

# Essays on Sovereign Debt Crises and Macroeconomic Volatility

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TESI DOCTORAL UPF / 2010

DIRECTOR DE LA TESI

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Dipòsit Legal:  
ISBN:

*In the memory of my father, Franco,  
who always supported me with trust and love.*



## Acknowledgments

This thesis wouldn't have been possible without the constant help and encouragement of my advisor, Jaume Ventura. During all these years he taught me how to dissect complex economic interactions, emphasizing the crucial aspects of a problem such to make it understandable in simple terms. This invaluable lesson will accompany me for many years.

I am also highly indebted with Alberto Martin. His guidance in the early stages of my research has been fundamental to complete this thesis.

Many thanks go to Fernando Broner, Paula Bustos, Vasco Carvalho, Gino Gancia, Nicola Gennaioli, Joachim Voth. They devoted me plenty of time, participating to all my seminars and leaving their doors always open to further discussion. Their continuous suggestions and criticism forced me to think hard about each aspect of the problems I was analyzing.

Marta Araque, with her help and patience, walked me through the administrative work and gave me invaluable support during the job market experience.

I would like to thank Sofia Bauducco, Davide Debortoli, José Dorich, Christina Felfe, Shikeb Farooqui, Nathan Foley-Fisher, Antonio Mele, Arturo Ormeño, Diego Walter Pereira, Gonçalo Pina, Rhiannon Sowerbutts, Federico Todeschini, Giovanni Ursino, Robert Zymek. I have learned a lot talking with them.

My life in Barcelona has been enriched by many extraordinary friends: Davide and Barbara, Antonio, José, Christina and Arturo, Martina, Sofia, Giovanni, Carmine and Valeria, Eva, Rhiannon, Shikeb and Zeynep, Federico and Tatiana, Diego and Juan, and many others. Thanks for being always there for me during all these years. Paolo and Andrea, Giovanna, Caterina, Michela and Francesca always encouraged me, no matter how far. A special thank goes to Dario, for his heartening words in the darkest moments.

My mother, Maria Rita, and my brother, Davide, have been my strength and resolution, my comfort and my shelter, my inner confidence and my direction. This thesis is theirs as much as mine, as I would have given up long ago without their constant encouragement and unconditional love. I also thanks my uncle Alberto and my aunt Anna, and their cheerful crew, for being so closed to me, my mother and my brother

in the most tragic event of our lives.

Finally, a huge thank goes to Angela, who has been walking with me through peaks and troughs for many years. She is the ultimate artifice of this work, for making me find always new enthusiasm.



## **Abstract**

Income growth is much more volatile in developing countries than in developed ones. One argument is that weak legal and political institutions exacerbate macroeconomic shocks precipitating the economy into widespread crises. The first chapter of my thesis focuses on sovereign debt crises and discusses how government default in bad times can trigger a liquidity crisis within the economy even in absence of classic foreign penalties. The second chapter takes a complementary perspective and emphasizes the role of sectoral specialization as a source of the higher volatility of emerging markets, much in line with recent empirical evidence.

## **Resumen**

En las últimas décadas el crecimiento de la renta en los países en desarrollo ha sido mucho más volátil que en los desarrollados. Una explicación es que la debilidad de las instituciones jurídicas y políticas agravan las crisis macroeconómicas precipitando la economía en una crisis generalizada. El primer capítulo de mi tesis se centra en la crisis de la deuda soberana y analiza cómo la insolvencia del gobierno puede desencadenar una crisis de liquidez en la economía, incluso en ausencia de sanciones desde el extranjero. El segundo capítulo adopta una perspectiva complementaria y destaca el papel de la especialización sectorial como fuente de la mayor volatilidad de los mercados emergentes, en consonancia con una reciente evidencia empírica.





# Foreword

Over the last four decades developing countries have experienced much wider income fluctuations than developed countries, with periods of sustained growth accelerations being followed by deep recessions. The macroeconomic research agenda has devoted particular attention to identifying the sources of the higher volatility of emerging countries for a number of reasons. First, output volatility has a negative effect on growth, arguably because uncertainty about future economic prospects discourages investment and capital inflows (Ramey and Ramey (1995)). Second, a highly volatile economy generates substantial welfare costs that add on the negative impact on growth, as cyclical output fluctuations and extreme output events or crises raise both the time-series volatility of aggregate consumption, particularly in less financially developed and integrated countries (e.g. Pallage and Robe (2003)), and the cross-sectional distribution of consumption within the economy or inequality (e.g. Calderon and Yeyati (2009)).

The conventional view justifies the higher volatility of developing countries emphasizing both their large reliance on few commodities exports and foreign capital inflows, which exposes them to external demand shocks and changes in market sentiments, and on their lack of strong political and legal institutions, which play a crucial role in the evolution of the initial adverse shock into sovereign debt crises, banking crises and currency crises.

The first chapter of my thesis focuses in particular on sovereign debt crises in emerging markets and analyzes a specific mechanism through which the government decision to default on its debt in response to an adverse shock degenerates into a liquidity crisis in the economy. Sovereign defaults are inherently different from corporate defaults, as they arise not as a consequence of their inability-to-pay but rather on their unwillingness-to-pay. As commonly argued, creditor rights are extremely difficult to enforce (due to the jurisprudential principle of “sovereign immunity”) and the only reason why we observe repayment is that governments want to avoid the cost associated with default. However, there is no agreement on the exact nature of these costs. Traditionally, past studies have focused on “external” cost channels as trade sanctions or borrowing restrictions. Much less attention has been devoted to the analysis of direct costs on the domestic economy.

In this chapter, I study the government incentive to repay without considering any

intervention of foreign creditors. The costs of sovereign default arise from two natural assumptions for emerging markets: first, much in line with a literature in corporate finance, public debt represents a source of liquidity for the private sector and, second, the government is not able to discriminate between domestic and foreign bond holders in the event of default. In such a context, the prospect of drying up the private sector's liquidity restores the ex-post incentive to pay of the government and external debt emerges even in absence of foreign penalties. Nonetheless, default occurs when economic conditions deteriorate and productivity falls since the government prefers to trigger a liquidity crisis and reduce private investment rather than collecting taxes from domestic agents to repay public debt.

The model is then used to explore the consequences of a financial reform which expand the range of contracts available in the economy. In particular, domestic firms are allowed to trade contracts that are contingent of future liquidity needs. The reform has unexpected implications in this setup. Clearly, private agents benefit as markets are completed by the introduction of a contingent asset. However, since firms would substitute government bonds with the new asset, sovereign default would become a more desirable option and the government will lose access to credit markets. The trade-off inherent in such reforms constitutes a novel aspect of the model, which could rationalizes why some countries tend to adopt regulatory regimes that favor government securities with respect to other assets (for instance by imposing different weighting schemes in banks reserve requirements).

A complementary view for why developing countries are more volatile has been recently proposed. This view stresses the role of compositional effects in aggregate production rather than differences in the magnitude and the transmission of country specific shocks. In a highly influential study, Koren and Tenreyro (2007b) show empirically that cross-country differences in aggregate volatility can be accounted for by differences in country-specific shocks, but also, and in a similar measure, by differences in the sectoral composition of aggregate production. In other words, they argue that developing countries are more volatile because they specialize in sectors that are inherently more volatile.

The second chapter of this thesis analyzes the sources of such compositional effects and proposes an explanation for why developing countries specialize in more volatile sectors. The premise for the theory is twofold. On one side, this paper takes a technological view

of volatility differences between sectors, which arguably depends on the diversification of input-output structures across many intermediate inputs. On the other side, given that more diversified sectors usually show greater contract intensities as producers need to deal with a wider range of suppliers, this paper recognizes that institutional quality can be a source of comparative advantages and specialization in production.

More specifically, my paper augments a North-South Ricardian model of international trade in two respects. First, I consider that the economy can produce a continuum of final goods and that final goods production requires a continuum of intermediate goods, which are subject to imperfectly correlated productivity shocks. Then, final output is less volatile in sectors where the production technology uses a relatively large number of intermediate goods. Second, I introduce contracting frictions using the incomplete contract framework, as in Williamson (1985) and Grossman and Hart (1986). In particular, I consider that final producers (upward firms) outsource intermediate goods to downward suppliers (downward firms) and that intermediate goods are relationship-specific. When parties cannot write ex-ante enforceable contracts, this situation leads to the well-known hold-up problem, where parties bargain over the division of revenues from production. Assuming that contract enforcement is weaker in South, in this region upward firms experience a cost disadvantage in sectors where the number of intermediate inputs, and therefore contract intensity, is greater. The model, then, proposes a view where legal institutions represent a source of comparative advantage across sectors with different output volatility.



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# 1 LEGAL ENFORCEMENT, PUBLIC SUPPLY OF LIQUIDITY AND SOVEREIGN RISK

## 1.1 Introduction

Sovereign defaults are very different from corporate defaults. Creditors, indeed, have little power to enforce repayment under existing legal arrangements (due to the jurisprudential principle of “sovereign immunity”) and, ultimately, debt repayment hinges on sovereign willingness-to-pay. Then, the common perception in the literature is that the existence of costs associated with default is the only mechanism making sovereign debt possible. Yet, there is much less agreement on the nature of these costs. Past studies have typically focused on “external” cost channels as trade sanctions, borrowing restrictions or reputational issues,<sup>1</sup> but there is no clear-cut evidence supporting the existence of these classic penalties.<sup>2</sup> This paper, instead, studies a different cost channel that does not rely on foreign retaliation: namely, sovereign default is costly as it triggers a liquidity crisis in the economy.

Anecdotal and empirical evidence suggests that sovereign debt crises are usually associated with liquidity and banking crises in emerging economies. A clear example is provided by the Argentine crisis in 2001, where the temporary suspension of debt payments by the government concurred to undermine the strength of banks’ balance sheets. With banks not granting new loans, businesses dramatically cut back on their spending, aggravating further the economic downturn.<sup>3</sup> Such a “domino effect” might be a latent threat in many emerging markets, where domestic financial institutions, in particular commercial banks, are major holders of public debt.<sup>4</sup> As a matter of fact,

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<sup>1</sup>Since the seminal papers of Eaton and Gersovitz (1981) and Bulow and Rogoff (1989), several authors have contributed to make the sovereign debt literature a very active field of research. See Grossman and Van Huyck (1988), Bulow and Rogoff (1989), Fernandez and Rosenthal (1990), Cole and Kehoe (1998), Kletzer and Wright (2000), Wright (2002), Amador (2004), Yue (2005), Aguiar and Gopinath (2006) and Arellano (2008), among others. Eaton and Fernández (1995) and Sturzenegger and Zettelmeyer (2006) provide two excellent surveys.

<sup>2</sup>Though, the academic debate on the identification of these “classic” penalties is alive and well. Borensztein and Panizza (2008) review past empirical studies on the cost of defaults.

<sup>3</sup>A similar analysis is made by Mishkin (2006), as reported in the appendix.

<sup>4</sup>Kumhof and Tanner (2005) show that financial institutions’ net credit to the government relative to their total assets ranges from 20% to 40% in emerging markets, whereas this ratio is typically around 10% in advanced countries.

Borensztein and Panizza (2008) show that over the period 1980-2000 sovereign defaults often predicted banking crises in a wide sample of emerging economies.<sup>5</sup>

The model builds on two natural assumptions for emerging markets. First, public debt represents a source of liquidity for the private sector. More specifically, firms save in government bonds (either directly or indirectly through the banking sector) to finance a future investment opportunity, given that limited contract enforcement restricts their access to spot credit markets. This feature of the model captures the negative correlation between creditor rights protection and banks' holdings of government debt which is observed in the data.<sup>6</sup> Second, the government cannot discriminate between domestic and foreign bond holders in the event of default. While this assumption is admittedly extreme, it nevertheless fits the experience of recent debt crises, as for instance Russia 1998 and Argentina 2001, where domestic financial institutions suffered considerable haircuts on government bond holdings.

In such a context, the prospect of drying up the private sector's liquidity restores the ex-post incentive to pay of the government and external debt emerges even in absence of foreign penalties. Nonetheless, default occurs when economic conditions deteriorate and productivity falls since the government prefers to trigger a liquidity crisis and reduce private investment rather than collecting taxes from domestic agents to repay public debt. Sovereign default is then countercyclical and raises output volatility through its effect on private investment.

The model is then used to explore the consequences of a financial reform which expand the range of contracts available in the economy. In particular, domestic firms are allowed to trade contracts that are contingent of future liquidity needs. The reform has unexpected implications in this setup. Clearly, private agents benefit as contracts become more complete. However, since firms would substitute government bonds with the new financial instruments introduced by the reform, sovereign default would become a more desirable option and the government will lose access to credit markets. The trade-off

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<sup>5</sup>Applying a methodology similar to Kaminsky and Reinhart (1999) to a large sample of countries over 1975-2000, these authors find that the probability of a banking crisis in a given year conditional on having a sovereign default in the same year or in the year before is 14 percent, whereas the unconditional probability is only a 2 percent, and the difference between the conditional and unconditional probability is statistically significant. On the other hand, the probability of a sovereign default conditional on a banking crisis is not statistically different from the unconditional probability. This evidence seems to indicate that sovereign defaults might lead to banking crises, while the contrary is on average not true.

<sup>6</sup>See Kumhof and Tanner (2005).

inherent in such reforms constitutes a novel aspect of the model, which could rationalizes why some countries tend to adopt regulatory regimes that incentive government securities to other assets (for instance by imposing different weighting schemes in banks reserve requirements).

A recent strand of the sovereign debt literature which focuses specifically on the direct consequences of default on the domestic economy, as Sandleris (2006) and Broner and Ventura (2006, 2008). In particular, my paper is closely related to the last two papers, where the inability of the government to distinguish between domestic and foreign bondholders yields an undesirable redistribution of resources in the event of default. One novelty of my paper is to model specifically the reasons that induce the private sector to hold government bonds. By doing so, the model helps to understand how the adverse effects of default propagate throughout the economy and how reforms of private financial markets can backfire on the sustainability of public debt.

In addition, my paper shares several aspects also with a literature studying the role of government debt to enhance private liquidity, as Woodford (1990) and Holmstrom and Tirole (1998). The latter authors, in particular, show that the presence of financial frictions can generate an excess demand of liquidity by raising agents' precautionary savings while constraining the supply of private financial assets. Full efficiency then requires the intervention of the government, which can always raise its bond issuance by committing the future income of taxpayers.<sup>7</sup> While it is natural to expect that the liquidity role of public debt tend to disappear once the economy integrate with a large international financial market, my model suggests that it is not necessary the case once sovereign risk is introduced. Indeed, the procyclicality of government bonds relative to foreign bonds allows domestic firms to transfer resources to the states where they have the highest value.

Finally, the empirical section provides an evidence that is suggestive of the main mechanism emphasized in the model. In particular, sovereign default appears to have a disproportionate negative impact on the growth rate of financially dependent sectors. This result is certainly consistent with the idea that sovereign default triggers a liquidity crisis in the economy, but it cannot be considered a proper test of the theory. Indeed, an exclusion from international capital markets following a default episode would have

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<sup>7</sup>The benefits of public liquidity provision have been discussed also by Reinhart et al. (2000), Allen and Gale (2004a), Kumhof (2004), Taddei (2004), Gorton and Huang (2004), Caballero and Krishnamurthy (2008).

similar implications.

The rest of the paper is organized as follows. Section 2 describes a baseline model of government debt as a source of liquidity. Section 3 introduces sovereign risk in this setup and analyzes the mechanism leading to liquidity crises. Section 4 discusses the model implications on institutional and political reforms. Section 5 presents the empirical evidence. Finally, section 6 concludes.

## 1.2 A model of government debt as a source of liquidity

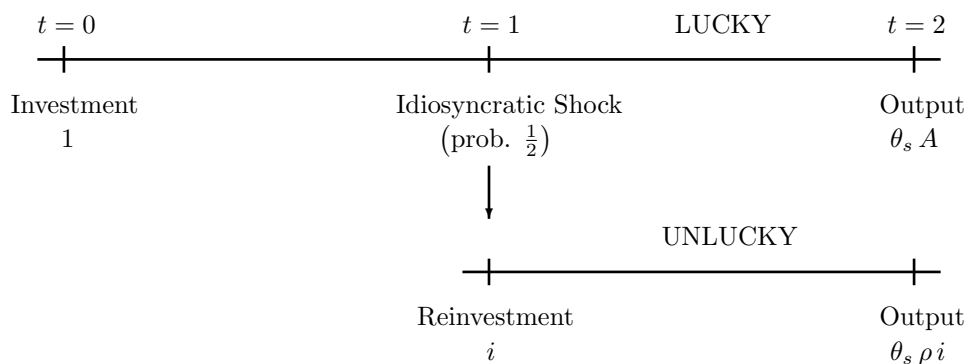
In this section I set up the environment of the economy. The model highlights: (i) the problem of domestic entrepreneurs (firms), who start a long-term investment facing the risk of a shock on total costs (expenditure shock) before completion; (ii) the problem of a benevolent government, who chooses public debt issuance in order to finance a public investment project. As a consequence of capital market imperfections, domestic firms save in government bonds to hoard a reserve of liquidity against the future shock. This setup will be enriched by introducing sovereign risk in section 3, in order to study the connection between sovereign default and liquidity and banking crises.

### a Technology

Consider a small open economy lasting for three periods:  $t = 0, 1, 2$ . The economy produces a single homogenous good and the production technology is represented by a continuum of risky investment projects. Investment in each project  $j$  costs one unit of the good in  $t = 0$  and returns a stochastic output  $\theta_s A_j$  in  $t = 2$ , where  $\theta_s$  and  $A_j$  denote two independent shocks that are observed in  $t = 1$ .  $\theta_s$  captures an aggregate “productivity” shock, which affects all projects in the same measure and takes values  $\theta_H > 1$  when the state of the economy is good and  $\theta_L < 1$  when the state is bad. Let  $\pi_H$  and  $\pi_L = 1 - \pi_H$  denote the respective probability of the two states and normalize the expected shock to one, i.e.  $\pi_H \theta_H + \pi_L \theta_L = 1$ .  $A_j$  captures an idiosyncratic “expenditure” shock, which affects each project individually and takes values  $A > 0$  if the project is lucky and zero if the project is unlucky. In the latter case, the project

admits an additional investment with variable size,  $i$ , which returns a final output  $\theta_s \rho i$ , with  $\rho < A$ . Let each project have an equal probability of being lucky or unlucky. Setting  $\frac{A}{2} > 1$  and  $\theta_L \rho > 1$ , both date 0 and date 1 investments are profitable. Figure 1 describes the timing of investment projects.

Figure 1.1: Timing of Investment Projects



## b Agents and Preferences

The economy is populated by a continuum of individuals with mass one, who have zero initial endowment, consume only at date 2 and are risk neutral. There are two types of individuals: a mass one half of *entrepreneurs* (firms) and a mass one half of *workers*. Entrepreneurs have access to the investment technology and each one can start a single project. Workers, on the other hand, have no access to the investment technology, but get income a per capita income  $w$  at date 1.

In addition to private individuals, there is a benevolent *government* who maximizes the average consumption of domestic individuals. At date 0 the government finances a public investment project  $g$  by issuing debt and collecting a lump-sum tax on all individuals at date 1. The investment project has marginal return  $\rho_G > 1$  and maximum size  $\bar{g}$ .

## c Private Financial Markets

In order to invest in the investment projects entrepreneurs need to borrow. Suppose the economy is financially integrated with an international financial markets (IFM) with standard properties: it is risk neutral, has deep-pockets, can lend/borrow at the normalized interest rate  $r^* = 1$  and can commit to future payments. However, entrepreneurs' access to credit markets is restricted by imperfect enforcement of financial contracts by domestic courts. In particular, I consider that, in case of default, creditors can seize only a share of debtor's assets, from which Assumption 1 follows.

**Assumption 1** *Entrepreneurs can commit only a fraction  $\gamma$  of future revenues, while workers cannot commit their future income.*

It is well known that financial frictions can affect firms' investment decisions along multiple dimensions.<sup>8</sup> In this paper I consider that they create a demand for liquidity by domestic firms by imposing the following restrictions on the parameters of the model:

$$(i) \quad \gamma \frac{A}{2} > 1, \quad (ii) \quad \gamma \theta_{HP} < 1.$$

Condition (i) ensures that date 0 investment is profitable for both the entrepreneurs and the IFM. Then, entrepreneurs are able to borrow at date 0. Condition (ii) ensures that date 1 investment is profitable for entrepreneurs but not for the IFM and unlucky entrepreneurs cannot borrow at date 1. As a result, entrepreneurs would increase date 0 borrowing and save in financial assets as a buffer against future shocks.<sup>9</sup> As the only reason to save is to finance investment if they are unlucky, entrepreneurs would

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<sup>8</sup>Since the seminal contribution of Modigliani and Miller (1958), scholars have been aware that the presence of financial frictions affects the capital structure of private companies and distorts their investment choices. Hubbard (1998) and Stein (2003) provide two excellent reviews of the economic literature studying the effects of capital market imperfections on corporate investment. Past research has also shown that a number of macroeconomic consequences can arise from the presence of borrowing constraints at the corporate level. A necessarily incomplete list of past contributions include: studies that show that financial frictions generate credit cycles and amplify aggregate volatility, e.g. Bernanke and Gertler (1989), Bernanke et al. (1999), Kiyotaki and Moore (1997), Carlstrom and Fuerst (1997), Kocherlakota (2000), Martin (2005); studies that show that financial frictions generate divergence in cross-country wealth distribution, in cross-country or current account balances, respectively Matsuyama (2004) and Caballero et al. (2008); studies that show that financial instability and sudden stops in capital inflows in emerging markets are exacerbated by collateral constraints, e.g. Aghion et al. (2004), Caballero and Krishnamurthy (2001), Mendoza (2006).

<sup>9</sup>For simplicity, I restrict my attention only to financial assets, as they have higher liquidity than other type of assets.

optimally choose to buy a contingent security. For the time being, we restrict this possibility.

**Assumption 2** *Entrepreneurs cannot enter into contingent contracts with the IFM.*

Absent contingent contracts, the only alternative open to entrepreneurs is to accumulate savings in two non-contingent bonds: namely, a government bond and a foreign bond. Next section will solve the competitive equilibrium for a benchmark case where the government can commit to repay in the future. This assumption will be relaxed later on to study the implications of sovereign risk in this model.

## d Equilibrium with government commitment

At date 0, each entrepreneur borrows  $d$  from the IFM, invests in the project and purchases an amount of government and foreign bonds with face value  $b$  and  $f$ . At date 2, depending on whether he is lucky or unlucky, the entrepreneur gets revenues

$$y_l(\theta_s) = \theta_s A + (b + f - \tau) - d \quad \text{or} \quad y_u(\theta_s) = \theta_s \rho(b + f - \tau) - d, \quad (1.1)$$

where  $s = H, L$  depending on the state of the economy and  $\tau$  denotes per capita taxation at date 1 by the government. Notice that I have substituted for  $i = b + f - \tau$  given the additional investment  $i$  has positive net returns in any state  $\theta$ . The budget constraint of the entrepreneur is

$$1 + b + f = d, \quad (1.2)$$

since entrepreneurs have no initial endowment. Given perfect commitment by the government, the price of government bonds is equal to the price of foreign bonds and is equal to one. Finally, limited contract enforcement imposes the following constraint on date 0 borrowing:<sup>10</sup>

$$d \leq \gamma \frac{(A + b + f) + \rho(b + f)}{2}. \quad (1.3)$$

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<sup>10</sup>For simplicity, date 1 taxation does not affect firms' collateral. This assumption however does not change the results of the model.

Then, the problem of the representative entrepreneur consists in choosing  $\{b, f, d\}$  in order to maximize the expected value of future revenues from the project

$$\Pi = \sum_{s=H,L} \pi_s \left( \frac{y_l(\theta_s) + y_u(\theta_s)}{2} \right). \quad (1.4)$$

subject to (1.1)-(1.3). It is easy to see that this problem has a corner solution where the borrowing constraint (1.3) is binding. Indeed, by borrowing to buy one bond more, the entrepreneur gets an expected revenue  $(1 + \rho)/2 - 1$ , which is strictly positive since  $\rho > 1$ . Maximization of the above program then implies the following optimality conditions for savings in government and foreign bonds:

$$b + f = \gamma \frac{\frac{A}{2} - 1}{1 - \gamma \tilde{\rho}}. \quad (1.5)$$

where  $\tilde{\rho} \equiv \frac{1+\rho}{2}$ . Not surprisingly, the entrepreneur is indifferent between saving at home or saving abroad, given that government and foreign bond are perfect substitutes. As shown in the next section, however, this result depends crucially on the assumption of perfect commitment by the government.

Consider now the problem of the benevolent government, which has to choose the investment in the public project  $g$  in order to maximize the social welfare function

$$W = \frac{1}{2}\Pi + \frac{1}{2}(w - \tau) + \rho_G g \quad (1.6)$$

subject to the government budget constraint at date 0 and date 1, i.e.  $B = g$  and  $\tau = B$ . The solution of the government problem then implies that public investment is maximized whenever the return on the public project exceeds the cost of taxation on domestic individuals, i.e.

$$g = \bar{g} \quad \text{if} \quad 2\rho_G \geq \tilde{\rho} + 1. \quad (1.7)$$

Then, for  $\bar{g} \leq \frac{1}{2}(b + f)$ , the supply of bonds by the government is lower than domestic demand and there exists at least one equilibrium in which the entire government debt is held domestically. For  $\bar{g} > \frac{1}{2}(b + f)$ , the supply of bonds by the government exceeds domestic demand and a share of government debt is held by the IFM. In the rest of the



paper, this second situation would represent the case of interest.

## e Discussion

The previous section has depicted a stylized economy where the lack of contract enforcement creates a demand for liquidity by the private sector. Given that generality has been sacrificed in favor of analytical simplicity, it is convenient to provide a careful discussion of some aspects of the model.

- A possible criticism is that in most cases firms do not save in government bonds but rather rely on financial intermediaries to manage their liquidity needs (e.g. through cash deposits or credit lines). However, I argue that this point does not imply a rejection of the model. Suppose the previous framework is enriched to allow for a competitive banking sector, where each bank borrows from the IFM and lends to one firm. It is easy to see that when there is no commitment problem between banks and firms (i.e. banks can monitor projects), but there is a commitment problem between banks and the IFM (e.g. banks can pledge only a fraction of their assets), the model converges exactly to the same setup as before. This interpretation is suggested by Gennaioli et al. (2009). Empirical evidence consistently shows that the banking sector in many developing countries holds a large fraction of their assets in government bonds, e.g. Reinhart et al. (2003) and Kumhof and Tanner (2005). In particular, the latter authors show that the ratio of banks' claims on the government over their net assets is higher in countries with weaker creditors right protection, since banks use government bonds as collateral in private financial transactions. For consistency, I will stick to the initial version of the model where there are only entrepreneurs and workers, but I will return to this alternative interpretation in future discussions.
- In the model the absence of contingent contracts is taken as a description of a missing market. This feature of the economy could be easily endogenized by considering a simple moral hazard problem, where entrepreneurs need to exert a non-observable effort to reduce the probability of getting the expenditure shock at date 1. The incentive of the government to reduce moral hazard by improving financial regulation and monitoring are then discussed in a later section of the paper.

- The key ingredients of the model are that firms need to save resources for the future and the government needs to borrow. While these features follow naturally from the stark assumptions of the model, it is not difficult to think to more general settings which deliver the same implications. We only need that firms face tighter borrowing constraint in the future (in this case firms would save in bonds until the marginal return on investment is equalized across time) and the government has a reason to issue debt (e.g. distortionary cost of taxation).

The idea that government debt enhances private liquidity provision when there is a lack of collateral is not new and has been already discussed by Woodford (1990) and Holmstrom and Tirole (1998). In particular, the latter show that the shortage of collateral creates an under-supply of private securities posing a limit on the saving capacity of firms. On the contrary, the government, thanks to its assumed ability to commit workers' income through taxation, can expand the supply of financial assets above the value of private collateral. However, it must be remarked that Holmstrom and Tirole's argument depends crucially on the assumption that domestic firms cannot store liquidity by saving abroad. When there are no restrictions on international capital flows and no sovereign risk, the IFM provides the economy with sufficient liquidity (as entrepreneurs are indifferent between foreign and government supply and the supply of foreign bond is infinitely elastic) and there is no need for government intervention. The following section, however, shows that, by relaxing the government commitment assumption in the same setup as before, Holmstrom and Tirole's argument can be restored in an open economy setting: as government repayment becomes contingent on the state of the economy, public debt then represents an imperfectly substitutable source of liquidity for the domestic private sector. Nonetheless, the optimal fiscal policy of the government has a downside, as it exposes the economy to costly liquidity crises.

### 1.3 Sovereign risk and liquidity crises

Using the same framework as before, it is now possible to discuss the implications that arise from the interaction between domestic financial frictions and sovereign risk.

**Assumption 3** *The government cannot commit to repay in the future.*

The absence of commitment introduces a classic unwillingness-to-pay problem. Ex-post the government has an incentive to default on its obligations with foreign creditors (the IFM) to maximize domestic consumption. Then, the threat of future opportunistic behavior induces foreign creditors to stop lending to the government. Conventional models in the sovereign debt literature usually restore the ex-post incentive to repay by introducing either a default penalty or a reputational cost when a default occurs. Yet, these classic penalties have ambiguous empirical support. In this paper, I take a different perspective to support external debt, which focuses on the direct consequences of default on the domestic economy.

As noted by Broner and Ventura (2006), the unwillingness-to-pay problem depends crucially on the ability of the government to discriminate between domestic and foreign bond holders. Indeed, when selective default on the IFM is not possible, the cost of default is borne also by domestic agents and this reduces the attractiveness of the ex-post opportunistic behavior. In the setup described previously, the non-discrimination assumption has clear-cut implications. Given that a default on government bonds affects the reserve of liquidity of domestic firms and precludes the profitable reinvestment in distressed projects, the government has an ex-post incentive to honor its obligations. This would be the case whenever the cost of a liquidity crisis within the economy exceeds the cost of repaying foreign bond holders.

**Assumption 4** *The government cannot discriminate between domestic and foreign bond holders.*

Assumption 4 has both an empirical and a theoretical underpinning. Over the last decade, sovereign debt has been increasingly issued in the form of anonymous bonds, highly traded in secondary markets by both domestic and foreign market participants.<sup>11</sup> As observed by Broner and Ventura (2006) and Panizza (2008), governments are usually unable to track down the nationality of the ultimate bondholder and to selectively default on foreign bondholders.<sup>12</sup> The following quote from Reinhart et al. (2003) remarks the same point: *“the view that external debt is completely separable from domestically issued debt is dead wrong”*.

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<sup>11</sup>A strong impulse to the development of sovereign bond markets was given by the Brady plan and its initiative to restructure distressed commercial bank debt into liquid and tradable public securities.

<sup>12</sup>Panizza (2008) reports that in most emerging countries governments commonly fail to keep track of the large volumes of secondary market transactions and end up with almost no information on the ultimate holders of debt.

Broner et al. (2006) argue that, when secondary markets work perfectly, acquiring such information could be a suboptimal policy for governments. Suppose the government can discriminate among domestic and foreign bondholders. Then, foreigners would always unfold their positions by selling bonds to domestics (which have the incentive to buy the bond at any non-negative discount) before maturity and would *de facto* receive their payment in any future contingency. Then, if the government wants to avoid the repayment of foreigners, it must commit to default on all bond holders indiscriminately (e.g., by not gathering information on secondary market transactions). By doing so, the government can gain an additional degree of freedom and, as shown in the next section, implement a contingent repayment policy.

## a Equilibrium with sovereign risk

At date 1 the government now decides opportunistically whether to repay public debt. Debt repayment transfers resources from domestic taxpayers (the workers) to both domestic bond holders (the entrepreneurs) and foreign bond holders (the IFM). The transfer to domestic entrepreneurs involves just a costless redistribution within the economy (due to linear preferences), but allows unlucky entrepreneurs to reinvest in their projects. On the other hand, the transfer to the IFM involves a costly redistribution of resources away from the economy, as the government does not care about foreigners. Given that selective default on foreigners is not possible, the government faces a trade-off. Let  $\tau = \frac{1}{2}b + b^*$  denote the necessary taxation at date 1 to repay public debt, which is held both by domestic entrepreneurs,  $\frac{1}{2}b$ , and the IFM,  $b^*$ . Repayment occurs only if the average benefit for entrepreneurs (LHS) exceed the average cost for workers (RHS),<sup>13</sup> as in

$$\tilde{\rho}_s (b - \tau) \geq \tau, \tag{1.8}$$

where  $\tilde{\rho}_s \equiv (1 + \theta_s \rho)/2$ . Condition (1.8) depends crucially on the state of the economy and on the amount of external debt relative to domestic debt. Consider first a bad shock in aggregate productivity at date 1. Clearly, returns on additional investment would drop, lowering the need for liquidity by unlucky entrepreneurs and the government

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<sup>13</sup>The LHS is simply the difference between entrepreneurs' revenues in the two regimes (repayment or default), taking into account that private debt  $d$  is non-contingent. The RHS is obtained in a similar way.

incentives to repay the outstanding bonds. Consider now an increase in the share of debt held by the IFM. This would increase the fiscal pressure on domestic individuals at date 1, reducing the consumption of both entrepreneurs and workers.

Suppose that condition (1.8) is satisfied only in the good state of the economy and there can be sovereign default in equilibrium. This case depicts a situation where the share of external debt is relatively large with respect to domestic debt. As discussed later on, this hypothesis is verified in the equilibrium. Let  $e$  denote the repayment policy of the government: then,  $e = 1$  in state  $s = H$  and  $e = 0$  in state  $s = L$ . The revenues of the representative entrepreneur are then,

$$y_l(\theta_s, e) = \theta_s A + f + e(b - \tau_1) - d \quad \text{and} \quad c_u(\theta_s, e) = \theta_s \rho(f + e(b - \tau_1)) - d, \quad (1.9)$$

depending on whether the entrepreneur is lucky or unlucky and on the state  $s$ .<sup>14</sup> The budget constraint of the representative agent is now equal to

$$1 + f + \pi_H b = d, \quad (1.10)$$

where government bonds are now issued at the actuarial fair price to compensate risk neutral agents for the possibility of future default. Finally, date 0 borrowing is constrained by:

$$d \leq \gamma \frac{(A + f + \pi_H b) + \rho(f + \pi_H \theta_H b)}{2}. \quad (1.11)$$

The problem of the representative agent, then, consists in choosing  $\{b, f, d\}$  in order to maximize future revenues conditional on the government repayment policy,

$$\Pi(e) = \sum_{s=H,L} \pi_s \left( \frac{y_l(\theta_s, e) + y_u(\theta_s, e)}{2} \right), \quad (1.12)$$

subject to (1.9)-(1.11). A first result that arises from the presence of sovereign risk is that domestic entrepreneurs are no more indifferent between government and foreign

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<sup>14</sup>Notice that once again I substituted for  $i = eb + f$  considering that the maximum reinvestment constraint  $i \leq 1$  is not binding in equilibrium. This simplification requires to impose a slightly stricter condition on the parameters of the model than condition (iii). Namely,

$$(iii') \quad 1 + \pi_H < \gamma \frac{A + \pi_H(1 + \theta_H \rho)}{2}.$$

bonds, but strictly prefer the former. This follows from the fact that the repayment policy of the government is procyclical and this guarantee to entrepreneurs saving in government bonds greater liquidity when the return on additional investment is higher. Then, by substituting one foreign bond with an equally costly amount of government bonds, entrepreneurs can increase their expected revenues by  $(\theta_H - 1)\rho > 0$ . Given that the borrowing constraint must be binding for the same argument as before, maximization of the above program yields:

$$b = \gamma \frac{\frac{A}{2} - 1}{\pi_H (1 - \gamma \tilde{\rho}_H)} \quad \text{and} \quad f = 0. \quad (1.13)$$

Consider now the problem of the benevolent government, which has to choose taxation and debt issuance at date 0 in order to maximize the social welfare function

$$W = \frac{1}{2}\Pi(e) + \frac{1}{2}(w - \tau(e)) + \rho_G g \quad (1.14)$$

where  $\tau(e)$  denotes the expected value of date 1 taxation. The government budget constraint implies that  $\pi_H(\frac{1}{2}b + b^*) = g$  and  $\tau(e) = \pi_H(\frac{1}{2}b + b^*)$ . Finally, in absence of government commitment, future repayment must be incentive compatible in at least one state of nature. Using (1.8), this condition implies the following limit of external debt,

$$b^* \leq \frac{1}{2} \frac{\tilde{\rho}_H - 1}{\tilde{\rho}_H + 1} b. \quad (1.15)$$

Maximization of the social welfare function implies that the government issues an amount of debt that is consistent with future repayment only in the good state of the economy. By doing so, indeed, the government can attract the demand for bonds by domestic entrepreneurs and, as the ex-post cost of default will increase, this will also increase foreign demand for bonds.<sup>15</sup> In the limiting case in which the incentive compatibility constraint is binding, i.e. the return on the public project exceeds the cost of taxation also in the good state, the level of external government debt is pinned down by the level of domestic government debt, as implied by (2.5).

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<sup>15</sup>The government has a further incentive to issue external debt other than increase public investment. Indeed, future sovereign default increases the contingency of government bonds and raises the revenues of entrepreneurs (see Zame (1993) and Allen and Gale (2004b) for similar arguments).

## b Discussion

The previous section shows that (i) sovereign debt arises even in absence of “classic” default penalties and that (ii) default triggers a liquidity crunch in the adverse state and increases output volatility. These results require some discussion.

- Domestic agents, either firms or banks in the alternative interpretation, prefer government bonds to foreign bonds given that the government repays when economic conditions are good and returns from investment are high. Admittedly, preferences play a crucial role here. This result is true when the degree of risk aversion is zero or sufficiently small, but it does not survive when risk aversion increases. Then, the nature of future liquidity needs has an effect on the domestic demand for sovereign bonds. The previous model could represent a fair description of reality if banks store liquidity mainly to finance future investment opportunities. However, this model would provide little intuition if most liquidity needs are in the form of consumer loans. However, it is important to keep in mind that the government would have an incentive to foster the internal demand for bonds in order to relax its borrowing constraint, e.g. by imposing restrictions on capital outflows.
- Liquidity crises arise as government default exerts a negative balance sheet effect on domestic agents. Then, banks cut on loans to rebalance their portfolios and firms are denied credit. A possible critique is that during credit crunches we observe spikes in interest rates. In the model this would imply that banks prefer to transfer resources to the bad state rather than the good state and stop buying government bonds. Yet, crises are also associated with higher informational noise and lemons problems. Then, even if observed interest rates increase, it is not clear whether the average value of liquidity is greater during bad times.
- A key assumption, which has not yet been discussed, is the absence of discrimination in taxation. Without such restriction the government would always default on debt and just redistribute resources from workers to entrepreneurs through taxation. This assumption, however, seems a realistic one, as a similar redistribution scheme generally entails substantial political costs for the government, and represents a common stand in the recent literature (see Broner and Ventura (2006), Guembel and Sussman (2009), Gennaioli et al. (2009)).

## 1.4 Institutional reforms

So far, the main contribution of the paper has been to analyze in an unified framework two common features of emerging markets, i.e. financial market imperfections and sovereign risk, and to study the implications that arise from their interaction. In particular, the key aspects of the model are the following:

- (i) the lack of private collateral, as described in Assumption B.1;
- (ii) the absence of contingent contracts, as described in Assumption B.2;
- (iii) the sovereign risk friction, as described in Assumptions 3 and 4.

First, the lack of collateral restricts domestic firms' access to the spot market at date 1 and creates the need to store reserves of liquidity. Second, the missing market for private insurance implies that domestic entrepreneurs cannot write contingent contracts with the IFM, promising a positive transfer when the firm is unlucky in exchange for a positive payment when the firm is lucky. Third, the sovereign risk friction creates the possibility of future liquidity crises which arise from the opportunistic behavior of the government when economic conditions worsen.

The model is now used to discuss the effects of an improvement in domestic financial markets on the government ability to issue debt. Arguably, more disciplined markets would (i) alleviate the lack of collateral, i.e. higher  $\gamma$ , and (ii) improve the ability of the domestic private sector to enter in contingent contract with the IFM. The first point is controversial. As discussed by a vast literature in macroeconomics, collateral constraints play an important role also in developed countries.<sup>16</sup> Then, the following section focuses exclusively on the second point.

### a Contingent contracts

Suppose the government can undertake a reform that affects domestic access to contingent contracts offered in the frictionless IFM. More specifically, the government can

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<sup>16</sup>The financial accelerator literature, e.g. Bernanke and Gertler (1989), Bernanke et al. (1999), Kiyotaki and Moore (1997), shows that the existence of collateral constraints helps to replicate some aspects of the business cycle that cannot be explained in presence of perfect capital markets.



choose the fraction  $\lambda$  of firms that can enter into contingent contracts with the IFM. I will henceforth refer to these firms as “sophisticated” firms to distinguish them from “naive” firms, which have no access to contingent contracts. An interpretation for the two types of firms is provided later. Clearly, the government faces a trade-off in choosing  $\lambda$ . An increase in the share of sophisticated firms in the economy would entail clear benefits providing a more efficient way to insure against adverse shocks for domestic firms. Yet, this would restrain the government ability to issue public debt, by reducing the number of naive firms that can only save in government bonds.

In order to explore the consequences of a change in  $\lambda$ , it is convenient to abstract from the aggregate productivity shock in the model and focus only on the idiosyncratic expenditure shock. Then,  $\theta$  is set to one. As a result, there would be no sovereign default in equilibrium. Nonetheless, the amount of government debt would still depend on the ex-post cost of default, which is ultimately determined by the bond holdings of local firms.<sup>17</sup>

## Equilibrium

Suppose that sophisticated firms can buy from the IFM a contingent security that promises one unit of the good in case of expenditure shock at date 1. This is equivalent to assume that they have access to a contingent credit line from foreign intermediaries. Let  $x$  denote the quantity of contingent securities purchased by each sophisticated firm, which are traded at the actuarial fair price  $q = \frac{1}{2}$ . Substituting for  $x$  and  $q$  in (1.1)-(1.4), it is easy to see that sophisticated firms choose not to hold government bonds and get an expected revenue,

$$\Pi_S = \frac{A}{2} - 1 + \frac{\rho - 1}{1 - \gamma\rho} \left( \gamma \frac{A}{2} - 1 \right) - \frac{1 + \rho}{2} \tau. \quad (1.16)$$

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<sup>17</sup>As discussed before, in absence of sovereign default, government and foreign bonds are perfect substitutes. Yet, I assume that local firms save only in government bonds. As extensively discussed above, this assumption is only necessary when there are no aggregate shocks. Finally, the relative revenue of global and local firms are unaffected by the exclusion of aggregate shocks, as contingent contracts could be made contingent on the aggregate productivity shock as well.

The expected revenue of naive firms is instead,

$$\Pi_N = \frac{A}{2} - 1 + \frac{\tilde{\rho} - 1}{1 - \gamma\tilde{\rho}} \left( \gamma \frac{A}{2} - 1 \right) - \frac{1 + \rho}{2} \tau. \quad (1.17)$$

where  $\tilde{\rho} = \frac{1+\rho}{2}$ . Given that  $\rho > 1$ , the expected revenue of sophisticated firms is higher than the expected revenue of naive firms. Then, the marginal benefit from the reform is given by  $\Pi_S - \Pi_N > 0$ .

Let's now turn to the problem of the government, which now chooses the investment  $g$  in the public project and the fraction  $\lambda$  of sophisticated firms. The social welfare function is,

$$W = \frac{1}{2} \left( \lambda \Pi_S + (1 - \lambda) \Pi_N \right) + \frac{1}{2} (w - \tau) + \rho_G g. \quad (1.18)$$

Public investment is financed by issuing debt and collecting taxes at date 1, i.e.  $\frac{1-\lambda}{2}b + b^* = g$  and  $\tau = \frac{1-\lambda}{2}b + b^*$ . As in the previous section, future repayment by the government requires the following incentive compatibility constraint,

$$b^* \leq \frac{1 - \lambda}{2} \frac{\tilde{\rho} - 1}{\tilde{\rho} + 1} b. \quad (1.19)$$

Let's suppose once again that the government is willing to borrow as much as possible to finance the public project, as implied by condition (1.7). The incentive compatibility constraint (1.19) is binding and can be substituted into (1.18) together with the government budget constraint. Then, the first order condition with respect to  $\lambda$  implies the following,

$$\begin{cases} \lambda = 0 & \text{if } \kappa \rho_G \geq (\Pi_S - \Pi_N) \\ \lambda = 1 & \text{if } \kappa \rho_G < (\Pi_S - \Pi_N) \end{cases}$$

where  $\kappa = \frac{\tilde{\rho}b}{\tilde{\rho}+1}$  is the marginal increase in public investment with respect to  $\lambda$ . The above result then implies that the government's incentive to undertake a legal reform is positively related to the average return on private investment and negatively to the return on public investment.

## b Discussion

It is widely accepted that legal institutions are crucial to foster economic development. Yet, institutions show also a strong persistence, with poor countries being particularly resilient to legal reforms despite substantial benefits. To the best of my knowledge, the previous literature addresses the strong persistence in institutions emphasizing either the role of initial conditions that are extremely costly to revert (e.g. the legal origin literature pioneered by ) or political economy arguments according to which the economic elite is willing to maintain the *status quo* to reduce competition (e.g. ). The model presented in the previous section does not share these features of the literature, given that reforms have no exogenous costs and the government is benevolent, but has similar implications. In particular, when sovereign risk is considered, legal reforms, that expand the range of contracts the agents can sign, are not necessarily pareto-improving since they reduce the provision of public goods by the government.

Far from making a normative statement on financial reforms, the model provides an explanation for why some countries tend to adopt legal standards that increase the appetite of domestic agents for government bonds. Mishkin (2006) reports the example of Argentina, where bank reserve requirements clearly privileged government bonds by classifying them as “*being the least risky of all assets that a bank could hold*” and by successively raising the share of government bonds in total reserves to allow the central government to collocate additional debt.

A natural question to ask is whether the government can affect domestic demand for government bonds through other channels. One possible channel is the interest rate paid on bonds. Indeed, the government could encourage domestic demand for government bonds by raising interest rates and lowering the opportunity cost of holding liquidity. However, in presence of increasingly integrated bond markets is not clear whether the government would be able to affect the interest rate as agents will try to exploit arbitrage possibilities.

## 1.5 Empirical Evidence

As discussed in previous sections, sovereign default triggers a liquidity crisis within the economy. Although the model takes a representative agent perspective, it is natural to

think that firms with larger liquidity needs will experience sharper consequences in the event of default. In this section, I provide cross-country, cross-industry empirical evidence that is suggestive of the mechanism emphasized by the model. More specifically, the empirical strategy consists in using cross-country data on manufacturing sectors to test whether industries highly dependent on external finance and with large working capital needs experience sharper contractions in the event of default. Since the seminal contribution of Rajan and Zingales (1998), scholars have been looking at the performance of industries with different reliance on financial intermediation in order to derive implications on the real effects of cross-country, cross-time variation in financial institutions. In this paper, I apply a similar methodology to inspect whether industries with high liquidity needs and strong dependence on external finance experience a disproportionate output contraction in the event of default, as suggested by the theoretical model.

Nevertheless, it is fair to say that the empirical analysis here performed cannot be considered as a proper test of the model, but rather a way to provide empirical evidence consistent with its predictions. Indeed, there exist alternative theories that predict a disproportional effect of sovereign default on industries that rely on external sources of finance. In particular, if a sovereign default provokes a sudden stop in foreign lending, financially dependent industries would likely suffer the most. In this case, the empirical evidence would be consistent with the prediction of my model, but the mechanism in place would be different from the one I suggest. As commonly recognized, the identification of the exact nature of the costs associated with sovereign default is not an easy task, given that such costs could arise either from direct sanctions, loss of access to international markets or, as here supposed, from an economy-wide liquidity crisis.<sup>18</sup> One advantage of using the cross-industry variation within each country is that it is possible to control for country-wide characteristics, as for instance the degree of capital account liberalization (and thus the effects captured hold for any level of penetration of foreign financial institutions in the domestic credit market). Yet, although this methodology permits to reduce the omitted variable criticism, the reader should be aware of potential identification pitfalls, as above described.

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<sup>18</sup>Refer to Sturzenegger and Zettelmeyer (2006) for a survey of the most influential empirical attempts in this respect.

This empirical hypothesis is tested using the dynamic panel data model,

$$y_{i,c,t} = \alpha_{i,c} + \lambda_{i,t} + \mu_{c,t} + y_{i,c,t-1} + \sum_{\tau=0}^T \left( \beta_{F,\tau} FinDep_i + \beta_{L,\tau} Liq_i + \beta_{X,\tau} X_i \right) \cdot DEF_{c,t-\tau} + \epsilon_{i,c,t}, \quad (1.20)$$

where the (log) value added in industry  $i$  of country  $c$  in time  $t$ ,  $y_{i,c,t}$ , is fitted using the lagged dependent variable to control for mean reverting dynamics and a set of industry-country,  $\alpha_{i,c}$ , industry-time,  $\lambda_{i,t}$ , and country-time,  $\mu_{c,t}$ , fixed effects to control for additional explanatory variables omitted in the regression. Notice that the average effect of default on manufacturing production is captured by the country-time fixed effect  $\mu_{c,t}$ . Lastly, the above specification includes a set of interaction terms constructed using a default indicator  $DEF_{c,t-\tau}$ , which takes a value of one if country  $c$  defaulted  $\tau$  years ago, and a variety of industry characteristics. In particular,  $FinDep_i$  is a measure of an industry's dependence on external finance,  $Liq_i$  is a measure of an industry's need for liquidity and  $X_i$  is a variable set of additional industry characteristics which is used to check the robustness of the results to the inclusion of further controls. An important aspect of this specification is that both financial dependence and liquidity needs are computed using data on US industries and do not vary across countries. This assumption is standard in the empirical literature that built on Rajan and Zingales (1998). The economic justification for using a country-invariant index based on US data (where financial frictions are arguably negligible) is to isolate technological differences that affect each industry's demand for both external finance and liquidity from country characteristics that affect their supply (as for instance different degrees of financial development).<sup>19</sup> Furthermore, as long as those technological differences are likely to persist across countries, these US-based indexes are valid proxies for the relative financial needs of industries based in other countries. Given that  $FinDep_i$  and  $Liq_i$  take higher values when an industry shows greater financial dependence and higher liquidity needs, negative coefficients on the interaction terms, i.e.  $\beta_F < 0$  and  $\beta_L < 0$ , suggest that this industry experiences sharper output losses in the event of default.

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<sup>19</sup>See Rajan and Zingales (1998) for a similar justification.

## a Econometric methodology

This subsection describes the econometric methodology applied to estimate equation (1.20). First, I remove the industry-time effects,  $\lambda_{i,t}$  and the country-time effects,  $\mu_{c,t}$ , by industry-time and country-time differencing prior to estimation, i.e. all instruments and all regressors are differenced by subtracting the mean for each industry and each time period and then by subtracting the mean for each country and each time period. In particular, the average effect of default on all industries in a given country is captured by the country-time effect  $\mu_{c,t}$  and therefore does not appear in the final results. Second, the presence of the lagged dependent variable among regressors affects the consistency of the within estimator used in static panel data. As reviewed in Bond (2002), the standard procedure in dynamic panel data models is then to use a Generalized Method of Moments (GMM) estimator after first-differencing the data (with the exception of the terms interacted with the default dummy in this particular study) in order to eliminate the industry-country fixed effects. This method was first proposed by Holtz-Eakin et al. (1988) and Arellano and Bond (1991). As instruments to set the identifying moment conditions, I use the first lag the lagged dependent variable, taken in levels. Instead, the interaction between the default dummies and the industry characteristics are assumed to be fully exogenous and, to the extent that the model is already over-identified, are not used as instruments.<sup>20</sup> In addition, a number of statistical tests apply to control the validity of the assumptions on which the GMM difference estimator is based, as suggested by Arellano and Bond. The first is a Sargan test of overidentifying restrictions that tests the validity of the instruments. The second is a test of second-order serial correlation in the error term. Baltagi (1995) (p. 131), indeed, stresses that a crucial assumption to apply this method is that the differenced error term is MA(1) and therefore its autocorrelation must fade away after the first lag.

## b Data

Data on manufacturing industries are obtained from the INDSTAT3 2005 database available from the United Nations Industrial Development Organization. The UNIDO

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<sup>20</sup>In particular, I would like to stress that the sovereign default represents an exogenous shock in the dynamics of sectoral outputs. Indeed, this assumption would fail only if governments repudiate their debt when financially dependent industries perform relatively poorly. Though, this appears to be quite unrealistic since a default possibly reflects a widespread economic downturn rather than a localized sectoral contraction.

database reports annual data for value added in each manufacturing sector at the 3-digit ISIC classification for a broad sample of countries starting from the 1960s. Original data in current US dollars are first converted in constant prices using the US GDP deflator, as reported in the World Bank's *World Development Indicators 2006*. As reported in the data appendix, I impose some restrictions to the original data in order to reduce measurement errors and sporadic observations. This is a standard procedure in previous studies employing the same database, which tend to be quite noisy.

As in Rajan and Zingales (1998), the financial dependence index,  $FinDep_s$ , measures the share of investment that is not financed with cash flow from operations. I take the data from Kroszner et al. (2007), who report the Rajan and Zingales' index over the period 1980-1999 on a three-digit ISIC level (rather than a mixture of three-digit and four-digit levels). Based on U.S. publicly listed firm data, this index arguably reflects technological characteristics of industries that are relatively stable across space and time. The original data are, then, normalized such that they range from 0 to 1, with a higher number indicating greater financial dependence. This eases results readability.

The measure of industry liquidity needs,  $Liq_s$ , is defined following Raddatz (2006). His measure is computed as the median ratio of inventories over annual sales of US public manufacturing firms from Compustat, in the same spirit as the Rajan and Zingales' measure of external dependence. This ratio captures the fraction of inventories that can be financed with ongoing revenue and, arguably, is particularly suitable for capturing technological aspects that shape liquidity needs. In particular, firms' needs for working capital raise with the spell of the production process: indeed, the longer the production process the larger is the value of inventories over current sales. Once again, I take the data from Kroszner et al. (2007), who report the Raddatz index over the period 1980-1999 on a three-digit ISIC level (rather than a four-digit level as in the original Raddatz measure). Notice that the correlation between the external dependence index,  $FinDep_s$ , and the liquidity needs index,  $Liq_s$ , is low (0.09) and not statistically different from zero, suggesting that the two index capture different aspects of an industry's financial needs. In particular, the Raddatz measure is specifically designed to capture very short term working capital needs, while the Rajan and Zingales index represents a broader measure of financial needs which does not necessarily distinguish between the short-term and the long-term horizon.

In order to control for additional industry characteristics,  $X_s$ , that might affect industry performance in the event of default, I include in the main specification the interaction terms between the default indicator and two more industry-specific indexes: namely, an index of assets' tangibility,  $Tang_s$ , and an index of export orientation,  $ExpOr_{s,c}$ . The former index is computed as the median ratio of fixed assets over total assets for US firms in the period 1980-1999 at the 3-digit ISIC classification and is taken from Kroszner et al. (2007). The latter index is instead measured at the country-industry level, as in

$$ExpOr_{s,c} = \frac{1}{T} \sum_{t=1980}^{1980+T} \frac{Exports_{s,c,t}}{Output_{s,c,t}}.$$

In words,  $ExpOr_{s,c}$  is the average share of exports over total sales. Notice that the export orientation index cannot be computed using only US data, as the other industry characteristics. Indeed, the crucial assumption in the Rajan and Zingales methodology is that the rank of US industries based on financial needs is maintained across all countries (if an industry is more financially dependent in the US it is likely to be more financially dependent also in Argentina). Whilst this assumption is reasonable when it refers to financial needs, it is likely to be rejected when we look at industries' export orientation since technological factors do predict that the export orientation of industries in different countries is shaped by country-specific comparative advantages (if a US industry exports more with respect to other industries, this does not imply that the same industry in Argentina will export more than other Argentine industries). The data source used to construct the export orientation index is Nicita and Olarreaga (2001), who report export and import values for each ISIC industry.

Data on default episodes are sourced from the Standard and Poor's sovereign default database, as reported in Beers and Chambers (2002). This database includes all sovereign defaults on loans or bonds with private agents between 1975 and 2002, and reports the period during which the debtor government remained in default. The immediate effect of default is captured giving a value of one to the dummy variable in the first year of each default episode. Finally, the resulting sample includes 28 manufacturing sectors in a cross-section of 108 countries over the period 1980-2002, although the sectoral representation can vary across countries and years.



## c Results

Table 2 reports the one-step first-differenced GMM estimates of (1.20) where I do not include positive lags for the default indicator (i.e.  $T = 0$ ) in order to focus on the instantaneous effects of default. Furthermore, table 2 reports the main estimates for 1980-1990 sample and for the 1990-2002 sample to check the time stability of the key coefficients over the two periods. Notice, first, that the autocorrelation coefficient  $\rho$  is statistically significant and pretty stable over the different specifications. A back-of-envelope calculations suggests that temporary shocks to sectoral output are quite persistent over time, with an implied persistency of about three years.

Turning to the interaction between sovereign default and industry characteristics, the point estimates of  $\beta_F$  and  $\beta_L$  have negative sign over all specifications and this result suggests that industries with high dependence on external finance and high liquidity needs experience a disproportionate contraction in the event of sovereign default. Yet, the results also show that this effect is statistically significant and robust to the inclusion of additional industry controls only in the sub-period 1990-2002. This result does not imply a rejection of the theoretical model, but, possibly, a stronger support for it. Indeed, a crucial assumption in the model, namely the non-discrimination between foreign and domestic bond holders, suits more realistically the institutional set-up of sovereign debt markets in the 1990s. As noted by Broner and Ventura (2006), during the 1980s most sovereign borrowing was granted by foreign financial institutions in the form of syndicated bank loans, whilst private national financial markets were highly segmented. *“This institutional setup clearly facilitates ex-post discrimination, as governments can choose not to pay foreign banks without interfering with domestic asset trade.”* During the 1990s, instead, many governments in emerging markets started to issue debt in the form of anonymous bonds, which are highly traded in secondary markets. In these economies, governments usually fail to keep track of the large volumes of transaction in public bond secondary market and end up with almost no information of the ultimate holders of debt (Panizza (2008)). Finally, notice that the effect captured by coefficient  $\beta_1$  is also economically significant, as it implies that, in the first year of a default episode, the level of output in the most financially dependent sector (Transportation equipment) is roughly a 27 percent lower than the output in the least financially dependent one (Tobacco), after controlling for additional industry characteristics.

Finally, I inspect whether the effect of default on different industries is persistent over time by adding up to 2 lags of for interaction terms between the default indicator and each industry characteristics to the baseline specification (1.20). The results are reported in table 3. In particular, the results obtained suggest that the disproportional effect of sovereign default on financially dependent industries decays very rapidly, as the coefficient on the lagged interaction terms are never statistically significant.

In conclusion, the evidence shows that default episodes are associated with a disproportional output contraction in industries that rely extensively on external sources of finance. In particular, there is no significant evidence suggesting that sovereign default determines a decline in industries where the demand for external finance is specifically targeted to the very short-term. Yet, while the theoretical model suggests that sovereign default might be connected with a widespread credit crunch within the economy, it does not univocally predict whether the consequences of default are different between industries with short or medium term liquidity needs.

## 1.6 Conclusion

Sovereign debt crises in emerging markets are usually associated with financial turmoil and liquidity crises throughout the economy. This connection is suggested by both anecdotal and empirical evidence. In particular, defaults episodes appear to lead banking crises. However, there is no clear evidence supporting the application of foreign penalties when default occurs.

This paper then proposes a novel mechanism linking sovereign defaults with liquidity and banking crises without any intervention of foreign creditors. The model considers a standard unwillingness-to-pay problem assuming that: (i) the enforcement of private contracts is limited and, as a result, public debt represents a source of liquidity; (ii) the government cannot discriminate between domestic and foreign agents. The model shows that external debt might emerge even in absence of classic penalties imposed by foreign creditors. Indeed, the prospect of triggering a liquidity crisis throughout the economy restores the ex-post incentive to pay of the government. Nonetheless, liquidity crises might arise when economic conditions deteriorate and the government chooses opportunistically to default in order to avoid the repayment of foreign agents.

This paper then contributes to a recent strand of the sovereign debt literature that focuses on the direct consequences of sovereign default on the domestic economy, most notably Broner and Ventura (2006). Yet, the mechanism and, thereby the consequences arising in the event of default, differ from the one highlighted by these authors. In their setup, a sovereign default leads to an undesirable redistribution of resources within the economy. In my model, instead, sovereign default leads to a disruption of private investment. Along different lines, these two papers suggest a remarkable policy implication: as they show that the source of the costs associated with default is to be looked for in the direct consequences on the domestic private sector and not in foreign penalties, these papers provide a theoretical underpinning for crises resolution policies that refuse to sacrifice domestic claims to service external debt.

Finally, this paper provides a fully-fledged framework to think about domestic legal and institutional reforms. Different types of reforms are considered and, for each one of them, the implications on international capital flows are remarked. In particular, the model shows that government's incentive to undertake a legal reform is positively related to the average return on private investment and negatively to the return on public investment. The paper then suggests a possible explanation for cross-country and cross-time variation in legal institutions which differs from studies stressing political economy issues.

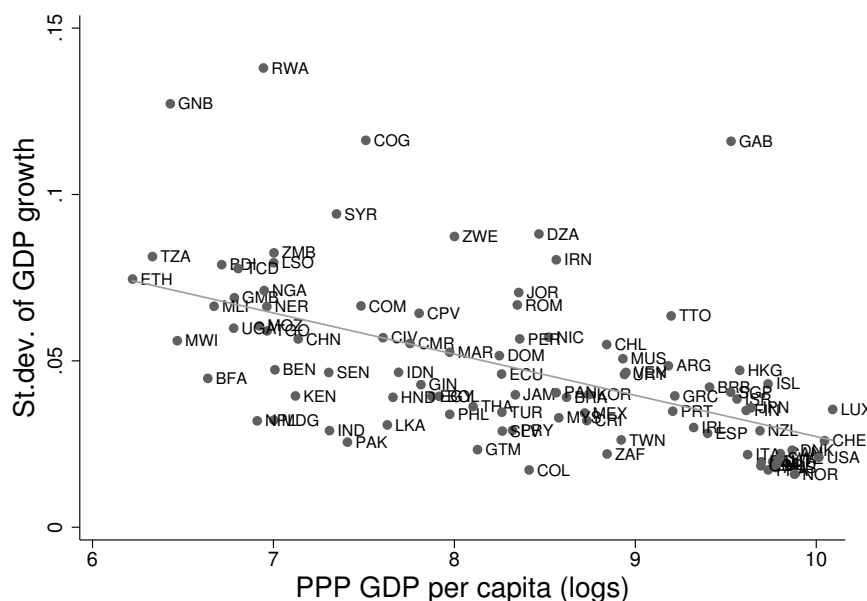


## 2 SUPPLY CONTRACTS, TECHNOLOGICAL DIVERSIFICATION AND VOLATILITY

### 2.1 Introduction

It is well known that the growth process of developing countries over the past four decades has been more volatile than the growth process of developed countries. Figure 1 plots the standard deviation of per capita income growth against average income per capita for a large sample of countries over the period 1960-2000 and shows that the two variables relate negatively.

Figure 2.1: **Aggregate Volatility and Development**



Notes: The plot shows the standard deviation of the growth rate of GDP per capita over the period 1960-2000 against the average GDP per capita in 2000 PPP dollars over the same period.

Identifying the sources of volatility differences across developed and developing countries represents a crucial task in the macroeconomic research agenda for several reasons: aggregate volatility, indeed, depresses growth (Ramey and Ramey (1995)), raises inequality (Laursen and Mahajan (2005)) and, in presence of financial market imperfections, causes substantial welfare costs.

There are two ways to interpret the negative relation between growth volatility and income levels. The first view focuses on country-specific shocks, arguing that poor countries are characterized by greater macroeconomic risk due to their lack of political stability and their strong reliance on commodity production. Yet, countries differences in aggregate volatility are only partially explained by differences in political and monetary stability and natural resources endowments (e.g. Kraay and Ventura (2007)). The second view focuses on sector-specific shocks and compositional effects, suggesting that high volatility in poor countries simply reflects specialization in sectors that are intrinsically more volatile. Empirically, both arguments find strong support suggesting that the two views are complementary. Indeed, Koren and Tenreyro (2007b) report that country-specific shocks explain half of the differences in volatility between developed and developing countries, while the remaining half is accounted for by differences in sectoral composition.

The aim of my paper is to analyze the sources of such compositional effects and to propose an explanation for why developing countries tend to specialize in more volatile sectors. The premise for the theory is twofold. On one side, this paper takes a technological view of volatility differences between sectors, which arguably depends on the diversification of input-output structures across many intermediate inputs. On the other side, given that more diversified sectors usually show greater contract intensities as producers need to deal with a wider range of suppliers, this paper recognizes that institutional quality can be a source of comparative advantages and specialization in production.

More specifically, my paper augments a North-South Ricardian model of international trade in two respects. First, I consider that the economy can produce a continuum of final goods and that final goods production requires a continuum of intermediate goods, which are subject to imperfectly correlated productivity shocks. Then, final output is less volatile in sectors where the production technology uses a relatively large number of intermediate goods. Second, I introduce contracting frictions using the incomplete contract framework, as in Williamson (1985) and Grossman and Hart (1986). In particular, I consider that final producers (upward firms) outsource intermediate goods to downward suppliers (downward firms) and that intermediate goods are relationship-specific. When parties cannot write ex-ante enforceable contracts, this situation leads to the well-known hold-up problem, where parties bargain over the division of revenues from production. Assuming that contract enforcement is weaker in South, in this region

upward firms experience a cost disadvantage in sectors where the number of intermediate inputs, and therefore contract intensity, is greater. The model, then, proposes a view where legal institutions represent a source of comparative advantage across sectors with different output volatility.

The model then studies the consequences of an improvement in legal institutions in South and points out two opposing effects. On one hand, a better contract enforcement improves efficiency in production, expanding both the specialization set of South towards less volatile sectors and raising the relative wage in South. On the other hand, this improvement has an additional effect which might lead to divergence, rather than convergence, in aggregate income across North and South. As shown in the model, weak contract enforcement implies that the price of intermediate varieties in South includes a markup over marginal cost, which is transferred into an higher price for final goods. Then, weak contract enforcement in South leads to an income redistribution from North consumers to South firms. This result resembles the welfare implications of an improvement in institutional quality obtained by Levchenko (2007) by merging an Heckscher-Ohlin-Ricardo model of international trade with the incomplete contract literature.

Data seems to give support to the two crucial assumptions that drive the results of the model. The first set of empirical evidence shows that sectoral output volatility is significantly and negatively correlated with the number of intermediate inputs used in each sector. Sectoral output volatility is measured as the standard deviation of the cross-country average growth rate of value added per worker in each sector using UNIDO data on a set of 28 manufacturing sectors and 45 countries, where the number of intermediate inputs in each sector is measured using US input-output tables in order to capture pure technological differences across sectors. This result is closely related to a very recent evidence provided by Krishna and Levchenko (2009) using only US data. The second set of empirical evidence shows that countries with better institutions tend to export relatively more in sectors that use a relatively large number of intermediate inputs, consistently with the idea that legal institutions represent a source of comparative advantage between sectors with different degrees of contract intensity. This evidence is closely related to Nunn (2007), who focuses on the fraction of inputs that are relationship-specific rather than on the number of inputs.

My paper is closely related to the literature that studies the effects of trade integra-

tion on income volatility. Past studies (e.g. Easterly, Islam, and Stiglitz (Easterly et al.), Bejan (2006), Cavallo (2007), di Giovanni and Levchenko (2006), di Giovanni and Levchenko (2008), among others) have addressed this topic mainly from an empirical point of view. Trade openness appears to raise income volatility, especially in developing countries, as a consequence of specialization and vulnerability to external shocks. Theory, however, is still lacking behind. One exception is Kraay and Ventura (2007). These authors propose a model where comparative advantage leads developed countries to specialize in sophisticated industries while developing countries specialize in traditional industries. The two industries differ with respect to their market structure, rather than their intrinsic volatility as assumed in my model. Then, as sophisticated industries face more inelastic demand, fluctuations in supply cause opposing changes in prices which stabilize income growth in developed countries. Recently, Krishna and Levchenko (2009) have taken a stand that is very close to my paper. These authors argue indeed that institutional quality represents a source of comparative advantage across sectors with different level of complexity. As complexity is negatively related to output volatility, developing country specialize in more volatile sectors. Finally, my paper also contributes to a wider literature that studies the factors linking volatility and development (e.g. Greenwood and Jovanovic (1990), Saint-Paul (1992), Obstfeld (1994), Acemoglu and Zilibotti (1997), Koren and Tenreyro (2007a)). These paper, however, do not explicitly address the consequences of trade integration on income volatility.

The remaining of the paper proceeds as follows. Section 2 presents the empirical evidence that serves to motivate the theoretical analysis. Section 3 presents the model and section 4 concludes.

## 2.2 Motivating evidence

This section describes a twofold empirical evidence, which suggests that: i) sectors that use a relatively small number of intermediate inputs are characterized by larger fluctuations in productivity; ii) country with better institutions tend to export relatively more in sectors that use a large number of intermediate goods. This evidence is then used to motivate a theoretical model suggesting that legal institutions represent a source of comparative advantage among sectors with different intrinsic volatilities.



The first set of evidence studies the relation between the number of intermediate inputs used in each sector and the volatility of global sector-specific productivity shocks. Following Koren and Tenreyro (2007b), global sector-specific productivity shocks can be identified using the following decomposition for the growth rate of value added per worker in each manufacturing sector  $s$  and country  $c$ :

$$g_{s,c,t} = \gamma_{s,c} + \lambda_{s,t} + \mu_{c,t} + \epsilon_{s,c,t}. \quad (2.1)$$

The first component,  $\gamma_{s,c}$ , captures the long-term trend in the growth rate of value added per worker in each sector  $s$  and country  $c$ . The second component,  $\lambda_{s,t}$ , captures global sector-specific shocks, i.e. events that affects the productivity of a specific sector in all countries. Global process innovation or price fluctuations in major production inputs enter in this category. The second component,  $\mu_{c,t}$ , captures country-specific shocks, i.e. events that affects the productivity of all sectors in a specific country. Clear examples are labor market reforms or financial liberalizations. The third component,  $\epsilon_{s,c,t}$ , captures all residual shocks, i.e. events that are specific to each sector and each country.

Assuming that the country-specific shocks  $\mu_{c,t}$  are zero on average, i.e.  $\sum_{c=1}^C \mu_{c,t} = 0$ ,<sup>1</sup> it is possible to measure global productivity shocks in each sector as the cross-country average of the innovations in the growth rate of value added per worker with respect to the long term trend, i.e.  $\hat{\lambda} = \sum_{c=1}^C (g_{s,c,t} - \gamma_{s,c})$  for each sector  $s$ . Finally, the “intrinsic” volatility of each sector  $s$ , i.e. the fraction of total volatility of the growth rate  $g_{s,c,t}$  in each sector and country that depends on sector-specific shocks, is measured by  $\hat{\sigma}_\lambda = \sqrt{\frac{\sum_{t=1}^T \hat{\lambda}_t^2}{T}}$ .

Using UNIDO Indstat 2006 data on value added per worker for a panel of 28 manufacturing sectors in 45 countries in the period 1963-2000, it is possible to see that some sectors have been systematically affected by larger fluctuations in productivity growth.<sup>2</sup> Table 4 reports that sectors as Non-ferrous metals, Iron and Steel, Petroleum refineries are at the top end of the most volatile sectors, while sectors as Food products, Printing

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<sup>1</sup>Notice that this is equivalent to express country shocks as relative to the world average

<sup>2</sup>The countries included in the sample are: Australia, Austria, Bangladesh, Belgium, Canada, Chile, Colombia, Denmark, Ecuador, Egypt, Finland, France, Ghana, Greece, Guatemala, Hong Kong, Hungary, India, Indonesia, Ireland, Israel, Italy, Japan, Kenya, Malaysia, Netherlands, New Zealand, Nicaragua, Norway, Pakistan, Philippines, Poland, Portugal, Singapore, South Africa, South Korea, Spain, Sri Lanka, Sweden, Turkey, United Kingdom, United States, Uruguay, Venezuela, Zimbabwe.

and publishing and Other chemicals are at the bottom end.

Let's now see whether the volatility of sector-specific shocks shows a significant correlation with the number of intermediate inputs used in each sector. Indeed, it could be argued that productivity growth should respond more to shocks to individual inputs in sectors with a less diversified input structure, either because idiosyncratic input-specific shocks cannot be diversified across many goods or because input substitution is limited due to technological reasons. Data on the number of intermediate inputs in each sector are sourced from Cowan and Neut (2007), which use US input-output tables to construct a measure of sectoral diversification or complexity. As suggested by Rajan and Zingales (1998), the focus on the United States allows to capture pure technological differences across sectors. In order to control for alternative determinants of sectoral volatility, I use data on capital, skill and natural resource intensity in each sector in the United States. Data definitions and sources for the control variables are reported in Table 4. Figure 2.2 confirms this argument showing that the correlation between the standard deviation of global sector-specific shocks and the number of intermediate goods, conditional on capital, skill and natural resource intensity in each sector, is negative and statistically significant.

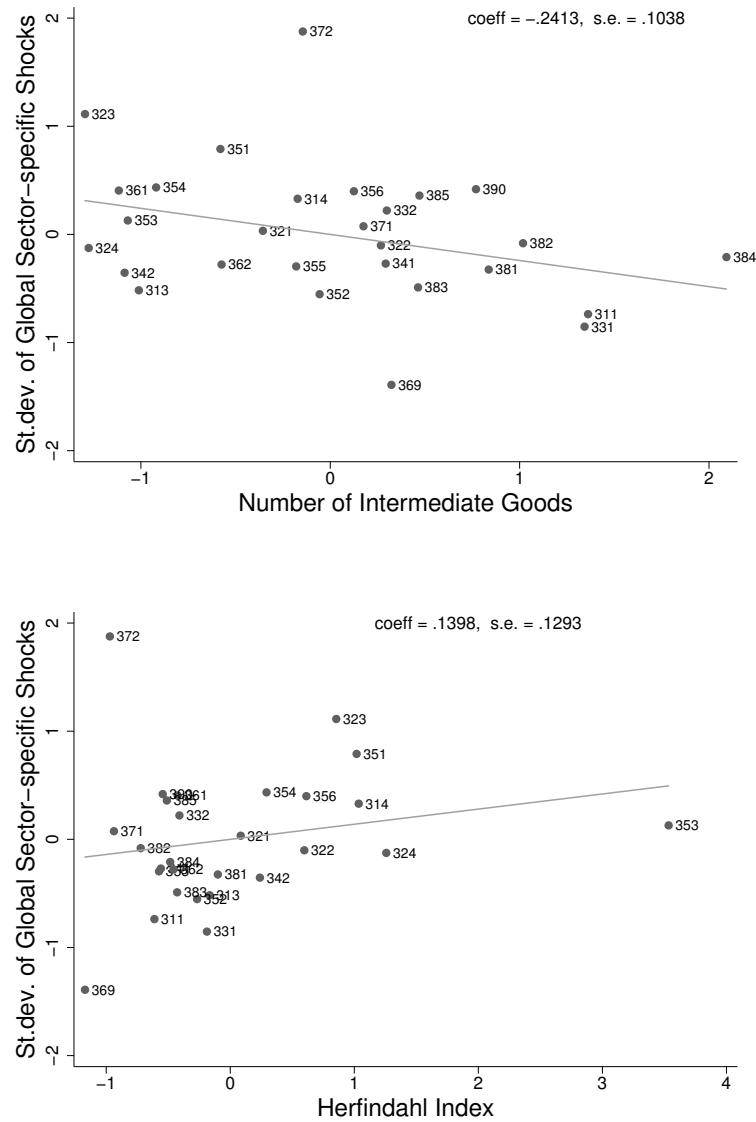
The negative correlation between input diversification and volatility is maintained when I measure input diversification using the Herfindhal index of intermediate good shares. This index measures the level of diversification in each sector using both the number of inputs and the quantity of each individual input effectively used in final production. Given that this index takes high values when input demand is concentrated only in few items, we should expect that the volatility of productivity growth in each individual sector is positively related with the Herfindhal index. As shown by figure 2.2 the partial correlation is positive, although it is not statistically significant.

The second set of empirical evidence studies whether good legal institutions lead to a comparative advantage in sectors that use a large number of intermediate goods. This hypothesis is tested by estimating the following equation:

$$\ln x_{s,c} = \alpha_s + \alpha_c + \beta_1 n_s Q_c + \beta_2 k_s K_c + \beta_3 h_s H_c + \epsilon_{s,c}$$

where  $x_{s,c}$  denotes country  $c$  exports in sector  $s$ ;  $n_s$  denotes the number of inputs used in sector  $s$ ;  $Q_c$  is a measure of the quality of contract enforcement in country  $c$ ;  $h_s$  and

Figure 2.2: Sectoral volatility and intermediate goods



(a)

Notes: The plot provides a graphical representation of the partial correlation between the standard deviation of global sector-specific shocks and a) the number of intermediate goods b) the Herfindahl index of input shares, while controlling for measures of sectoral capital, skill and natural resources intensity.

$k_s$  denote respectively skill and capital intensities in sector  $s$ ;  $H_c$  and  $K_c$  denote country  $c$ 's endowments of skilled labor and capital;  $\alpha_s$  and  $\alpha_c$  capture sector and country fixed effects. This estimating equation is similar to the ones used by Levchenko (2007) and Nunn (2007). Data definitions and sources are as in Nunn (2007). OLS estimates are reported in the first column of Table 5. The estimated coefficient for the interaction between the number of intermediate inputs and institutions quality is positive and statistically significant, suggesting that country with better institutions have on average a comparative advantage in sectors that use a large number of intermediate goods. Finally, the second column of Table 5 reports the two-stage IV estimates, where the first stage controls for the potential endogeneity of legal institutions using data on the legal origins of all countries in the sample.

## 2.3 Model

Consider a world economy that lasts for one period. The world economy is constituted by two regions, North and South, each including a continuum with mass one of countries. Each country has the technology to produce a continuum of final goods, denoted by  $i \in [0, 1]$ , and a continuum of intermediate goods, denoted by  $j \in [0, 1]$ . Final goods are used for consumption and can be traded across countries. Intermediate goods, instead, are used to produce final goods and cannot be traded. Each country is populated by three types of agents: a continuum with mass one of workers/consumers, a continuum of *upward* firms, which produce only final goods, and a continuum of *downward* firms, which produce only intermediate goods.<sup>3</sup> All agents are competitive and risk neutral. Consumers/workers are endowed with one unit of labor and one share of all firms operating in their country and have symmetric Cobb-Douglas preferences over the final goods  $i$ . Lastly, there are no cross-country differences in preferences and technology.

### a Technology

Each upward firm in final good sector  $i$  has access to a Leontief technology that requires one unit of labor and  $m$  units of a composite intermediate good to produce one unit of

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<sup>3</sup>Notice that the number of firms in each country is not fixed but is determined in equilibrium.

final output. The composite intermediate good is produced by each upward firm using a continuum of perfectly substitutable intermediate varieties  $j$ , as described by

$$X = \int_0^{J_i} \theta_j x_j dj$$

where  $x_j$  denotes the quantity of each variety  $j$  used in the production of the composite good  $X$ ,  $J_i$  is the total number of varieties used and  $\theta_j$  denotes a productivity shock on each variety.

Assuming that the shocks  $\theta_j$  are idiosyncratic and are observed only at the end of the period, upward firms can reduce future output volatility by raising the number of varieties  $j$ . Let's now assume that productivity shocks are imperfectly distributed across intermediate goods and independently distributed across countries, as stated by the following assumptions.

**Assumption 5** *In each country there exists a continuum of equally likely states of technology,  $s \in S \equiv [0, 1]$ , which determine the productivity  $\theta_j$  of each intermediate good  $j$ , as in*

$$\theta_j = \begin{cases} \frac{1}{dj} & \text{if } s = j \\ 0 & \text{if } s \neq j \end{cases} .$$

This formalization is similar to Acemoglu and Zilibotti (1997) and Martin and Rey (2004) and captures in a tractable way the main ingredient of the model: expected output is increasing in the number of intermediate goods as a result of a technological diversification effect. Indeed, by raising the number of intermediate good varieties used in final production, upward firms are able to diversify the productivity shocks on each individual variety and reduce fluctuations in future output.

**Assumption 6** *The states of technology  $s$  are independently drawn across countries, both within and across regions.*

Assumption 6 greatly simplifies the analysis, ruling out aggregate uncertainty and making the problem of upward firms in each country perfectly symmetric.

Diversification of productivity shocks among varieties  $j$ , however, is costly. Consider, for instance, that each worker spends time in learning how to use each intermediate

variety. Then, when the number of intermediate varieties is  $J_i$ , each upward firm needs, for each unit of labor used in final production, an additional amount of labor  $\kappa_i C(J_i)$ , where  $\kappa_i$  is increasing in the index  $i$  and  $C(\cdot)$  is a zero-valued, strictly increasing and convex function, i.e.  $C(0) = 0$ ,  $C'(\cdot) > 0$  and  $C''(\cdot) > 0$ . In particular, the parameter  $\kappa_i$  reflects technological differences across final good sectors in the cost of combining different inputs and, as shown below, determines the number of intermediate varieties used in each sector. The convexity of the cost function reflects, instead, the existence of non-linearities in the relation between technological complexity and the cost of technology adoption and guarantees the existence of an internal solution where the mass of intermediate goods used in final production may differ from one.

Upward firms cannot produce intermediate varieties internally. In order to produce the composite intermediate good, then, each upward firm in final good sector  $i$  must purchase  $J_i$  intermediate varieties from an equal number of suppliers, or downward firms, each producing only one intermediate variety  $j$ . Production technology is assumed to be symmetric across all varieties  $j$ , uses only labor and is not subject to productivity shocks, as described by

$$x_j = l_j \tag{2.2}$$

where  $l_j$  denotes the labor used to produce a quantity  $x_j$  for variety  $j$ .

## b Outsourcing, contracts and legal enforcement

The main point of the model is to study how cross-country institutional differences cause comparative advantages and shape specialization across sectors with different levels of intrinsic volatility. To that end, I take two additional and fairly realistic assumptions. The first assumption is:

**Assumption 7** *Each intermediate variety  $j$  used in final production is relationship-specific.*

As shown by Williamson (1985) and Grossman and Hart (1986), the specificity of intermediate varieties can result in a two-sided bargaining process over the division of final output between each downward supplier and the upward firm, commonly known as the “hold-up” problem. The threat of future hold-ups, then, provokes an efficiency

loss in production, as the ex-ante incentives of downward suppliers and upward firms now depend on the ex-post allocation of bargaining powers rather than on the marginal contribution to future output. Yet, incentives can be correctly aligned and the inefficiency removed by writing ex-ante contracts between the two parties. In this model, I consider that the quality of contract enforcement differs across the two countries.

**Assumption 8** *In North there is complete contract enforcement, while in South courts enforce contracts only with probability  $0 < \phi < 1$ .*

It is now convenient to describe the timing of events in order to clarify the structure of the model.

1. Each upward firm in the final good sector  $i$  in North (South) chooses the number  $J_i$  ( $J_i^*$ ) of intermediate varieties to use in final production and outsource the production of each variety to a single supplier chosen among the competitive pool of downward firms. Due to symmetry, each outsourcing contract specifies a quantity  $x_i$  ( $x_i^*$ ) and a price  $\tau_i$  ( $\tau_i^*$ ) for each variety  $j$  used in the final sector  $i$ .
2. In North, contracts are enforced and each supplier must deliver the quantity  $x_i$  at unit price  $\tau_i$ . In South, instead, only a fraction  $1 - \phi$  of suppliers is forced by courts to deliver the quantity  $x_i^*$  at unit price  $\tau_i^*$ . The remaining fraction  $\phi$  can renege on the initial contract and bargains with the upward firm over the price  $\hat{\tau}_i^*$  of each unit of the intermediate variety produced.
3. The state of technology in each country is observed and the upward firm produces only if the state of technology is  $s \in [0, J_i]$  ( $s \in [0, J_i^*]$ ). Given that states of technology are independently drawn across countries, in North (in South) upward firms can produce only in a mass  $J_i$  ( $J_i^*$ ) of countries.

Let's now provide a short intuition for the inefficiency created by the enforcement friction. Notice first that the assumptions of the model permit to focus exclusively on the investment of upward firms in technological diversification (which ultimately determines the number of intermediate varieties used in final production). Indeed, given the Leontief technology, downward firms produce a constant quantity  $m$  for each intermediate varieties, independently of the quality of contract enforcement in the contract. Consider first the benchmark case of North. In this case, the price of each intermediate variety is specified ex-ante by the contract and are set at marginal costs due to perfect

competition among the pool of potential suppliers. Upward firms then can fully appropriate production rents and choose the number of intermediate varieties to maximize expected profits. In South, instead, upward firms know that they would have to share future production rents with a fraction of their suppliers. Then, they internalize just a fraction of expected profits and reduce investment in technology adoption. As discussed later on with further details, this lead to a positive gap between the production costs of South and North, which increases with the number of intermediate varieties or contract intensity of each final good sector.

## c Equilibrium

In this section I solve for the equilibrium of an integrated economy where there are no barriers to trade in final goods. Recall that cross-country symmetry within each region allows to focus on a simple North-South equilibrium, where the only source of comparative advantages is the difference in contracts enforcement. Let's now begin the equilibrium analysis from the supply side of, respectively, North and South, taking factors prices as given.

### Supply side in North

Consider a final good sector  $i$  in a given country in North. Set the amount of labor used in final production by each upward firm equal to one.<sup>4</sup> Then, each firm needs at least  $m$  units of the composite intermediate good to produce one unit of final output. Given that the varieties  $j$  are subject to idiosyncratic shocks, the upward firm maximizes expected profits by setting the quantity of each variety to  $x_j = m$  and by choosing a number  $J_i$  of varieties that satisfies

$$p_i = w \left( m + \kappa_i C'(J_i) \right), \quad (2.3)$$

where I have already substituted for the equilibrium price of each intermediate variety, i.e.  $\tau_i = w$ . Condition (2.3) states that the expected marginal gain from raising the

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<sup>4</sup>This assumption is without loss of generality as there are constant returns to scale in production. It only ensures that in the general equilibrium we can solve for the number of firms in each sector  $i$  rather than for total production.



number of intermediate varieties by one unit must be equal to its marginal cost, which is given by the sum of the price paid to downward firms for each variety  $j$  and the marginal increase in the cost of technology adoption. Furthermore, expected profits of upward firms are equal to zero in equilibrium due to free entry in each final good sector and the following condition must also hold:

$$p_i = w \left( m + \frac{1 + \kappa_i C(J_i)}{J_i} \right). \quad (2.4)$$

Combining conditions (2.4) and (2.3), it is possible to pin down the number of intermediate varieties  $J_i$  and the equilibrium price  $p_i$  for any final good  $i$  produced in North for any given labor wage  $w$ . Clearly, the number of intermediate varieties is decreasing in the parameter  $k_i$ , which measures technological differences across sectors in the cost of combining intermediate inputs in final production. Henceforth, it will be convenient to reorder the final good sectors such that  $\kappa_i$  is decreasing in  $i$  and, thus, the number of intermediate goods is increasing in  $i$ . It is also important to remark that these values are obtained under full-efficiency in final production. In the following section, I will compare these conditions with the ones describing the supply side equilibrium in South under weak contract enforcement.

### Supply side in South

Consider now a final good sector  $i$  in a given country in South. The characterization of the supply side for each sector  $i$  in South is obtained by solving for the sub-game perfect equilibrium of the three-stage game described before. Let's proceed by backward induction, starting from the penultimate stage. In this stage, outsourcing contracts are enforced by courts with probability  $1 - \phi$ . By the law of large number, then, the same fraction of downward suppliers is forced by courts to fulfill the initial contract and deliver a quantity  $x_i^* = m$  at unit price  $\tau_i^* = w^*$  for the intermediate variety produced. With probability  $\phi$ , instead, contracts are not enforced. In this case, each supplier enters a bilateral Nash bargaining game with the upward firm over the non-contractual price  $\hat{\tau}_i^*$ . The following assumption defines the bargaining powers of the upward firm and each intermediate supplier.

**Assumption 9** *Let  $1 - \beta(J_i^*)$  define the bargaining power of the upward firm and*

$\beta(J_i^*)$  the bargaining power of each downward supplier that can renege on the contract. Furthermore, let  $\beta(J_i^*)$  be a decreasing function of  $J_i^*$ , i.e.  $\frac{d\beta(J_i^*)}{dJ_i^*} < 0$ .

Assumption 9 states that the fraction of total revenues appropriable by upward firms is inversely related to the number of intermediate suppliers faced in the negotiation process. Undoubtedly, this assumption is crucial. It implies that the inefficiency created by weak contract enforcement varies across sectors, biasing the comparative advantage of South towards sectors with a low level of diversification. Nevertheless, this assumption could arise endogenously as a solution of a multilateral bargaining game between the upward firm and the mass of downward firms. Following Hart and Moore (1990), the equilibrium distribution of revenues for the multilateral game is determined by the Shapley value of each player, which measures the average contribution of each player to final output. Consider two extreme examples. When final production requires the cooperation between the upward firm and all downward firms, i.e. intermediate varieties are perfect complements, each player has the same Shapley value, given by the value of final revenues divided by the number of players. Then, the value appropriable by the upward firm is inversely related to the number of downward firms. Instead, when final production requires the cooperation between the upward firm and only one downward firm, i.e. intermediate varieties are perfect substitutes, the Shapley value of the upward firm is equal to half the value of final revenues while the remaining half is equally divided across downward firms. In such a case, the value appropriable by the upward firm is independent of the number of downward firms. Assumption 9, then, can be considered as a description of an intermediate case, where the slope of the value appropriable by the upward firm with respect to the number of intermediate supplies lies between these two extremes.<sup>5</sup>

Solving for the Nash-bargaining outcomes, it is possible to define the expected revenues of the upward firm and each downward supplier as in<sup>6</sup>

$$r_u = (1 - \phi\beta(J_i^*))J_i^*p_i^* \quad \text{and} \quad r_d = \phi\beta(J_i^*)p_i^* + (1 - \phi)m w^*.$$

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<sup>5</sup>Acemoglu et al. (2007) show formally that a high degree of complementary between intermediate inputs increases the outcome of downward firms in a bargaining game with an upward firm.

<sup>6</sup>In the Nash-bargaining game, the non-contractual price is set to  $\hat{\tau}_i^* = \frac{\beta(J_i^*)p_i^*}{m}$ , such to maximize the net gains from trade between the upward firm and each intermediate supplier, defined by

$$G = (p_i^* - \hat{\tau}_i^* m)^{1-\beta(J_i^*)} (\hat{\tau}_i^* m)^{\beta(J_i^*)}$$

for each variety  $j \in [0, \phi J_i^*]$ .

In the first stage of the game, then, downward firms accept the outsourcing contract only if they can expect a positive profit from intermediate production, or equivalently

$$\beta(J_i^*) p_i^* \geq w^* m. \quad (2.5)$$

Provided (2.5) is satisfied, each supplier  $j$  produces a quantity  $x_j^* = m$  for each intermediate variety. At the same time, the upward firm maximizes expected profits by choosing the mass  $J_i^*$  of intermediate varieties such to satisfy<sup>7</sup>

$$(1 - \phi\beta(J_i^*))p_i^* = (1 - \phi)w^* m + \kappa_i C'(J_i^*)w^*. \quad (2.6)$$

By comparing conditions (2.6) and (2.3), it is possible to show that upward firms in South underinvest in technology adoption. Indeed, the average price of intermediate varieties now exceeds the marginal cost of production, as implied by (2.5). Furthermore, given that  $\frac{d\beta(J_i^*)}{dJ_i^*} < 0$ , the underinvestment in technology adoption is inversely related to the number of intermediate varieties used in each sector.

Finally, free entry in each sector  $i$  implies that in equilibrium expected revenues equal production costs, as in

$$(1 - \phi\beta(J_i^*))p_i^* = \frac{(1 - \phi)J_i^*m + 1 + \kappa_i C_i(J_i^*)}{J_i^*} w^*. \quad (2.7)$$

Combining conditions (2.7) and (2.6), we can then pin down the number of intermediate good varieties  $J_i^*$  and the equilibrium price  $p_i^*$  for any final good  $i$  produced in South for any given wage  $w^*$ . Once again, the number of intermediate varieties used in final production is increasing in the index  $i$ .

## Comparative advantages

The pattern of comparative advantages can now be characterized in a manner similar to Dornbusch et al. (1977) by comparing relative prices for each final good  $i$  in the two regions. Using (2.4) and (2.7), the price of each final good  $i$  in North relative to South

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<sup>7</sup>Notice that I have assumed without loss of generality that the upward firm takes the future bargaining power as given when choosing the number of intermediate goods.

equals,

$$\frac{p_i}{p_i^*} = A(i) \frac{w}{w^*}, \quad (2.8)$$

where  $A(i) = \left(1 - \phi\beta(J_i^*)\right) \frac{(1+J_i m + \kappa_i C(J_i))/J_i}{(1+(1-\phi)J_i m + \kappa_i C(J_i))/J_i}$  denotes the inverse of the relative unit production costs, or the relative productivity, of upward firms in South in each final sector  $i$ .<sup>8</sup> Notice now that  $d\beta(J_i^*)/di > 0$  implies that the relative productivity of upward firms in South is downward sloping:<sup>9</sup> Then, as  $i$ , and thus the number of downward suppliers  $J_i^*$ , increases, upward firms in South lose bargaining power and inefficiency in production is magnified. Then, for any relative wage  $\frac{w^*}{w}$ , the model predicts that South specializes in the production of final goods  $i \in [0, \bar{i}]$  and North in the production of final goods  $i \in [\bar{i}, 1]$ , where the threshold sector  $\bar{i}$  is defined by,

$$\frac{w^*}{w} = A(\bar{i}). \quad (2.9)$$

Having determined the pattern of comparative advantages between North and South for any relative wage  $\frac{w^*}{w}$ , we need now to compute the relative demand of North and South to determine the equilibrium value of the relative wage.

## Demand side and trade balance

Trade balance between the two regions requires that the fraction of North aggregate income spent on final good varieties produced in South equals the fraction of South aggregate income spent on final good varieties produced in North. Aggregate income in North is equal to the wage rate  $w$ , as firms' profits are zero on average and total population is equal to one.<sup>10</sup> Instead, aggregate income in South is equal to the wage rate  $w^*$  plus the profits of downward firms, denoted by the integral on the right hand side: as shown before, indeed, weak contract enforcement in South allows downward

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<sup>8</sup>Production costs are expressed per units of expected output.

<sup>9</sup>This is a necessary condition when the price of the final goods  $i$  increases with the number of intermediate varieties used in production, i.e.  $\kappa_i C'(J_i)$  is increasing.

<sup>10</sup>In equilibrium, indeed, the expected profits of upward firms are zero due to free-entry and the profits of downward firms are zero given that the contractual price of intermediate goods is equal to the average cost of production of intermediate varieties.

firms to extract positive rents from intermediate good production. Using the properties of Cobb-Douglas preferences, the trade balance condition between North and South can be written as follows,

$$\bar{i} w = (1 - \bar{i}) \left( w^* + \int_0^{\bar{i}} n_i^* J_i^* \phi \left( \beta (J_i^*) p_i^* - w^* m \right) di \right), \quad (2.10)$$

where  $n_i^*$  denotes the number of upward firms in each sector  $i \in [0, \bar{i}]$  in South. A more detailed derivation of (2.10) is contained in the appendix.

Substituting for the number of upward firms  $n_i^*$  in each sector  $i \in [0, \bar{i}]$  of South using both optimality in demand and the labor market condition, the trade balance condition can be rearranged as follows,

$$\frac{w^*}{w} = B(\bar{i}) = \frac{\bar{i}}{1 - \bar{i}} \Gamma_{\bar{i}}, \quad (2.11)$$

where  $\Gamma_{\bar{i}} \equiv \left[ 1 + \frac{\int_0^{\bar{i}} \frac{p_0^*}{p_i^*} \phi \left( \beta (J_i^*) \frac{p_i^*}{w^*} - m \right) di}{\int_0^{\bar{i}} \frac{p_0^*}{p_i^*} \frac{1 + J_i^* m + \kappa_i C(J_i^*)}{J_i^*} di} \right]^{-1}$ . Given that  $B(\bar{i})$  is upward sloping, conditions (2.9) and (B.3) pin down the values of  $\bar{i}$  and  $\frac{w^*}{w}$ . Finally, the equilibrium of the model is fully characterized (up to the choice of the wage rate in one of the two country) by retrieving the levels of production in each final good sector  $i$  using labor market clearing conditions.

## d Institutional improvement and relative welfare

Let's now study what is the effect of a better contract enforcement in South (i.e. a lower  $\phi$ ) on the relative welfare of the two regions. Clearly, the improvement in contract enforcement improves efficiency in final production. As upward firms are less likely to be held up by their downward suppliers, they internalize a larger fraction of future revenues and their investment in technology adoption approaches the first-best. Then, the efficiency gain tends to translate into an higher relative wage in South. Consider indeed the relative productivity schedule  $A(i)$ , defined as in condition (2.8). A lower value of  $\phi$ , which measures the likelihood of hold-ups in production, shifts  $A(i)$  upward and make it flatter. Everything else equal, an improvement in legal institutions then

expands the specialization set of South and, given that the quantity of labor available in South must be now allocated over a larger number of sectors, the relative wage in South increases.

However, an improvement in legal institutions has an additional effect on South aggregate income, which could lead to divergence, rather than convergence, in relative welfare. Weak contract enforcement, indeed, implies that the price of intermediate varieties in South includes a markup over the marginal cost, as implied by (2.5). Given that the markup is transferred into an higher price for final goods, weak contract enforcement in South leads to an income redistribution from consumers in North to downward firms in South and, thus, to consumers in South. Then, improving institutions in South have an ambiguous effect on relative welfare.

The comparative statics analysis, then, delivers quite striking results. In the context of a trade integrated world, weak contract enforcement in one region leads to specialization towards less complex and more volatile sectors, but is not necessarily welfare detrimental. In some sense, this result is close to Levchenko (2007). This author introduces the incomplete contract framework into an otherwise standard Heckscher-Ohlin-Ricardo model of international trade and shows that an improvement in institutional quality in one country might have a negative impact on the gains from trade of the country itself.

## 2.4 Conclusion

It is a well documented fact that developing countries have experienced a more volatile income growth with respect to developed countries in the period 1960-2000. Recent empirical evidence has shown that the higher volatility in developing countries can be accounted for both by more pronounced country-specific shocks and by a specialization structure biased towards more volatile sectors. This paper, then, focuses on the sources of these compositional effects and proposes a view according to which developing countries specialize in more volatile sectors as a consequence of weak legal institutions.

This paper augments a standard North-South Ricardian model in two respects. First, I consider that the economy can produce a continuum of final goods and that final goods production requires a continuum of intermediate goods, which are subject to

imperfectly correlated productivity shocks. Then, final output is less volatile in sectors where the production technology uses a relatively large number of intermediate goods. Second, I introduce contracting frictions using the incomplete contract framework, as in Williamson (1985) and Grossman and Hart (1986). In particular, I consider that final producers (upward firms) outsource intermediate goods to downward suppliers (downward firms) and that intermediate goods are relationship-specific. When parties cannot write ex-ante enforceable contracts, this situation leads to the well-known hold-up problem, where parties bargain over the division of future revenues from production. Assuming that contract enforcement is weaker in South, in this region upward firms experience a cost disadvantage in sectors where the number of intermediate inputs, and therefore contract intensity, is greater. The model, then, proposes a view where legal institutions represent a source of comparative advantage across sectors with different output volatility.

This paper also provides empirical evidence that is consistent with the assumptions that drive the result of the model. First, I show that sectors that use a relatively small number of intermediate goods tend to suffer from more volatile sector-specific productivity shocks. This evidence suggests that output fluctuation in individual sectors depends on technological factors that affect the degree of diversification across individual production inputs. Second, I show that countries with better institutions tend to export relatively more in sectors that use a relatively large number of intermediate inputs, consistently with the idea that legal institutions represent a source of comparative advantage between sectors with different degrees of contract intensity.

Finally, the model studies the consequences of an improvement in legal institutions in South and points out two opposing effects. On one hand, a better contract enforcement improves efficiency in production, expanding both the specialization set of South towards less volatile sectors and raising the relative wage in South. On the other hand, this improvement has an additional effect which might lead to divergence, rather than convergence, in aggregate income across North and South. As shown in the model, weak contract enforcement implies that the price of intermediate varieties in South includes a markup over marginal cost, which is transferred into a higher price for final goods.

## BIBLIOGRAPHY

- Acemoglu, D., P. Antras, and E. Helpman (2007, June). Contracts and technology adoption. *American Economic Review* 97(3), 916–943.
- Acemoglu, D. and F. Zilibotti (1997, August). Was Prometheus unbound by chance? risk, diversification, and growth. *Journal of Political Economy* 105(4), 709–51.
- Aghion, P., P. Bacchetta, and A. Banerjee (2004). Financial development and the instability of open economies. *Journal of Monetary Economics* 51(6), 1077–1106.
- Aguiar, M. and G. Gopinath (2006). Defaultable debt, interest rates and the current account. *Journal of International Economics* 69(1), 64–83.
- Allen, F. and D. Gale (2004a). Financial intermediaries and markets. *Econometrica* 72(4), 1023–1061.
- Allen, F. and D. Gale (2004b, 07). Financial intermediaries and markets. *Econometrica* 72(4), 1023–1061.
- Amador, M. (2004). A political model sovereign debt repayment. 2004 Meeting Papers 762, Society for Economic Dynamics.
- Arellano, C. (2008). Default Risk and Income Fluctuations in Emerging Economies. *American Economic Review* 98(3), 690–712.
- Arellano, M. and S. Bond (1991). Some tests of specification for panel data: Monte carlo evidence and an application to employment equations. *The Review of Economic Studies* 58(2), 277–297.
- Baltagi, B. H. (1995). *Econometric Analysis of Panel Data*. eds J. Wiley&Sons, Chichester.
- Beers, D. and J. Chambers (2002). Sovereign Defaults: Moving Higher Again in 2003? *Standard and Poor's Research*. New York.
- Bejan, M. (2006, February). Trade openness and output volatility. MPRA Paper 2759, University Library of Munich, Germany.
- Bernanke, B. and M. Gertler (1989). Agency costs, net worth, and business fluctuations. *The American Economic Review* 79(1), 14–31.



- Bernanke, B. S., M. Gertler, and S. Gilchrist (1999). The financial accelerator in a quantitative business cycle framework. In J. B. Taylor and M. Woodford (Eds.), *Handbook of Macroeconomics*. Elsevier Science.
- Bond, S. (2002). Dynamic panel data models: a guide to microdata methods and practice. CeMMAP working papers CWP09/02, Centre for Microdata Methods and Practice, Institute for Fiscal Studies.
- Borensztein, E. and U. Panizza (2006). Do sovereign defaults hurt exporters? RES Working Papers 1018, Inter-American Development Bank, Research Department.
- Borensztein, E. and U. Panizza (2008). The Cost of Default. IMF Working Papers 08/238, International Monetary Fund.
- Braun, M. (2002). Financial contractability and assets' hardness: Industrial composition and growth. Technical report, Harvard University, mimeo.
- Broner, F., A. Martin, and J. Ventura (2006). Sovereign Risk and Secondary Markets. *Working Papers (Universitat Pompeu Fabra. Departamento de Economía y Empresa)* (998), 1.
- Broner, F. and J. Ventura (2006). Globalization and risk sharing. Universitat Pompeu Fabra. Mimeo.
- Broner, F. and J. Ventura (2008). Rethinking the effects of financial liberalization. Universitat Pompeu Fabra. Mimeo.
- Bulow, J. and K. Rogoff (1989). Sovereign debt: Is to forgive to forget? *American Economic Review* 79(1), 43–50.
- Caballero, R., E. Farhi, and P. Gourinchas (2008). An Equilibrium Model of “Global Imbalances” and Low Interest Rates. *The American Economic Review* 98(1), 358–393.
- Caballero, R. and A. Krishnamurthy (2001). International and domestic collateral constraints in a model of emerging market crises. *Journal of Monetary Economics* 48(3), 513–548.
- Caballero, R. and A. Krishnamurthy (2008). Collective risk management in a flight to quality episode. *Journal of Finance* 63(5), 2195–2230.

- Calderon, C. and E. L. Yeyati (2009, April). Zooming in : from aggregate volatility to income distribution. Policy Research Working Paper Series 4895, The World Bank.
- Carlstrom, C. T. and T. S. Fuerst (1997). Agency costs, net worth, and business fluctuations: A computable general equilibrium analysis. *American Economic Review* 87(5), 893–910.
- Cavallo, E. A. (2007, April). Output volatility and openness to trade: A reassessment. RES Working Papers 4518, Inter-American Development Bank, Research Department.
- Cole, H. L. and P. J. Kehoe (1998). Models of sovereign debt: Partial versus general reputations. *International Economic Review* 39(1), 55–70.
- Cowan, K. and A. Neut (2007, June). Intermediate goods, institutions and output per worker. Working Papers Central Bank of Chile 420, Central Bank of Chile.
- di Giovanni, J. and A. A. Levchenko (2006). Trade openness and volatility. *Review of Economics and Statistics* (forthcoming).
- di Giovanni, J. and A. A. Levchenko (2008, October). The risk content of exports: A portfolio view of international trade. Working Papers 581, Research Seminar in International Economics, University of Michigan.
- Dornbusch, R., S. Fischer, and P. A. Samuelson (1977, December). Comparative advantage, trade, and payments in a ricardian model with a continuum of goods. *American Economic Review* 67(5), 823–39.
- Easterly, W., R. Islam, and J. E. Stiglitz. Explaining growth volatility. World Bank Report.
- Eaton, J. and R. Fernández (1995). Sovereign debt. *Handbooks in Economics* (3), 2031–2078.
- Eaton, J. and M. Gersovitz (1981). Debt with potential repudiation: Theoretical and empirical analysis. *The Review of Economic Studies* 48(2), 289–309.
- Fernandez, R. and R. W. Rosenthal (1990). Strategic models of sovereign-debt renegotiations. *Review of Economic Studies* 57(3), 331–49.

- Gennaioli, N., A. Martin, and S. Rossi (2009). Institutions, public debt and foreign finance. Economics Working Papers 1170, Department of Economics and Business, Universitat Pompeu Fabra.
- Gorton, G. and L. Huang (2004). Liquidity, Efficiency, and Bank Bailouts. *The American Economic Review* 94(3), 455–483.
- Greenwood, J. and B. Jovanovic (1990). Financial development, growth, and the distribution of income. *The Journal of Political Economy* 98(5), 1076–1107.
- Grossman, H. I. and J. B. Van Huyck (1988). Sovereign debt as a contingent claim: Excusable default, repudiation, and reputation. *American Economic Review* 78(5), 1088–97.
- Grossman, S. J. and O. D. Hart (1986, August). The costs and benefits of ownership: A theory of vertical and lateral integration. *Journal of Political Economy* 94(4), 691–719.
- Guembel, A. and O. Sussman (2009, October). Sovereign debt without default penalties. *Review of Economic Studies* 76(4), 1297–1320.
- Hart, O. and J. Moore (1990, December). Property rights and the nature of the firm. *Journal of Political Economy* 98(6), 1119–58.
- Holmstrom, B. and J. Tirole (1998). Private and public supply of liquidity. *Journal of Political Economy* 106(1), 1–40.
- Holtz-Eakin, D., W. Newey, and H. S. Rosen (1988). Estimating vector autoregressions with panel data. *Econometrica* 56(6), 1371–1395.
- Hubbard, R. (1998). Capital-Market Imperfections and Investment. *Journal of Economic Literature* 36(1), 193–225.
- Kaminsky, G. and C. Reinhart (1999). The Twin Crises: The Causes of Banking and Balance of Payments Crises. *American Economic Review* 89(3), 473–500.
- Kiyotaki, N. and J. Moore (1997). Credit cycles. *The Journal of Political Economy* 105(2), 211–248.
- Kletzer, K. M. and B. D. Wright (2000). Sovereign debt as intertemporal barter. *American Economic Review* 90(3), 621–639.

- Kocherlakota, N. (2000). Creating Business Cycles Through Credit Constraints. *Federal Reserve Bank of Minneapolis Quarterly Review* 24(3), 2–10.
- Koren, M. and S. Tenreyro (2007a). Technological diversification. CEPR Discussion Papers 6523, C.E.P.R. Discussion Papers.
- Koren, M. and S. Tenreyro (2007b, 02). Volatility and development. *The Quarterly Journal of Economics* 122(1), 243–287.
- Kraay, A. and J. Ventura (2007, December). Comparative advantage and the cross-section of business cycles. *Journal of the European Economic Association* 5(6), 1300–1333.
- Krishna, P. and A. A. Levchenko (2009, May). Comparative advantage, complexity and volatility. NBER Working Papers 14965, National Bureau of Economic Research, Inc.
- Kroszner, R., L. Laeven, and D. Klingebiel (2007). Banking crises, financial dependence, and growth. *Journal of Financial Economics* 84(1), 187–228.
- Kumhof, M. (2004). Fiscal crisis resolution: Taxation versus inflation. 2004 Meeting Papers 874, Society for Economic Dynamics.
- Kumhof, M. and E. Tanner (2005). Government debt: A key role in financial intermediation. IMF Working Papers 05/57, International Monetary Fund.
- Laursen, T. and S. Mahajan (2005). Volatility, income distribution and crises. In *Managing Volatility and Crises: A Practitioner's Guide*. Cambridge University Press.
- Levchenko, A. A. (2007, 07). Institutional quality and international trade. *Review of Economic Studies* 74(3), 791–819.
- Martin, A. (2005). Endogenous credit cycles. Economics Working Papers 916, Department of Economics and Business, Universitat Pompeu Fabra.
- Martin, P. and H. Rey (2004, December). Financial super-markets: size matters for asset trade. *Journal of International Economics* 64(2), 335–361.
- Matsuyama, K. (2004). Financial market globalization, symmetry-breaking, and endogenous inequality of nations. *Econometrica* 72(3), 853–884.

- Mendoza, E. (2006). Endogenous Sudden Stops in a Business Cycle Model With Collateral Constraints: A Fisherian Deflation of Tobin's Q. *NBER Working Paper*.
- Mishkin, F. S. (2006). *The Next Great Globalization*. Princeton, N.J.: Princeton University Press.
- Modigliani, F. and M. H. Miller (1958). The cost of capital, corporation finance and the theory of investment. *The American Economic Review* 48(3), 261–297.
- Nicita, A. and M. Olarreaga (2001). Trade and production, 1976-99. Policy Research Working Paper Series 2701, The World Bank.
- Nunn, N. (2007). Relationship-Specificity, Incomplete Contracts, and the Pattern of Trade\*. *The Quarterly Journal of Economics* 122(2), 569–600.
- Obstfeld, M. (1994). Risk-taking, global diversification, and growth. *The American Economic Review* 84(5), 1310–1329.
- Pallage, S. and M. A. Robe (2003, 05). On the welfare cost of economic fluctuations in developing countries. *International Economic Review* 44(2), 677–698.
- Panizza, U. (2008). Domestic and external public debt in developing countries. Debt and Finance Analysis Unit, Division of Globalization and Development Strategies, UNCTAD. Mimeo.
- Raddatz, C. (2006). Liquidity needs and vulnerability to financial underdevelopment. *Journal of Financial Economics* 80(3), 677–722.
- Rajan, R. G. and L. Zingales (1998). Financial dependence and growth. *American Economic Review* 88(3), 559–86.
- Ramey, G. and V. A. Ramey (1995). Cross-country evidence on the link between volatility and growth. *The American Economic Review* 85(5), 1138–1151.
- Reinhart, C., K. Rogoff, and M. Savastano (2003). Debt intolerance. *Brookings Papers on Economic Activity* (1), 1–75.
- Reinhart, V., B. Sack, and J. Heaton (2000). The economic consequences of disappearing government debt. *Brookings Papers on Economic Activity* 2000(2), 163–220.

- Saint-Paul, G. (1992, May). Technological choice, financial markets and economic development. *European Economic Review* 36(4), 763–781.
- Sandleris, G. (2006). Sovereign Defaults: Information, Investment and Credit. Johns Hopkins. Mimeo.
- Stein, J. C. (2003). Agency, information and corporate investment. In G. Constantinides, M. Harris, and R. M. Stulz (Eds.), *Handbook of the Economics of Finance*. Elsevier.
- Sturzenegger, F. and J. Zettelmeyer (2006). *Debt defaults and lessons from a decade of crises*. Cambridge: MIT Press.
- Taddei, F. (2004). Liquidity and the allocation of credit: Business cycle, government debt and financial arrangements. Collegio Carlo Alberto. Mimeo.
- Williamson, O. (1985). *The Economic Institutions of Capitalism: Firms, Markets, Relational Contracting*. New York: The Free Press.
- Woodford, M. (1990). Public debt as private liquidity. *The American Economic Review* 80(2), 382–388.
- Wright, M. (2002). Reputation and sovereign debt. Mimeo. Stanford.
- Yue, V. Z. (2005). Sovereign default and debt renegotiation. 2005 Meeting Papers 138, Society for Economic Dynamics.
- Zame, W. R. (1993, December). Efficiency and the role of default when security markets are incomplete. *American Economic Review* 83(5), 1142–64.

## A APPENDIX TO CHAPTER ONE

### A.1 Data Description

LOG VALUE ADDED ( $y$ ). Log of value added in US dollars at the 3-digit ISIC classification for manufacturing sectors. Data are sourced from the UNIDO INDSTAT 2005 database. Original data are deflated using the GDP deflator in United States from the World Bank's *World Development Indicators 2006 CD-ROM*.

DEFAULT DUMMY ( $DEF$ ). Dummy variable taking a value one in the first year of a default episode. Data on default episodes are sourced from the Standard and Poor's sovereign default database, as reported in Beers and Chambers (2002). This database includes all sovereign defaults on loans or bonds with private agents between 1975 and 2002, and reports the period during which the debtor government remained in default.

FINANCIAL DEPENDENCE ( $FinDep$ ). An index constructed as the median share of capital expenditures not financed with the cash flow from operations (capital expenditures minus cash flow from operation divided by capital expenditures) by US-based, publicly listed firms. The index is sourced from Kroszner et al. (2007), who provide a 3-digit ISIC based reclassification of the data originally constructed by Rajan and Zingales (1998) for a mixture of 3-digit and 4-digit ISIC sectors. The data refer to the period 1980-1999 and, originally, range from -1.14 (Tobacco) to 0.72 (Transport equipment), with a higher number indicating greater financial dependence. To ease statical inference, I normalize the index such that it ranges from 0 to 1.

LIQUIDITY NEEDS ( $Liq$ ). An index constructed as the median ratio of inventories over total sales for US-based, publicly listed firms. This index has been initially proposed by Raddatz (2006) to measure industry's financial needs that focuses on short-term liquidity needs. The data are sourced from Kroszner et al. (2007), who compute the Raddatz index for the 3-digit ISIC manufacturing sectors. The data refer to the 1980s and, originally, range from 0.07 (Tobacco) to 0.72 (Plastic Products), with a higher number indicating greater financial dependence. To ease statical inference, I normalize the index such that it ranges from 0 to 1.

TANGIBILITY ( $Tang_s$ ). An index constructed as the median ratio of net property,

plant and equipment to total assets by US-publicly listed firms during the period 1980-1999 in each 3-digit ISIC manufacturing sector. The data are sourced from Kroszner et al. (2007). The original data range from 0.12 to 0.62, and are normalized such that they range from 0 to 1.

*ExpOr<sub>s,c</sub>*. An index of export orientation computed as the average share of exports over total sales for each industry in each country included in the sample. The data source used to construct the export orientation index is Nicita and Olarreaga (2001), who report export and import values for each ISIC industry.

## A.2 Deletion criteria

First, I delete all observations for which the data for value added are either missing or negative. Second, given that the initial panel is unbalanced, I remove all sector-country-year observations with data for less than 5 years. This reduces the within estimator's sensitivity to isolated observations in the panel. Third, I exclude all country-year pairs reporting data for less than 10 sectors, in order to guarantee sufficient within country-year variation in the interaction between financial dependence and default (captured by the coefficient  $\beta_1$ ). The same criterium is applied in Borensztein and Panizza (2006). Fourth, I drop those observations for which the growth rate of value added fall in the top and bottom 1 percent of the distribution. This is a common strategy in order to limit the noise created by outliers.





## B APPENDIX TO CHAPTER TWO

### B.1 Trade Balance

Trade balance requires that the fraction of North income spent on final good varieties produced in South equals the fraction of South income spent on final good varieties produced in North. Let's now compute the aggregate income in both regions. In North, aggregate income is equal to the wage rate  $w$  since firms' average profits are zero in equilibrium. Instead, South income is equal to the labor income  $w^*$  plus the profits of downward firms. Let's now compute the profits of downward firms in each sector  $i \in [0, \bar{i}]$ . Let  $J_i^*$  be the number of intermediate good varieties used by each upward firm in sector  $i$  and  $n_i^*$  the number of upward firms in each country and sector  $i$ . As implied by Assumption 5 and 6, in each state of nature final output of good  $i$  is positive (and equal to  $n_i^*$  as each upward firm can produce at most one unit of output) in a number  $J_i^*$  of countries and zero in the remaining  $1 - J_i^*$  countries. Then, downward firms' profits in each sector  $i \in [0, \bar{i}]$  are equal to,

$$J_i^* \phi \left[ n_i^* J_i^* \left( \frac{\beta(J_i^*)}{J_i^*} p_i^* - w^* m \right) \right] + (1 - J_i^*) \phi [n_i^* J_i^* (-w^* m)] = n_i^* J_i^* \phi \left( \beta(J_i^*) p_i^* - w^* m \right),$$

such that the aggregate income in South is given by,

$$w^* + \int_0^{\bar{i}} n_i^* J_i^* \phi \left( \beta(J_i^*) p_i^* - w^* m \right) di.$$

Finally, as consumers preferences are Cobb-Douglas, the trade balance condition between North and South can be written as follows,

$$\bar{i} w = (1 - \bar{i}) \left( w^* + \int_0^{\bar{i}} n_i^* J_i^* \phi \left( \beta(J_i^*) p_i^* - w^* m \right) di \right). \quad (\text{B.1})$$

Let's now simplify further the above condition. This simplification requires a few steps. First, notice that labor market clearing requires that the following condition is satisfied in equilibrium,

$$\int_0^{\bar{i}} n_i^* J_i^* \left( \frac{1 + J_i^* m + \kappa_i C(J_i^*)}{J_i^*} \right) di = 1, \quad (\text{B.2})$$

where the term within the integral denotes the amount of labor used in each sector  $i \in [0, \bar{i}]$ . Second, notice that  $n_i^* J_i^*$  measures both the number of firms that get positive output in sector  $i$  and the total output of final good  $i$  in each state of nature, as each upward firm can produce at most one unit of output. Using optimality in demand, we can then substitute for  $n_i^* J_i^* = \frac{p_0^*}{p_i^*} n_0^* J_0^*$  in both (B.1) and (B.2). Finally, substitution of (B.2) into (B.1) allows to rewrite the trade balance condition as follows,

$$\frac{w^*}{w} = B(\bar{i}) = \frac{\bar{i}}{1 - \bar{i}} \Gamma_{\bar{i}}, \quad (\text{B.3})$$

$$\text{where } \Gamma_{\bar{i}} \equiv \left[ 1 + \frac{\int_0^{\bar{i}} \frac{p_0^*}{p_i^*} \phi \left( \beta (J_i^*) \frac{p_i^*}{w^*} - m \right) di}{\int_0^{\bar{i}} \frac{p_0^*}{p_i^*} \frac{1 + J_i^* m + \kappa_i C(J_i^*)}{J_i^*} di} \right]^{-1}.$$

Table 1: Default episodes

Country	Default year
Argentina	1989
Bolivia	1986
Bolivia	1989
Chile	1983
Costa Rica	1981
Costa Rica	1984
Cuba	1982
Dominican Republic	1981
Ecuador	1982
Egypt, Arab Rep.	1984
El Salvador	1981
Ghana	1987
Guatemala	1986
Honduras	1981
Jamaica	1981
Jamaica	1987
Jordan	1989
Kuwait	1990
Madagascar	1981
Madagascar	1986
Malawi	1982
Mexico	1982
Morocco	1986
Nigeria	1982
Panama	1983
Panama	1987
Peru	1983
Philippines	1983
Poland	1981
Senegal	1981
Senegal	1990
Serbia and Montenegro	1983
South Africa	1985
South Africa	1989
Tanzania	1984
Turkey	1982
Uruguay	1983
Uruguay	1987
Uruguay	1990
Venezuela, RB	1983
Venezuela, RB	1990

Table 2: Estimation Results

	(1)	(2)	(3)	(4)	(5)
	1980-1990	1980-1990	1990-2002	1990-2002	1990-2002
$y_{s,c,t-1}$	0.373*** (0.054)	0.375*** (0.054)	0.455*** (0.059)	0.454*** (0.059)	0.483*** (0.055)
$DEF_{c,t} \cdot FinDep_s$	-0.094 (0.070)	-0.097 (0.071)	-0.208* (0.117)	-0.196* (0.117)	-0.275* (0.148)
$DEF_{c,t} \cdot Liq_s$	-0.092* (0.052)	-0.069 (0.069)	-0.053 (0.088)	-0.126 (0.115)	-0.093 (0.125)
$DEF_{c,t} \cdot Tang_s$		0.033 (0.065)		-0.115 (0.116)	-0.044 (0.143)
$DEF_{c,t} \cdot ExpOr_{s,c}$					-0.078 (0.160)
1 <sup>st</sup> autocorr.	0.00	0.00	0.00	0.00	0.00
2 <sup>nd</sup> autocorr.	0.00	0.00	0.42	0.42	0.27
Sargan test	0.00	0.00	0.21	0.21	0.12
Obs.	15406	15406	15605	15605	12828

\*\*\*, \*\*, \* represent significance at 1%, 5%, and 10%, respectively. The table reports the one-step first-differenced GMM estimator for the main specifications for the 1980-1990 and the 1990-2002 samples. The set of instruments includes the first lag of the lagged dependent variable. Country-time effects are removed by country-time differencing prior to estimation. Sector-country fixed effects are removed by first differencing. Heteroskedasticity-consistent standard errors are reported within parenthesis. 1<sup>st</sup> autocorr. and 2<sup>nd</sup> autocorr. are autocorrelation tests on the estimation residuals.  $p$ -values for the asymptotic  $N(0, 1)$  distribution are reported. The Sargan test of over-identifying restrictions is based on a two-step GMM estimation.  $p$ -values for the asymptotic  $\chi^2$  distribution are reported.

Table 3: Estimation Results

	(1)	(2)	(3)	(4)	(5)
	1980-1990	1980-1990	1990-2002	1990-2002	1990-2002
$y_{s,c,t-1}$	0.379*** (0.054)	0.378*** (0.054)	0.450*** (0.059)	0.451*** (0.059)	0.480*** (0.055)
$DEF_{c,t} \cdot FinDep_s$	-0.094 (0.069)	-0.097 (0.070)	-0.225** (0.113)	-0.213* (0.113)	-0.303** (0.140)
$DEF_{c,t-1} \cdot FinDep_s$	0.102* (0.061)	0.100* (0.061)	0.086 (0.115)	0.077 (0.116)	0.163 (0.148)
$DEF_{c,t-2} \cdot FinDep_s$	-0.127* (0.072)	-0.120* (0.072)	0.099 (0.097)	0.097 (0.097)	0.116 (0.109)
$DEF_{c,t} \cdot Liq_s$	-0.096* (0.051)	-0.076 (0.067)	-0.050 (0.085)	-0.122 (0.112)	-0.091 (0.123)
$DEF_{c,t-1} \cdot Liq_s$	0.002 (0.049)	0.015 (0.067)	-0.020 (0.085)	0.037 (0.097)	0.056 (0.106)
$DEF_{c,t-2} \cdot Liq_s$	-0.085 (0.055)	-0.131* (0.078)	-0.002 (0.077)	0.007 (0.104)	0.015 (0.106)
$DEF_{c,t} \cdot Tang_s$		0.030 (0.064)		-0.112 (0.114)	-0.033 (0.141)
$DEF_{c,t-1} \cdot Tang_s$		0.019 (0.063)		0.087 (0.101)	0.059 (0.114)
$DEF_{c,t-2} \cdot Tang_s$		-0.068 (0.071)		0.013 (0.097)	-0.011 (0.102)
$DEF_{c,t} \cdot ExpOr_{s,c}$					-0.051 (0.155)
$DEF_{c,t-1} \cdot ExpOr_{s,c}$					-0.019 (0.143)
$DEF_{c,t-1} \cdot ExpOr_{s,c}$					-0.081 (0.117)
1 <sup>st</sup> autocorr.	0.00	0.00	0.00	0.00	0.00
2 <sup>nd</sup> autocorr.	0.00	0.00	0.52	0.53	0.26
Sargan test	0.00	0.00	0.23	0.22	0.13
Obs.	15406	15406	15605	15605	12828

\*\*\*, \*\*, \* represent significance at 1%, 5%, and 10%, respectively. The table reports the one-step first-differenced GMM estimator for the main specifications for the 1980-1990 and the 1990-2002 samples. The set of instruments includes the first lag of the lagged dependent variable. Country-time effects are removed by country-time differencing prior to estimation. Sector-country fixed effects are removed by first differencing. Heteroskedasticity-consistent standard errors are reported within parenthesis. 1<sup>st</sup> autocorr. and 2<sup>nd</sup> autocorr. are autocorrelation tests on the estimation residuals.  $p$ -values for the asymptotic  $N(0, 1)$  distribution are reported. The Sargan test of over-identifying restrictions is based on a two-step GMM estimation.  $p$ -values for the asymptotic  $\chi^2$  distribution are reported.

Table 4: Number of Intermediate Goods and Herfindhal Index

isic3	description	sectorsd	n	herfindhal	Kint	Hint	NRint
372	Non-ferrous metals	3.17	-0.15	-0.44	1.24	-0.26	1
371	Iron and steel	1.63	-0.09	-0.26	1.99	-1.25	1
353	Petroleum refineries	1.63	-0.60	4.17	2.26	0.26	1
354	Misc. petroleum and coal products	1.41	-1.24	0.64	-0.09	-0.24	1
341	Paper and products	1.02	0.07	-0.03	1.08	-0.65	1
351	Industrial chemicals	0.64	0.01	1.00	0.96	0.66	0
323	Leather products	0.61	-1.53	0.64	-0.82	-0.22	0
331	Wood products, except furniture	0.19	0.58	0.20	-0.14	-1.21	1
356	Plastic products	0.04	0.07	0.48	-0.19	-0.17	0
361	Pottery, china, earthenware	-0.02	-1.53	-0.59	-0.65	-0.72	0
390	Other manufactured products	-0.03	1.00	-0.73	-0.34	0.56	0
321	Textiles	-0.14	-0.54	0.06	0.38	-0.76	0
369	Other non-metallic mineral products	-0.21	0.20	-0.71	0.76	-0.26	1
385	Professional and scientific equipment	-0.31	1.06	-0.83	-0.85	1.66	0
362	Glass and products	-0.32	-0.95	-0.40	0.72	-1.40	0
314	Tobacco	-0.43	-0.76	0.68	-1.95	-0.41	0
382	Machinery, except electrical	-0.45	1.54	-0.87	0.15	0.96	0
332	Furniture, except metal	-0.45	0.29	-0.72	-1.26	0.53	0
355	Rubber products	-0.47	-0.41	-0.60	0.33	-0.84	0
384	Transport equipment	-0.54	2.34	-0.60	0.12	0.35	0
324	Footwear, except rubber or plastic	-0.56	-1.91	1.09	-0.83	-1.13	0
381	Fabricated metal products	-0.63	0.97	-0.21	0.11	0.09	0
322	Wearing apparel, except footwear	-0.77	-0.60	0.30	-1.81	-1.12	0
313	Beverages	-0.84	-0.38	-0.29	0.39	1.07	0
383	Machinery, electric	-0.95	1.19	-0.63	-0.05	1.52	0
311	Food products	-0.97	1.06	-0.67	0.10	-0.88	0
342	Printing and publishing	-1.10	-0.25	-0.13	-0.98	2.28	0
352	Other chemicals	-1.16	0.55	-0.55	-0.63	1.57	0

Notes: all variables (with the exception of natural resource intensity) have been normalized such that they have mean zero and standard deviation equal to one. *Sectorsd* measures the volatility of global sector-specific shocks in each sector and is computed as described in the main text. *n* and *herfindahl* are respectively the number of intermediate inputs and the Herfindahl index of input shares in each sector. Both variables are constructed using the 1992 US input-output tables by Cowan and Neut (2007). *Kint* and *Hint* measure respectively capital and skill intensity in each sector. Both measures are constructed using the NBER Manufacturing Productivity database, as in ? and Nunn (2007). Capital intensity is defined as the log of total real capital stock divided by value added in each sector in the United States in 1996. Skill intensity is defined as the log of the ratio of non-production worker wages to total wages in each sector. Natural resource intensity is a dummy variable that takes value one if the sector use natural resources intensively and is sourced from Braun (2002).

Table 5: Estimation Results

	OLS	IV-2LS
$n_s Q_c$	1.833*** (0.597)	4.303*** (0.935)
$k_s K_c$	0.143** (0.072)	0.144** (0.073)
$h_s H_s$	1.124*** (0.290)	1.231*** (0.287)
Country fixed effects	Yes	Yes
Sector fixed effects	Yes	Yes
$R^2$	0.98	0.98
<i>Obs.</i>	1633	1633

\*\*\*, \*\*, \* represent significance at 1%, 5%, and 10%, respectively. Heteroskedasticity-consistent standard errors are reported within parenthesis. IV-2LS estimates are computed substituting the index of institutions quality  $Q_c$  with a first-stage OLS estimate of  $Q_c$  on three legal origins dummies, i.e.  $legor_{uk}$ ,  $legor_{fr}$ ,  $legor_{ge}$ .