to GDP as the threshold variable, interacted with gross financial openness to GDP)




Note: This plot illustrates the estimated nonparametric relationship between conditional growth once standard controls and dummy variables have been controlled for (excluding the indirect effect of gross financial openness and credit-to-GDP on these controls) and gross financial openness and credit-to-GDP. Growth estimates from the first-stage parametric regressions are demeaned to obtain "purged" or demeaned growth residual values that illustrate the nonparametric relationship at the mean of the parametric variables. The Robinson double residual estimator is employed using a local regression estimator (loess) with a span of 0.75.

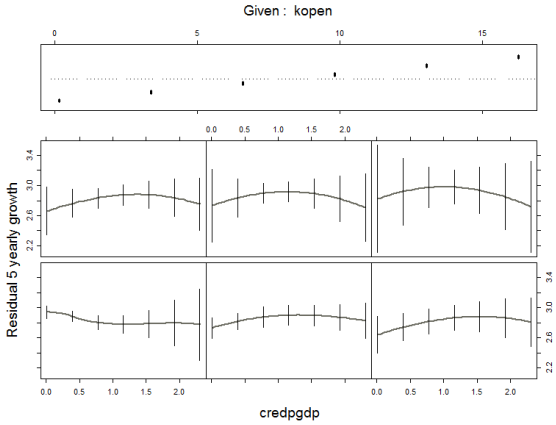
This is the range in which most country observations actually fall. The five-year growth rate purged of the linear determinants reaches a peak of around 0.1 for mid-ranges of financial openness and credit-to-GDP and lows of around -0.2 for low private credit-to-GDP and high or low financial openness

An alternative way to examine this relationship is to look at how the relationship of the demeaned growth residuals with financial openness varies with the level of the threshold variable (and vice versa). Figure 4.8 shows such relationships and their confidence intervals for different slices of the corresponding 3D plot. The right panel in this figure illustrates the negative relationship between demeaned growth residuals and financial openness at low levels of credit to GDP. The left panel shows that the inverted U-shaped relationship between these residuals and credit-to-GDP tends to be more prevalent at higher levels of financial openness. One point to note concerning these plots is that the slices are taken at equally spaced splits across the full range rather than at percentile values of the distribution of observations. Thus,

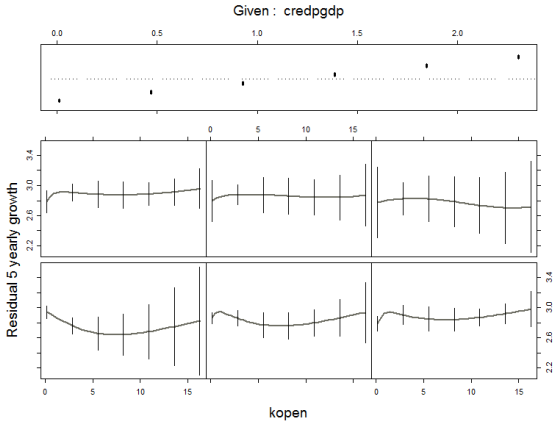
given the skewed distribution of both credit to GDP and financial openness most country data points lie in the bottom and left-hand side plots. Again, these plots illustrate the wide confidence intervals around the estimated effects, which in many cases are not significantly different from zero.

**Figure 4.8:** Cross-Sections of Double Residual Nonparametric Interaction Effects (Credit to GDP as the threshold variable, interacted with gross financial openness to GDP)

**(a)** Sliced at different values of financial openness to GDP




**(b)** Sliced at different values of credit to GDP



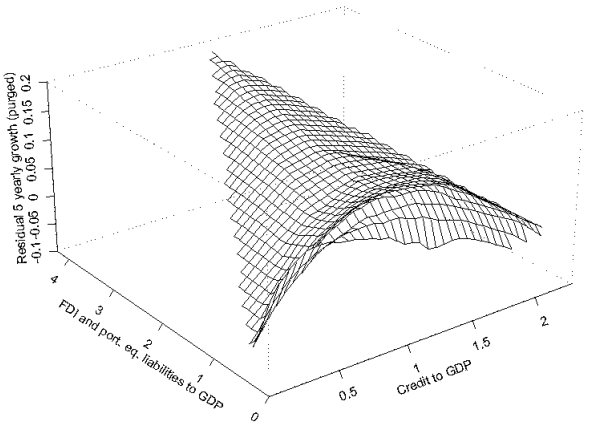

Note: The six lower panels show the relationship between residual growth and financial openness in part (a) and credit to GDP in part (b) with 95% confidence intervals indicated by the vertical lines. The six plots are taken at six equally spaced levels of credit-to-GDP and financial openness to GDP in parts A and B, respectively. The lowest value of the given variable is represented in the bottom left-hand panel with the level rising in subsequent panels as one moves from left to right and then up and long the second panel. The corresponding values of the given variable at which the slices are made are indicated by the dots in the uppermost plot across the width of the figure.

This analysis can be repeated for different measures of financial openness. As with the parametric estimates, the results for total liabilities are similar to those for the gross measures. There are again marked differences between the estimates using FDI and portfolio equity liabilities versus debt liabilities. With the former, the unconditional relationship between growth and financial openness is mostly flat or slightly positive throughout different sub-samples based on levels of credit to GDP. By contrast, with debt liabilities the relationship with growth is downward sloping for half of the sub-samples with lower levels of credit to GDP.

Turning to the nonparametric model, Figures 4.9 and 4.10 illustrate the fitted nonparametric interaction effects for FDI and portfolio equity and debt liabilities

as the financial openness variables when interacted with credit to GDP. For low to medium levels of credit to GDP, the relationship between growth and the financial openness measure based on FDI and portfolio equity liabilities is flat or increasing. However, at these low levels of credit to GDP, the relationship between growth and debt liabilities is negative. Again, when analyzing these results it is important to note that the confidence intervals around these estimates tend to be relatively large and that most observations lie at lower levels of financial openness and credit to GDP.

**Figure 4.9:** Double Residual Nonparametric Interaction Effects (Credit to GDP as the threshold variable, interacted with gross FDI and portfolio equity liabilities to GDP)

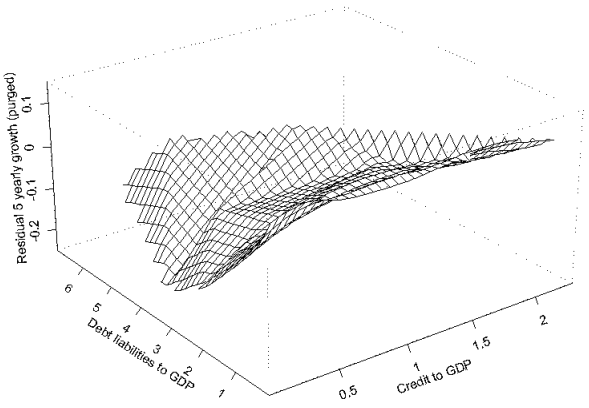



Note: See Figure 4.7 but with FDI and portfolio equity liabilities to GDP as the financial openness variable rather than gross financial openness to GDP.

We now apply this methodology to a few other threshold variables.[23] Unconditional growth plots illustrate that the relationship between growth and financial openness is negative for samples with lower trade openness ratios. This effect disappears once we control for other growth determinants and fixed effects in estimating the nonparametric interaction relationship with the relationship between residual

[23]See Appendix Figures 4.13 and 4.14 for trade openness and Appendix Figures 4.15 and 4.16 for institutional quality as the threshold variables.

**Figure 4.10:** Double Residual Nonparametric Interaction Effects (Credit to GDP as the threshold variable, interacted with gross external debt liabilities to GDP)




Note: See Figure 4.7 but with external debt liabilities to GDP used as the financial openness variable.

growth and financial openness broadly flat at different levels of trade.

Turning to institutional quality, again unconditional plots indicate a negative relationship between growth and financial openness at lower levels of the threshold variable. At low levels of institutional quality, the relationship between gross financial openness and growth is U-shaped. However, at higher levels of institutional quality the relationship becomes more linear. In line with the quadratic parametric estimation, for a given level of financial openness, residual growth increases with institutional quality at a decreasing rate. Once again, the interpretation of these results is subject to caveats on the size of confidence intervals and also on the actual distribution of observations by institutional quality and financial openness.[24]

[24]The double residual estimation process is complicated in this case by the non time-varying nature of the threshold variable. In the first stage nonparametric estimation we have been conducting a nonparametric regression of each of the baseline controls, including country dummy variables, on the threshold and financial openness variables. Applying this technique with institutional quality would mean that the country dummy variables are regressed on institutional quality, which is also a country-specific time invariant variable. This leads to a singular regressor matrix in the second stage regression. To get around this problem, we remove fixed effects from the first stage regression. We then estimate the second stage nonparametric interaction effects also without the country dummy variables (although we obtain similar results if we then include them).

## 4.8 Summary and Implications

Recent advances in the theoretical and empirical literatures indicate that the benefits of financial integration may be far subtler than had been presumed earlier. A new framework for analyzing financial globalization highlights the tension between the indirect benefits of financial integration and the potential risks if a country opens up to capital flows without the right initial conditions in place. From a practical policy perspective, however, a reasonable evaluation of the cost-benefit trade-off requires a better understanding of what these initial conditions are and how exactly they matter. This is an essential component of an analytical framework that can take account of country-specific features and initial conditions in designing a pragmatic approach to capital account liberalization (Prasad and Rajan, 2008). In this Chapter, we have tried to put some empirical structure on the concept of threshold conditions in order to give policymakers guidance on this issue. For instance, our results support the widely held conjecture that FDI and portfolio equity flows are safer than debt flows at low levels of financial and institutional development. We do not claim to have identified definitive thresholds. Our main contribution, instead, has been to develop an empirical structure to address this issue and frame it in a more concrete and tractable manner. Our analysis has already generated a number of interesting findings, which we now briefly summarize before discussing what policymakers should make of them.

Based on different methodologies and different definitions of thresholds, we conclude that there are threshold levels of certain variables that are important determinants of the relationship between financial integration and growth. In our empirical work, we have focused on a few variables motivated by the existing theoretical literature. These include domestic financial market development (in particular, the depth of credit markets), institutional quality, trade openness, and the overall level of development. All of these seem to be relevant threshold variables, with varying

degrees of importance—the most clearly-defined thresholds are based on the financial depth and institutional quality variables. We find that many of these thresholds are much lower when we measure financial integration by the stocks of FDI and portfolio equity liabilities rather than debt liabilities. The confidence intervals around some of the estimated thresholds are large, but in many cases the estimated coefficients yield reasonably tight estimates of the threshold conditions.

Do the thresholds have empirical content? Our results generally indicate that the estimated thresholds are reasonable and well within the ranges of the data samples. For instance, most industrial countries and a few emerging markets are above the estimated threshold levels of financial depth, while a majority of emerging markets and nearly all other developing countries are below them. This result is consistent with observed differences in growth outcomes associated with financial integration across these groups of countries. Of course, the recent global crisis shows that financial depth is not a reliable measure of financial stability, which should also take into account regulatory and supervisory structures.

Indeed, there is a rich research agenda that comes out of our work. Future theoretical studies in this area should focus on the precise nature of the threshold relationship and provide testable predictions in the context of reduced form solutions. On the empirical front, our results show that focusing on individual threshold variables could lead to misleading conclusions. Some of the open questions prompted by our analysis are as follows. Are there trade-offs among different threshold conditions, such that a high level of one variable can lower the threshold on another variable?[25] If the level of financial integration itself acts as a threshold, how can it be integrated into the framework based on other thresholds laid out in this Chap-

[25]We find preliminary evidence that financial depth matters less in countries that have high institutional quality levels. We also checked if a simple composite measure derived from the different threshold variables in our analysis could serve as a composite threshold indicator. Preliminary analysis suggests that there are indeed threshold effects in the data based on this composite indicator. We have not, however, developed a procedure to find the optimal composite indicator that captures the complementarity and substitutability among different threshold conditions and leave that for future work.

ter? Have the levels of different thresholds been changing over time as virtually all countries become more financially open in de facto terms, irrespective of their capital control regimes? How do circumstances in global financial markets affect the thresholds?

# 4.A Appendix: Sample description

**Table 4.7:** Country Sample

| Industrial | Emerging economies (EMs) | Other developing countries (ODCs) | |
|---|---|---|---|
| Australia | Argentina | Algeria | Mauritius |
| Austria | Brazil | Bangladesh | Mozambique |
| Belgium | Chile | Benin | Nepal |
| Canada | China | Bolivia | Nicaragua |
| Denmark | Colombia | Botswana | Niger |
| Finland | Egypt | Cameroon | Panama |
| France | India | Congo, Republic of | Papua New Guinea |
| Germany | Indonesia | Costa Rica | Paraguay |
| Greece | Israel | Dominican Republic | Rwanda |
| Ireland | Jordan | Ecuador | Senegal |
| Italy | Korea, Republic of | El Salvador | Sri Lanka |
| Japan | Malaysia | Ghana | Sudan |
| Netherlands | Mexico | Guatemala | Syria |
| New Zealand | Pakistan | Haiti | Togo |
| Norway | Peru | Honduras | Trinidad &Tobago |
| Portugal | Philippines | Iran | Tunisia |
| Spain | Singapore | Jamaica | Uganda |
| Sweden | South Africa | Kenya | United Arab Emirates |
| Switzerland | Thailand | Kuwait | Uruguay |
| United Kingdom | Turkey | Malawi | Zambia |
| United States | Venezuela | Mali | Zimbabwe |

Note: The sample comprises 84 countries—21 industrial and 63 developing (of which 21 are emerging market economies, EMs, and 42 are other developing countries, ODCs).

**Table 4.8:** Variable Definitions and Sources

| Variable | Sources |
|---|---|
| Growth rate of PPP real GDP per capita (log difference over period) | PWT |
| GDP per capita PPP, 1996 constant prices | PWT |
| Average investment to GDP | PWT |
| Average schooling years in population over 25 years old | Updated Barro and Lee (2000) database. Data available at http://www.cid.harvard.edu/ciddata/ciddata.html |
| Average annual population growth rate (log difference over period divided by length) | WDI |
| Gross de facto financial openness to GDP | Stock data from Lane and Milesi-Ferretti (2006). Current price US dollar GDP data from WDI. |
| Stock of external liabilities to GDP | As above |
| Stock of external FDI and portfolio equity liabilities to GDP | As above |
| Stock of external debt liabilities to GDP | As above |
| Gross flows to GDP defined as sum of absolute inflows and absolute outflows | Flow data from IMF IFS. Current price US dollar GDP data from WDI. |
| Total financial inflows to GDP | As above |
| FDI plus portfolio equity inflows to GDP | As above |
| Debt inflows to GDP | As above |
| Domestic credit to private sector to GDP | WDI |
| Current price trade openness (exports plus imports) to GDP | PWT |
| Average institutional quality index | Simple average of six World Bank Governance Indicators (data available from 1996) |
| Rigidity of employment index for employing workers | World Bank / International Finance Corporate Doing Business Database (data available from 2003) |
| Annual CPI inflation | IFS |

Note: PWT: Penn World Tables (version 6.2); IFS: International Financial Statistics; WDI: World Development Indicators.

# 4.B Appendix: Related literature

**Table 4.9:** Interaction effects: Financial depth (FD)

| Study | No. of econ. / period | Econometric methodology | Dependent variable | Financial openness variable | Interaction /threshold variables | Interaction/ threshold approach | Main findings on interaction effect |
|---|---|---|---|---|---|---|---|
| **1. FDI as financial openness (FO) measure** | | | | | | | |
| Hermes and Lensink (2003) | 67 developing (1970-1995) | Cross section OLS | Growth of real per capita GDP | Gross FDI inflows to GDP | Private bank credit to GDP | Linear | *Positive significant coefficient on interaction of FDI with FD variables.* |
| Alfaro et al (2004) | 71 (1975-1995) for banking variables<br><br>50 (1980-1995) for stock market variables | Cross section OLS plus IV | Growth of real per capita GDP | Net FDI inflows to GDP | Banking: liquid liabilities to GDP; commercial bank assets to commercial bank plus central bank assets; private credit to GDP; private bank credit to GDP.<br>Stock market: value traded to GDP; stock market capitalization to GDP. | Linear | *Positive significant coefficient on interaction of FDI with FD variables.* Robust to additional controls and IV estimation. |
| Durham (2004) | Up to 62 (1984-1998) | Cross section OLS | Growth of real per capita GDP | FDI flows from 1979-1983 (OECD and IFS measures) and net portfolio equity inflows from US from 1979-1983 | Stock market capitalization to GDP | Linear | *Mixed results.* Interaction coefficient positive significant for FDI using OECD data and with net portfolio equity inflows but insignificant with FDI using IFS data. |
| Carkovic and Levine (2005) | Up to 68 (1960-1995) | Cross section OLS and 5-yearly panel dynamic system GMM | Growth of real per capita GDP | Gross FDI inflows to GDP | Private credit by financial intermediaries to GDP | Linear | *Mixed results.* Interaction coefficient positive significant in cross-section but not significant in panel system estimation. |

**Table 4.10:** Interaction effects: Financial depth (FD) continued

| Study | No. of econ./ period | Econometric methodology | Dependent variable | Financial openness variable | Interaction /threshold variables | Interaction/ threshold approach | Main findings on interaction effect |
|---|---|---|---|---|---|---|---|
| **2. Other FO measures** | | | | | | | |
| Kraay (1998) | n.a.[a] (1985-1997) | Cross-section OLS and IV. Event study | Growth of real per capita GDP | AREAER share; Quinn index; gross capital flows to GDP | M2 to GDP; domestic private credit to GDP; 1- average number of banking crises per year; freedom to undertake "non-traditional" banking activities | Linear (for regressions) Sample split (above/ below median) for event study | *Little evidence of interaction effects.* Linear interaction coefficients either insignificant or mixed sign. Similar results with event studies. |
| Arteta et al (2001) | Up to 62 (1973-1992) | Cross section and sub-period panel pooled OLS | Growth of real per capita GDP (PPP) | Initial value of Quinn capital account liberalization index | Initial liquid liabilities to GDP | Linear | *Coefficient on FD interaction term insignificant* |
| Bekaert et al (2005) | Up to 95 (1980-1997) | 5-yearly panel (overlapping periods) GMM | 5-year average growth rate of real per capita GDP | De jure international equity market liberalization | Private credit to GDP Stock market turnover | Sample split: Above/ below median | *Countries with higher FD have significantly higher growth gain post-liberalization* |
| Hammel (2006) | 13 (1982–1995) | FE panel 3-year pre and post-liberalization | 3-year growth in real sectoral value added | Bekaert et al de jure international equity market liberalization | Stock market capitalization to GDP | Sample split: various (base result for >10% GDP) | *Positive sig. coefficient on interaction of sectoral external finance dependence and liberalization for countries with stock cap. over 10% GDP* (insig. if median split used) |
| Prasad et al (2007) | 83 (for aggregate analysis) (1980-1990) | Country and industry FE | Growth in real sectoral value added | Stock liabilities and gross and net flow liabilities to GDP: FDI; FDI and portfolio. De jure: Chinn-Ito; Edwards. | Private sector credit to GDP | Sample split: below median | *Generally negative significant coefficient on interaction of external finance dependence of industry and FO measure for countries with below median FD.* |
| Coricelli et al (2008) | 31 European economies, 1996-2004 | Annual panel dynamic GMM | Growth of real per capita GDP | Stock of external liabilities and assets plus liabilities to GDP: total, FDI; portfolio and other flows | Private sector credit to GDP and stock market capitalization plus private sector credit to GDP | Sample split: various (10% of GDP gradations)[b] | *Evidence supportive of non-linear interaction with coefficient on financial integration positive for financial development measures in the range 60-150% of GDP.* |

Notes: [a] Number of countries in interaction regressions not indicated in Kraay (1998). Financial openness measures are available for 117 countries for IMF AREAER share measure, 64 for Quinn liberalization measure and 94 for gross capital flows measure.
Samples and methodology: Details in table relate to sections of study when interaction effects are examined (and hence may differ from other parts of papers). Unless indicated country samples include industrial and developing economies. GDP noted as PPP where explicitly indicated in paper. Significant if at least 10% significance level.
Financial openness de jure measures: AREAER share: proportion of years in which countries had liberalized capital accounts based on the binary variable from AREAER; Quinn: de jure capital account liberalization measure based on Quinn (1997); Chinn-Ito: AREAER based measure of capital controls from Chinn and Ito (2006); Edwards index from Edwards (2005).

## **Table 4.11:** Interaction effects: Institutions

| Study | No. of econ./ period | Econometric methodology | Dependent variable | Financial openness variable | Interaction /threshold variables | Interaction/ threshold approach | Main findings on interaction effect |
|---|---|---|---|---|---|---|---|
| Kraay (1998) | n.a.[a] (1985-1997) | Cross-section OLS and IV. Event study | Growth of real per capita GDP | AREAER share; Quinn index; gross capital flows to GDP | Macro policy (weighted av. of gov. deficit and inflation); black market premium; ICRG corruption; ICRG bureaucracy quality | Linear (for regressions) Sample split (above/ below median) for event study | *Little evidence of interaction effects.* Linear interaction coefficients either insignificant or generally negative. Similarly no evidence from event studies. |
| Arteta et al (2001) | Up to 62 (1973-1992) | Cross section and sub-period panel pooled OLS | Growth of real per capita GDP (PPP) | Initial value of Quinn index | ICRG law and order | Linear | *Positive sig. interaction coefficient* in pooled sample (and for 1973-1981 and 1982-1987 but insig. for 1988-1992). |
| Durham (2004) | Up to 62 (1984-1998) | Cross section OLS | Growth of real per capita GDP | FDI flows (OECD and IFS) and net portfolio equity inflows from US from 1979-1983 | Regulation; property rights; corruption | Linear | *Mixed results* with positive interaction effects not robustly significant across FO measures. |
| Bekaert et al (2005) | Up to 95 (1980-1997) | 5-yearly panel (overlapping periods) GMM | 5-year av. growth rate of real per capita GDP | De jure international equity market liberalization | Legal measures; institutional variables; investment condition variables[b] | Sample split: Above/ below median | *Mixed results.* Some measures associated with sig. higher growth gain post-liberalization, e.g. English legal origin, high investment profile, whilst others, e.g. creditor rights insignificant |
| Chanda (2005) | Up to 82 (1975-1995) | Cross section OLS | Growth of real per capita GDP | AREAER share; Freedom House measure | Ethno-linguistic homogeneity | Linear | *Interaction coefficient on capital controls and ethno-linguistic homogeneity is positive and sig.* |
| Klein (2005) | Up to 71 (1976-1995) | Cross-section OLS and IV, non-linear LS | Growth of real per capita GDP | AREAER share | Institutional quality (average of 5 ICRG measures) [c] | Cubic; quadratic spline, quintile dummies | *Intermediate levels of institutional quality associated with a positive relation between growth and capital account liberalization.* |
| Quinn and Toyoda (2008) | Up to 85 (1955-2004) | 5-yearly panel FE and system GMM | Growth of real per capita GDP | Level of Quinn index | Ethnic fractionalization, black market premia, ICRG bureaucratic quality, ICRG corruption[d] | Linear | *Conclude that capital account liberalization effects generally direct over this period* with interaction effects generally insig, (or exhibiting contrary effects in different sub-periods). |

Notes: [a] Number of countries in interaction regressions not indicated in Kraay (1998). Financial openness measures are available for 117 countries for IMF AREAER share measure, 64 for Quinn liberalization measure and 94 for gross capital flows measure. [b] Bekaert et al (2005) legal measures include legal origin, judicial efficiency, speed of process; institutions include ICRG summary index (sum of three International Country Risk Group (ICRG) indices on bureaucratic quality; corruption, and; law and order); investment conditions included ICRG economic risk index, ICRG investment profile index, anti-director rights, creditor rights and accounting standards. [c] Klein institutional quality measure is average of ICRG measures for 1984-1995 for bureaucratic quality, corruption, expropriation risk, risk of repudiation of government contracts and rule of law. [d] Quinn and Toyoda also examine the interaction of their capital account measure with banking crises and financial crises and find no significant interaction effects.

For samples and methodology and financial openness measures see notes to preceding Table on financial development studies.

**Table 4.12:** Interaction effects: Income level

| Study | No. of econ./ period | Econometric methodology | Dependent variable | Financial openness variable | Interaction /threshold variables | Interaction/ threshold approach | Main findings on interaction effect |
|---|---|---|---|---|---|---|---|
| Arteta et al (2001) | Up to 62 (1973-1992) | Cross section and sub-period panel pooled OLS, weighted LS and IV 2SLS | Growth of real per capita GDP (international prices) | Level and change of Quinn index (plus AREAER share but not reported as insignificant) | Ln initial GDP per capita | Linear | *Interaction effects are very fragile and sensitive to sample and specification.* |
| Edwards (2001) | 56 (1980-1989) | Cross section weighted 3SLS IV (weighting with GDP per capita in 1985) | Growth of real per capita GDP (international prices) and TFP | Level of Quinn index in 1987 | Ln initial GDP per capita | Linear | *Direct effect of capital account liberalization negative with positive significant coefficient on interaction with level of initial income.* |
| Edison et al (2004) | Up to 71 (1976-1995) | Cross section OLS | Growth of real per capita GDP | De jure share measures based on AREAER dummy and Bekaert et al (2005) liberalization dates; Quinn index | Ln initial GDP per capita | Quadratic | *Inverted U-shape relationship between coefficient on FO and level of development*. Linear and quadratic interaction effects significant across FO measures. |
| Carkovic and Levine (2005) | Up to 68 (1960-1995) | Cross section OLS and 5-yearly panel dynamic system GMM | Growth of real per capita GDP | Gross FDI inflows to GDP | Ln exports plus imports to GDP | Linear | *No evidence that growth impact of FDI depends on level of income.* |
| Quinn and Toyoda (2008) | Up to 85 (1955-2004)[a] | 5-yearly panel FE and system GMM | Growth of real per capita GDP | Level of Quinn index | Ln per capita GDP | Linear, quadratic | No evidence from linear model of higher growth post-liberalization in richer countries. Quadratic model suggests that poorer and richer countries grew faster post-liberalization. |

Notes: [a] Samples for relevant Tables in Quinn and Toyoda taken from corresponding baseline regressions detailed in Table 8. The authors also use smaller sample with data 1970-2004.
For samples and methodology and financial openness measures see notes to preceding Table on financial development studies.

**Table 4.13:** Interaction effects: Trade openness measures

| Study | No. of econ./ period | Econometric methodology | Dependent variable | Financial openness variable | Interaction /threshold variables | Interaction/ threshold approach | Main findings on interaction effect |
|---|---|---|---|---|---|---|---|
| Balasubraman-yam et al (1996) | Up to 46 developing economies (1970-1985) | Cross section OLS and IV | Growth of real per capita GDP (PWT) | FDI to GDP | Imports to GDP (classify economy as import substituting IS or export promoting EP) | Regression estimated separately for the two sample splits | Significant difference across IS or EP samples. *Coefficient on FDI positive significant for EP countries but insignificant for IS.* |
| Arteta et al (2001) | Up to 60 (1973-1992) | Cross section and sub-period panel pooled OLS | Growth of real per capita PPP GDP | Initial value of Quinn index | Overall Sachs Warner (SW) openness indicator plus sub-components of tariff/non-tariff barriers and black market premium | Linear | Interaction with SW generally positive significant but insignificant if SW level added. Interaction with trade barriers measure insignificant. *Results supportive of positive relation between growth and capital account liberalization contingent on absence of large black market premium* (interpreted as absence of macro imbalances). |
| Carkovic and Levine (2005) | Up to 67 (1960-1995) | Cross section OLS and 5-yearly panel dynamic system GMM | Growth of real per capita GDP | Gross FDI inflows to GDP | Exports plus imports to GDP | Linear | *Interaction effect insignificant in OLS regressions. Positive significant results for panel not robust* to inclusion of other controls. |
| Gupta and Yuan (2006) | 31 emerging economics (1981-1998) | Annual sector-level panel, country and year FE. | Growth of real sectoral value added | Liberalization of stock market to foreign investors. | "Trade competitiveness", i.e. ratio of industry to total output of that industry across sample | Linear | Growth post-liberalization is significantly higher in industries which are more trade competitive. |

Notes: For samples and methodology and financial openness measures see notes to preceding Table on financial development studies.

# 4.C Appendix: Additional results

**Table 4.14:** Sensitivity of quadratic interaction results with gross financial openness for different period windows (fixed effects specification)

**(a)** Interaction with private credit-to-GDP

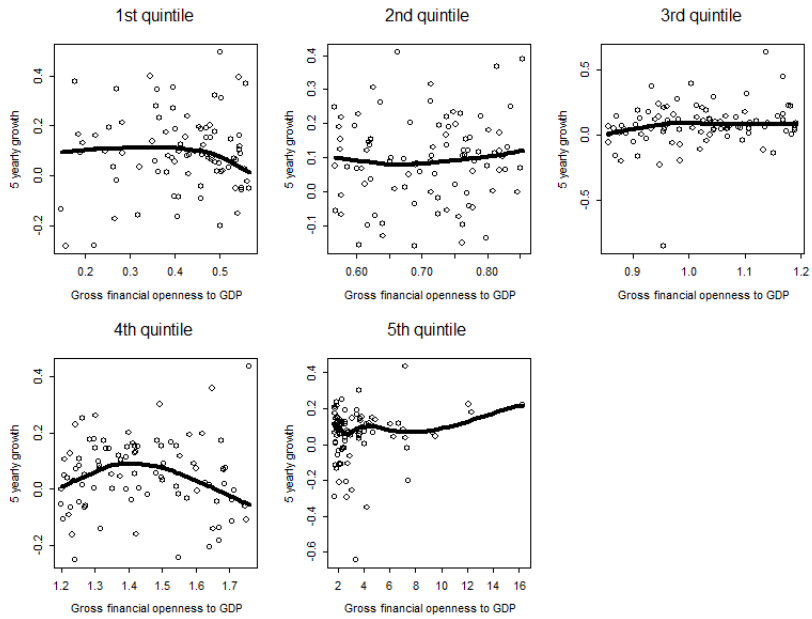
| | **Length of period (years)** | | | | | |
|---|---|---|---|---|---|---|
| | **5** | **7** | **8** | **8** | **9** | **10** |
| Coefficient estimates: | | | | | | |
| FO | -*** | - | - | -* | - | -* |
| FO*PC | +*** | +* | + | + | + | +** |
| FO*PC squared | -*** | -* | - | - | -* | -** |
| PC cut offs at which | 0.71 | 0.55 | 0.44 | 0.93 | 0.52 | 0.66 |
| overall FO coefficient is zero: | 1.37 | 1.55 | 1.68 | 1.52 | 1.52 | 1.53 |
| *Memo:* | | | | | | |
| Adjusted R-squared | 0.338 | 0.152 | 0.144 | 0.181 | 0.249 | 0.277 |
| Observations | 456 | 294 | 294 | 212 | 212 | 212 |
| Number of countries | 84 | 83 | 84 | 83 | 83 | 84 |
| Sample length | 1975-2004 | 1977-2004 | 1973-2004 | 1981-2004 | 1978-2004 | 1975-2004 |

**(b)** Interaction with institutional quality

| | **Length of period (years)** | | | | | |
|---|---|---|---|---|---|---|
| | **5** | **7** | **8** | **8** | **9** | **10** |
| Coefficient estimates: | | | | | | |
| FO | -** | - | - | -*** | - | - |
| FO*IQ | +*** | + | + | + | + | + |
| FO* IQ squared | -** | - | - | - | - | - |
| IQ index cut offs at which | 0.29 | 0.15 | 0.06 | 1.65 | 0.06 | 0.22 |
| overall FO coefficient is zero: | 1.85 | 1.79 | 1.99 | 2.70 | 1.78 | 1.78 |
| *Memo:* | | | | | | |
| Adjusted R-squared | 0.359 | 0.145 | 0.166 | 0.170 | 0.237 | 0.261 |
| Observations | 457 | 295 | 295 | 212 | 212 | 212 |
| Number of countries | 84 | 83 | 84 | 83 | 83 | 84 |
| Sample length | 1975-2004 | 1977-2004 | 1973-2004 | 1981-2004 | 1978-2004 | 1975-2004 |

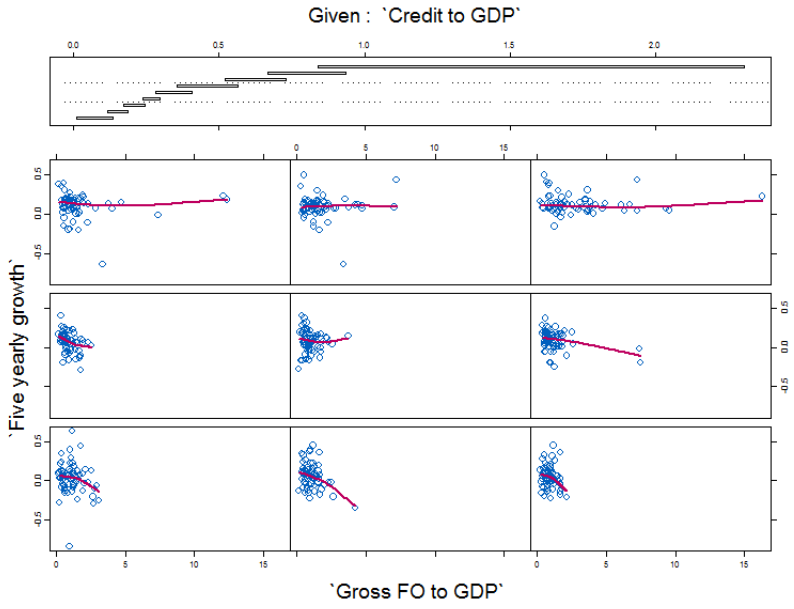
Note: All specifications include the same base controls as Table 4.2 and period effects, which are not reported. The symbols *, **, *** indicate significance at the 10%, 5% and 1% levels, respectively.

**Figure 4.11:** Unconditional relationship between five yearly growth and gross financial openness by quintile of gross financial openness



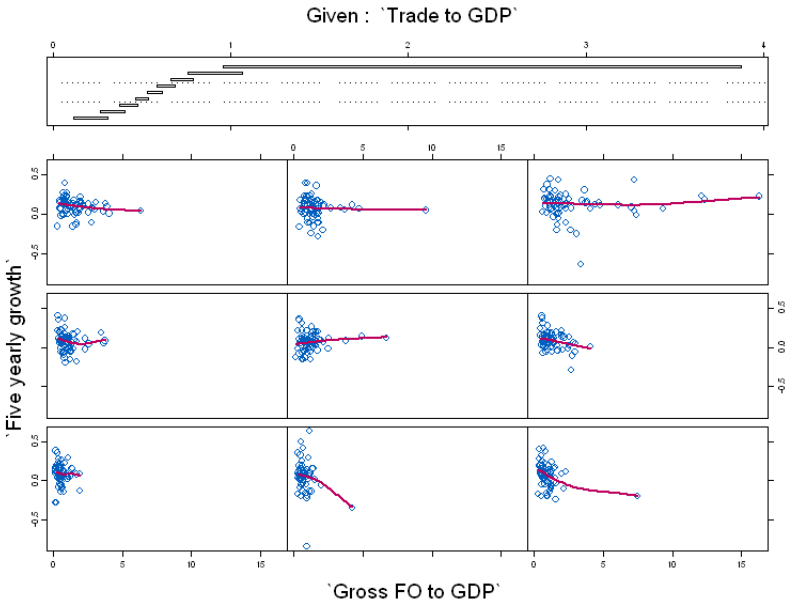

Note: Bold line indicates local regression smoother.

**Figure 4.12:** Unconditional five yearly growth against gross financial openness to GDP by sub-samples determined by credit to GDP



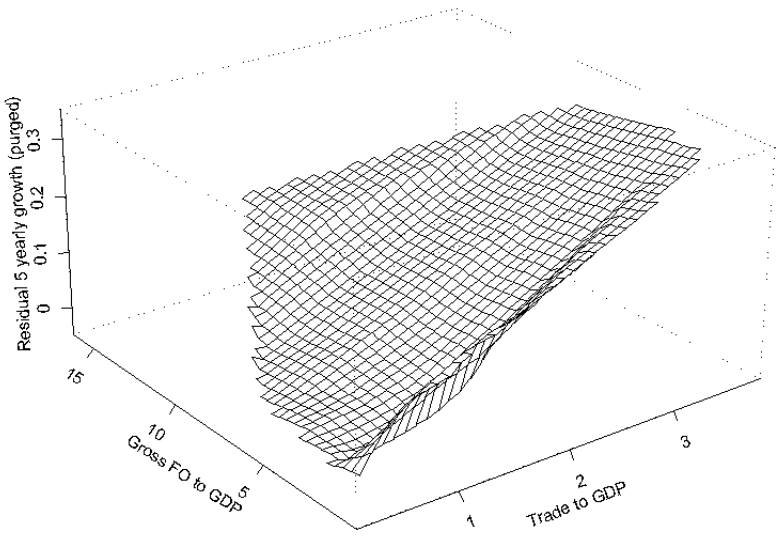

Note: Bold line indicates local regression smoother. The sub-sample with the lowest values of credit-to-GDP is represented in the bottom left-hand panel with the level rising in subsequent panels as one moves from left to right and then up and long the second and then the third panel. The top panel indicates the range of the different, non-overlapping sub-samples.

**Figure 4.13:** Unconditional five yearly growth against gross financial openness to GDP by sub-samples determined by trade to GDP



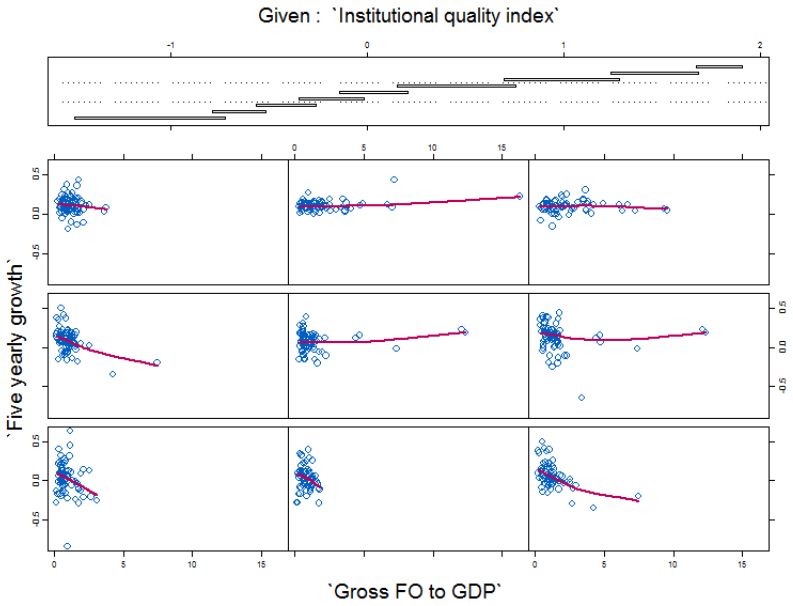

Note: Bold line indicates local regression smoother. The sub-sample with the lowest values of trade-to-GDP is represented in the bottom left-hand panel with the level rising in subsequent panels as one moves from left to right and then up and long the second and then the third panel. The top panel indicates the range of the different, non-overlapping sub-samples.

**Figure 4.14:** Double residual non-parametric interaction effects with trade to GDP as the threshold variable and gross financial openness to GDP as the financial openness variable



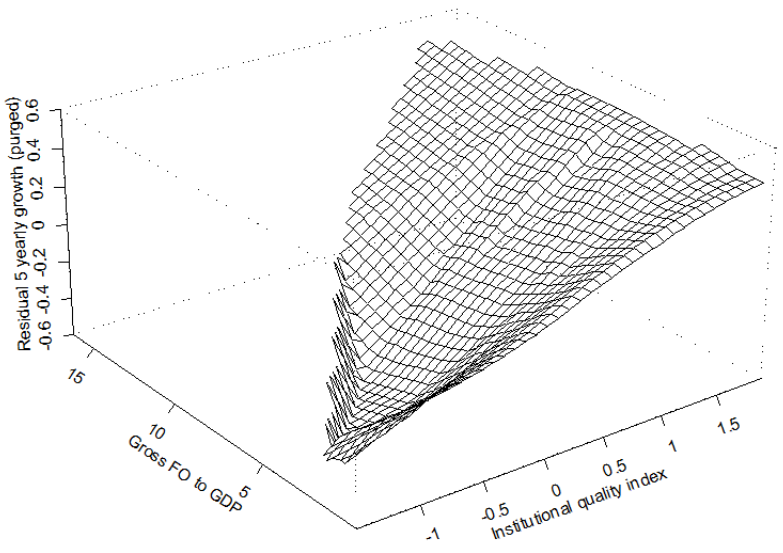

Note: As for Figure 4.7 but with trade to GDP as the threshold variable.

**Figure 4.15:** Unconditional five yearly growth against gross financial openness to GDP by sub-samples determined by institutional quality index




Note: Bold line indicates local regression smoother. The sub-sample with the lowest values of institutional quality index is represented in the bottom left-hand panel with the level rising in subsequent panels as one moves from left to right and then up and long the second and then the third panel. The top panel indicates the range of the different, non-overlapping sub-samples.

**Figure 4.16:** Double residual non-parametric interaction effects with institutional quality index as the threshold variable and gross financial openness to GDP as the financial openness variable




Note: As for Figure 4.7 but with institutional quality as the threshold variable. Country dummy variables not included in this estimation.

# Chapter 5

# Conclusions

This concluding chapter provides a brief recap of the main results of the preceding chapters, returning to the central questions posed in the introductory chapter - how do financial reforms affect an economy's allocation of production and long-run macroeconomic performance? how does this impact of financial reforms interact with that of other policy reforms or an economy's structural characteristics? It then considers the rich set of implications of the analysis of these three chapters for future work.

The heterogeneous firm trade model of Chapter 2 examines the interaction between domestic financial sector and trade policy reforms. Relative to the related literature, the value added is the ability to examine the general equilibrium steady state comparative static effects of the two reforms within a multi-country model. The interaction effects between trade reforms and domestic financial sector reforms appear qualitatively important. On the one hand, trade and domestic financial sector reforms can have complementary effects in increasing the average productivity and size of producing entrepreneurs. On the other hand, in such a case the marginal gains for wages and household utility as a result of trade liberalization are reduced. If credit constraints are less restrictive then effective borrowing costs are lower, intermediate prices are reduced and real wages are higher. Thus, the marginal benefits

of trade liberalization in lowering prices and increasing real wages are reduced if much reallocative work has already been done through a well-functioning domestic financial sector. In terms of the potential linkage between exports and credit constraints, improvements in the relative ability to pledge exports to creditors amplify the benefits of trade liberalization. A further insight of the paper is that even in financial autarky the financial development of not just the domestic economy but also its trading partner can play a role in determining the real wages and the efficiency of domestic production. In particular, domestic financial sector reforms in one economy can be exported via the trade channel putting downward pressure on foreign real wages.

Chapter 3 sets out a modified credit multiplier model to examine how domestic and international financial reforms interact in causing general equilibrium reallocations in production across firms and across sectors. Financial reforms lead to changes in the investment decisions of firms as they adjust to changes in their ability to borrow against future revenues. These partial equilibrium effects result in general equilibrium adjustments in sectoral relative prices and the domestic interest rate so as to maintain equilibrium between demand and supply of investment funds. As credit constraints are relaxed, the resultant changes in firms' incentives to invest depend on their productivity, leading to reallocations across firms, and on the sector of investment, shifting incentives to reallocate production across sectors. Through its impact on relative prices, the domestic recovery rate influences which entrepreneurs produce and in which sectors, and determines the partitioning of equilibria by different production combinations. Structural characteristics also act as conditioning factors determining the equilibrium allocation of production. There are potential policy complementarities between financial reforms and, for example, improvements in regulatory and legal certainty. The impact of capital account liberalization on relative prices also depends upon the state of domestic financial reforms since, for example, the leverage benefits of a relaxation in international credit

constraints will be greater at higher levels of overall domestic pledgeability.

The areas for future work stimulated by the analysis of Chapters 2 and 3 can be grouped into four main topics: how financial reforms are modeled and the focus on steady state comparative statics; the sensitivities of the results to the model set up; the need for further empirical investigation of the channels highlighted; the potential political economy implications.

In both chapters, different types of financial reforms are modeled as relaxations in the credit constraints faced by firms and the focus is on their comparative static implications in steady state equilibria. This takes a longer-term view of financial reforms. Future work could examine the transitional dynamics of the models which are used in the credit multiplier literatures to highlight the propagation and amplification of shocks to the financial health of firms. For reasons of tractability, the models also abstract from some of the key financial issues highlighted in the experiences of the 2008 and 2009 global financial crisis. As with much of the broader credit multiplier literature, this is due to a relatively simple approach to modeling financial intermediation which abstracts, for example, from risk-taking incentives within financial institutions, liquidity and counter-party risks, network linkages amongst institutions and regulatory and supervisory mechanisms.

Both models provide relatively tractable approaches to general equilibrium modeling of credit constraints which can vary across sectors, types of goods and types of creditors. However, additional empirical research is required on the quantitative significance of the interaction effects that are highlighted. In particular, as noted by Banerjee and Duflo (2005), the question of whether there are potential gains from adding multiple sources of inefficiency to models to explain productivity differences across countries is dependent upon their empirical relevance. An important next step would therefore be to see to what extent the models of both chapters can be applied to examine sectoral reallocations in output around trade and financial reforms.

The third area for future work related to the theoretical chapters is to examine how sensitive are the results to modifications of the baseline set up. For example, both production structures could be expanded to include labor, capital and land with the latter providing a powerful propagation and amplification mechanism, as emphasized in the work of Kiyotaki (1998) and Aoki et al. (2009). Another interesting extension is to follow the approach of Matsuyama (2007) where the productivity in each sector varies as well as the credit multiplier. This may be intuitive since, for example, a potentially high return sector may also be one in which it is harder for a creditor to take over and operate efficiently in the case of default.

Finally, since both models have heterogeneous agents who are differently affected by financial reforms, a natural extension is to use them to explore political economy questions. For example, how does the choice of optimal policy settings vary across agents? what are the implications of endogenizing policy choices? The two economy set-up of Chapter 2 could also be used to look at how these policy settings depend upon spillovers of trade and financial reforms across countries. Finally, the different credit multipliers across sectors in Chapter 3 could be employed to highlight the macro impact of directed credit policies.

Turning to Chapter 4, this analysis aims to put some empirical structure on the concept of threshold conditions which influence the relationship between international financial integration and growth in order to give policymakers guidance on this issue. Based on different methodologies and definitions of thresholds, the analysis finds that a range of variables, including domestic financial market development (in particular, the depth of credit markets), institutional quality, trade openness and the overall level of development, seem to be relevant threshold variables, with varying degrees of importance—the most clearly-defined thresholds are based on the financial depth and institutional quality variables. Many of these thresholds appear to be much lower when financial integration is measured by the stocks of FDI and portfolio equity liabilities rather than debt liabilities. The confidence intervals

around some of the estimated thresholds are large, but in many cases the estimated coefficients yield reasonably tight estimates of the threshold conditions. The results generally indicate that the estimated thresholds are reasonable and well within the ranges of the data samples.

The experience of the financial crisis provides a rich vein of follow-up work to this empirical analysis. The sample period examined in Chapter 4 excludes the largest global downturn since the Great Depression. Repeating this work including the experience of the past few years would likely provide new and interesting results. In addition, the experience of the crisis shows that financial depth is not a reliable measure of financial stability, which should also take into account regulatory and supervisory structures. Some of the other open empirical questions prompted by this analysis are as follows. Are there trade-offs among different threshold conditions, such that a high level of one variable can lower the threshold on another variable? If the level of financial integration itself acts as a threshold, how can it be integrated into the framework based on other thresholds laid out in this paper? Have the levels of different thresholds been changing over time as virtually all countries become more financially open in de facto terms, irrespective of their capital control regimes? How do circumstances in global financial markets affect the thresholds?

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