

# Bankruptcy Costs, Liability Dollarization, and Vulnerability to Sudden Stops\*

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## Abstract

Countries with intermediate levels of institutional quality suffer larger output contractions following sudden stops of capital inflows than less developed nations. However, countries with strong institutions seldom experience significant falls in output after capital flow reversals. We reconcile these two observations using a calibrated DSGE model that extends the financial accelerator framework developed in Bernanke, Gertler, and Gilchrist (1999). The model captures financial market institutional quality with creditors' ability to recover assets from bankrupt firms. Bankruptcy costs affect vulnerability to sudden stops directly but also indirectly by affecting the degree of liability dollarization. Simulations reveal an inverted U-shaped relationship between bankruptcy costs and the output loss following sudden stops.

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## 1. Introduction

Advanced economies with strong institutions seldom suffer large drops in output following capital flow reversals. One reason emphasized in this paper is that better institutional quality reduces domestic liability dollarization (Burger and Warnock, 2006; De Nicoló et al., 2005), decreasing the output loss following a sudden stop of capital inflows (Cavallo, 2004; Guidotti et al., 2004). Emerging economies with intermediate institutional quality, however, exhibit heightened vulnerability to capital flow reversals compared to less developed nations (Ranciere et al., 2008; Schneider and Tornell, 2004). These two observations imply a non-linear effect of institutional quality on the fall in output following a sudden stop.

In this paper, we model the non-linear relationship by extending the financial accelerator framework developed by Bernanke, Gertler, and Gilchrist (1999) (hereafter BGG). In particular, we show that in some cases an improvement in institutional quality can have the counterintuitive effect of increasing the cost of a sudden stop. We focus on financial market institutions and capture institutional quality with the cost of bankruptcy, a key parameter in the model.<sup>1</sup>

Bankruptcy costs enter the model through a financial contract between a bank and domestic entrepreneurs. According to this contract, as entrepreneurs borrow more for a given level of net worth, they are charged a higher interest rate. The financial imperfection that generates this external finance premium is the result of a cost that lenders must incur in order to observe and retrieve borrowers' realized returns when they default. Lenders pay this amount only when firms default; otherwise lenders receive a fixed payment. We can interpret this cost as a bankruptcy cost that reflects auditing, accounting, and legal expenditures associated with

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<sup>1</sup> Bankruptcy costs reflect institutional quality for several reasons. Countries with strong legal systems that protect creditor rights and provide an orderly bankruptcy process should have lower bankruptcy costs. In addition, given that a firm has declared bankruptcy, prudential regulation and supervision of the financial system that requires disclosure and transparency of firms' financial positions should also reduce these costs. We therefore focus on one aspect of institutional quality, bankruptcy costs, although we use the terms interchangeably in the paper.

liquidation as well as losses associated with the interruption of business (Carlstrom and Fuerst, 1997). The lower the cost, the greater the proportion of a firm's value creditors can recover.

In contrast to BGG (1999) and later work extending the financial accelerator framework to an open economy setting (Choi and Cook, 2004; Gertler, Gilchrist, and Natalucci, 2007, hereafter GGN), we calibrate the model using different levels of bankruptcy costs. We then analyze the effect of an exogenous increase in foreign interest rates, which initiates a sudden stop. There are two direct effects of a decrease in bankruptcy costs. First, a lower bankruptcy cost reduces the level of financial frictions due to asymmetric information, weakening the transmission of external shocks to entrepreneurs' net worth and costs of capital. This financial accelerator effect causes a more muted output response to external shocks. Second, when financial frictions are lower, the external finance premium and therefore borrowing costs are less sensitive to leverage. The reason is that creditors are not as affected by bankruptcy since they can retrieve a greater portion of a bankrupt firm's assets. Therefore, when there is a sudden stop and borrowing costs increase, firms must respond by decreasing investment sharply to lower their risk premium. This effect, which we refer to as the leverage sensitivity effect, amplifies the response of output. These two competing effects play a crucial role in the non-linear relationship between bankruptcy costs and vulnerability to sudden stops.

We use the framework to model three types of economies. We first analyze a benchmark economy that is characterized by the ability of domestic firms to obtain finance in local currency. In this economy, the first effect dominates, and a reduction in bankruptcy costs reduces vulnerability to sudden stops. We then look at an economy in which domestic firms must borrow in foreign currency. In this case, we find the opposite result that lower bankruptcy costs actually

increase the output loss following a sudden stop. Specifically, liability dollarization and the depreciation of the currency strengthen the second effect, leading to a larger drop in output.

Finally, we look at a more realistic intermediate case in which some firms borrow in local currency and others borrow in dollars. In contrast to GGN (2007) and Choi and Cook (2004) in which all borrowing is denominated in a single currency, we make liability dollarization endogenous. Specifically, we model a causal relationship between bankruptcy costs and local currency borrowing. As mentioned above, there is some evidence of a negative relationship between institutional quality and domestic liability dollarization.<sup>2</sup> To model this relationship, we assume a fixed wedge between bankruptcy costs for domestic and foreign lenders (Hermalin and Rose, 1999; Iacoviello and Minetti, 2006; Rajan and Zingales, 1998). As we explain below, this wedge implies that liability dollarization decreases as bankruptcy costs decrease.

Simulations of our partial dollarization economy reveal an inverted U-shaped relationship between institutional quality and vulnerability to sudden stops.<sup>3</sup> In particular, a lower bankruptcy cost increases the output loss following a sudden stop, but this effect only applies to countries with initially high bankruptcy costs. Finally, the model's simulated output loss is similar to actual declines in output.

The rest of the paper is organized as follows: Section 2 presents and calibrates the model. We then simulate sudden stop-induced output drops for different values of the bankruptcy cost parameter. Section 3 concludes.

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<sup>2</sup> Burger and Warnock (2006) provide evidence that better institutional quality promotes local currency bond markets. Better institutions are also correlated with less dollarization in the domestic banking system (De Nicoló et al., 2005; Honig, 2009). In addition, there is evidence that better institutional quality, such as credit rights, spurs the development of the domestic banking system and/or bond market, regardless of currency denomination (c.f. Djankov et al., 2008). To the extent that local lending is in local currency, greater domestic borrowing and less foreign borrowing should reduce the share of foreign currency debt.

<sup>3</sup> The inverted U-shaped relationship is consistent with recent models (Aghion et al., 2004; Schneider and Tornell, 2004; Ranciere et al., 2008) showing that countries with intermediate levels of institutional quality that are characterized by limited contract enforcement and bailout guarantees are more likely to experience sudden stops. Our paper adds to this literature by describing the dynamic behavior of vulnerability to sudden stops as countries transition from low to high institutional quality economies. This paper also represents a first attempt to capture this non-linear effect using a DSGE model.

## 2. Model Economy

In this section, we build a model to analyze the relationship between institutional quality and vulnerability to sudden stops. The financial accelerator framework of BGG (1999) in an open economy setting is well suited for this purpose. First, the model includes bankruptcy costs that can proxy for institutional quality. Second, bankruptcy costs determine the leverage of domestic firms, which in turn affects a country's vulnerability to sudden stops. Third, the general equilibrium framework together with reasonable calibration allows us to quantify the vulnerability to sudden stops.

### 2.1. Benchmark Model (No Liability Dollarization)

There are six types of agents in the benchmark economy: households, entrepreneurs, a domestic bank, retailers, capital producers, and a central bank. Households work, consume, and invest in deposits denominated in domestic and foreign currency that have a riskless rate of return. Entrepreneurs are risk neutral and borrow from domestic banks to finance the production of wholesale goods. A domestic bank finances entrepreneurs using the deposits of consumers.<sup>4</sup> Retailers are monopolistically competitive and transform wholesale goods into final consumption goods. Retailers are included at this stage to simplify the financial contract and motivate price stickiness. Capital producers turn investment into capital goods. Finally, a central bank conducts monetary policy using a Taylor (1993) rule.

We begin by defining the financial contract since it is the component of the model used to study the effects of institutional quality. Aside from the financial contract, the rest of the economy follows a standard dynamic New-Keynesian small open economy model. The financial contract is embedded in this framework, the details of which are deferred to Appendix B.

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<sup>4</sup> Funding does not have to come exclusively from domestic sources. But we assume in this section that all financing is denominated in local currency.

### *The Contract between the Domestic Bank and Entrepreneurs*

There is a continuum of entrepreneurs with insufficient net worth to internally finance their investments. Entrepreneurs borrow the difference between their desired investment and net worth from a domestic bank. Let  $Q_{t-1}$ ,  $K_{it}$ , and  $N_{it}$  denote the price of capital, the capital stock, and the net worth of entrepreneur  $i$ , respectively. Desired investment is  $Q_{t-1}K_{it}$ . Funds borrowed from the bank,  $B_{it}$ , are therefore given by

$$B_{it} = Q_{t-1}K_{it} - N_{it} \quad (1)$$

The external finance premium on these loans,  $x_{it}$ , is determined according to two equations that characterize the contract with the bank. The first equation is given by:

$$[1 - F(\bar{A}_{it})](R_t + x_{it})B_{it} + (1 - \mu) \left[ \int_0^{\bar{A}_{it}} A_{it} R_t^k Q_{t-1} K_{it} dF(A_{it}) \right] = R_t B_{it} \quad (2)$$

Equation (2) shows that banks set their expected rate of return equal to the risk free rate,  $R_t$ . The right hand side represents the opportunity costs of financing the entrepreneur. Expected returns consist of the principal and interest payments with probability  $1 - F(\bar{A}_{it})$  and whatever the firm has if it defaults net of bankruptcy costs. The bankruptcy cost coefficient,  $\mu$ , represents the cost per dollar that lenders must pay when borrowers default in order to observe and retrieve borrowers' realized returns. This implies a recovery rate of  $1 - \mu$ .  $A_{it}$  is a log normally, i.i.d. idiosyncratic shock to entrepreneurs' return on capital.  $\bar{A}_{it}$  is the expected cutoff value of the firm specific shock below which the firm is unable to pay back its debt. Entrepreneurs' return on capital,  $A_{it}R_t^k$ , is given by:

$$A_{it}R_t^k = A_{it} \left( \alpha \frac{P_t^w A_t K_t^\alpha L_t^{1-a}}{P_t} + (1 - \delta) \frac{Q_t}{P_t} \right) / \frac{Q_{t-1}}{P_{t-1}} \quad (3)$$

where  $P_t / P_t^w$  is the markup of retail goods over wholesale goods. We assume that entrepreneurs purchase their entire capital stock every period. This ensures that the external finance premium is determined based on the overall leverage of the firm and not just the marginal investment.

The second equation that characterizes the contract is as follows:

$$\bar{A}_{it} R_t^k Q_{t-1} K_{it} = (R_t + x_{it}) B_{it} \quad (4)$$

According to this equation, entrepreneurs need at least the cutoff value of the idiosyncratic shock to pay the principal and interest. Entrepreneurs in the model are assumed to be risk neutral and are exposed to both idiosyncratic and aggregate shocks. Therefore, technology-related risks are transferred from risk-averse consumers to the entrepreneurs via the financial intermediary.<sup>5</sup>  $\bar{A}_{it}$  and the risk premium,  $x_{it}$ , are determined simultaneously by equations (2) and (4).

From the profit maximization problem of the entrepreneur, subject to (2), we derive a supply of capital relation, as in BGG (1999):

$$\frac{E_{t-1}[R_t^k]}{R_t} = v\left(\frac{Q_{t-1} K_{it}}{N_{it}}\right) \quad v'\left(\frac{Q_{t-1} K_{it}}{N_{it}}\right) > 0 \quad (5)$$

Equation (5) shows that if firms become more leveraged, banks charge a higher premium to compensate for the higher probability of default. Similarly, we can show by inverting (5) that leverage is positively related to the relative returns to capital.

$$\frac{Q_{t-1} K_{it}}{N_{it}} = \varphi\left(\frac{E_{t-1}(R_t^k)}{R_t}\right), \quad \varphi'\left(\frac{E_{t-1}(R_t^k)}{R_t}\right) > 0 \quad (6)$$

The overall demand for capital is obtained by aggregating over all entrepreneurs.

$$Q_{t-1} K_t = \varphi(E_{t-1}(R_t^k) / R_t) N_t \quad (7)$$

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<sup>5</sup> Assuming the country is exposed to an adverse aggregate shock, the financial accelerator framework implies the bank collects more from entrepreneurs that survive to compensate for losses from bad loans. A more realistic contract in which foreign banks include the expected, instead of the ex post, returns to capital in the financial contract does not change the results (Aysun, 2008).

According to this relation, firms base their investment decisions on the expected returns to capital relative to the risk free rate. Furthermore, in steady state, higher bankruptcy costs correspond to lower leverage ( $\varphi'(\mu) < 0$  and  $v'(\mu) > 0$ ).<sup>6</sup> In particular, when the bankruptcy cost coefficient rises, firms reduce their leverage to counteract the effects on the external finance premium, implying a negative steady state relationship between the two variables.<sup>7</sup>

The entrepreneurs' net worth evolves according to the following equation:

$$N_{it+1} = \gamma^e V_{it} + W_t^e / P_t \quad (8)$$

where  $W_t^e / P_t$  and  $V_{it}$  are an entrepreneur's real wage and equity.  $V_{it}$  is given by,

$$V_{it} = R_t^k Q_{t-1} K_{it} - \left( R_t (Q_{t-1} K_{it} - N_{it}) + \mu \int_0^{\bar{A}_t} A_{it} R_t^k Q_{t-1} K_{it} dF(A_{it}) \right) \quad (9)$$

The first term,  $R_t^k Q_{t-1} K_{it}$ , represents the returns to capital given that the firm does not go bankrupt. The second term is the expected debt payment.  $\gamma^e$  in equation (8) is the survival probability of the entrepreneur. This variable is needed to prevent entrepreneurs from building up enough net worth and becoming self sufficient. Net worth is composed of the net returns to capital if the firm stays afloat and real wages.

Equations (8) and (9) predict that if there is an increase in asset prices, returns to capital along with firms' net worth increases as well.<sup>8</sup> If entrepreneurs fail, they consume the returns to capital net of debt payments such that  $C_{it}^e = (1 - \gamma^e) V_{it}$  and then perish.

## 2.2. Parameterization

In this section we discuss the calibration of the financial sector. The calibration of the rest of the model is discussed in Appendix B. When possible, we calibrate the model to data from

<sup>6</sup> The proof is available in Appendix A.

<sup>7</sup> With a slight abuse of notation, we denote the external finance premium (EFP) by  $R^k / R = 1 - x / R$  in the rest of the paper.

<sup>8</sup> Equation (9) can be used to show that  $dV_{it} / dQ_t > 0$ .



Argentina, which was chosen due to data availability. When Argentine data are not available, we choose parameter values used for emerging market countries or that are standard in the literature.

We choose the financial sector parameters to match the following: 1) Annual business failure rate of 0.12%. 2) External finance premium of 5.2 percentage points. 3) Leverage ratio,  $QK / N$ , equal to 1.8 or debt-net worth ratio of 0.8. In order to obtain these steady state values we fixed the bankruptcy cost coefficient  $\mu$  to 0.31, the quarterly survival rate of entrepreneurs to 0.9744, and assumed that the idiosyncratic productivity variable  $A_{it}$  is log-normally distributed with a standard deviation equal to 0.18 and a mean of unity.

In most models of financial imperfections used to study advanced economies, bankruptcy costs are chosen to be less than 30% of firms' assets (e.g. BGG, 1999: 12%; Carlstrom and Fuerst, 1997: 20%). According to the World Bank's 2008 Doing Business report, costs are much larger for emerging market countries than advanced economies (78.3% vs. 14.6%).<sup>9</sup> In Argentina, bankruptcy costs averaged 69.6% between 2004 and 2009. Therefore,  $\mu = 0.31$ , a number significantly higher than 0.12 for the U.S., is a reasonable parameter value for Argentina.

The only evidence we could find on the business failure rate for Argentina was from Claessens and Klapper (2005). The authors use the ministry of justice database to compute the average number of bankruptcy filings relative to the total number of firms in Argentina between 1992 and 1999. This value is not unreasonably low as bankruptcy rates in developing countries are often lower than in advanced economies (c.f. Hall and Sobel, 2006).<sup>10</sup>

The only empirical study we found related to leverage in Argentina was a 1999 survey of small and medium sized enterprises (SMEs) by Instituto Argentino de Mercado de Capitales (IAMC). The IAMC report indicates that SMEs' total debt to net worth ratio in 1994 and 1996

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<sup>9</sup> Djankov et al., (2008) develop the survey methodology for closing a business.

<sup>10</sup> For example, statistics announced by Office of Advocacy show that bankruptcy rates are approximately 2.3% for the U.S.

was approximately 0.8. According to the same survey, SMEs constitute 99.6% of all the firms in Argentina. However, large firms provide 26% of the total employment in Argentina and thus only using SME data to compute leverage may not be correct, especially given that small and large firms may have different debt structures (c.f. Beck et al., 2004). To investigate leverage ratios of large firms, we collected data from the Mergentonline Database. The dataset consists of 59 public Argentine firms that are listed in the Buenos Aires Stock Exchange. Using data from 1995 to 2009 we computed an average debt to net worth ratio of 0.67 for large firms. Since the ratios were not too different, we set the leverage ratio to 0.8 in our benchmark model.<sup>11</sup>

Finally, according to the World Development Indicators, the average spread between lending and deposit rates for the 1994-2008 period was equal to 4.93%. Therefore, the steady state interest rate premium in the model (5.2%) is not too different from the data.

### **2.3. Capital Reversals in the Benchmark Model**

In this section we study the effects of capital reversals in two economies: a high institutional quality economy (HIQE) with low bankruptcy costs and a low institutional quality economy (LIQE) with high bankruptcy costs. We simulate capital reversals with a positive shock to the exogenous component of the country risk premium or equivalently a shock to foreign interest rates.<sup>12</sup> We then compare the impulse responses obtained from the two economies.

Parameter values for the LIQE are set to the values discussed in Section 2.2. For the HIQE, the only change we make is setting the bankruptcy cost coefficient to 0.1 (in the

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<sup>11</sup> Using a ratio of 0.67 did not change our results significantly.

<sup>12</sup> In general equilibrium models, sudden stops are typically modeled in two ways. 1) Quantity restrictions in which foreign lending constraints that bind in the event of a sudden stop cause multiple equilibria. Izquierdo (2000), Mendoza (2006), and Christiano et al. (2004) are good examples for this modeling strategy. 2) The shock that leads to a financial crisis is an exogenous increase in the foreign interest rate (c.f. Céspedes et al., 2004; Devereux et al., 2006; GGN, 2007). In this context, interpreting the shock as an exogenous increase in the country risk premium and foreign interest rates is equivalent. We chose the second option mainly because checking the quantitative relevance of our impulse responses is a critical part of our analysis. In particular, we are interested in where the hump occurs, (and the relative strength of the two counteracting effects in our model) and a reasonably calibrated DSGE model does a better job than a model with multiple equilibria. In addition, there is evidence that foreign interest rates are an important determinant of capital flows (Calvo et al., 2004) and impact the likelihood of financial crises in developing countries (Frankel and Rose, 1996). For example, a rise in U.S. real interest rates played a role in the Latin American debt crisis.

sensitivity analysis section we calibrate all parameter values using data from Canada, a HIQE). This value is close to the values used for developed economies in the literature (albeit, closer to the lower end). For example, Carlstrom and Fuerst (1997) argue that bankruptcy costs should be within the 0.2-0.36 range for a developed economy. BGG (1999) indicate that 0.12 is a reasonable value for the U.S. Following the evidence for Canada (Justiniano and Preston, 2004), we use a value of 0.1 for the HIQE. The value of the bankruptcy cost coefficient in the HIQE implies a leverage ratio of 3.9 and an interest rate spread of 2.4 percentage points. This compares with the values of 0.31, 1.8, and 4.9 in the benchmark model, respectively. Therefore, the HIQE is characterized by lower bankruptcy costs, higher leverage, and a lower risk premium than the LIQE.<sup>13</sup>

Next, we log-linearize our model and report the impulse responses to a 100 annualized basis points (1 percentage point) increase in foreign interest rates in the two economies. Figure 1 shows the results. In both economies, a positive shock to foreign interest rates results in an increase in domestic interest rates and a depreciation of the currency. The latter generates a rise in foreign goods' prices and inflation. The central bank responds by raising the interest rate. Real interest rates increase due to price rigidities, and prompt a drop in output, consumption, and investment. As asset prices decrease in response to a drop in investment, entrepreneurs' net worth falls. This produces an increase in leverage, despite the drop in investment. The fall in investment also increases returns to capital, thus matching the increase in the external finance premium.

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<sup>13</sup> When we used different values of the bankruptcy cost coefficient in calibration, the change in steady state leverage was exactly offset by a change in the external finance premium, so that the cutoff value of the technology shock could be held constant, as can be seen in equation (4). This implied that the bankruptcy rate was constant as well since the distribution of the idiosyncratic shock and the cutoff value of the technology shock are the only determinants of the bankruptcy rate.

In addition, the amplitude of impulse responses in the LIQE is higher. There are two counteracting effects that determine this outcome. First, when bankruptcy costs are low, the effect of the financial accelerator mechanism is more muted, and the output loss due to financial frictions is lower. This can be seen more clearly if we consider the evolution of net worth shown in equation (8) and the aggregate resource constraint given by,

$$Y_t = C_t^H + C_t^{eH} + C_t^{H*} + I_t^H + \mu \left( \int_0^{\bar{A}_t} A_t f(\bar{A}_t) \delta A_t \right) R_t^k Q_{t-1} K_t \quad (10)$$

Low bankruptcy costs also imply that entrepreneurs' net worth falls by less, as can be seen from equation (9). The smaller drop in net worth prevents a sharp increase in the external finance premium and a large decrease in investment. We refer to this combined effect as the financial accelerator effect.

The second effect is due to the nature of the financial contract and can be observed more clearly if we log-linearize (5) around a non-stochastic steady state:<sup>14</sup>

$$\tilde{EFP}_t = \alpha_1(\mu, \bar{A}_t) \tilde{LEV}_t \quad (11)$$

where  $\alpha_1'(\mu) > 0$ ,  $\tilde{EFP}_t = \tilde{R}_t^k - \tilde{R}_t$ ,  $\tilde{LEV}_t = \tilde{Q}_{t-1} + \tilde{K}_t - \tilde{N}_t$ , and “ $\sim$ ” denotes percent deviation from steady state. In the HIQE, the external finance premium is less sensitive to leverage ratios. In other words, the coefficient of the leverage variable in equation (11) is lower for the HIQE. The reason is that when bankruptcy costs are low, creditors are not as affected by bankruptcy since they can retrieve a greater portion of a bankrupt firm's assets. In this case, the risk-free rate is a relatively more important determinant of external finance rates than firm leverage. In contrast, when bankruptcy costs are high, leverage plays a more predominant role. Therefore, after the initial surge in leverage prompted by a drop in net worth, investment in the HIQE has to

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<sup>14</sup> The expression for the coefficient of the leverage variable is provided in Appendix A.

fall significantly to reduce the risk premium, which counteracts the increase in the risk free rate. We refer to this effect as the leverage sensitivity effect. By changing bankruptcy costs, we uncover this feature of the model, which to this point has not been documented theoretically despite the sizeable literature on the financial accelerator effect.

To summarize, we find, as shown in Figure 1, that when borrowing is denominated in local currency, the financial accelerator effect dominates the leverage sensitivity effect. In this case, the output response to capital reversals is more muted when institutional quality is higher. These initial results are similar to studies (BGG, 1999; GGN, 2007) showing that output responses to various shocks are smaller when the financial accelerator effect is shut off ( $\mu = 0$ ).

## 2.4. Complete Liability Dollarization

In this section, we look at the case of an economy in which domestic entrepreneurs are assumed to rely exclusively on foreign financing, which is denominated in foreign currency. Introducing liability dollarization to the model affects only the part of the model pertaining to the financial contract; the rest of the economy is the same. By incorporating balance sheet effects, we obtain the opposite result from Section 2.3. In particular, a reduction in bankruptcy costs increases an economy's vulnerability to a capital reversal.

The terms of the contract are determined according to the equations below:

$$[1 - F(\bar{A}_{it})](R_t^* + x_{it})F_{it} + (1 - \mu_t) \left[ \int_0^{\bar{A}_{it}} A_{it} R_t^k Q_{t-1} K_{it} \delta F(A_{it}) \right] / s_t^r = R_t^* F_{it} \quad (12)$$

$$\bar{A}_{it} R_t^k Q_{t-1} K_{it} / s_t^r = (R_t^* + x_{it}) F_{it} \quad (13)$$

$$Q_{t-1} K_{it} - N_{it} = s_t^r F_{it} \quad (14)$$

where  $s_t^r$ ,  $R_t^*$ , and  $F_{it}$  denote the real exchange rate, foreign risk free interest rate, and nominal foreign borrowing, respectively. The financial contract is different from that in the benchmark

model in two ways. First, loans are denominated in dollars, and lenders equate their expected returns to the foreign interest rate.<sup>15</sup> Second, the supply of capital relationship depends on the exchange rate. Thus exchange rates directly impact the external finance premium. Given the terms of the contract, we can obtain the relationship between the external finance premium and leverage in a similar fashion, as in BGG (1999).

$$\frac{E_{t-1}[(s_{t-1}^r / s_t^r)R_t^k]}{R_t^*} = v_f \left( \frac{Q_{t-1}K_{it}}{N_{it}} \right) \quad \text{where } v_f \left( \frac{Q_{t-1}K_{it}}{N_{it}} \right) > 0 \quad (15)$$

As in the previous section, we calibrate this economy using high and low levels of bankruptcy costs and report the impulse responses to a 100 annualized basis point foreign interest rate shock. Results are displayed in Figure 2.<sup>16</sup> There are two main results. First, compared to the economy with no dollarization, the amplitudes of the responses are significantly higher for each level of institutional quality. Second, the leverage sensitivity effect dominates the financial accelerator effect, so that the output response is greater when  $\mu$  is lower. This finding is exactly opposite to that in the previous section.

There are two factors that produce these different results. First, entrepreneurs' net worth now includes the foreign instead of the domestic interest rate and the exchange rate:

$$V_{it} = R_t^k Q_{t-1} K_{it} - \left( s_t^r R_t^* F_{it} + \mu \int_0^{\bar{A}_i} A_{it} R_t^k Q_{t-1} K_{it} dF(A_{it}) \right) \quad (16)$$

This modification causes foreign interest rate shocks to be fully transmitted to entrepreneurs' net worth in contrast to the previous section where part of the external shock was absorbed by exchange rates. Furthermore, the depreciating currency has a negative effect on net worth by

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<sup>15</sup> In our model it is not important in terms of currency risk whether foreigners or domestic residents provide the foreign currency denominated funds. In either case the opportunity cost for the lender is the risk free foreign interest rate. However, as we discuss below, the nationality of the lender does affect bankruptcy costs, although incorporating dollar lending by domestic lenders does not change the key results of the model.

<sup>16</sup> The figure shows a large fall in investment. Joyce and Nabar (2008) find empirically that for sudden stops to reduce investment, the banking system has to collapse following the withdrawal of funds by external depositors.

inflating the domestic currency value of the firms' loans. The larger negative impact on net worth causes a sharp increase in the external finance premium and a larger drop in investment following a sudden stop compared to the benchmark model.

Second, the relationship between the external finance premium and leverage is different.

This can be seen more clearly from the linearized version of equation (15):

$$\tilde{EFP}_t^* = \alpha_{1f}(\mu, \bar{A}_i) \tilde{LEV}_t + \left( \tilde{s}_t^r - \tilde{s}_{t-1}^r \right) \quad (17)$$

where  $\alpha_{1f}'(\mu) > 0$ ,  $\tilde{EFP}_t^* = \tilde{R}_t^k - \tilde{R}_t^*$ ,  $\tilde{LEV}_t = \tilde{Q}_{t-1} + \tilde{K}_t - \tilde{N}_t$ . In contrast to the benchmark model, the exchange rate impacts this relationship. Similarly, a capital reversal shrinks the wedge between the returns to capital and the risk free interest rate, prompting a drop in investment. However, investment falls by an additional amount to lower leverage and counteract the rise in foreign debt caused by the depreciation. Therefore, the drop in investment is more pronounced than in Section 2.3.

As mentioned above, the second difference with a non-dollarized economy, which is more critical for our analysis, is that an increase in institutional quality produces a larger output drop following a sudden stop. The intuition is as follows: first, as discussed in this section, the presence of liability dollarization induces a larger fall in investment, implying that leverage sensitivity becomes more important. Second, leverage sensitivity of the external finance premium is low when institutional quality is high (this is the leverage sensitivity effect, i.e.,  $\alpha_{1f}$  in equation (17) is smaller in a HIQE). Therefore, the drop in investment in a HIQE is larger than in a LIQE as a result of this stronger leverage sensitivity effect. In fact, under our calibration, the subsequent larger response of output is enough to overcome the weaker financial accelerator effect associated with better institutions. Thus, reductions in bankruptcy costs increase vulnerability to sudden stops when there is liability dollarization.

## 2.5. Partial Dollarization - The Intermediate Case

In this section, we allow for borrowing in both local and foreign currency and derive a relationship between institutional quality and liability dollarization. In the new economy, there are firms that borrow from abroad in foreign currency (Type 1) and firms that borrow domestically in local currency (Type 2).<sup>17, 18</sup> Since agents are risk neutral, they are indifferent between borrowing in domestic or foreign currency as long as the interest parity condition holds. Each firm produces a different intermediate good that are aggregated to produce the final good.

$$Y_t = (\lambda^d Y_{1t}^{\rho^d} + (1 - \lambda^d) Y_{2t}^{\rho^d})^{1/\rho^d} \quad (18)$$

where  $Y_{it} = A_{it} K_{it}^\alpha L_{it}^{1-\alpha}$ ,  $i = 1, 2$ . Contracts with creditors differ by type of firm and yield:

$$\frac{E_{t-1}[(s_{t-1}^r / s_t^r) R_{1t}^k]}{R_t^*} = v \left( \frac{Q_{1t-1} K_{1t}}{N_{1t}} \right) : \text{Type 1}, \quad \frac{E_{t-1}(R_{2t}^k)}{R_t} = v \left( \frac{Q_{2t-1} K_{2t}}{N_{2t}} \right) : \text{Type 2}$$

We assume a higher bankruptcy cost coefficient,  $\mu^*$ , for borrowing from abroad. In particular, we assume there is a positive fixed wedge between the bankruptcy costs of domestic and foreign currency denominated loans equal to  $FC$  such that  $\mu^* = \mu + FC$ . We explain later why this assumption is critical to derive the non-linear relationship between bankruptcy costs and vulnerability to sudden stops. A significant number of papers including those cited in the introduction argue that bankruptcy costs are higher for foreign lenders. This difference is due to factors such as limited local experience and knowledge of foreign lenders, an inability to

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<sup>17</sup> Of course foreigners can also lend in local currency in foreign or domestic markets and lend in foreign currency in domestic markets. Similarly, domestic lenders can lend in foreign currency in domestic markets. In terms of currency risk, what matters is the currency denomination of the loan, not the nationality of the lender.

<sup>18</sup> We do not model FDI even though it is a significant part of capital flows to emerging economies. Introducing FDI into the model significantly complicates the model. In addition, even if domestic firms are not the primary recipient of capital inflows, in the model sudden stops still adversely affect domestic firms by increasing the domestic interest rate. There is also recent evidence for emerging markets that bank loans have become a larger share of capital inflows (Cetorelli and Goldberg, 2008). Moreover, debt flows are the most relevant type of capital flow when analyzing sudden stops since they are more prone to reversals than FDI. For example, Levchenko and Mauro (2006) find that FDI is the least volatile form of financial flow and that the differences are even higher during sudden stops. During these episodes they find that FDI is quite stable, portfolio equity plays a limited role, portfolio debt experiences a reversal but recovers quickly, while banks loans drop significantly and remain depressed for years.



identify efficient borrowers due to a lack of a credit/relationship history, higher costs of additional information for foreign lenders, nationalistic bias in the legal system, and international capital flow barriers. In Section 2.6, we discuss the implications for bankruptcy costs of lending by locals that is dollar-denominated. While the nationality of the dollar lender does not matter in terms of currency risk, it does matter for differences in bankruptcy costs.

Due to arbitrage, the returns to capital for the two firms are equal such that  $E_{t-1}(R_{1t}^k - R_{2t}^k) = 0$ . This condition also implies that the external finance premiums for the two types of firms are equal, and that they are indifferent between borrowing in domestic and foreign currency.<sup>19</sup> However, the price of capital and leverage are different for each type of firm.

$$E_{t-1}[Q_{it} / P_t^w - [\Phi'(I_{it} / K_{it})]^{-1}] = 0, \quad \Phi'(\bullet) > 0, \quad i = 1, 2 \quad (19)$$

Liability dollarization is the proportion of borrowing in foreign currency:

$$LD_t = s_t^r B_{1t} / (s_t^r B_{1t} + B_{2t}) \quad (20)$$

where  $LD_t$  represents liability dollarization and  $B_{1t} = (Q_{1t-1}K_{1t} - N_{1t}) / s_t^r$  and  $B_{2t} = (Q_{2t-1}K_{2t} - N_{2t})$  are foreign and domestic currency borrowing, respectively. To calibrate this economy, we further set liability dollarization to 52%, which matches Argentina's average for the years 1990 to 2002.<sup>20</sup> To obtain this value we set  $FC$ ,  $\mu$ , and the share parameter  $\gamma^d$  to 0.22, 0.25, and 0.46, respectively. These parameter values also imply that the average (weighed by share of borrowing) bankruptcy cost as a percent of assets is set to 0.31, and average leverage (weighed by the share of borrowing) is equal to 1.8. Allowing for imperfect substitutability did not produce significant deviations from our results; we therefore set  $\rho^d = 1$ . In our simulations,

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<sup>19</sup> This implies, consistent with Schulz (2006), that foreign and domestic banks' performance after sudden stops are not different..

<sup>20</sup> Data is from the Inter-American Development Bank and is constructed using the methodology of Kamil (2006). The liability dollarization ratio is computed as the share of dollar-linked debt as a percentage of total liabilities of non-financial firms. We use the whole sample and the mean values of debt dollarization to compute the average liability dollarization between 1990 and 2002.

we deviate from this baseline calibration by altering only the bankruptcy coefficient. We then measure the output response to foreign interest rate shocks for different values of  $\mu$ .

To understand the intuition for the relationship between bankruptcy costs and liability dollarization, we first need to understand the relationship between bankruptcy costs and leverage, which was mentioned above in the discussion of the financial contract. As expected, when the bankruptcy cost coefficient rises, firms reduce their leverage to counteract the effects on the external finance premium, implying a negative non-stochastic steady state relationship between the two variables. In addition, as displayed in the left panel of Figure 3, we find that the relationship is convex. The reason is that with high bankruptcy costs, firms rely more on internal financing and reduce their chance of default significantly. The default probability falls by more as external borrowing approaches zero. Furthermore, since, the marginal product of capital is higher at high levels of  $\mu$ , the negative effect of an increase in bankruptcy costs on lenders expected return is counteracted by smaller drops in leverage.

As a consequence of this relationship between leverage and the bankruptcy cost coefficient, we find that higher bankruptcy costs correspond to higher liability dollarization.<sup>21</sup> The right panel of Figure 3 depicts this positive relationship. The intuition is as follows: when bankruptcy costs are high, the difference between the leverage of the two types of firms is small despite the wedge,  $FC$ , and liability dollarization is relatively high. However, when bankruptcy costs are low, due to the convex relationship between  $\mu$  and leverage, the difference in bankruptcy costs,  $FC$ , plays a more important role. Specifically, the risk premium on domestic borrowing is much lower than on foreign borrowing; thus liability dollarization is relatively low.

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<sup>21</sup> We do not claim that institutional improvement reduces the share of foreign liabilities that are denominated in foreign currency. All foreign lending is in foreign currency, which matches the observed inability of almost all countries to borrow abroad in their own currency, a phenomenon known as original sin (c.f. Hausmann and Panizza, 2003). Rather, institutional improvement reduces the share of dollar lending by encouraging local lending, which is assumed to be in local currency. While this is not always the case, there is evidence of a negative relationship between institutional quality and domestic liability dollarization.

Therefore, due to the fixed wedge between the two monitoring costs, we vary the level of dollarization in the economy by calibrating to different levels of  $\mu$ . This in turn alters the relationship between vulnerability to sudden stops and bankruptcy costs. Figure 4 shows the output responses to a 100 basis point positive shock to foreign interest rates for different values of  $\mu$ . We can see from the bottom figure that for high values of  $\mu$  (low institutional quality), a reduction in  $\mu$  (an improvement in quality) increases the vulnerability to sudden stops. The reason is that there is enough liability dollarization for the leverage sensitivity effect to dominate the financial accelerator effect. A fall in  $\mu$ , however, also results in less liability dollarization so that the financial accelerator effect becomes relatively more important. In fact, below a certain value of  $\mu$ , vulnerability to sudden stops starts to diminish, as depicted in the top panel.

Figure 5 summarizes this non-linear relationship between output responses and bankruptcy costs. We measure vulnerability to sudden stops with the maximum amplitude of the output response to a 100 annualized basis points increase in foreign interest rates. The figure reveals an inverted U-Shaped relationship between bankruptcy costs, the aspect of institutional quality that we focus on, and vulnerability to sudden stops.

Furthermore, the model's prediction for the magnitude of the output loss following a sudden stop is similar to what is observed during actual crisis episodes. The mean (median) output loss during sudden stops between 1982 and 2004 was 2.7% (2.2%) (Honig, 2008). During this period, country risk premiums during sudden stops obtained from the Emerging Market Bond Index (EMBI) rose by a mean (median) of 8.2 (4.4) percentage points. This mean (median) change in interest rates implies in our model that output falls by 1.9% to 8.9% (1.0% to 4.7%) depending on the value of the bankruptcy cost coefficient (intermediate values generate the largest drops in output). Thus the actual drop in output is in the range predicted by the model.

## 2.6 Sensitivity Analysis

We first check the sensitivity of our results to different parameter values. Figure 6 displays the results. So far we have assumed that the central bank operates a flexible exchange rate regime. Under a fixed exchange rate regime, where the exponent of the exchange rate variable  $\gamma_e$  is set equal to an arbitrarily large value (this implies that domestic interest rates are identical to foreign interest rates, a result that does not match the large increase in domestic rates to maintain fixed exchange rates during sudden stops). In this case, we no longer obtain an inverted U-shaped curve, as depicted in the top left panel of Figure 6. This is not surprising since Type 1 agents face the same contract as Type 2 when the exchange rate is fixed, notwithstanding the fixed cost wedge between the two bankruptcy costs. Therefore, the leverage sensitivity effect never dominates the financial accelerator effect as bankruptcy costs fall, since leverage does not have to fall further to compensate for the depreciating currency. Furthermore, since interest rates are increased more aggressively under a fixed regime, the financial accelerator effect is amplified. Thus, we find that under a fixed exchange rate, improving institutions unambiguously reduces vulnerability to sudden stops. Another noteworthy observation is that the benchmark Taylor rule does a better job of insulating the economy from external shocks for each value of  $\mu$ .

We initially set the fixed cost wedge parameter,  $FC$ , to match the level of dollarization in the economy. This is an important parameter that determines the relative strength of the financial accelerator and leverage sensitivity effects. Because we do not have an empirical estimate for this fixed cost, we set  $FC$  to two other values and report the results in the top right panel of Figure 6. As can be seen, when  $FC$  is smaller, the U-Curve reaches its maximum at a smaller value of  $\mu$ . This reflects a higher level of investment and borrowing by Type 1 agents and, therefore, a higher share of liability dollarization. Since the higher level of liability

dollarization increases the strength of the leverage sensitivity effect, the turning point on the U-Shaped curve is observed for smaller values of  $\mu$ . Also, the higher share of dollarization has an amplifying effect.

In the model, the only difference between the high and low institutional quality economies was the bankruptcy cost coefficient. However, most of the parameter values for these two types of economies are different in reality. To check the robustness of our results, we calibrated our high institutional quality economy to Canadian data.<sup>22</sup> Output responses to a foreign interest rate shock, displayed in the middle two panels of Figure 6, are qualitatively similar to those in Figures 1 and 2. Specifically, we observe that the economy with relatively high quality institutions, Canada, is insulated more (less) when there is no (complete) liability dollarization. Consistent with our initial results, the last panel shows that if liability dollarization depends on institutional quality, as in Section 2.5, Canada is less vulnerable to external shocks.

Following the standard practice in the financial accelerator literature, we assume that entrepreneurs are risk neutral to simplify considerably the solving of the model. However, due to the relatively small number of firms/projects that entrepreneurs invest in, currency risk neutrality may be an unreasonable assumption for entrepreneurs (c.f. Gale and Helwig, 1985). Given this strong assumption, our results should be interpreted with caution.<sup>23</sup>

Finally, we consider the realistic possibility that dollar credit is provided by local lenders, not just by foreign lenders. In fact in many emerging market economies, dollar lending by locals

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<sup>22</sup> Parameter values used to calibrate the model to Canadian data are summarized and discussed in Appendix B.

<sup>23</sup> Nevertheless, extrapolating from Pardo (2005), we expect introducing risk-aversion to strengthen both the financial accelerator and leverage sensitivity effects. The intuition is as follows: if entrepreneurs are risk averse, they would demand insurance from the bank, and would choose the proportion of their net worth they would like to insure. Entrepreneurs would also require higher returns to capital to invest in risky projects compared to the risk neutrality case, and leverage would decrease. This additional interest premium would reflect higher costs of insurance. In this setup, if there is a drop in net worth, the external finance premium would increase just as in the risk neutrality case. However, risk-averse entrepreneurs would require higher returns to capital since the amount of insurance decreases, and investment would fall by more. Thus, the financial accelerator effect would be stronger. The effect of risk-aversion on the leverage sensitivity effect is straightforward. When bankruptcy costs are low, the bank would have more resources to provide insurance and the risk premium would be less sensitive to leverage. Therefore, the leverage sensitivity effect would be stronger. Without solving the model, we cannot know which effect strengthens by more.

is larger than dollar lending by foreigners. Our assumption that bankruptcy costs are higher for dollar lending cannot be justified by a bias in the legal system against foreigners if it is local lenders that are making dollar loans. However, even if we assume that bankruptcy costs for dollar and peso lending by locals are the same (but still lower than for dollar lending by foreigners), we still obtain the result that a decline in bankruptcy costs lowers liability dollarization. In particular, let  $F^{\$}$  and  $D^{\$}$  denote the dollar denominated loans extended by foreign and domestic banks, and  $D^{Peso}$  denote domestic currency denominated loans extended by domestic banks (note that in our baseline model we do not distinguish between  $F^{\$}$  and  $D^{\$}$ ). The share of lending in foreign currency is given by:  $(F^{\$} + D^{\$}) / (F^{\$} + D^{\$} + D^{Peso})$ . Given this setup if there is an decrease in bankruptcy costs (a decrease in  $\mu$ ) and if  $F^{\$}$  increases by less than domestic lending  $D^{\$}$  and  $D^{Peso}$  for the reasons explained above (the convex relationship and the fixed wedge  $FC$ ), then liability dollarization still decreases even if  $F^{\$} < D^{\$}$ .

In addition, there is evidence that the extent of dollar lending by foreign banks is not insignificant.<sup>24</sup> In this case, the wedge between foreign and domestic lenders' monitoring costs can still be important in determining liability dollarization.

### 3. Conclusion

Emerging market countries that experience initial improvements in institutional quality also become more vulnerable to sudden stops. This result is surprising and breaks with the widespread literature on the benefits of good institutions. Advanced economies with strong

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<sup>24</sup> To get a sense of the degree of foreign participation in domestic lending activity, we collected data from the locational banking statistics report of the BIS. Our calculations reveal that the ratio of foreign lending to domestic credit for developing countries is between 14 and 19 percent. There are three reasons why these values understate the extent of foreign bank foreign currency lending. First, the loans of foreign banks' local offices are not included in our calculations. This is important because bankruptcy recovery rates have been argued to be lower for branches of foreign banks, not just for cross-border loans (Iacoviello and Minetti, 2006; Rajan and Zingales, 1998; Hermalin and Rose, 1999). Second, the domestic credit variable includes claims on the banking sector as well as the non-bank sector. If we include foreign lending to all sectors, the figures are higher. Third, domestic credit includes both foreign currency and domestic currency lending. We were unable to obtain data on the currency composition of domestic credit. However, foreign currency lending by foreign banks is certainly a greater percentage of total foreign currency lending than of total domestic credit, implying a higher ratio than the 14-19% reported above.

institutions, on the other hand, do not suffer large drops in output during capital flow reversals. These two observations imply a non-linear effect of institutional quality on the contractionary impact of sudden stops. In this paper, we provide a theoretical explanation for this relationship using a small open economy DSGE model.

To derive this relationship, we first analyze the direct effects of an improvement in institutional quality. A reduction in the bankruptcy cost coefficient weakens the financial accelerator effect during a sudden stop, leading to a smaller drop in output. However, lower bankruptcy costs also reduce the sensitivity of the external finance premium to leverage, requiring a larger fall investment in response to a capital reversal. This leverage sensitivity effect plays a critical role in the model. We then show that the relative strengths of these two effects depend on the level of liability dollarization. When liabilities are heavily dollarized, the leverage sensitivity effect dominates, so that lower bankruptcy costs actually magnify the output loss during sudden stops. When we further model a causal effect of bankruptcy costs on liability dollarization, simulations yield an inverted U-shaped relationship between institutional quality and the output loss during sudden stops.

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Figure 1: Impulse Responses (in percentage points) to a 1 percentage point (Annualized) increase in foreign interest rates (Benchmark model)

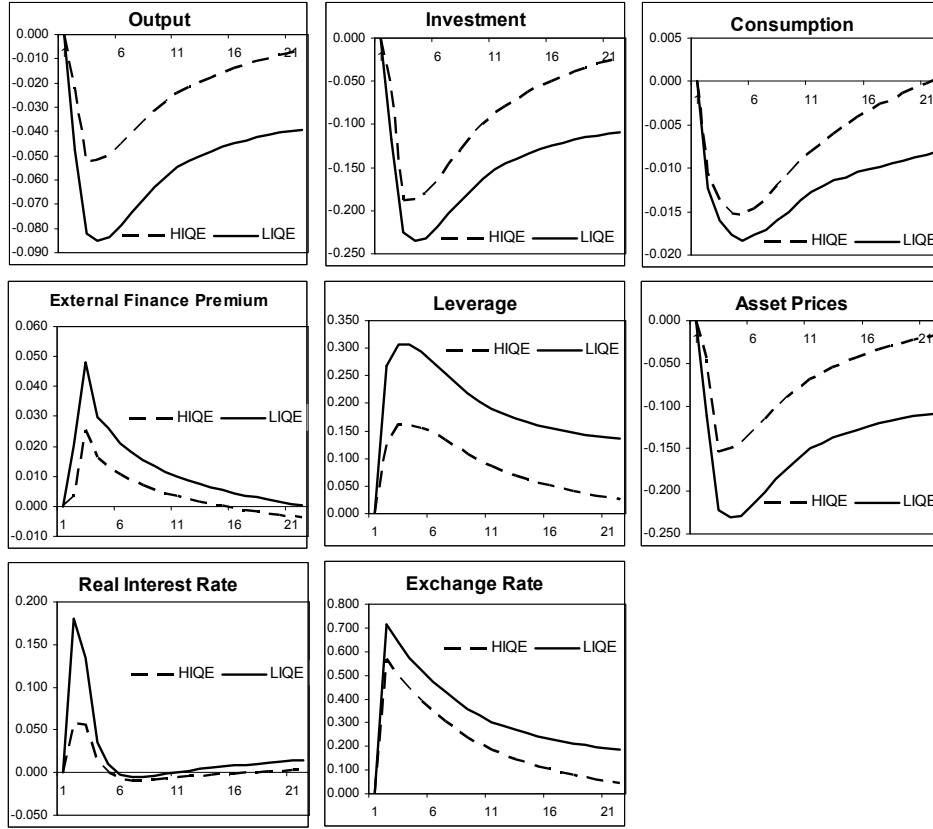


Figure 2: Impulse Responses (in percentage points) to a 1 percentage point (Annualized) increase in foreign interest rates (Liability dollarized economy)

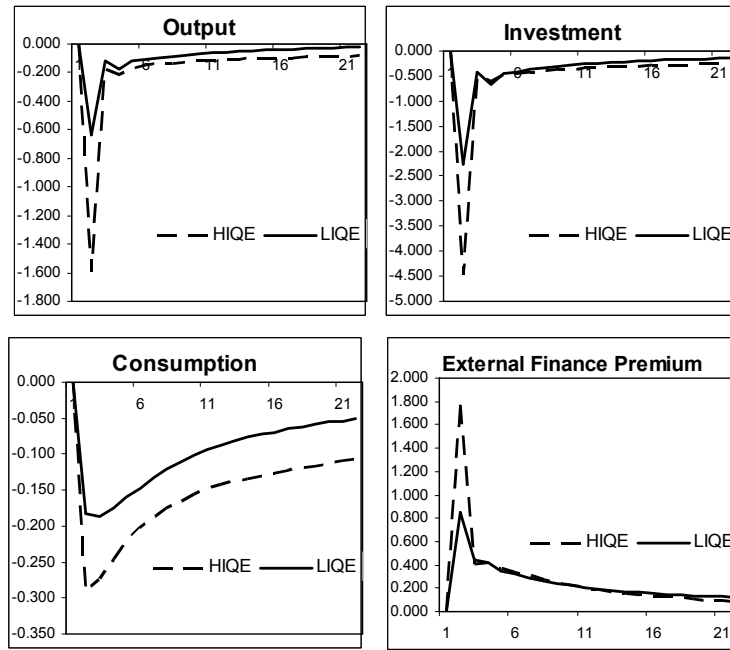


Figure 3: Steady state relationship between leverage, bankruptcy costs and liability dollarization

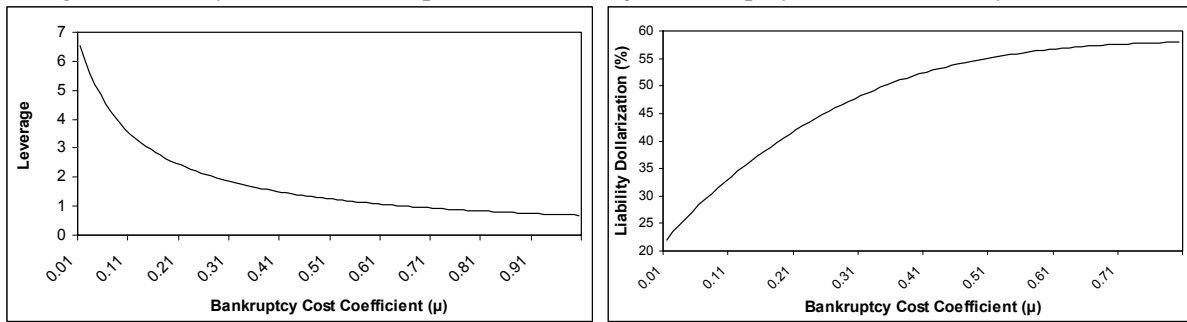


Figure 4: Output responses (in percentage points) to a 1 percentage point (Annualized) positive shock to foreign interest rates (For different levels of the bankruptcy cost coefficient)

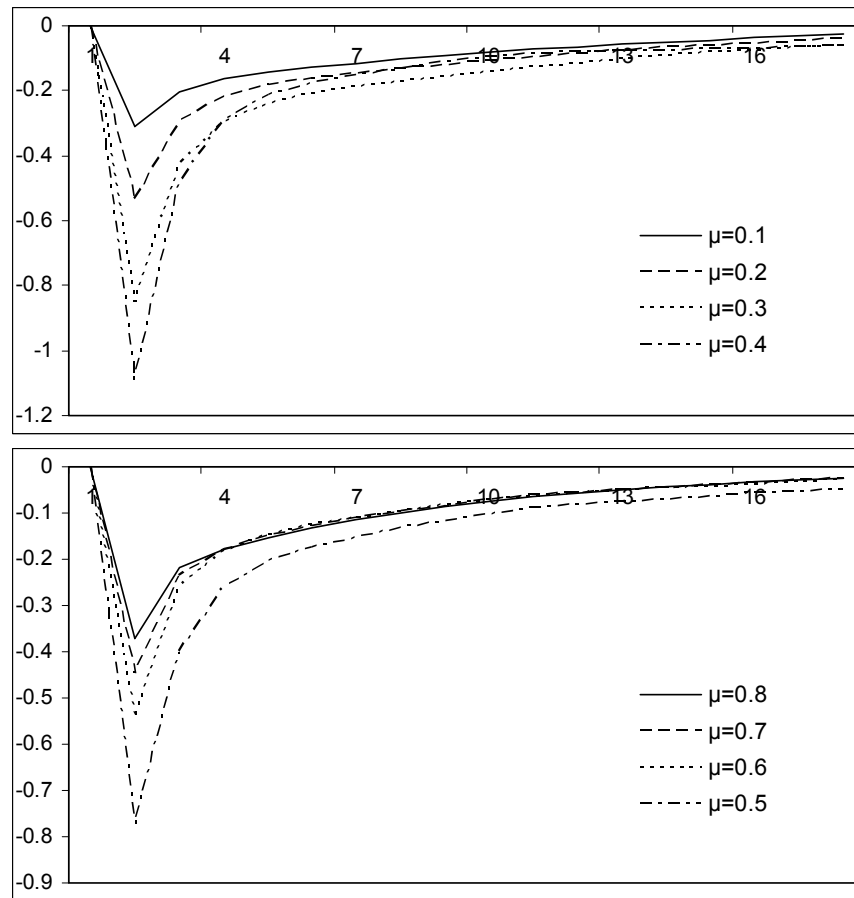
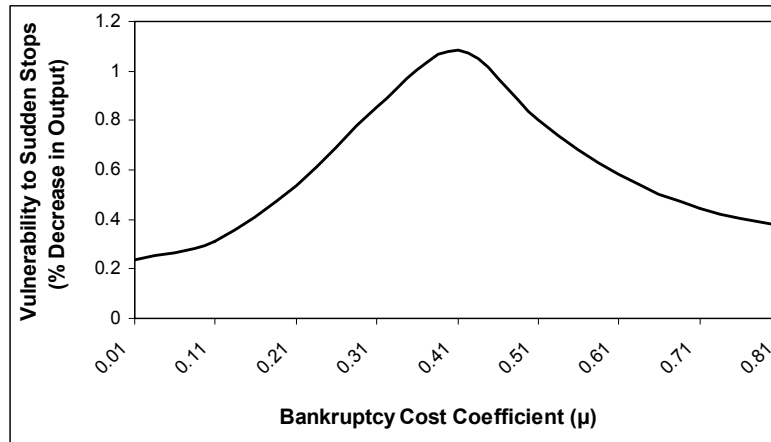
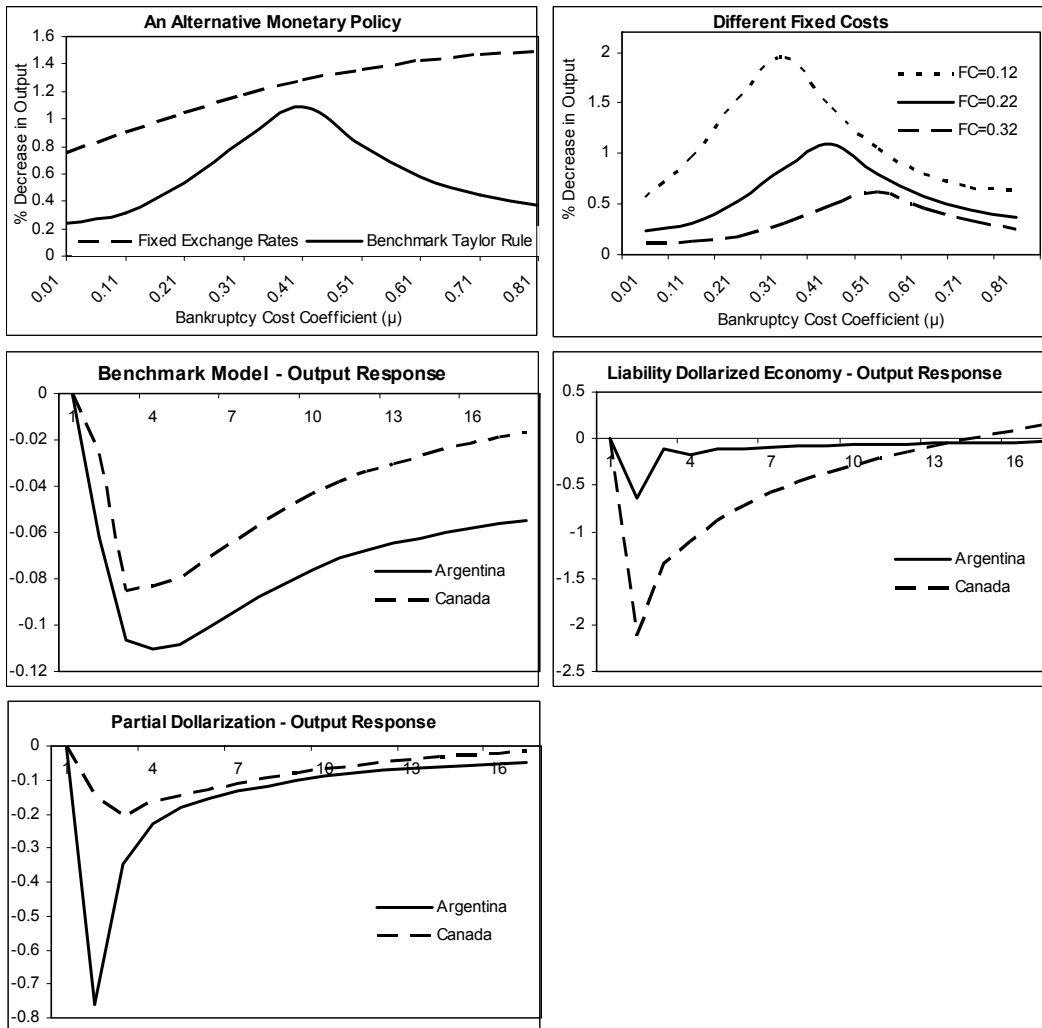


Figure 5: Relationship between vulnerability to sudden stops and bankruptcy costs (\*)



(\*) Vulnerability to Sudden Stops represents the maximum amplitude of the negative output response to a 100 basis point increase in foreign interest rates corresponding to the level of each bankruptcy cost coefficient.

Figure 6: Sensitivity Analysis



(\*) Vulnerability to Sudden Stops represents the maximum amplitude of the negative output response to a 100 basis point increase in foreign interest rates corresponding to the level of each bankruptcy cost coefficient.

## Appendix A: The External Finance Premium

### A.1 Deriving the External Premium

This section derives the relationship between the external finance premium and institutional quality. As in Gale and Helwig (1985), Williamson (1987), and Carlstrom and Fuerst (1997), we define the optimal contract as the  $K$  and  $\bar{A}_i$  pair that maximizes entrepreneurs' profits given that the lender receives the risk free rate  $R$  on the loans. Since  $\bar{A}_i$  is the same for every entrepreneur we will denote it as  $\bar{A}$ . Lender's share of profits can be written as:

$$LS(\bar{A}) = \int_0^{\bar{A}} Af(A)dA + \bar{A}[1 - F(\bar{A})] \quad (\text{A.1})$$

Define entrepreneurs' share of profits as:

$$ES(\bar{A}) = 1 - LS(\bar{A}) = \int_{\bar{A}}^{\infty} Af(A)dA - \bar{A}[1 - F(\bar{A})] \quad (\text{A.2})$$

The optimal contract can now be obtained from the following maximization problem.

$$\begin{aligned} \max_{K, \bar{A}} & \left( \int_{\bar{A}}^{\infty} Af(A)dA - \bar{A}[1 - F(\bar{A})] \right) R^k QK \\ \text{s.t.} & \left( (1 - \mu) \int_0^{\bar{A}} Af(A)dA + \bar{A}[1 - F(\bar{A})] \right) R^k QK = R(QK - N) \end{aligned} \quad (\text{A.3})$$

The first order conditions are as follows:

$$\bar{A} : 1 - F(\bar{A}) - \lambda(1 - F(\bar{A}) - \mu\bar{A}f(\bar{A})) \quad (\text{A.4})$$

$$K : \left( \int_{\bar{A}}^{\infty} Af(A)dA - \bar{A}[1 - F(\bar{A})] \right) R^k Q + \lambda \left( (1 - \mu) \int_0^{\bar{A}} Af(A)dA + \bar{A}[1 - F(\bar{A})] \right) R^k Q - \lambda RQ = 0 \quad (\text{A.5})$$

$$\lambda : (1 - \mu) \int_0^{\bar{A}} Af(A)dA + \bar{A}[1 - F(\bar{A})] = R(QK - N) \quad (\text{A.6})$$

where  $\lambda$  is the Lagrange multiplier. If we define the external finance premium as  $EFP = R^k / R$ , equation (A.5) can be used to solve for this variable.

$$EFP = \frac{\lambda}{\left(\int_{\bar{A}}^{\infty} Af(A)dA - \bar{A}[1 - F(\bar{A})]\right) + \lambda((1 - \mu)\int_0^{\bar{A}} Af(A)dA + \bar{A}[1 - F(\bar{A})])} \quad (\text{A.7})$$

where  $\lambda = (1 - F(\bar{A})) / (1 - F(\bar{A}) - \mu\bar{A}f(\bar{A}))$  from equation (A.4).

Similarly, we can solve for the leverage ratio  $LR = QK / N$  using equation (A.6):

$$LR = 1 + \frac{\lambda((1 - \mu)\int_0^{\bar{A}} Af(A)dA + \bar{A}[1 - F(\bar{A})])}{\int_{\bar{A}}^{\infty} Af(A)dA - \bar{A}[1 - F(\bar{A})]} \quad (\text{A.8})$$

As in BGG (1999), we take derivatives of equations (A.5) and (A.6) with respect to  $\bar{A}$  and find that  $EFP$  and  $LR$  are positively related such that:

$$EFP = \theta(LR) \quad \theta'(LR) > 0 \quad (\text{A.9})$$

We use the linearized form of equation (A.9) when solving the model:

$$\tilde{EFP}_t = \alpha_1 \tilde{LR}_t \quad (\text{A.10})$$

where “ $\sim$ ” represents deviations from steady state values, and

$$\alpha_1 = \frac{\left( \frac{\frac{\delta\lambda}{\delta\bar{A}}\bar{A}}{(\lambda_1 + \lambda\lambda_2)EFP} - \frac{\lambda\bar{A}}{(\lambda_1 + \lambda\lambda_2)^2 EFP} \left( \frac{\delta\lambda_1}{\delta\bar{A}} + \lambda\lambda_2 \frac{\delta\lambda}{\delta\bar{A}} + \lambda^2 \frac{\delta\lambda_2}{\delta\bar{A}} \right) \right)}{\frac{\bar{A}}{\lambda_1} \left( \frac{\delta\lambda}{\delta\bar{A}}\lambda_2 + \frac{\delta\lambda_2}{\delta\bar{A}}\lambda - \frac{\delta\lambda_1}{\delta\bar{A}} \frac{\lambda_2\lambda}{\lambda_1} \right)}$$

$$\lambda_1 = \int_{\bar{A}}^{\infty} Af(A)dA - \bar{A}[1 - F(\bar{A})], \quad \lambda_2 = (1 - \mu)\int_0^{\bar{A}} Af(A)dA + \bar{A}[1 - F(\bar{A})]$$

This relationship is obtained by eliminating  $\bar{A}_t$  from the linearized forms of equations (A.7) and (A.8).

## A.2 Steady State Relationship between the Bankruptcy Cost Coefficient and the External Finance Premium

In this paper we are interested in how the bankruptcy cost affects the relationship between  $EFP$  and  $LR$  in steady state. Therefore, we take the derivatives of equations (A.7) and (A.8) with respect to  $\mu$  and obtain:

$$\frac{\partial EFP}{\partial \mu} = EFP^2 \int_0^{\bar{A}} Af(A)dA > 0 \quad (\text{A.10})$$

$$\frac{\partial LR}{\partial \mu} = -\frac{\lambda \int_0^{\bar{A}} Af(A)dA}{\int_A^{\infty} Af(A)dA - \bar{A}[1 - F(\bar{A})]} < 0 \quad (\text{A.11})$$

since entrepreneurs' share of profits  $0 < ES < 1$ . Combining (A.10) and (A.11) with (A.9), we can derive the following steady state relationship:

$$EFP = \nu(LR, \mu) \text{ where } \nu'(LR) > 0, \nu'(\mu) > 0 \quad (\text{A.12})$$

Equation (A.12) shows that higher bankruptcy costs increase the external finance premium for the same values of leverage. Similarly, we can argue that there is a negative relationship between leverage and  $\mu$ . The latter result allows us to obtain different leverage values for the two types of firms in Section 2.5 and motivates the relationship between bankruptcy costs and liability dollarization.

**Appendix B: General Equilibrium Framework and Calibration** – available online at [http://homepages.uconn.edu/~ula06001/appendix\\_B\\_online.pdf](http://homepages.uconn.edu/~ula06001/appendix_B_online.pdf)