

Institutions, Informal Labor Markets, and Business Cycle Volatility

ABSTRACT I build a business cycle labor search-and-matching model with informal labor markets, which shows that different dimensions of institutional quality have similar effects on the size of the informal sector, but different effects on the relationship between informality and long-run macroeconomic outcomes and between informality and labor market volatility. For the same change in informal sector size, changes in different proxies for institutional quality have contrasting quantitative implications for the steady state and the volatility of the labor market, despite having similar consequences on other macroeconomic variables. These results highlight the importance of identifying the source behind changes in the size of the informal sector to characterize the link between informality and business cycle dynamics.

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The informal sector, where firms and workers produce legal, market-based goods and services but circumvent government regulations, accounts for an important share of economic activity, ranging from 8 percent of GDP in some developed countries to almost 70 percent of GDP in some developing countries. The empirical literature on informality has found that institutional quality is particularly relevant in explaining cross-country differences in the size of the informal sector.¹ In fact, weak institutional quality is often seen as generating higher informality.² The existence of a large proportion of individuals and firms operating outside the official institutional framework has important implications on the speed of factor reallocation in response to fluctuations in aggregate economic conditions. On the one hand, the informal sector can act as a shock absorber during downturns.³ On the other hand, informal firms, by avoiding regulations, can swiftly adjust their inputs in response to aggregate shocks.⁴ Ferreira-Tiryaki provides empirical evidence

1. Throughout the paper, I use the terms *institutions*, *institutional quality*, and *governance* interchangeably. Institutional quality broadly embodies the effectiveness of the rules and norms, established by a country's governing body, that underlie and support economic transactions and interactions, including the effectiveness and quality of the legal system, contract enforcement, and property rights (Kaufmann, Kraay, and Mastruzzi, 2012). See Loayza, Oviedo, and Servén (2004, 2005), Johnson, Kaufman, and Zoido-Lobaton (1999), and Perry and others (2007) for more on informality, regulations, and institutions.

2. Oviedo, Thomas, and Karakurum-Özdemir (2009).

3. Bosch and Maloney (2006); OECD (2009c); Loayza and Rigolini (2011).

4. Boeri and others (2008).

suggesting that a larger informal sector is associated with higher volatility in consumption, investment, and output.⁵ However, the theoretical literature has ignored whether the determinants of informality—in particular, the different dimensions of institutional quality in the economy—play a role in shaping the link between informality and business cycles. While the quality of institutions appears to have a uniform effect on the size of the informal sector in the data, institutional quality can work through different channels and potentially lead to contrasting effects on aggregate economic activity. The relationship between informality and macroeconomic performance may then depend on how institutions are reflected in economic activity and whether specific sectors are affected by these institutions.⁶

In this paper, I explore whether the relationship between informality and aggregate volatility, with an emphasis on labor market volatility, depends on the underlying dimensions of institutional quality, which in turn affect the size of the informal sector. The aggregate effects of particular institutional differences may be difficult to disentangle in the data, since most measures of institutional quality are highly correlated with each other. This motivates the use of a simple business cycle model with frictional labor markets and informal employment, which allows me to examine the impact of different dimensions of institutional quality on informality and, in turn, the link between the informal sector and aggregate economic activity.⁷ In the model, I focus on two different dimensions of institutional quality that affect the size of the informal sector across economies: the economic environment in which formal firms operate, as reflected (exogenously) in the productivity of the formal sector, and the degree of enforcement of labor regulations in the informal sector.⁸

With regard to the economic environment, low institutional quality can lead to uncertain rules of the game pertaining to the regulations with which

5. Ferreira-Tiryaki (2008).

6. See Acemoglu and Johnson (2005) on the relevance of exploring the impact of institutions on economic outcomes at a more disaggregated level. Acemoglu and others (2003) explore the link between institutions and volatility. Barseghyan and DiCecio (2010) focus on regulations, property rights, and volatility.

7. Labor market frictions generate involuntary unemployment. This allows me to study the relationship between institutional quality changes, informality, and unemployment dynamics.

8. For evidence on the link between institutions and productivity, see Quijada (2006) for Latin America, De Rosa, Goroorchurn, and Görg (2010) on the link between corruption and firm-level productivity, Scarpetta and others (2002) on productivity and regulations (which are a reflection of institutions), and Bhaumik and others (2012) for an empirical investigation on the impact of institutions on productivity and efficiency.

firms must comply.⁹ If firms decide to participate in the economy's institutional arrangements, this uncertainty can increase firms' costs (for example, from hiring lawyers to make sure the firm is complying with certain regulations) and also generate production bottlenecks by delaying investments and training, which all put a dent in productivity. In contrast, improvements in institutional quality can lead, for example, to better-tailored financial reforms that advance the efficiency of the formal banking system, by promoting competition that increases the quality of services offered to bank clients and, importantly, guaranteeing that the improvements fostered by the reform are carried through and maintained in a consistent fashion. Since formal firms are the ones with access to formal financial institutions, these improvements in quality and access to better services can reduce bottlenecks and increase productivity in formal firms by facilitating access to financing.¹⁰ These issues represent changes in institutions that improve the environment in which formal firms (with access to formal financial institutions) operate, without directly affecting the informal sector.¹¹ With regard to enforcement, if formal firms are generally compliant with labor regulations, improvements in the enforcement of these regulations are likely to have a stronger impact on informal firms without directly disrupting formal firms. In particular, better enforcement can force informal firms to dissolve informal employment contracts.

The results from the model suggest that both labor market volatility and the long-run levels of particular macroeconomic aggregates such as output, consumption, and unemployment can differ widely across economies with the same-sized informal sector depending on the dimension of institutional quality that is responsible for the size of the informal sector. Thus, identifying the

9. Oviedo (2005).

10. A notable example is the time and resources that firms and individuals must spend to deal with simple deposits, banking transactions, and bank bureaucracy in many Latin American countries. The inefficiency and deficient quality of banking services can delay investments, reduce labor productivity, and crowd out resources that could otherwise be used to boost firm productivity.

11. These reforms may have some positive spillovers into the informal sector, but the formal sector benefits more from these changes. Other examples of institutional improvements that are more important for the formal sector are the streamlining of tax filing procedures and the reduction in time spent dealing with tax authorities and regulators. Finally, to the extent that the formal sector is more capital intensive and relies on electricity to produce, improving the accountability of energy providers—where better accountability is a manifestation of better institutions—may improve the reliability of the electric grid and, in turn, stem productivity losses from uncertain electricity supply to the private sector. While a deficient electric grid may also affect the informal sector, the formal sector is likely to benefit more in relative terms.

way institutional quality is associated with differences in informal sector size may be crucial for correctly characterizing the short-run and long-run macroeconomic consequences of informality.

The model I use is a business cycle version of the search-and-matching framework developed by Ulyssea.¹² I introduce capital accumulation in the formal sector and contribute to the literature by considering the determinants and size of informality and their influence on aggregate fluctuations. The model can successfully capture the negative relationship between institutional quality and informality, as well as the positive link between informality and consumption and investment volatility in the data, regardless of the underlying cause of changes in informality. However, the model predicts the observed negative relationship between informality and the level of output only if the variation in informality is driven by changes in institutional quality that mainly affect the formal sector. Stricter enforcement in the informal sector reduces informality but generates a fall in the level of total output.¹³ Finally, I find that the root cause of differences in the size of the informal sector—institutional quality reflected either in formal sector productivity or in enforcement in the informal sector—plays a key role in the behavior of unemployment volatility: a decline in informality driven by an increase in institutional quality that affects the formal sector generates higher unemployment volatility, whereas a similar-sized decline in informality driven by an increase in enforcement of regulations in the informal sector leads to lower unemployment volatility. If in reality we observe a mix of enforcement and improvements in the institutional environment that mainly affects formal firms, then the model provides a possible explanation for the fact that, as suggested by the empirical evidence below, there is no apparent significant relationship between unemployment volatility and informal sector size in the data.

The link between unemployment volatility and informal sector size depends on how the average level of unemployment is affected by the underlying factors driving the level of informality, in this case two different, but related,

12. Ulyssea (2010). For some examples of search models with informality, see Albrecht, Navarro, and Vroman (2006) and Bosch and Esteban-Pretel (2009, 2012). Business cycle models with informality and search include Cook and Nosaka (2006), Castillo and Montoro (2010), and Bridji and Charpe (2011). Real business cycle (RBC) models with informality include Restrepo-Echavarría (2014) and Granda-Carvajal (2012). None of these papers explicitly address the link between the sources of informality, the size of the informal sector, unemployment volatility, and business cycles.

13. See Elgin and Öztunalı (2014) for recent evidence suggesting that informality and output levels are positively related in economies with weaker institutional quality.

dimensions of institutions.¹⁴ In particular, a higher informal worker separation rate (which proxies for better enforcement) generates a sharp rise in steady-state unemployment. The higher average level of unemployment dampens the effect of fluctuations in formal and informal employment on unemployment volatility and creates a positive link between informality and unemployment volatility. Conversely, a rise in institutional quality that improves productivity in the formal sector reduces average unemployment in the economy. The fall in unemployment magnifies the impact of cyclical movements in formal and informal employment on the variability of unemployment. Thus, informality and unemployment volatility are negatively related when institutional quality improves formal sector productivity. This suggests that if institutional quality affects informality, then the characterization of the relationship between informality and unemployment and between informality and unemployment volatility depends on the dimension of institutional quality that initially affected the size of the informal sector.

The paper is organized as follows. The next section provides a brief empirical motivation. The paper then describes the model and discusses the quantitative results, including policy implications. The final section concludes.

Empirics on Institutions, Informality, and Aggregate Volatility

This section illustrates the following facts: (1) institutional quality and informality are negatively correlated; (2) consumption and investment volatility are positively correlated with informality; and (3) there is no apparent relationship between output and unemployment volatility and the level of informality.

Table 1 revisits the determinants of informality using a large sample of developed and developing countries.¹⁵ The details of the variables and estimation are presented in the appendix for expositional purposes. The findings are as follows: when the measure of overall institutional quality (law and order)

14. Djankov and Ramalho (2009) summarize several papers on employment laws, the informal sector, and unemployment. Oviedo, Thomas, and Karakurum-Özdemir (2009) offer a comprehensive overview of the determinants and costs of informality.

15. Many of the stylized facts in this section are documented in earlier literature, most prominently the relationship between law and order and gross domestic product (GDP) and the informal sector (see Loayza, Oviedo, and Servén, 2005; Oviedo, Thomas, and Karakurum-Özdemir, 2009). I use a measure of the informal sector expressed as a percent of official GDP, from Schneider, Buehn, and Montenegro (2010), to have a larger country sample.

TABLE 1. Cross-Country Determinants of the Size of the Informal Sector^a

<i>Explanatory variable</i>	<i>Specification</i>		
	(1)	(2)	(3)
French legal origin	5.859** (2.650)	6.973** (3.089)	1.178 (2,524)
Law and order (LO)			-5.442*** (0.816)
Hiring regulations (HR)	-1.140** (0.459)		-0.761* (0.431)
Dismissal costs (DC)	-0.947*** (0.347)		-0.379 (0.328)
Labor regulations		-1.189 (0.919)	
Log RGDP 1999	-1.318*** (0.502)	-1.235*** (0.558)	-0.778** (0.347)
<i>Summary statistic</i>			
<i>R squared</i>	0.30	0.17	0.51
<i>No. observations</i>	94	93	87

*Statistically significant at the 10 percent level.

**Statistically significant at the 5 percent level.

***Statistically significant at the 1 percent level.

a. The dependent variable is the size of the informal sector. The constant term is omitted for expositional purposes. Higher values for hiring regulations and dismissal costs denote less stringent regulations. Robust standard errors are shown in parentheses.

is included, a deterioration in institutions, more stringent hiring regulations, and a lower a level of development are associated with a larger informal sector, while firing regulations are no longer significant.

In the model, and without loss of generality, I focus on a broader proxy for institutional quality in the formal sector that is more general than labor market regulations.¹⁶

Table 2 revisits the link between informality and aggregate volatility. In addition to the variables used by Ferreira-Tiryaki, I include unemployment volatility.¹⁷ I confirm that the informal sector is positively correlated with investment and consumption volatility.¹⁸ In contrast to Ferreira-Tiryaki, I

16. The results are similar if I change the size of the informal sector by changing the cost of hiring formal workers, which I take as a proxy for changing hiring regulations.

17. Ferreira-Tiryaki (2008).

18. Following Ferreira-Tiryaki (2008), I also experiment with specifications where I instrument for informal sector size to address the potential endogeneity between informality and volatility. Using explicit measures of institutional quality as instruments, as in Ferreira-Tiryaki (2008), gives a mixed picture for the strength and validity of the instruments under richer specifications. Since these results are only meant as motivation, I present the simplest specifications.

TABLE 2. Informal Sector Size and Aggregate Volatility

<i>Explanatory variable</i>	<i>Specification</i>			
	<i>Consumption (1)</i>	<i>Investment (2)</i>	<i>Output (3)</i>	<i>Unempl. (4)</i>
Informal sector size	0.035** (0.015)	0.128*** (0.041)	0.010 (0.014)	0.043 (0.155)
Government spending	-0.041 (0.038)	-0.101 (0.082)	-0.066** (0.027)	-0.117 (0.265)
Credit to the private sector	-0.003 (0.005)	0.007 (0.014)	-0.001 (0.004)	-0.020 (0.033)
Openness	0.004 (0.002)	0.006 (0.007)	0.002* (0.001)	-0.001 (0.026)
<i>Summary statistic</i>				
<i>R squared</i>	0.25	0.38	0.31	0.08
<i>No. observations</i>	43	43	43	25

**Statistically significant at the 5 percent level.

***Statistically significant at the 1 percent level.

a. The dependent variable in specification 1 is the volatility of consumption; in specification 2, the volatility of investment; in specification 3, the volatility of output; in specification 4, the volatility of unemployment. The constant term is omitted for expositional purposes. Robust standard errors are shown in parentheses.

find no significant relationship between informality and output volatility once I control for other factors that might affect the volatility of output.¹⁹ I also find no significant relationship between the volatility of unemployment and the informal sector. The model I present below is consistent with the stylized facts in tables 1 and 2. It also offers a potential reason for the apparent disconnect between unemployment and output volatility and the size of the informal sector.

The Model

The structure of the labor market is similar to that used by Ulyssea, but I have expanded it to include capital accumulation in the formal sector in a business cycle environment.²⁰ I introduce the informal sector via the labor market. Formal firms face payroll taxes and have higher vacancy posting costs relative to informal firms. Formal workers have higher wage bargaining power relative

19. This last result is particularly sensitive to the country sample and to the set of regressors included in the analysis.

20. Ulyssea (2010).

to informal workers. Informal firms also open vacancies.²¹ The enforcement parameter in the informal sector acts through the separation rate of informal workers.²² Stricter enforcement may be accompanied by the need to formalize the employment contract, and it may also require informal firms to pay a penalty if detected. Thus, I consider an increase in the informal worker separation rate as a proxy for better enforcement, since informal firms are required to end the informal employment relationship upon detection. Using this proxy for enforcement also allows me to relate my results to Ulyssea’s work.²³

A representative final goods firm aggregates output from the formal and informal sectors into final output. I assume imperfect substitution between formal and informal output.²⁴ Improvements in institutional quality in the economy manifest themselves in two ways: through higher firm productivity in the formal sector (which I call formal sector institutional quality) and through better enforcement that only affects the informal sector via higher worker separation rates (which I call informal sector enforcement).

HOUSEHOLDS. Household utility depends on an aggregate consumption good whose price is normalized to one. There is an infinitely lived representative household of measure one, consisting of a large number of family members who supply their labor inelastically. There is perfect risk pooling in the economy.²⁵ A household member can be unemployed, employed in a formal firm, or employed in an informal firm. The household’s problem is to choose sequences of aggregate consumption, c_t , and assets, a_t , to maximize

$$(1) \quad \max E_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{c_t^{1-\sigma}}{1-\sigma} \right],$$

subject to

$$(2) \quad c_t + a_t = w_{F,t} n_{F,t} + w_{I,t} n_{I,t} + \prod_{F,t} + \prod_{I,t} + \prod_t + d_t + T_t + R_{t-1} a_{t-1}.$$

21. I merge self-employment and informal salaried employment into a single category. For a setup with frictional, endogenous entry into self-employment in a business cycle environment, see Finkelstein Shapiro (2014).

22. This follows Ulyssea (2010).

23. Ulyssea (2010).

24. Chen (2007); Ulyssea (2010).

25. The informal sector is often characterized as being riskier than the formal sector. However, empirical evidence suggests that there are (formal and informal) insurance mechanisms that partially insulate households whose members work in the informal sector from idiosyncratic shocks (see, for example, Levy 2008).

The choice over assets makes the pricing of interest rates explicit. The variables $\Pi_{F,t}$, $\Pi_{I,t}$ and Π_t are profits in the final goods sector, the formal intermediate goods sector, and the informal intermediate goods sector, respectively; $w_{F,t}$ and $n_{F,t}$ denote the real wage and the measure of individuals working in the formal sector, respectively; and $w_{I,t}$ and $n_{I,t}$ represent the same variables in the informal sector.²⁶ The variable d denotes unemployment benefits, and T_t are real lump-sum transfers from the government. I normalize the total labor force (formal and informal) to one and define unemployment as $u_t = 1 - n_{F,t} - n_{I,t}$. Let $u(c_t)$ be the utility function over the aggregate consumption good. The first-order conditions yield a standard consumption-savings decision: $u_c(c_t) = E_t \beta [R_t u_c(c_{t+1})]$. I define the stochastic discount factor of firms as $\Xi_{t+1|t} = [\beta u_c(c_{t+1})] / [u_c(c_t)]$. Households do not make an explicit labor supply decision for their members. Also, unemployed individuals can match with either formal or informal firms, so there is no labor market segmentation.

PRODUCTION. Production in the formal sector depends on formal labor $n_{F,t}$, formal capital $k_{F,t}$, and aggregate productivity z . Formal sector institutional quality enters as a sectoral productivity-enhancing parameter, denoted by a_F .²⁷ The firm's production function is assumed to be constant-returns-to-scale and given by $y_{F,t} = z_t a_{F,t} f(n_{F,t}, k_{F,t})$. Formal firms choose sequences of formal vacancies $v_{F,t}$, desired formal employment $n_{F,t+1}$, and desired capital $k_{F,t+1}$, to maximize

$$(3) \quad \max E_0 \sum_{t=0}^{\infty} \Xi_{t|0} \left\{ p_{F,t} y_{F,t} - w_{F,t} n_{F,t} (1 + \tau^p) - \Psi_F v_{F,t} - i_{F,t} \right\},$$

subject to the perceived law of motion for employment

$$(4) \quad n_{F,t+1} = (1 - \delta^F) \left[n_{F,t} + v_{F,t} q(\theta_{F,t}) \right],$$

and

$$(5) \quad k_{F,t+1} = i_{F,t} + (1 - \delta) k_{F,t},$$

where the price of intermediate formal sector output relative to final output is $p_{F,t}$, the separation rate for formal workers is δ^F , the depreciation rate of capital

26. Adding a labor income tax for workers in the formal sector does not change the main conclusions of the paper.

27. For evidence on the connection between institutions and productivity, see Oviedo (2005).

is δ , and investment is $i_{F,t}$. Firms in the formal sector pay payroll taxes, τ^p . The variable $q(\theta_{F,t})$ stands for the job-filling rate, where $\theta_{F,t} = v_{F,t}/u$ is labor market tightness in the formal sector. The variable Ψ_F is the vacancy posting cost, which, following related literature on labor market institutions, can include the cost of hiring regulations.²⁸ This yields a job-creation condition and a Euler equation for capital:

$$(6) \quad \frac{\Psi_F}{q(\theta_{F,t})} = (1 - \delta^F) E_t \Xi_{t+1|t} \left[p_{F,t+1} a_F z_{t+1} f_{n_{F,t+1}} - w_{F,t+1} (1 + \tau^p) + \frac{\Psi_F}{q(\theta_{F,t+1})} \right],$$

and

$$(7) \quad 1 = E_t \Xi_{t+1|t} [p_{F,t+1} a_F z_{t+1} f_{k_{F,t+1}} + (1 - \delta)].$$

The job-creation condition equates the expected marginal cost of posting a formal vacancy to the expected marginal benefit, where the latter includes the continuation value if the employment relationship survives into the next period.

Informal firms also face search frictions, but the cost of posting vacancies is lower than in the formal sector, $\Psi_F > \Psi_I$.²⁹ The production function for informal firms depends on aggregate productivity and is linear in informal labor. The representative informal firm chooses sequences of vacancies, $v_{I,t}$, and desired informal employment, $n_{I,t+1}$, to maximize

$$(8) \quad \max E_0 \sum_{t=0}^{\infty} \Xi_{t|0} \{ p_{I,t} z_t n_{I,t} - w_{I,t} n_{I,t} - \Psi_I v_{I,t} \},$$

subject to the perceived law of motion for informal employment:

$$(9) \quad n_{I,t+1} = (1 - \delta^I) [n_{I,t} + v_{I,t} q(\theta_{I,t})],$$

where $q(\theta_{I,t})$ is the informal sector job-filling probability, which depends on informal market tightness, $\theta_{I,t} = v_{I,t}/u$; $p_{I,t}$ is the relative price of informal output relative to final output; δ^I is the separation rate in the informal sector;

28. Introducing a separate cost to differentiate between vacancy and hiring costs does not change the general conclusions of the paper. A similar comment applies to the inclusion of firing costs.

29. Bosch and Esteban-Pretel (2006).

and $\delta^F < \delta^I$.³⁰ Informal firms make their hiring decisions according to the job-creation condition:

$$(10) \quad \frac{\Psi_I}{q(\theta_{I,t})} = (1 - \delta^I) E_t \Xi_{t+1|t} \left[p_{I,t+1} z_{t+1} - w_{I,t+1} + \frac{\Psi_I}{q(\theta_{I,t+1})} \right].$$

WAGE DETERMINATION. We assume that wages are determined via Nash bargaining. One can show that the wages for each sector are given by³¹

$$(11) \quad w_{F,t} = \chi^F \left[p_{F,t} a_F z_t f_{nF,t} + \Psi_F \theta_{F,t} \right] + (1 - \chi^F) \left[b + \frac{v_I}{1 - v_I} \Psi_I \theta_{I,t} \right]$$

and

$$(12) \quad w_{I,t} = v_I \left[p_{I,t} a_I + \Psi_I \theta_{I,t} \right] + (1 - v_I) \left[b + \frac{\chi^F}{1 - \chi^F} \Psi_F \theta_{F,t} \right],$$

where χ^F is the effective bargaining power for formal workers (which takes into account the presence of payroll taxes). The wage in each sector depends on the outside option within that sector and in the other sector, embodied in $\theta_{F,t}$ and $\theta_{I,t}$, as well as the contemporaneous value of unemployment, b .

FINAL GOODS FIRM. A representative final goods firm uses output from both intermediate formal and informal firms to produce final consumption goods. The representative final goods firm chooses output from the two intermediate sectors, $y_{F,t}$ and $p_{I,t}$, to maximize³²

$$(13) \quad \max \left\{ \left[\alpha_y y_{F,t}^\gamma + (1 - \alpha_y) y_{I,t}^\gamma \right]^{\frac{1}{\gamma}} - p_{F,t} y_{F,t} - p_{I,t} y_{I,t} \right\},$$

where total output in the economy is $y_t = [\alpha_y y_{F,t}^\gamma + (1 - \alpha_y) y_{I,t}^\gamma]^{\frac{1}{\gamma}}$, $0 \leq \alpha_y \leq 1$ and $\gamma < 1$. The first-order conditions yield the relative prices for formal and informal intermediate goods:

$$(14) \quad p_{F,t} = \alpha_y y_{F,t}^{\gamma-1} y_t^{1-\gamma}$$

30. Bosch and Maloney (2008).

31. Results available on request. The appendix presents the value functions used to find the Nash wages.

32. This follows Ulyssea (2010).

and

$$(15) \quad p_{I,t} = (1 - \alpha_y) y_{I,t}^{\gamma-1} y_t^{1-\gamma}.$$

GOVERNMENT AND MARKET CLEARING. The government budget constraint is given by $T_t + bu_t = w_{F,t} n_{F,t} \tau^r$. The aggregate resource constraint is given by $y_t = c_t + \Psi_F v_{F,t} + \Psi_I v_{I,t} + i_{F,t}$, where the vacancy posting costs are a resource cost and I assume that y in the model represents GDP in the data.³³

Quantitative Analysis

I calibrate the model to Mexico, which actively tracks informal sector activity through household and firm surveys and incorporates estimates of informal production in its national income accounts.³⁴

Functional Forms and Stochastic Processes

The production function in the formal sector is Cobb-Douglas, while the production function in the informal sector is linear in informal labor: $f(n_{F,t}, k_{F,t}) = (k_{F,t})^{\alpha_F} n_{F,t}^{1-\alpha_F}$, $f(n_{I,t}) = n_{I,t}$. The matching function in each sector is Cobb-Douglas, so $m_j(u, v_{j,t}) = M_j u^\xi v_{j,t}^{1-\xi}$, $0 < \xi < 1$, where M_j denotes the sectoral matching efficiency parameter, and $v_{j,t}$ denotes sectoral vacancies, $j = F, I$. The job-finding rate in each sector is $p(\theta_{j,t}) = m_j(u, v_{j,t})/u$, and the job-filling rate is $q(\theta_{j,t}) = m_j(u, v_{j,t})/v_{j,t}$ for $j = F, I$. The aggregate technology shock (total factor productivity, TFP), z_t , follows a standard first-order autoregressive, or AR(1), process in logs with persistence parameter ρ_z , where the shock $\varepsilon_t^{z_{iid}} \sim N(0, \sigma_z)$.

Calibration

Table 3 presents the benchmark parameterization. The time period is one quarter. I assume that the subjective discount factor is 0.98, consistent with the international business cycle literature. The capital share in formal sector production is set to 0.30, a common value in dynamic stochastic general equilibrium (DSGE) models for developing countries. The depreciation rate

33. According to the United Nations (2008), countries are supposed to include a measure of informal sector activity in their national accounts. The general conclusions of the paper do not change if formal output in the model is interpreted as GDP.

34. Quintin and Pratap (2006); Oviedo, Thomas, and Karakurum-Özdemir, (2009); United Nations (2008).

TABLE 3. Parameters from the Literature

<i>Parameter</i>	<i>Value</i>	<i>Parameter description</i>	<i>Parameter source</i>
α_r	0.30	Capital share in production function	DSGE literature
α_f	1.00	Institutional quality, formal sector	Benchmark assumption
β	0.98	Discount factor	DSGE literature
δ	0.02	Depreciation rate of capital	DSGE literature
δ^f	0.03	Formal salaried separation rate	Bosch and Maloney (2008)
δ^i	0.06	Informal salaried separation rate	Bosch and Maloney (2008)
γ	0.50	Elasticity of substitution, final goods	Benchmark assumption
ν_f	0.50	Formal worker bargaining power	Search-and-matching literature
ν_i	0.25	Informal worker bargaining power	Benchmark assumption
ρ_z	0.90	Autocorrelation of TFP	DSGE literature
τ^p	0.12	Payroll tax rate	OECD, <i>Taxing Wages: Mexico</i>
b	0	Unemployment insurance	Assumption
ξ	0.50	Matching elasticity	Search-and-matching literature

for capital is 0.02. The quarterly separation rates in the two sectors are taken from Bosch and Maloney for Mexico.³⁵ The elasticity of substitution between formal and informal intermediate goods is taken to be somewhat higher than the value assumed by Ulyssea.³⁶ The autocorrelation parameter for TFP is 0.90. The payroll tax is set to its average for 2001 and 2002 and is at the lower bound of existing estimates.³⁷ The elasticity of the matching functions and the bargaining power of workers in the formal sector take standard values in the literature, equal to 0.50. I set a lower bargaining power for informal workers that is half the bargaining power of formal workers.³⁸

CALIBRATED PARAMETERS. Table 4 presents the calibrated parameters. The cost of posting formal vacancies is set to 30 percent of steady-state formal wages, and the informal vacancy costs are 3.5 percent of steady-state informal wages.³⁹ The value for α_y is chosen to match a steady-state ratio of informal sector output to total output of 40 percent, which is higher than other estimates for Mexico.⁴⁰ However, I assume a higher steady-state share to be able to

35. Bosch and Maloney (2008).

36. Ulyssea (2010). The degree of substitutability plays an important role for the response of unemployment volatility to changes in formal sector institutional quality and to informal sector enforcement, but the general message of the paper holds for alternative values for the elasticity of substitution parameter.

37. OECD (2009b, p. 118); see Levy (2007).

38. This follows Ulyssea (2010).

39. Levy (2007).

40. Perry and others (2007); Schneider, Buehn, and Montenegro (2010).

TABLE 4. Calibrated Parameters in the Benchmark Model

<i>Parameter</i>	<i>Value</i>	<i>Parameter description</i>	<i>Target</i>	<i>Target source</i>
α_f	0.523	Formal employment production share	$p_f y_f / y = 0.40$	Benchmark
M_f	0.226	Formal matching efficiency	$n_f = 0.50$	ENEU, ^a ILO
M_i	0.074	Informal matching efficiency	$n_i = 0.45$	ENEU, ^a ILO
ψ_f	0.133	Formal vacancy cost	$\psi_f = 0.035w_f$	Levy (2007)
ψ_i	0.015	Informal vacancy cost	$\psi_i = 0.035w_i$	Benchmark assumption
σ_y	0.0174	Standard deviation of TFP	$\sigma_y = 2.17$	Lama and Urrutia (2012)

a. The National Survey on Urban Employment (ENEU) in Mexico, carried out by the National Institute of Statistics and Geography (INEGI).

obtain a longer range for changes in the size of the informal sector in the numerical experiments and ease the exposition. This value does not alter the main message of the paper.

I calibrate the matching scale parameters to match the average shares of formal and informal employment as a percent of the labor force in Mexico from 1987 to 2004, where informal employment is the sum of informal salaried employment and self-employment.⁴¹ Finally, I set the standard deviation of TFP to match the volatility of output reported by Lama and Urrutia.⁴²

Numerical Experiments: Informal Sector Size and Institutional Quality

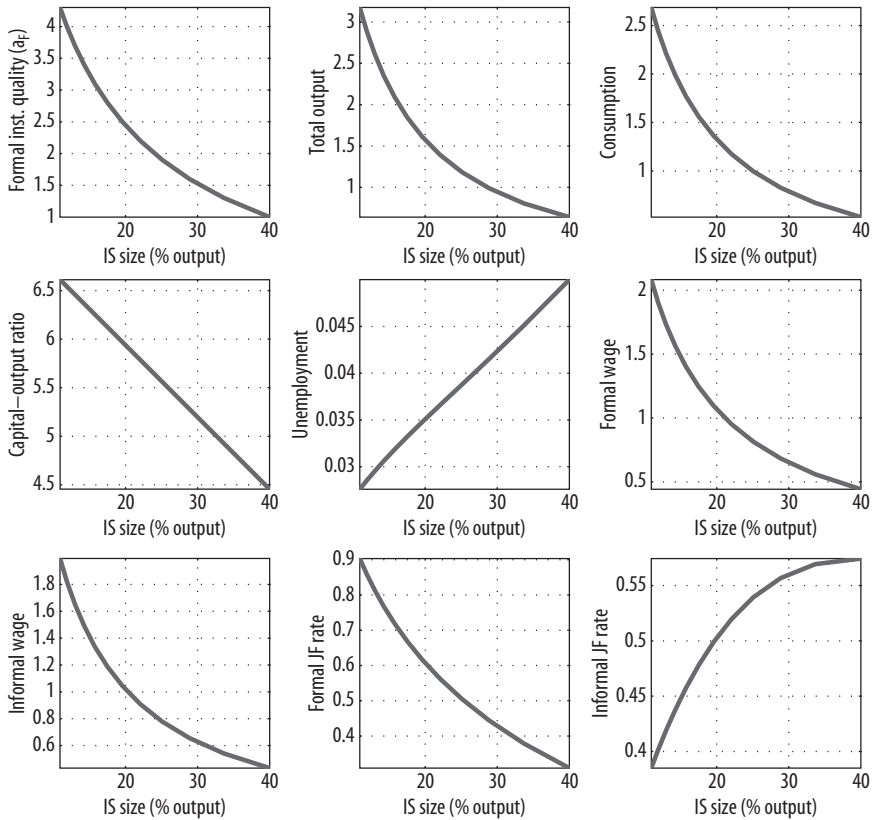
Figures 1 and 2 show the relationship between the size of the informal sector and the steady state of various macroeconomic aggregates of interest. The first quadrants of both figures show the relationship between the steady-state size of the informal sector (as a percent of total output) and the two parameters proxying for institutional quality—namely, formal sector institutional quality and informal sector enforcement, respectively. In each figure, the relevant parameter (a_f or δ^i) varies while all other parameters are held constant.⁴³ The model delivers a (qualitative) negative link between institutional quality and informal sector size, consistent with the data, regardless of the specific interpretation of institutional quality in the model—better productivity in the formal sector or higher enforcement in the informal sector. However, the sign of

41. Depending on the definition of informal labor and the data set used (urban or national), the values for the share of informal labor in Mexico range from 27 percent to 60 percent of the labor force.

42. Lama and Urrutia (2012).

43. A similar experiment can be performed by changing the hiring cost in the formal sector as a proxy for hiring regulations. The results are in general similar to those obtained by changing a_f .

FIGURE 1. Informal Sector Size and Steady-State Comparisons: Changes in Formal Sector Institutional Quality

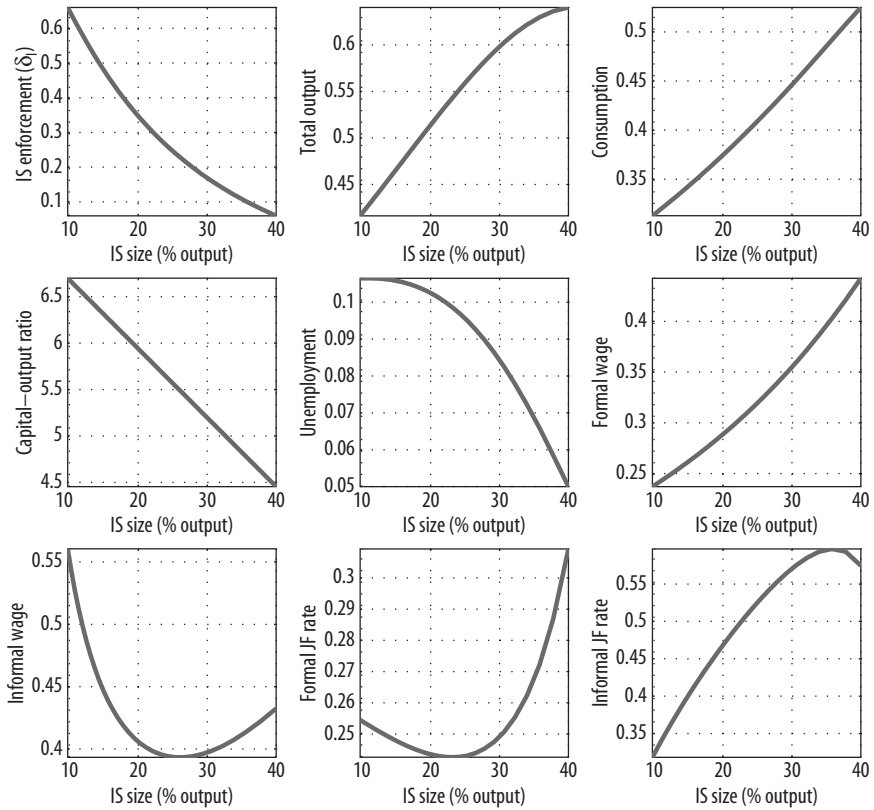


the relationship between informality and economic performance does depend on whether changes in informality are driven by changes in formal sector institutional quality or by changes in enforcement in the informal sector.

The comparative statics results (discussed below) can be summarized as follows: improving the economic environment for firms in the formal sector is more effective than making participation in the informal sector more costly via stricter enforcement.⁴⁴ These results are in line with similar arguments

44. See Ulyssea (2010). There may be other additional costs associated with being informal that the model does not capture. Reducing those other costs can also have an impact on the share of informality.

FIGURE 2. Informal Sector Size and Steady-State Comparisons: Changes in Informal Sector Enforcement



previously articulated in the literature. More importantly, the results in figures 1 and 2 highlight that the cross-country link between informality and long-run macroeconomic outcomes in general will depend on the underlying reason for variation in informal sector size (that is, on whether changes in formal sector institutional quality or informal sector enforcement—both measures of institutional quality—are responsible for the changes in informality). The intuition is simple: a deterioration in institutions that only affects the informal sector through weaker enforcement allows informal firms to expand employment and output without necessarily having a large impact on formal sector firms. This generates a counterfactual positive relationship between output

and informality (measured as a share of total output) in the model. Thus, the underlying source of changes in the size of the informal sector matters for the relationship between informality and particular long-run macroeconomic outcomes.

HIGHER FORMAL SECTOR INSTITUTIONAL QUALITY. Figure 1 shows the relationship between informal sector size and various steady-state variables traced out by variations in a_F . Better formal sector institutional quality—a higher a_F —increases the value of hiring formal workers and accumulating capital in the formal sector, leading to higher formal vacancies, a higher formal job-finding rate, and an increase in formal employment. Formal intermediate output, formal market tightness, and the marginal product of formal labor are now higher, where the latter two put upward pressure on formal wages. The higher formal job-finding rate puts upward pressure on informal wages as well, but since the informal job-finding rate is decreasing in a_F , a higher a_F generates a negative link between informal wages and informal sector size. The increase in formal vacancies dominates the fall in informal vacancies, so that the unemployment rate and the size of the informal sector are positively related.⁴⁵ Finally, since capital and formal output respond strongly to the increase in a_F , these economies have higher output and consumption levels.

HIGHER INFORMAL SECTOR ENFORCEMENT. Figure 2 shows the results when better institutional quality manifests itself in stricter informal sector enforcement (that is, a higher informal separation rate).⁴⁶ Stricter informal sector enforcement reduces informality and leads to a drastic rise in unemployment. Formal wages fall since the reduction in the probability of entering informal employment reduces the outside option for formal workers and puts downward pressure on the formal wage. Conversely, the reduction in informality puts upward pressure on the relative price of output in the sector, which ultimately increases informal wages. Importantly, given the rise in unemployment, output and consumption fall, which goes against the cross-country evidence on the link between informality and the level of development.⁴⁷

45. Thus, the informal sector cannot fully absorb the fall in formal employment when institutions deteriorate (Heckman and Pagés, 2000).

46. This follows the experiment in Ulyssea (2010). My results are in line with his.

47. Elgin and Öztunalı (2014) find evidence suggesting that the size of the informal sector and the level of output are positively related in economies with poorer institutions, while countries with better institutional quality exhibit a negative link, but they consider general measures of institutions. My model suggests that weaker institutions must be reflected in weaker enforcement alone to deliver a positive link between informality and output levels.

Numerical Experiments: Informal Sector Size and Aggregate Volatility

Figures 3 and 4 show the relationship between the size of the informal sector and aggregate volatility when we change a_F and δ' , respectively.⁴⁸ Changes in the size of the informal sector are engineered in the same way as above. The volatility results can be summarized as follows. For both improvements in formal sector institutional quality and informal sector enforcement, there is a positive relationship between the size of the informal sector and the volatility of consumption and investment, as in the data. Conversely, an improvement in formal sector institutional quality increases unemployment volatility, whereas the opposite occurs with stricter informal sector enforcement. The changes in output volatility are negligible.

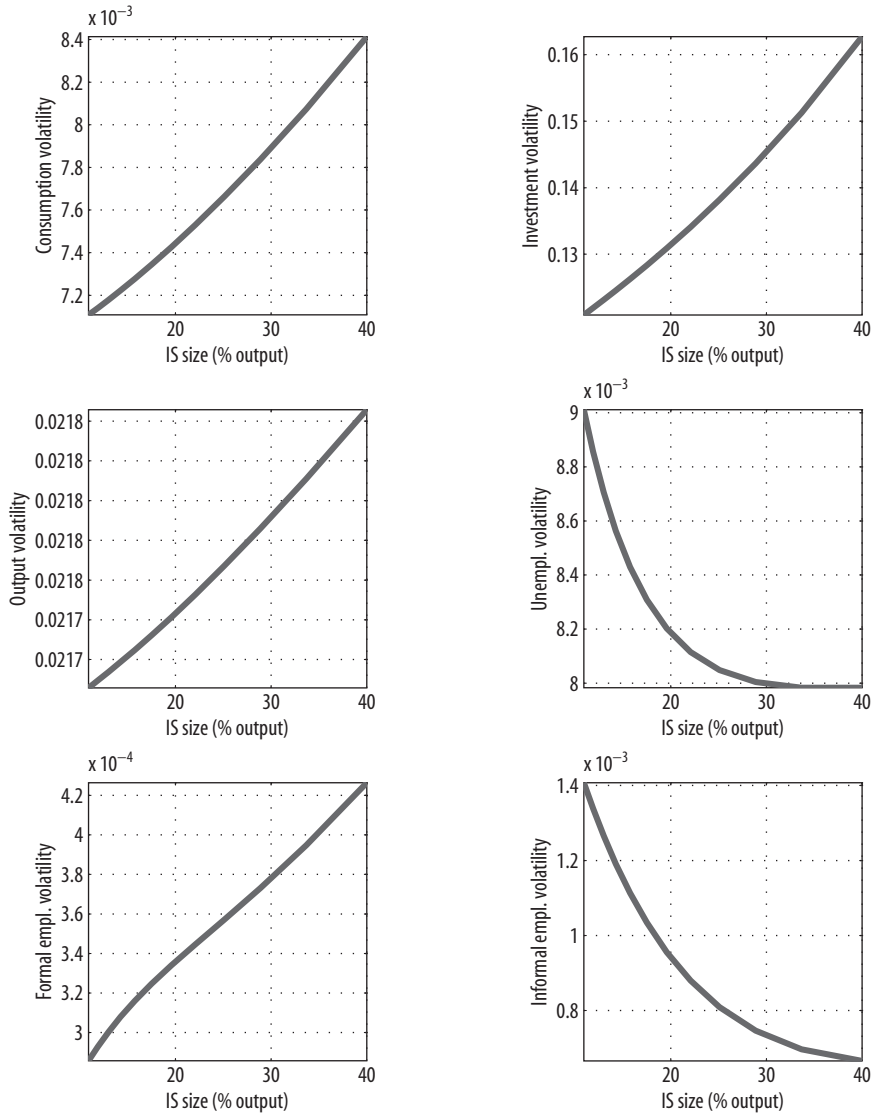
The link between informality and consumption and investment volatility hinges on the fact that economies with a larger informal sector have smaller steady-state formal employment shares, which in turn lowers the steady-state marginal product of capital, and a lower value of employing formal workers since these economies have less capital. These features affect formal firms' decisions to post vacancies and increase the sensitivity of the value of employing formal workers to aggregate shocks. Thus, formal vacancy postings become more volatile in economies with a larger informal sector, which translates into higher variability in investment. Finally, since this volatility is reflected in firm profits, and firm profits are part of the household's resources, higher consumption volatility follows from higher investment volatility.⁴⁹

CHANGES IN FORMAL SECTOR INSTITUTIONAL QUALITY. As shown in figure 3, a higher a_F raises the value of hiring workers and accumulating capital in the formal sector. This makes vacancy postings and capital accumulation less sensitive to productivity shocks and reduces the volatility of formal employment, investment, and consumption. Recall that total output is a combination of formal and informal output. The volatility of formal output increases marginally with the size of the informal sector, whereas the volatility of informal output falls (marginally as well), mainly due to the behavior of relative prices. If informality falls due to improvements in formal sector institutional quality, we obtain a very mild positive but quantitatively negligible relationship

48. I log-linearize the model around the nonstochastic steady state and compute a first-order approximation of the equilibrium conditions. I simulate the economy for 188 periods, drop the first 100 periods, use the Hodrick-Prescott (HP) filter with smoothing parameter 1,600 on the simulated data, extract the cyclical component, and compute the standard deviations of the model's variables.

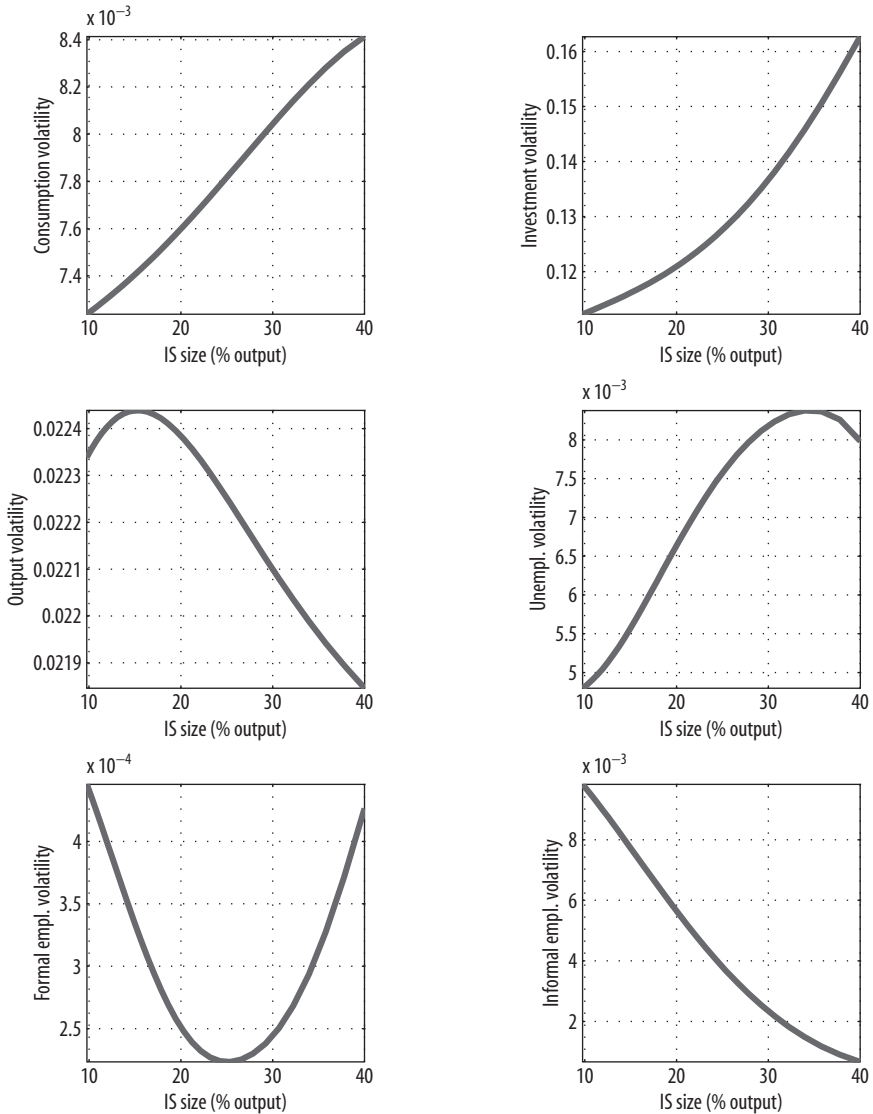
49. This intuition is similar to Andrés, Doménech, and Fatás (2008) in a different economic environment.

FIGURE 3. Informal Sector Size and Aggregate Volatility: Changes in Formal Sector Institutional Quality^a



a. The volatility of a variable is defined as the standard deviation of the cyclical component of the log of the variable of interest, where the cyclical component is obtained using an HP-filter with smoothing parameter 1,600.

FIGURE 4. Informal Sector Size and Aggregate Volatility: Changes in Informal Sector Enforcement^a



a. The volatility of a variable is defined as the standard deviation of the cyclical component of the log of the variable of interest, where the cyclical component is obtained using an HP-filter with smoothing parameter 1,600.

between total output volatility and the size of the informal sector.⁵⁰ Now consider the response of the labor market. The fact that the steady-state value of hiring formal workers rises with a_F makes formal employment less volatile. The opposite holds true for informal employment. Furthermore, a higher a_F leads to a reduction in steady-state unemployment. This lower level of unemployment increases the sensitivity of unemployment to fluctuations in formal and informal employment.⁵¹ The end result is a negative relationship between informal sector size and unemployment volatility.

CHANGES IN INFORMAL SECTOR ENFORCEMENT. Consider an economy with stricter enforcement in the informal sector. As shown in figure 4, the positive relationship between consumption and investment volatility and informal sector size is similar to the case in which informality falls due to a_F . The intuition for this result is similar. In contrast to an economy with better formal sector institutional quality, a higher δ' reduces informality and raises total output volatility, but once again, the changes are quantitatively small given the change in the size of the informal sector.

With regard to the labor market, changing δ' generates a nonmonotonic relationship between formal employment volatility and the size of the informal sector.⁵² Conversely, an increase in δ' reduces informality and the future value

50. To understand why total (and formal) output volatility exhibit virtually no change with the size of informality, consider the resource constraint. The volatility of consumption, investment, and vacancy postings (as well as the comovement between these variables) has an impact on output volatility. As the size of the informal sector rises, the volatility of consumption, investment, and formal vacancies rises. This puts upward pressure on the volatility of output. Conversely, the volatility of informal vacancies falls. The rise in informality is also accompanied by a rise in informal vacancies, however, and steady-state total output falls with the size of the informal sector. Combining the last two results implies that the volatility of informal vacancies exerts more influence on the volatility of output and counteracts the rise in the volatility of consumption, investment, and formal vacancies.

51. Writing the definition of unemployment in log-linear terms yields $\hat{u}_t = (n_F/u)n_{F,t} + (n_I/u)\hat{n}_{I,t}$, where hatted variables correspond to log deviations from steady state. Since higher formal sector institutional quality through a_F increases formal employment and decreases informal employment and unemployment in steady state, the response of formal employment to a productivity shock has a larger impact on unemployment. Furthermore, since the variability of informal employment increases with a smaller informal sector, fluctuations in informal employment will also have a larger impact on unemployment dynamics.

52. Consider an economy with a very low δ' . As enforcement increases, the fall in informality and the rise in unemployment imply a higher formal job-filling probability. These elements lead to a reduction in the volatility of formal vacancies and employment. However, there is an enforcement threshold beyond which the steady-state unemployment level becomes less sensitive to a higher δ' (column 2 in figure 3). This affects the change in the formal job-filling probability as δ' changes, as well as the incentive to post formal vacancies such that further increases in δ' increase the response of formal hires to shocks.

of hiring informal workers, and it makes informal employment more volatile. Recalling that more stringent informal sector enforcement generates a sharp rise in steady-state unemployment, the latter reduces the sensitivity of unemployment to formal and informal employment variability. This ultimately leads to a positive link between unemployment volatility and informality.

Based on the above results, the model suggests one possible explanation for why the link between informal sector size and unemployment volatility is apparently absent in the data: if institutional quality in the formal sector and enforcement in the informal sector move in unison to reduce informality, the individual changes in unemployment volatility arising from a_F and δ' , respectively, may cancel each other out, thereby leading to a fall in informality with no apparent change in unemployment variability. Looked at individually, however, the stark differences in the response of unemployment volatility for the same change in informal sector size echo the message outlined above: the underlying source of changes in the size of the informal sector due to variations in different proxies of institutional quality matters for characterizing the consequences of informality for macroeconomic outcomes and for unemployment volatility in particular.

Robustness Tests

I conduct three robustness tests: substitution between formal and informal production; changes in hiring regulations; and the introduction of investment in the informal sector.

SUBSTITUTION BETWEEN FORMAL AND INFORMAL PRODUCTION. A lower value for the elasticity of substitution between formal and informal goods would strengthen the quantitative implications of changing the size of the informal sector and keep the relationship between output and informal sector size qualitatively intact. A similar claim holds for the links between informal sector size and aggregate volatility. Moreover, the differences in the response of unemployment to productivity shocks when the size of the informal sector changes would become even starker.⁵³ For values of γ above the benchmark value, the results are reversed, and unemployment is now less volatile in

53. Acemoglu (2001) and Ulyssea (2010) suggest that the two intermediate inputs are unlikely to be perfect substitutes, and Ulyssea (2010) shows that in his model, there are multiple equilibria when $\gamma \in \{0.8, 0.9, 1\}$. Intuitively, when formal and informal intermediate production are very good substitutes, the fall in informal output resulting from a higher δ' is easily offset by the rise in formal production. A smaller informal sector puts downward pressure on formal wages and pushes formal firms to increase formal vacancies, employment, capital, and finally output. However, the root cause of changes in the size of the informal sector still matters for

economies with a smaller informal sector due to better institutional quality in the formal sector. The opposite is observed with a higher informal separation rate. Despite this result, the main message of the paper remains: the underlying sources of changes in informality—even within institutional quality broadly defined—matter for labor market and aggregate volatility.

CHANGES IN HIRING REGULATIONS. Changing the cost of posting vacancies in the formal sector in the model, which is a proxy for changes in hiring regulations, yields similar results to those obtained when overall institutional quality in the economy changes. This simple exercise suggests that policies that have a direct impact on the behavior of agents in the formal sector tend to yield results that are in line with the cross-country evidence on informality and its relationship to macroeconomic aggregates.

INVESTMENT IN THE INFORMAL SECTOR. Assuming that informal firms accumulate capital and use capital and labor to produce their goods does not change the results. An improvement in formal sector institutional quality in the economy pushes formal firms to increase formal investment, while informal firms decrease capital accumulation. The former dominates the latter so that investment and consumption volatility fall. Unemployment falls and unemployment volatility increases for the same reason as in the benchmark model. Conversely, an improvement in informal sector enforcement (a rise in δ') leads to a decrease in capital accumulation in the informal sector, but to a larger fall in informal and total output. Investment and consumption volatility decrease with a rise in δ' .

Policy Implications

Improvements in institutional quality can have many benefits for economic activity, including deeper financial markets, a more stable economic environment that can improve productivity, and a reduction in informal employment. The model in this paper carries the message from the earlier literature: improving the economic environment for formal firms (which can take the form of less burdensome and clearer regulations or less uncertainty about the rules that guide economic transactions, both of which are associated with improved institutions) generally yields better outcomes than increasing the

the volatility of unemployment, even as the degree of substitutability between the two sectors increases. What ends up happening is that the results are reversed for high values of γ . This is due to a combination of the change in the sensitivity of steady-state unemployment to changes in a_f and δ' , and the change in the volatility of each employment state as the degree of substitutability increases.

costs of informality via stricter informal sector enforcement.⁵⁴ I go a step beyond the literature and argue that this difference also carries through to the performance of the labor market over the business cycle. An important message from this paper is that while informality and aggregate volatility are often positively correlated, this need not be the case, and this holds particularly true for labor market dynamics. In particular, when considering changes in the enforcement of regulations among informal firms, policymakers should take into account two key issues. First, if this policy is not accompanied by improvements in the environment in which formal firms operate, the policy can increase the level of unemployment, with potentially important welfare losses. Second, while unemployment volatility may decrease, the volatility of informal (vulnerable) employment may increase dramatically. Given the absence of proper safety nets in countries with widespread informality, the need to consider the aggregate effects of changes in the economy's institutional environment becomes more pressing.

Conclusion

The quality of institutions is one of the most important factors behind cross-country differences in the size of the informal sector. Institutional quality can manifest itself through different channels; for example, it can affect the level of enforcement of regulations in different sectors, or it can affect sectoral firm productivity in asymmetric ways. Using a business cycle search model with informal employment, I show that changes in institutional quality, as reflected in the productivity of formal firms or, alternatively, in the degree of enforcement in the informal sector, tend to have similar consequences on the size of the informal sector, but differing implications for both long-run macroeconomic outcomes and short-run labor market and aggregate volatility.

I consider two main experiments. The first one generates changes in the average size of the informal sector through stricter enforcement in the informal sector. The second focuses on changes in informality stemming from improvements in institutional quality that affect formal sector productivity. Both cases replicate a negative link between informality and institutional quality. However, the first experiment generates a positive link between the size of the informal sector and the level of output, in contrast to existing

54. See, for example, Ulyssea (2010).

evidence, whereas the second experiment generates the correct relationship in the data. I also obtain a positive link between informality and consumption and investment volatility consistent with the empirical evidence, regardless of the institutional proxy that changes the level of informality.

While the results for consumption and investment volatility are independent of the origin of differences in informality, the same is not true for labor market volatility. I find a negative relationship between the size of the informal sector and unemployment volatility when better institutional quality in the formal sector leads to lower informality. Conversely, I find a positive link between informality and unemployment volatility when informality falls due to stricter enforcement in the informal sector. The link between informal sector size and unemployment volatility depends heavily on how the underlying source of changes in the size of the informal sector affects the average level of unemployment, which in turn has implications for the volatility of unemployment. The impact of informality on unemployment volatility is sensitive to the substitutability of output between sectors. For high levels of substitutability, improvements in formal sector institutional quality generate less unemployment volatility, whereas the opposite occurs with higher enforcement in the informal sector. If the two sectors become increasingly integrated, then the importance of accounting for the aggregate effects of better enforcement on macroeconomic aggregates may be more policy-relevant if countries have weak safety nets and decide to undertake important reforms to tackle informality while postponing social protection reforms.

Appendix: Data Sources, Definitions, and Estimations

For the determinants of informal sector size, the largest sample includes ninety-four countries (in Africa, Asia, Latin America, and wealthy OECD countries). For the analysis of aggregate volatility, I take the same country sample as Ferreira-Tiryaki to have easily comparable results, but exclude Argentina from the sample since it represents an outlier, leaving forty-three countries.⁵⁵ Most of the series for the explanatory variables are taken from Catini, Panizza, and Saade's compilation of the World Bank's World Development Indicators (WDI).⁵⁶

55. Ferreira-Tiryaki (2008).

56. Giulia Catini, Ugo Panizza, and Carol Saade, "Macro Data 4 Stata," 2010 (sites.google.com/site/md4stata).

Definitions

Consumption volatility: Standard deviation of the cyclical component of annual private consumption, using the Baxter-King band-pass filter from 1985 to 2002. Source: Ferreira-Tiryaki (2008).

Dismissal costs (DC): This index is available starting in 2002. Dismissal costs (DC) are expressed in weeks of salary and capture any severance payments, explicit costs of notifying workers and third parties in advance of termination, and penalties that the firm faces on formalizing a worker separation. DC takes values from 0 to 10, where higher values denote lower dismissal costs. I use DC from 2002. Source: Gwartney, Hall, and Lawson (2010).

Distance from the equator: Measured as the distance (in degrees) from the equator. Source: Rodrik, Subramanian, and Trebbi (2004).

Domestic credit: Domestic credit to the private sector as a share of GDP from 1985 to 2002. Averaged over the sample period to obtain one point estimate per country. Source: WDI.

Engfrac and Eurofrac: The fraction of the population that speaks English and the fraction of the population that speaks a Western European language, respectively. Source: Rodrik, Subramanian, and Trebbi (2004).

French legal origin: Dummy variable equal to one if the legal system is based on the French legal system. Source: Djankov, and others (2002).

Government spending-GDP ratio: General government final consumption expenditure as a percent of GDP for 1985 through 2002. Source: WDI.

Hiring regulations (HR): Fraser Institute's Economic Freedom of the World Report 2010. This index captures whether fixed-term contracts can be offered for tasks or jobs that generally do not expire, the maximum duration and number of renewals of fixed-term contracts, and the ratio between the minimum wage and the average value added by the worker. The HR index, which is available starting in 2002, takes values from 0 to 10, where higher values denote less stringent hiring regulations. I use HR from 2002. Source: Gwartney, Hall, and Lawson (2010). More information is provided in the appendix to the report (www.freetheworld.com/2010/reports/world/EFW2010-appendix.pdf).

Informal sector size (IS): Measured as a share of official GDP and borrowed from Schneider, Buehn, and Montenegro (2010). I use the estimates from 2002 to have a single point estimate per country.

Investment volatility: Standard deviation of the cyclical component of annual gross capital formation, using the Baxter-King band-pass filter from 1985 to 2002. Source: Ferreira-Tiryaki (2008).

Labor Regulations (LR): Composed of six subindexes: hiring regulations and minimum wage, hiring and firing regulations, centralized collective bargaining, hours regulations, mandated cost of worker dismissal, and conscription. I use the measure from 2002. Source: Gwartney, Hall, and Lawson (2010).

Law and order: Measure of institutional quality from the International Country Risk Guide (ICRG), published by the PRS Group, for 1998 through 2007. It takes values from one to six, where higher values denote better institutions. I use 1999 to have a point estimate for each country.

Legal enforcement of contracts: A summary of the time and monetary cost of collecting a debt. Source: Gwartney, Hall, and Lawson (2010).

Log of real gross domestic product in 1999: The logarithm of real GDP in 1999 expressed in 2000 dollars. Source: WDI.

Openness: Constructed as the sum of imports and exports divided by GDP from 1985 to 2002. Averaged over the sample period to obtain one point estimate per country. Constructed with data from the WDI.

Output volatility: Standard deviation of the cyclical component of annual log real GDP using the Baxter-King band-pass filter from 1985 to 2002. Source: Ferreira-Tiryaki (2008).

Rule of law: Measure of institutional quality, which takes values from -2.5 to 2.5 , where higher values denote better institutions. I use 1998 to obtain a point estimate for each country. Source: Worldwide Governance Indicators (Kaufmann, Kraay, and Mastruzzi, 2012).

Unemployment rate volatility: Standard deviation of the cyclical component of the annual unemployment rate, using a Baxter King band-pass filter from 1985 to 2002. Country sample determined by availability of continuous series. Source: WDI.

Estimations

DETERMINANTS OF INFORMAL SECTOR SIZE. The dependent variable is the size of the informal sector as a percent of official GDP in 2002, obtained from Schneider, Buehn, and Montenegro (2010). Since informality in the model is defined in terms of employment, I also explore the role of labor market regulations when estimating the impact of regulations on informal sector size. I use data from 2002 since the variables I use to measure labor regulations are available starting in 2002. I use two specific components of labor regulations from the *Economic Freedom of the World* report (regulations on hiring and on firing) instead of an aggregate measure in order to isolate some of the particular elements of the institutional and regulatory environment that may

have a direct impact on the informal sector.⁵⁷ More stringent hiring regulations and dismissal costs are reflected in lower values for these indexes. I also consider a widely used measure of overall institutional quality in the literature, mainly law and order from the International Country Risk Guide (ICRG). I use this variable for 1999.⁵⁸ I use French legal origin as a proxy for enforcement when I include law and order in the specification.⁵⁹ Finally, I use the log of real GDP in 1999, obtained from the World Bank's World Development Indicators (WDI), to control for the level of development. The estimation equation for the determinants of informality has the form

$$IS_i = \beta_0 + \beta_1 \text{Enforcement}_i + \beta_2 \text{Institutions}_i + \beta_3 \text{HR}_i + \beta_4 \text{DC}_i + \sum_{k=5}^n \beta_k X_{ki} + \varepsilon_i,$$

where $n \geq 5$ and IS_i denotes the size of the informal sector as a percent of official GDP in country i , Enforcement_i is captured by French legal origin, Institutions_i denotes the measure of institutions (law and order), HR_i and DC_i are hiring regulations and dismissal costs, respectively, and ε_i is an error term. X_{ki} includes the log of real GDP in 1999.⁶⁰

INFORMAL SECTOR SIZE AND AGGREGATE VOLATILITY. For the purpose of comparison, I use Ferreira-Tiryaki's data set on annual consumption, investment,

57. Gwartney, Hall, and Lawson (2010).

58. The results are qualitatively the same if I use rule of law from the World Bank's Worldwide Governance Indicators (Kaufmann, Kraay, and Mastruzzi, 2012), although the significance of hiring regulations is sensitive to the proxy of institutions used.

59. This treatment follows Botero and others (2004). The World Bank's Worldwide Governance Indicators (Kaufmann, Kraay, and Mastruzzi, 2012) include a measure of regulatory quality, which could in principle capture the degree of enforcement in the economy. This measure is very highly correlated with other common measures of institutional quality. I use French legal origin as a proxy for enforcement since it is significant in explaining differences in contract enforcement, even after controlling for other factors that may account for differences in enforcement across countries. For country-specific proxies for enforcement, see Ronconi (2010) for Argentina and Almeida and Carneiro (2011) for Brazil.

60. The log of real GDP per capita is highly correlated with the institutional quality measure. As a robustness test, the controls include other variables that could potentially affect the size of the informal sector, including the inflation rate, a measure that captures the mean tax rate, and business regulations. Based on Loayza, Servén, and Sugawara (2009), it may be important to control for business regulations. However, when I do so, the measure of business regulations turns out to be very highly correlated with institutional quality. Also, a natural extension would be to include interaction terms between institutions and the two measures for labor regulations to test whether the impact of regulations falls with better institutions. I tested this by introducing interaction terms but found that institutional quality becomes insignificant since there is a high degree of multicollinearity between the interaction terms and the measure of institutional quality. The main specifications exclude any interaction terms.

and output volatility for a total of forty-four countries.⁶¹ I use the same measure of informality as Schneider, Buehn, and Montenegro (2010).⁶² I use year 2002 for the data on informal sector size, which is the same year I use for the determinants of informality.⁶³ I use the government-to-GDP ratio, the share of credit to the private sector as a percent of GDP, and a measure of openness (imports plus exports as a percent of GDP) as additional regressors (all obtained from the World Development Indicators). The estimation equation has the form

$$\sigma_{j,i} = \gamma_0 + \gamma_1 IS_i + \sum_{k=2}^n \gamma_k X_{ki} + \mu_i,$$

where $\sigma_{j,i}$ denotes the volatility of variable j in country i , where j can be aggregate consumption, unemployment, investment, or output. IS_i is informal sector size, and μ_i is an error term. As before, X_{ki} encompasses mean government spending as a share of GDP, a measure of openness to trade, and the mean of domestic credit to the private sector as a share of GDP. Additional controls to test for robustness (not shown in the main regression results) include the median inflation rate, a measure of exchange rate fluctuations, and the growth rate in trend real GDP, similar to the regressors used by Ferreira-Tiryaki.⁶⁴

SOLUTION TO THE NASH BARGAINING PROBLEM AND WAGE EQUATIONS. The value to a worker of being employed in the formal sector, $\mathbf{W}_{F,t}$, is given by

$$\mathbf{W}_{F,t} = w_{F,t} + E_t \Xi_{t+1|t} \left\{ (1 - \delta^F) \mathbf{W}_{F,t+1} + \delta^F \mathbf{W}_{U,t+1} \right\}.$$

The value function for a worker in the informal sector, $\mathbf{W}_{I,t}$, is

$$\mathbf{W}_{I,t} = w_{I,t} + E_t \Xi_{t+1|t} \left\{ (1 - \delta^I) \mathbf{W}_{I,t+1} + \delta^I \mathbf{W}_{U,t+1} \right\}.$$

The value function for an unemployed agent, $\mathbf{W}_{U,t}$, can be written as

$$\mathbf{W}_{U,t} = b + E_t \Xi_{t+1|t} \left\{ \begin{aligned} & (1 - \delta^F) p(\theta_{F,t}) \mathbf{W}_{F,t+1} + (1 - \delta^I) p(\theta_{I,t}) \mathbf{W}_{I,t+1} \\ & + \left[1 - (1 - \delta^F) p(\theta_{F,t}) - (1 - \delta^I) p(\theta_{I,t}) \right] \mathbf{W}_{U,t+1} \end{aligned} \right\},$$

61. Ferreira-Tiryaki (2008).

62. Schneider, Buehn, and Montenegro (2010). The results for consumption volatility are sensitive to the inclusion of Argentina, which is part of the original country sample. The main results exclude Argentina to give a more general picture of the connection between informality and volatility.

63. Using the average for 1999 to 2002 does not change the main conclusions.

64. Ferreira-Tiryaki (2008). One difference relative to Ferreira-Tiryaki (2008) is that I do not include the standard deviation of the cyclical component of the Solow residual as an explanatory variable in the volatility regressions.

where I interpret b purely as the value of unemployment benefits measured in consumption units.⁶⁵ Denoting the value function of having a worker in place during production for a formal sector firm by $\mathbf{J}_{F,t}$, I have

$$\mathbf{J}_{F,t} = p_{F,t} a_F z_t f_{n_{F,t}} - w_{F,t} (1 + \tau^p) + E_t \Xi_{t+1|t} \left\{ (1 - \delta^F) \mathbf{J}_{F,t+1} \right\}.$$

The value of having a worker for a firm in the informal sector, $\mathbf{J}_{I,t}$, is

$$\mathbf{J}_{I,t} = p_{I,t} z_t - w_{I,t} + E_t \Xi_{t+1|t} \left\{ (1 - \delta^I) \mathbf{J}_{I,t+1} \right\}.$$

I assume free entry in vacancy posting in both sectors. Formal sector firms and workers bargain over the real wage, so that the formal wage, $w_{F,t}$, solves

$$\max \left\{ (\mathbf{W}_{F,t} - \mathbf{W}_{U,t})^{v_F} (\mathbf{J}_{F,t})^{1-v_F} \right\},$$

where $(\mathbf{W}_{F,t} - \mathbf{W}_{U,t})$ is the worker's surplus, $\mathbf{J}_{F,t}$ is the firm's surplus, and v_F is the worker's bargaining power. The Nash bargaining problem in the informal sector is

$$\max \left\{ (\mathbf{W}_{I,t} - \mathbf{W}_{U,t})^{v_I} (\mathbf{J}_{I,t})^{1-I} \right\},$$

where $(\mathbf{W}_{I,t} - \mathbf{W}_{U,t})$ is the worker's surplus, $\mathbf{J}_{I,t}$ is the firm's surplus, and the bargaining power for informal sector workers is $v_I < v_F$. Formal and informal wages are implicitly given by

$$\left(\frac{\xi^F}{1 - \xi^F} \right) \mathbf{J}_{F,t} = \mathbf{W}_{F,t} - \mathbf{W}_{U,t}, \quad \left(\frac{v_I}{1 - v_I} \right) \mathbf{J}_{F,t} = \mathbf{W}_{F,t} - \mathbf{W}_{U,t},$$

where $\xi^F = v_F / [v_F + (1 - v_F)(1 + \tau^p)]$ is the effective bargaining power of formal workers. We can then use the value functions above to find explicit expressions for the wages.

65. The interpretation of this parameter is not clear-cut for developing countries. If we take the interpretation of b as pure unemployment benefits, then we should set the parameter to zero, as only a small number of developing countries have adequate safety nets. An alternative interpretation is to assume that b includes the value of home production. For developing countries, some papers consider home production as a form of self-employment, even though the self-employed are counted as active labor market participants (Maloney, 2004; Fiess, Fugazza, and Maloney, 2010). This does not seem to be an adequate label since informal work, including self-employment, is tied to market activities.

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