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Twin Crises in Emerging Markets: The Role of Liability Dollarization and Imperfect Competition in Banking

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Abstract

Currency crises in emerging markets have been accompanied by banking crises, with concentration in the market for bank credit increasing after large devaluations. This paper examines how the presence of imperfect competition and liability dollarization in banking shapes the real effects of the just mentioned twin crises. An important gap in the theoretical literature is filled, by being the first paper to provide a model of twin crises in the presence of imperfect competition in banking, and the changes in market structure that occur in the aftermath of crises. Doing so, the analysis is able to reveal that currency devaluations generate more severe twin crises in economies with less competitive banking sectors. This result is consistent with the empirical evidence on the concentration-fragility view, and it unveils the importance of prudential regulation that focuses on the market structure in banking.

1. Introduction

Substantial empirical evidence points to the existence of twin crises in emerging markets. Kaminsky and Reinhart (1999) emphasize that many of the countries that have experienced currency crises were also afflicted by fully-fledged domestic banking crises around the time when their foreign exchange market was in mayhem. Burnside et al. (2001) also concurred that in the post-Bretton Woods era currency crises have been accompanied by banking crises, and many banks have gone bankrupt after a currency devaluation.

A common explanation for twin crises in the existing literature is to assume liability dollarization in borrowers balance sheets such that a currency devaluation reduces the profitability of bank debtors, who are then unable to repay their debt. Good loans turn bad and the banking industry collapses.

With this work assuming perfect competition in the banking industry, the theoretical literature still lacks an analysis of twin crises in the presence of market power in banking. This represents an important gap, since empirical work in banking seems to have reached a consensus that banking industries in emerging markets are not perfectly competitive (Gelós and Roldós, 2004; Claessens and Laeven, 2004; Yildirim and Philippatos, 2007a,b).

Our goal in this paper is to fill this gap between theoretical and empirical work. By incorporating imperfectly competitive banks we contribute to the literature in two

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ways. First, we are able to focus on the changes in the market structure in banking that occur in the aftermath of crises, which previous work with perfectly competitive banks is silent about. Second, we are able to study how the degree of competition in banking determines the severity of these twin crises.

Thus, in this paper we study a channel for the occurrence of twin crises in which banking crises are unrelated to borrowers defaulting on their loans. Alternatively, the roots of crises can be traced to two other imperfections: imperfect competition in the banking industry and liability dollarization in the balance sheets of banks themselves. We build a dynamic stochastic general equilibrium (DSGE) model of a small open economy which introduces currency mismatches in a modified version of the Schargrodsky and Sturzenegger (2000) model of an imperfectly competitive banking industry. In our model banks compete in two dimensions: price of loans and product differentiation.[1]

What role do imperfect competition and liability dollarization in banking play in shaping the real effects of twin crises? We provide the following answer: In the presence of currency mismatches on banks' balance sheets (i.e. banks' assets are denominated in domestic currency, while their liabilities are denominated in foreign currency), banks' net worth falls after a devaluation. As a consequence, those banks that become illiquid exit the industry, thereby causing concentration to rise and we reproduce a banking crisis. We label this effect the "concentration effect." Further, the resulting increase in market concentration lowers competitive pressures and induces the banks that stay in business to increase the degree of their products generality (i.e. make their financial services less focused). By producing more general purpose services, they can increase the size of the market they serve and their profits. We label this effect the "product differentiation effect." The "concentration effect" and the "product differentiation effect" represent relevant changes in the market structure in banking that occur in the aftermath of crises, and that we are able to study using our alternative framework.

A novel insight we obtain is that currency devaluations generate more severe twin crises in economies with less competitive banking sectors. This result is consistent with the empirical evidence, and it unveils the importance of prudential regulation that focuses on the market structure in banking.

Last, the consideration of product differentiation in banking captures an empirically relevant aspect of the banking industry. It has been observed that crises lead to changes in banking concentration together with changes in product differentiation and the availability of banking services.

Only a few theoretical papers consider frictions in the banking sector in explaining either twin crises or the contractionary effects of devaluations. They all do so in the presence of perfectly competitive banks.

In Edwards and Végh (1997) the real effects of currency devaluations are derived from the fact that banking is costly, and are unrelated to borrowers' default or liquidity shortages. In their setup banks are perfectly competitive, but use resources to manage and monitor deposits and loans. An unanticipated increase in the devaluation rate raises the nominal interest rate and the cost of credit, imposing negative real effects on the economy. There is no liability dollarization in the banking sector studied in this paper, nor are banking crises discussed.

Burnside et al. (2001) modeled currency crises that coincide with banking crises because banks are subject to both currency and default risk. The presence of government guarantees induces banks not to hedge against exchange rate risk, but rather to increase their exposure in the derivatives market. After a currency devaluation, banks

go bankrupt, the domestic interest rate rises, and output falls. In Disyatat (2004) firms depend on bank credit to finance working capital needs, and banks finance loans by borrowing from foreign investors and are subject to default risk. A currency depreciation leaves the value of assets unchanged and increases the debt burden of banks. Their net worth falls as a result and they cannot guarantee firms funding as before. This is translated into higher interest rates and lower employment. In Choi and Cook (2004) banks also have a mismatch in the currency denomination of their assets and liabilities, and a currency depreciation lowers banks' net worth. Due to asymmetric information between the bank and foreign investors, the country's risk premium increases and drives up the cost of borrowing.

Also related to our work is the literature on the implications of consolidation in banking for banks' exposure to financial risk. On the empirical side this literature is very vast, but has produced mixed results. Studies such as Keeley (1990), Beck et al. (2006), Dick (2006) and Evrensel (2008), among others found a negative link between concentration and the probability of a banking crisis what provided evidence for concentration-stability theories. Others like Jayaratne and Strahan (1998), de Nicoló (2000), de Nicoló et al. (2004) and Uhde and Heimeshoff (2009), among others found a positive link between concentration and risk, and supported the concentration-fragility views. Work in this literature is much scarcer on the theoretical side. Boyd et al. (2004) presented a general equilibrium monetary model where the banking sector can be either perfectly competitive or monopolistic, and is potentially subject to crises. In their setup "liquidity preference shocks" lead to a withdrawal demand that, when high enough, causes banks to exhaust their cash reserves, and generates a banking crisis. They have two main results: First, that the probability of a banking crisis may be higher either under perfectly competitive or monopolistic banking depending on the conduct of monetary policy and the level of the inflation rate. Second, that the probability of a costly banking crisis is always higher under competition than under monopoly. Also, Boyd and de Nicoló (2005) showed theoretically that there exist fundamental risk-taking mechanisms that cause banks to become more risky as markets become more concentrated. This mechanism works on the asset-side of banks' balance sheets in a way such that as competition declines and banks start earning higher rents in loans markets, higher interest rates lead to an increase in the bankruptcy risk of borrowers with moral hazard who also raise their own risk of failure.

However, this literature deals only with banking crises, with no consideration whatsoever of currency crises and of the interplay between these two types of crises, i.e. this literature does not study "twin crises" phenomena. Moreover, there is no mention in this work of market structure changes related to the degree of product differentiation in the financial services offered by banks. Last, this work is mostly empirical. Boyd and de Nicoló (2005) stated "we are unaware of any compelling theoretical arguments that banking stability decreases (or increases) with the degree of competition in bank markets." We believe that this statement is still true. Thus, in this paper we also aim to contribute to the literature by providing a micro-founded, general equilibrium model of banking crises useful for studying the distortions associated with these twin crises and their macroeconomic and market structure effects. With such a model we can evaluate the interaction of the real sector and the financial sector, which neither the empirical nor the partial equilibrium theoretical work can. Also, in the absence of this type of framework, it is hard to understand the costs and benefits associated with these distortions, and to disentangle the reasons for the lack of consensus in the empirical literature discussed above.

The rest of the paper is organized as follows. Section 2 contains some empirical and anecdotal evidence on the importance of the transmission channels we emphasize in this paper. Section 3 presents the model. Section 4 studies the effects of a currency crisis. Section 5 concludes.

2. Motivation

There is extensive anecdotal evidence that many banks in emerging markets have collapsed during currency crises. The number of banks fell from 32 to 22 in Mexico during the 1994–1995 crisis and from 33 to 20 in South Korea between 1998 and 2002; also, most large Russian banks failed after the 1998 ruble depreciation, and a large number of Argentine banks collapsed after the 2002 peso devaluation (Mishkin, 2006). Banks appear to have been affected directly because their liabilities were more highly dollarized than their assets, and only indirectly by an increased borrowers default risk (see Burnside et al., 2001; Levy-Yeyati, 2006). Moreover, the banking sector seems to have been far from perfectly competitive in all these episodes, and it is best characterized by monopolistic competition (see Levy-Yeyati and Micco, 2003; Gelós and Roldós, 2004; Claessens and Laeven, 2004; Yildirim and Philippatos, 2007a,b). There is also evidence that a lower number of banks does not necessarily decrease the availability of banking services (Damar, 2007).

Our story in this paper is that changes in market structure in banking are the propagation mechanism of currency crises. More precisely, after large devaluations, some banks are driven out of the market, and the remaining banks increase their margins, which raises firms' cost of credit and leads to output contraction. We further provide some empirical evidence that the propagation mechanism we discuss in the paper has been indeed at work during recent crises. We use annual data for a sample of Latin American and Asian countries for the period 1996–2003. We focus on these two regions because they have experienced either currency crises or significant devaluations during this period.[2]

Figure 1 presents the correlations between the aggregate net interest margins (NIMs) charged by commercial banks and the rate of devaluation of the domestic currency, and between NIMs and the growth rate of real GDP, respectively. We use margins as a measure of market power in the banking industry, following our theoretical model, but also because the banking literature argues that they are a better and more general measure of competitiveness than concentration indicators (e.g. Northcott, 2004; Berger et al., 2004). We use bank-level balance sheet and income statement data to calculate aggregate NIMs, defined as the weighted average of the ratio of individual banks' net interest revenues to total interest-earning assets. Note that this is an *ex-post* measure of margins, calculated based on the interest revenues (instead of quoted interest rates), which already accounts for borrowers' default.

The first subplot in Figure 1 shows a positive correlation between margins and the devaluation rate, indicating that banks' margins are larger in the presence of currency devaluations. The second subplot shows the negative correlation between margins and GDP growth. It supports our result that the lower the banking competitiveness and therefore the larger the margins, the larger the contraction in aggregate economic activity. It is important to notice that the negative correlation cannot be the result of the risk perception of banks increasing during recessions, as our margin measure is default risk-adjusted.

Table 1 presents the results of an econometric analysis where we regress the growth rate of real GDP on the first difference in the NIMs, the currency devaluation rate and

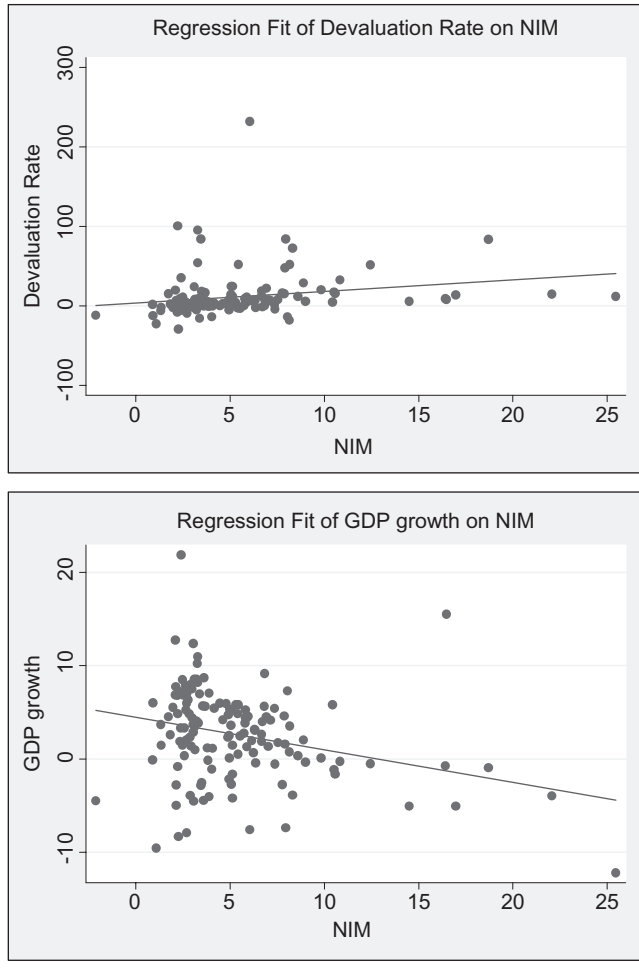

Figure 1. Empirical Evidence on the Real Effects of Currency Crises

the interaction term of the first two variables. A negative and significant coefficient on the interaction term provides empirical support to our result that currency devaluations become contractionary (or less expansionary) in the presence of increasing market power in the banking sector. Two more results arise from this analysis. First, devaluations could be expansionary in the absence of margin changes. Second, the direct effect of NIMs becomes insignificant after we add the interaction of margins and the devaluation rate. This indicates that margins have a negative effect on output through devaluations, and no other direct effect. These observations suggest that the mechanism at work in our model is realistic.

3. The Model

This is an infinite-period DSGE model of a small open economy. Households are composed of workers that consume and provide their services in a competitive labor market. Firms operate in a perfectly competitive market and produce a tradable good using labor. They need to borrow from domestic banks to finance working capital needs.

Table 1. The Real Effects of Currency Crises: Regression Analysis

	Dependent variable: Growth Rate of Real GDP			
	(1)	*(2)*	*(3)*	*(4)*
ΔNIM	–0.0332*	–0.0015	–0.0327*	0.0015
	(0.0164)	(0.0195)	(0.0180)	(0.0225)
Devaluation rate	–0.0058	0.0358	0.0026	0.0421*
	(0.0223)	(0.0248)	(0.0234)	(0.0241)
Interaction term		–0.0012***		–0.0012***
		(0.0004)		(0.0004)
Constant	2.3849***	2.3007***	2.2824***	2.2357***
	(0.4005)	(0.3976)	(0.2925)	(0.1967)
Country effects	No	No	Yes	Yes
N	126	126	126	126
R^2	0.0667	0.1700	0.2077	0.3025
Adj. R^2	0.0515	0.1496	0.0657	0.1696

Note: Robust standard errors are reported in parentheses, adjusted for heteroskedasticity and serial correlation. The model is estimated by pooled OLS (specifications 1 and 2) and fixed effects (specifications 3 and 4).
*, **, *** Significant at 10%, 5%, and 1%, respectively.

Consistent with empirical evidence, the banking sector is imperfectly competitive, modeled as monopolistically competitive using a circular road model *à la* Salop (1979). Banks compete in two dimensions: price and degree of differentiation of their financial services. Banks intermediate funds between the small open economy and the rest of world by borrowing from foreign investors in foreign currency and lending to local firms in domestic currency. Therefore, they face a currency mismatch between the asset and liability sides of their balance sheets. To model the banking sector we build on Schargrodsky and Sturzenegger (2000) and extend their framework to allow for currency mismatches for banks (which then allows us to study twin crises), and for the demand for credit faced by banks to change after a currency devaluation.

Following Burnside et al. (2001) we model a currency crisis as an unexpected large currency devaluation taking place after banks and firms have decided on their portfolio allocations. We assume devaluations are exogenous events. Moreover, there is no exchange rate uncertainty once a devaluation occurs: the currency then depreciates at a constant rate Ω per period. Thus, the exchange rate S (expressed in units of domestic currency per unit of foreign currency) follows a Markov chain: The economy starts with a fixed exchange rate regime $S_t/S_{t-1} = 1$ with $S_t = S^I$ and it can switch to a devaluation regime where $S_t/S_{t-1} = \Omega$, which is an absorbing state. The probability transition matrix is:

$$\begin{bmatrix} (1-p) & p \\ 0 & 1 \end{bmatrix} \tag{1}$$

where $p = Pr\left(\frac{S_{t+1}}{S_t} = \Omega \middle| \frac{S_t}{S_{t-1}} = 1\right)$. S^D is the level of the exchange rate in the first period of the devaluation regime, such that $S^D = \Omega S^I$. This Markov specification implies that, before a devaluation takes place, $E_t(S_{t+1}) = [p\Omega + (1-p)]S_t$ and after, $E_t(S_{t+1}) = S_{t+1} = \Omega S_t$.

The Production Sector

There is a continuum of mass 1 of identical firms indexed by k. They operate in a competitive market and use labor to produce a final tradable consumption good, using a decreasing returns to scale technology:

$$Y_{kt} = Ah_{kt}^{\alpha} \tag{2}$$

where $0 < \alpha < 1$, Y_k denotes firm k's output, h_k denotes firm k's employment and A is a constant representing total factor productivity.

We denote the international price of the tradable good, which the small open economy takes as given, by P^* and the nominal exchange rate by S. Without any restrictions to international trade, purchasing power parity holds and the domestic currency price of the good is $P_t = S_t P_t^*$. The tradable good is the numeraire ($P_t^* \equiv 1$), and by perfect pass-through from exchange rates to prices, $P_t = S_t \forall t$.

Firms need to borrow from domestic banks to finance their working capital needs. They borrow from the banking sector in domestic currency and their sales revenue and wage bill are both denominated in domestic currency.

At every point in time t, firm k chooses the amount of credit from bank i_t ($L_{i_t kt}$) and employment when borrowing from bank i_t ($h_{i_t kt}$) to maximize the expected present discounted value of its lifetime real profits. Thus, firm k's optimization problem is given by:

$$\max_{L_{i_t kt}, h_{i_t kt}} E_0 \sum_{t=0}^{\infty} \frac{1}{(1+r^*)^t} \Pi_{i_t kt}^F \tag{3}$$

s.t.

$$\Pi_{i_t kt}^F = Y_{i_t kt} - \frac{w_t}{S_t} h_{i_t kt} + \frac{L_{i_t kt}}{S_t} - (1 + R_{i_{t-1} t-1}) \frac{L_{i_{t-1} kt-1}}{S_t} - \theta_{i_t t} x_{i_t kt} \tag{4}$$

$$Y_{i_t kt} = Ah_{i_t kt}^{\alpha} \tag{5}$$

$$L_{i_t kt} \geq \phi w_t h_{i_t kt} \tag{6}$$

$$i_t \in \{1, \ldots\ldots, N_t\}$$

where r^* denotes the constant interest rate on foreign deposits, given by the world interest rate that the small open economy takes as given, $R_{i_{t-1} t-1}$ is the net interest rate on loans contracted in period $t-1$ with bank i_{t-1} charged in period t,[3] and $\theta_{i_t t}$ is the degree of product differentiation chosen in period t by bank i_t. Notice that there is a time subscript for each bank i. This is because a firm can borrow from different banks in different periods, and i_t could be different from i_{t-1}.

Equation (4) defines the cash flow for firm k in period t when borrowing from bank i_t. This is denoted by $\Pi_{i_t kt}^F$ and the superscript F is used to denote firms. This is in turn given by sales revenue for firm k when borrowing from bank i_t ($Y_{i_t kt}$) minus the wage bill plus loans obtained in period t minus repayment of loans contracted in period $t-1$ minus the costs of purchasing differentiated services from bank i_t.

The costs of purchasing differentiated products are given by the last term in the profit function. A standard assumption in circular road models *à la* Salop (1979) is that these

costs are linear in the "distance" to the bank x and the degree of differentiation θ. x_{ik} is the distance between borrower k and the bank i that she decides to borrow from. Given that we give this framework a sectorial interpretation as opposed to a purely geographical one, x_{ik} can be thought of as how different the sector in which bank i specializes is from the sector in which the borrower operates. Therefore, loans are more costly as the distance to the bank of choice increases.[4] With these costs given by $\theta_i x_{ik}$, the parameter θ can be interpreted as the per-unit distance transport cost of "traveling" the distance to bank i. Thus, the more general purpose the services offered by bank i (i.e. the lower θ_i), the lower the costs of borrowing from bank i for all firms. Therefore, these services will better accommodate the needs of borrowers. Degryse and Ongena (2005) provide comprehensive evidence on the existence of spatial price discrimination in bank lending caused by transportation costs.[5] In the next subsection we elaborate more on the structure of the banking industry and discuss product differentiation strategies in more detail.

Equation (6) states that at least a fraction ϕ of firm k's wage bill needs to be financed by bank credit.[6]

Following the steps outlined in detail in a longer working paper version,[7] we obtain the total demand faced by bank i at time t (l_{it}) as:

$$l_{it}(\theta_{it}, \theta_{jt}, R_{it}, R_{jt}) = 2\phi w_t h_{it} \hat{x}_{it}. \tag{7}$$

The firms' FOC for the optimal choice of employment when borrowing from bank i is:

$$A\alpha h_{it}^{\alpha-1} = \frac{w_t}{S_t}\left[(1-\phi) + \phi E_t\left(\frac{(1+R_{it})}{(1+r^*)\dfrac{S_{t+1}}{S_t}}\right)\right]. \tag{8}$$

The Banking System

Consider a Salop circular city with a perimeter equal to one, and a unitary density of firms located uniformly around the circle. Each borrower is identified by a point on the circle (and x is the distance between the borrower and its preferred bank). Banks are located symmetrically around the circle, and each bank is allowed to choose only one location. As discussed in Schargrodsky and Sturzenegger (2000), we interpret this model as one of sectorial product differentiation, so that a particular bank's location on the circle implies a particular sector towards which the bank targets its financial services. There is a continuum of activities around the circle. As a simplification, we assume perfect competition in the market for foreign deposits.

In the first period of operation each bank i is subject to an idiosyncratic cost shock (c_i), which then enters their profit function in an additive way in every period of operation. Therefore, there is no uncertainty regarding these operation costs after period 1. These can be thought of as operation costs or, as in Schargrodsky and Sturzenegger (2000), shocks that turn some of the banks' assets non-performing and that differ across banks. These shocks follow a discrete uniform distribution $U[0, \bar{c}]$. For simplicity, we assume that they are independent of the degree of product differentiation. Banks also pay a fixed operation cost $F(\theta)$ of producing financial services, where $F'(\theta) < 0$ and $F''(\theta) > 0$. We think of these costs as operation costs that banks need to incur to provide differentiated services, regardless of the

magnitude of loans made in each period, and explain them further later in this section.

Exogenous product differentiation To simplify the exposition we first discuss the case when banks compete only in price. This is the case of exogenous θ, with a high θ indicating a high degree of product differentiation (i.e. banks focus or target their services towards a few specific sectors).

Bank i's optimization problem is to choose deposits (d_{it}) and the interest rate on loans (R_{it}) to maximize the expected present discounted value of its lifetime real profits.

$$\max_{d_{it},R_{it}} E_0 \sum_{t=0}^{\infty} \frac{1}{(1+r^*)^t} \Pi_{it}^B \tag{9}$$

s.t.

$$\Pi_{it}^B = \left(d_{it} - \frac{l_{it}}{S_t} \right) + (1+R_{it-1}) \frac{l_{it-1}}{S_t} - (1+r^*) d_{it-1} - c_i - F(\theta_i) \tag{10}$$

$$d_{it} = \frac{l_{it}}{S_t} \tag{11}$$

$$l_{it} = 2\phi w_t h_{it} \hat{x}_{it} \tag{12}$$

$$\Pi_{it}^B \geq 0 \qquad \forall t. \tag{13}$$

Equation (10) shows the cash flow for bank i expressed in real terms, (11) is the balance sheet condition for banks, and (12) denotes the demand for loans that banks internalize.

Bank i's FOC for the choice of R_{it} is:

$$\frac{(1+R_{it})}{(1+r^*)} = \left(1 - \frac{1}{\varepsilon_{it}}\right)^{-1} \frac{[(1-p)+p v_{it}]}{\left[(1-p)+p\frac{v_{it}}{\Omega}\right]} \tag{14}$$

with $p = v_{it} = 1$ for the post-devaluation state, and where ε_{it} is the interest rate elasticity of the demand for credit and it is given by:

$$\varepsilon_{it} \equiv -\frac{\partial l_{it}}{\partial(1+R_{it})} \frac{(1+R_{it})}{l_{it}} = -\frac{\partial \hat{x}_{it}}{\partial(1+R_{it})} \frac{(1+R_{it})}{\hat{x}_{it}}. \tag{15}$$

Equation (14) shows that the price–cost margin charged by bank i is inversely related to the interest rate elasticity of the demand for loans. The pre-devaluation markup also depends on the likelihood of crises (p) and banks' probability of survival (v_{it}). Equation (15) shows the interest rate elasticity of loan demand, which equals the interest rate elasticity of each bank's market share ($2\hat{x}$).

In order to be able to interpret the elasticity and the markup, we next assume bank symmetry and drop the i subscript. The elasticity shown in (16) is larger when the competition is more intense, that is, the number of banks N is large and the degree of

product differentiation θ is small. It is also directly related to the real amount of the loan $\phi w_t h_t / S_t$.

$$\varepsilon_t = \frac{N_t}{\theta} E_t \left(\frac{(1+R_t)}{(1+r^*)\frac{S_{t+1}}{S_t}} \right) \frac{\phi w_t h_t}{S_t}. \tag{16}$$

Plugging equation (16) into (14), the markup becomes:

$$\frac{(1+R_t)}{(1+r^*)} = \frac{[(1-p)+p\nu_t]}{\left[(1-p)+p\frac{\nu_t}{\Omega}\right]} + \frac{\theta}{N_t}\left[\frac{\phi w_t h_t}{S_t}\left(\frac{p}{\Omega}+(1-p)\right)\right]^{-1} \tag{17}$$

with $p = \nu_t = 1$ for the post-devaluation state. ν_t is endogenous and a function of R_t itself, and therefore, we cannot obtain a closed form analytical expression for the price-cost markup. Equation (17) shows that pre-devaluation markups are affected by four key forces. First, they are positively related to market concentration (i.e. a fall in N raises markups). Second, they are positively related to θ as product differentiation provides a source of market power for banks. Third, they increase with the probability of banks staying in business. Fourth, they depend negatively on the amount financed.

Endogenous product differentiation If banks compete not only in prices, but also in the degree of product differentiation (i.e. if they choose θ_t), then they face a tradeoff when deciding how specialized they want to become. On the one hand, lowering θ implies following a generalist strategy (i.e. one through which banks offer "general purpose" financial services). When a bank lowers θ it is reducing "transportation costs" or trying to cater its services to a broader consumer base, and that increases the size of the market they serve. On the other hand, the operation costs for banks increase in the general purpose of their financial services, as banks spend more resources to target more sectors.

Bank i's FOC for the choice of θ_{it} is:

$$S_t \frac{\partial F(\theta_{it})}{\partial \theta_{it}} = \frac{\partial l_{it}}{\partial \theta_{it}} \frac{(1+R_{it})}{(1+r^*)} \left[(1-p) + \frac{p\nu_{it}}{\Omega} - \frac{(1+r^*)}{(1+R_{it})}[(1-p)+p\nu_{it}] \right] \tag{18}$$

with $p = \nu_{it} = 1$ for the post-devaluation state, where:

$$\frac{\partial l_{it}}{\partial \theta_{it}} = -\frac{\phi w_t h_{it}}{2\theta_{it} N_t}. \tag{19}$$

The intuition underlying (18) is the following. The left-hand side represents the marginal benefit a bank gets from increasing θ, in terms of reducing its fixed costs of producing differentiated financial services. The right-hand side represents the marginal cost of an increased θ. These costs are given by the fall in the quantity demanded of loans faced by the individual bank ($\partial l_{it}/\partial \theta_{it}$) multiplied by the per-unit profits and the change in the quantity demanded of loans when the interest rate changes as a result of the change in θ. A bank's optimal choice of θ is given by the point where marginal cost equals marginal benefit.

Households

Households are very standard in this model. They choose consumption (C) and work effort (h) to maximize the expected present discounted value of lifetime utility subject to their budget constraint. For simplicity, but without loss of generality, households are not allowed to access capital markets. Firms and banks profits (if any) are distributed to households in a lump-sum fashion. The representative household's optimization problem is presented in the extended working paper version.[8]

The Economy's Equilibrium

The equilibrium concept used is the non-cooperative Nash equilibrium in interest rates R_t and degree of focus θ_t. We restrict attention to symmetric equilibria with free-entry in the banking sector. Each bank i takes as given the rate and the degree of differentiation chosen by all other banks, and chooses R_{it} and θ_{it} to maximize the expected present discounted value of lifetime profits.

The economy's symmetric equilibrium is defined by a set of prices $\{w_t, R_t, P_t, S_t, P_t^*\}$, a set of allocations $\{C_t, h_t, Y_t, d_t, L_t, l_t, \theta_t\}$ and an endogenous number of banks N_t, such that all agents FOCs are met, the households' budget constraint holds, the labor and loans markets clear at all times, and the economy's resource constraint holds.

The economy's resource constraint is given by:

$$Y_t = C_t + \sum_{i=1}^{N}(F(\theta_{it}) + c_i) + \int_0^1 \theta_t x_{kt} dk - D_t + (1 + r^*) D_{t-1} \tag{20}$$

where $D_t = d_t N_t$, and the term $-(D_t - D_{t-1})$ measures the current account.

Market clearing in the market for loans requires $L_t = l_t N_t$.

The liquidity constraint that requires banks' profits to be non-negative allows us to find the idiosyncratic costs for the bank that breaks even in period t:

$$\hat{c}_{it} = \frac{(1 + R_{it-1}) l_{it-1}}{S_t} - (1 + r^*) d_{it-1} - F(\theta_{it}) \tag{21}$$

where the "hat" is used to index the marginal bank. Considering that c_i is a uniformly distributed discrete random variable in $[0, \overline{c}]$, and using $G(c)$ to denote its cumulative density function, the mass of banks that stay in business after the aggregate exchange rate shock is realized is:

$$G(\hat{c}_{it}) = \frac{\hat{c}_{it}}{\hat{c}_{it-1}}. \tag{22}$$

By the law of large numbers, $G(\hat{c}_{it})$ equals the probability of bank i staying in business during period $t+1$ after a currency devaluation in period t (i.e. $G(\hat{c}_{it}) = v_{it}$). Thus, ignoring the integer constraint, the endogenous equilibrium number of banks at time t (N_t) is:

$$N_t = G(\hat{c}_{it}) N_{t-1}. \tag{23}$$

Even though free entry is assumed for the banking industry, since we consider only negative shocks to the value of the currency that hurt banks and induce exit, in equilibrium there is no entry of banks.

4. The Effects of a Currency Crisis

A Discussion of the Model's Transmission Mechanisms After a Devaluation

Under perfect competition, and given the presence of dollarized liabilities and mismatches on banks' balance sheets, the interest rate on loans equals the exchange-rate adjusted marginal cost of funds for banks (i.e. $(1+R_{it}) = (1+r^*)\frac{E_t(S_{t+1})}{S_t}$). Given the Markov structure assumed for the exchange rate shock, the term $\frac{E_t(S_{t+1})}{S_t}$ increases from $[p\Omega + (1-p)]$ to Ω after a currency devaluation. The exchange-rate adjusted marginal cost of funds is higher after the devaluation, and this raises the interest rate on loans. We call this effect the "balance sheet effect."

We next look at the case where imperfectly competitive banks internalize the demand for loans that they face when choosing the interest rate on loans, but they cannot affect the degree of general purpose of their services (i.e. the case of exogenous θ). Owing to the presence of balance sheet mismatches, a devaluation increases the value of banks' liabilities relative to that of their assets, lowers banks' net worth and drives some banks out of business. We label this effect the "concentration effect".[9]

With this increase in concentration, it is clear from (17) that the markup charged by banks increases. This has a negative impact on employment and production, such that devaluations are contractionary.

An additional effect arises when banks compete not only in price but also in product differentiation, by choosing the degree of focus of their financial services (i.e. the case of endogenous θ). As N falls and concentration rises following an unexpected currency devaluation, competitive pressures fall and banks find it optimal to lower their degree of product specialization to attract customers located farther away on the circle and increase their market share (even if this increases their fixed operation costs). In other words, they lower θ to increase the general purpose of their loans. This drives down the cost of credit for firms, and employment and output are positively affected. We label this effect the "product differentiation effect."

The "concentration effect" and the "product differentiation effect" acting jointly constitute what we label the "market structure effect".

Simulation Results

Owing to the nonlinearity of the system, we cannot obtain analytical solutions. Therefore, in this subsection we present the results for numerical simulations of the model. It is worth highlighting that our goal is to provide a qualitative description of the effects of a currency crisis. It is not of a quantitative nature, and we are not trying to match any particular feature of recent crises episodes. Table 2 shows the parameter values used to simulate the benchmark model. The details of the calibration strategy are presented in an extended working paper version available online.

Table 2. Benchmark Parameter Values

$\alpha = 0.75$	$\omega = 2$	$\sigma = 2$
$\kappa = 0.1$	$A = 1$	$\phi = 0.1$
$r^* = 0.01$	$N_0 = 10$	$p = 0.95$
$\Omega = 1.15$	$F(\theta) = \theta^{-\tau}$	$\tau = 100$

Proposition 1. *Under a non-cooperative Nash equilibrium in which perfectly competitive banks on the deposit-side of the market compete in interest rates and degree of product differentiation on the loan-side of the market, a 15% currency devaluation to which banks attach a 95% chance of realization, induces a fall of approximately 1.5% in output and 2% in employment. This is a result of a significant reduction in the equilibrium number of banks (33% of the banks are driven out of the market), which together with a fall in θ of 1.15% causes real markups in the banking industry to rise by 3%, and the real interest rate on loans to rise by 25%.*

We demonstrate the results in Proposition 1 numerically in Table 3. This table presents the model simulation results together with the implied costs of product differentiation in banking expressed as a percentage of GDP and firms' and banks' profits.

Intuitively, the increase in the cost of borrowing is driven by an increase in the ratio θ/N, which causes a decline in the interest rate elasticity of the demand for credit. Both the number of banks and the degree of product differentiation fall, but the decline in N is larger than that in θ. The contraction in employment and output happens even with real wages falling after the shock, because the increase in interest rates more than offsets the fall in wages, and generates an increase in firms' total cost of labor.

Worthy of note is that aggregate loans fall by approximately 4%, but loans per bank increase by more than 40%, so that the banks that survive a currency devaluation benefit from it.

Introducing imperfect competition in banking and studying the market structure changes that occur in the aftermath of crises improves our understanding of the real effects of twin crises. Specifically, it allows us to study the role played in our model by the initial degree of competition in the banking industry, and to look at how the real effects of devaluations change with the initial number of banks N_0. Worthy of note is that by relying on borrowers default in the presence of perfect competition in banking, the previous literature is silent about this effect.

Proposition 2.

(i) If $N_0 < 25$, then the fall in output is diminishing in N_0, so that currency devaluations generate more severe twin crises and a larger drop in output in economies that start with less competitive banking sectors prior to the devaluation.

(ii) If $N_0 > 25$, then the fall in output is increasing in N_0.

To demonstrate Proposition 2, in panel (a) of Table 4 we present some comparative statics on the value of the parameter N_0.

The reason for the discontinuity in the behavior of the model as the value of N_0 changes can be understood by studying the behavior of the markup (see panel (a) of Table 4). As a result of the relative reductions in θ and N, the increase in the markup after a devaluation is diminishing in N_0 for $N_0 \leq 13$ and increasing in N_0 for $N_0 > 13$. The finding summarized in Proposition 2 is consistent with two pieces of empirical evidence presented in section 2, namely that NIMs (our measure of market power) are negatively correlated with GDP growth, and that currency devaluations, which are otherwise expansionary, tend to become contractionary in the presence of increasing market power in the banking sector.

Table 3. Simulation Results

	Pre-devaluation		*Post-devaluation*		*% Variation*	
	Endogenous θ	*Exogenous* θ	*Endogenous* θ	*Exogenous* θ	*Endogenous* θ	*Exogenous* θ
Macroeconomic aggregates						
Y	3.26	3.26	3.21	3.21	–1.44	–1.45
h	4.83	4.83	4.74	4.74	–1.91	–1.93
C	3.04	3.04	3.05	3.05	0.18	0.13
$\frac{L}{P}$	0.23	0.23	0.22	0.22	–3.78	–3.83
$\frac{\frac{L}{N}}{P}$	0.02	0.02	0.03	0.03	43.26	42.09
$\frac{w}{P}$	0.48	0.48	0.47	0.47	–1.91	–1.93
Parameters affecting the cost of credit						
R	0.70	0.70	1.00	1.01	44.23	44.72
N	10.00	10.00	6.71	6.77	–32.85	–32.32
θ	1.11	1.11	1.09	1.11	–1.15	0.00
$\frac{\theta}{N}$	0.11	0.11	0.16	0.16	47.21	47.75
$\frac{R}{P}$	0.70	0.70	0.87	0.88	25.42	25.85
$\frac{(1+R)}{P(1+r^*)}$	1.68	1.68	1.73	1.73	2.74	2.92
ε	3.10	3.10	2.38	2.37	–23.27	–23.46
Implied costs of product differentiation						
$\frac{\theta x}{\pi^F}$	7.27	7.27	9.63	9.66	32.52	32.96
$\frac{F(\theta)}{\pi^B}$	0.24	0.24	1.12	0.35	368.07	47.58
$\frac{\theta x}{Y}$	1.70	1.70	2.54	2.55	49.33	49.92
$\frac{F(\theta)}{Y}$	0.01	0.01	0.03	0.01	116.11	–31.32
$\frac{F(\theta)+c_i}{Y}$	4.92	4.92	2.27	2.29	–53.83	–53.46

Note: Values correspond to a devaluation rate of 15%.

PROPOSITION 3.

(i) Both N and θ fall monotonically in the rate of devaluation Ω in response to a currency devaluation. The variation in N dominates that of θ, such that the ratio θ/N, $(1 + R)/(1 + r)$ and R all rise monotonically in Ω.

(ii) As a result, the contractionary effects of devaluations are increasing in Ω.

To demonstrate Proposition 3, in panel (b) of Table 4 we present some comparative statics on the value of the parameter Ω.

Table 4. Effects of Devaluations on Macroeconomic, Financial and Banking Market Structure Variables. Growth Rates (in %)

Panel (a): Effects of degree of competition in banking as measured by N_0

N_0	*Output* (Y)	*Interest on loans* (R)	*Markup* $\frac{(1+R)}{(1+r)}$	θ	*Number of banks* (N)
3	–3.07	15.36	6.82	–0.61	–19.08
4	–2.35	15.66	4.90	–0.70	–21.38
5	–2.00	16.94	4.01	–0.78	–23.54
6	–1.79	18.54	3.50	–0.86	–25.59
7	–1.65	20.26	3.19	–0.93	–27.54
8	–1.56	22.01	2.99	–1.01	–29.39
9	–1.49	23.77	2.86	–1.08	–31.16
10	–1.43	25.51	2.78	–1.15	–32.85
13	–1.33	30.60	2.69	–1.35	–37.52
15	–1.29	33.86	2.72	–1.49	–40.34
20	–1.24	41.67	2.96	–1.80	–46.60
25	–1.23	49.26	3.38	–2.10	–51.96
30	–1.24	56.94	3.95	–2.38	–56.68
35	–1.28	65.13	4.70	–2.67	–60.94
40	–1.33	74.35	5.68	–2.97	–64.90
45	–1.41	85.54	7.03	–3.28	–68.71
50	–1.54	100.88	9.09	–3.64	–72.62
55	–1.82	129.90	13.39	–4.16	–77.46

Panel (b): Effects of devaluation rate as measured by Ω

Ω	Y	R	$\frac{(1+R)}{(1+r)}$	θ	N
1.01	–0.09	2.34	0.12	–0.09	–3.08
1.05	–0.55	12.24	0.86	–0.51	–16.13
1.1	–1.03	20.11	1.82	–0.88	–26.24
1.15	–1.43	25.51	2.78	–1.15	–32.85
1.2	–2.06	32.79	4.55	–1.52	–41.02
1.25	–2.62	38.53	6.38	–1.80	–46.64
1.3	–3.21	44.28	8.58	–2.06	–51.47
1.35	–3.85	50.32	11.22	–2.31	–55.69
1.4	–4.54	56.89	14.39	–2.55	–59.43
1.45	–5.30	64.30	18.22	–2.78	–62.79
1.5	–6.14	72.95	22.92	–3.02	–65.88
1.75	–14.79	199.92	95.91	–4.45	–80.48

Panel (c): Effects of probability of devaluation as measured by p

p	Y	R	$\frac{(1+R)}{(1+r)}$	θ	N
0	–2.10	105.01	25.64	–1.07	–41.79
0.05	–2.08	100.68	24.58	–1.07	–41.36
0.1	–2.06	96.35	23.50	–1.07	–40.92
0.15	–2.03	92.03	22.41	–1.08	–40.48

Table 4. Continued

Panel (c): Effects of probability of devaluation as measured by p

p	Y	R	$\frac{(1+R)}{(1+r)}$	θ	N
0.2	–2.01	87.71	21.31	–1.08	–40.03
0.3	–1.95	79.10	19.05	–1.09	–39.12
0.4	–1.89	70.54	16.73	–1.10	–38.19
0.5	–1.82	62.05	14.34	–1.10	–37.24
0.6	–1.75	53.66	11.88	–1.11	–36.28
0.7	–1.67	45.40	9.36	–1.12	–35.30
0.8	–1.58	37.30	6.77	–1.13	–34.32
0.9	–1.48	29.39	4.12	–1.14	–33.34
0.95	–1.43	25.51	2.78	–1.15	–32.85

Panel (d): Effects of cost sensitivity to θ as measured by τ

τ	Y	R	$\frac{(1+R)}{(1+r)}$	θ	N
5	–2.23	9.27	2.11	–15.14	–28.52
10	–1.71	15.51	2.38	–7.99	–28.87
20	–1.55	19.87	2.57	–4.71	–30.36
30	–1.50	21.89	2.65	–3.37	–31.19
40	–1.48	23.06	2.69	–2.63	–31.71
50	–1.46	23.82	2.72	–2.15	–32.05
60	–1.45	24.36	2.74	–1.83	–32.30
70	–1.44	24.76	2.75	–1.59	–32.49
80	–1.44	25.08	2.76	–1.40	–32.64
90	–1.43	25.33	2.77	–1.26	–32.76
100	–1.43	25.51	2.78	–1.15	–32.85
110	–1.43	25.70	2.78	–1.04	–32.94
120	–1.43	25.85	2.79	–0.96	–33.02
130	–1.42	25.97	2.79	–0.89	–33.08
140	–1.42	26.08	2.79	–0.83	–33.13
150	–1.42	26.16	2.80	–0.78	–33.17

Panel (e): Effects of external finance share of working capital needs as measured by ϕ

ϕ	Y	R	$\frac{(1+R)}{(1+r)}$	θ	N
0.01	–0.53	4.54	1.88	–0.50	–15.68
0.05	–0.92	14.56	2.25	–0.80	–24.17
0.1	–1.43	25.51	2.78	–1.15	–32.85
0.15	–1.98	35.45	3.39	–1.47	–40.01
0.2	–2.57	44.94	4.10	–1.77	–46.08
0.25	–3.21	54.43	4.95	–2.06	–51.34
0.3	–3.94	64.40	5.97	–2.34	–56.01
0.4	–5.72	88.31	8.89	–2.91	–64.20
0.5	–8.52	128.15	14.61	–3.57	–71.91

Proposition 4.

(i) The reduction in N (θ) *and the increase in* $(1 + R)/(1 + r)$ and R are both diminishing (increasing) in p.
(ii) As a result, the contraction in output after a devaluation is diminishing in p.

To demonstrate Proposition 4, in panel (c) of Table 4 we present some comparative statics on the value of the parameter p.

Intuitively, devaluations are more contractionary as they become more unexpected for economic agents (i.e. as p falls). When p is low, banks set a lower interest rate, which increases the probability of bankruptcy after the shock hits. Thus, the smaller p, the more banks are driven out of business as a result of a devaluation, the more markups and the cost of credit rise, and the more employment and output suffer.

Proposition 5.

(i) The drop in N (θ) *after a devaluation is monotonically increasing (decreasing) in the elasticity of the banks cost function* $F(\theta)$, *as measured by the parameter* τ.
(ii) As a result, the increase in $(1 + R)/(1 + r)$ *and* R *are monotonically increasing in* τ.
(iii) Still, the contraction in output is monotonically decreasing in τ.

To demonstrate Proposition 5, in panel (d) of Table 4 we present some comparative statics on the value of the parameter τ. The reason why the contractionary effects are diminishing in τ even with the increase in the cost of credit being increasing in this parameter is related to the fact that τ also has an impact on the size of the fixed costs $F(\theta)$, which enter the economy's resource constraint as given by equation (32).

Proposition 6.

(i) The reduction in N and θ *are both monotonically increasing in the dependence on external credit from an imperfectly competitive and liability dollarized financial sector as measured by the parameter* ϕ. *The effect on N dominates over the effect on* θ *such that the increase in the cost of credit and labor is monotonically increasing in* ϕ.
(ii) As a result, the contraction in output is monotonically increasing in ϕ.

To demonstrate Proposition 6, in panel (e) of Table 4 we present some comparative statics on the value of the parameter ϕ. The intuition is that as ϕ rises, a higher share of total labor costs is negatively affected by a devaluation of the currency.

The "product differentiation effect" There are two ways in which allowing banks to choose the degree of differentiation of the financial services that they offer might change results. On the one hand, with endogenous product differentiation, θ falls after the currency is devalued. This tends to lower price–cost margins and *ceteris paribus*, the cost of credit, which should raise employment and output. However, on the other hand, as margins tend to fall, banks face further incentives to exit coming from this channel and therefore, the equilibrium number of banks could end up falling by more in the endogenous product differentiation case. This second effect tends to raise margins, and negatively affects economic activity. Two potential outcomes arise depending on which of these two effects dominates. In the first case, endogenous differentiation may act as a buffer for banks, such that they do not need to raise interest rates on loans that much, which would result in crises with milder real effects

than in the case of exogenous θ, or even in expansionary devaluations if this effect is large enough to offset that of bank exit. In the second case, endogenous differentiation may work as an amplifier, resulting in deeper banking crises and larger contractions in employment and output.[10]

In general, we find numerically that in the simulated economies the buffer and the amplifier effects of an endogenous degree of product differentiation exactly offset each other, such that the real effects of devaluations on GDP are the same regardless of whether banks are allowed to alter the degree of differentiation in response to a devaluation of the currency. Thus, allowing banks to compete in the degree of differentiation is not a necessary assumption to generate our results. Still, under special circumstances either the buffer or the amplifier effect dominate. We discuss those in the next two propositions.

Proposition 7. *If* $N_0 > 25$ *or* $\Omega > 1.35$ *or* $\phi > 0.25$, *then endogenous product differentiation acts as an amplifier, such that the real effects of devaluations are stronger than when* θ *is exogenously determined.*

To demonstrate Proposition 7, in panels (a), (b) and (e) of Table 5 we present some comparative statics on the value of the parameters N_0, Ω and ϕ, respectively. For each variable and each parameter value, Table 5 shows the ratio of the variable's growth rate after a currency devaluation at the rate Ω[11] when the degree of differentiation θ is endogenously chosen by banks in the economy to the variable's growth rate for the case when θ is an exogenous parameter. In this way, a value larger than (below) 1 in this table indicates that endogenous product differentiation acts as an "amplifier" ("buffer") of the effects of currency devaluations.

A large enough banking industry ($N_0 > 25$) and large devaluation rates (above 35%) are needed for endogenous differentiation to act as an amplifier, since in these cases the endogenous drop in θ creates further incentives for banks to leave the industry, and causes markups and the cost of credit to rise by more than when θ is exogenously constant.

For large enough values of ϕ, the reduction in the degree of product differentiation lowers margins and drives more banks out of business than in the case where banks cannot compete in this dimension. The effect of N dominates and causes an increase in the cost of credit larger than for the case of exogenous θ, and a more significant contraction in real GDP. Thus, we can conclude that endogenous product differentiation acts as an amplifier in economies where firms are heavily dependent on bank credit to finance production. This might well be the case of emerging countries.

Proposition 8. *If* $\tau < 70$, *then endogenous product differentiation acts as a buffer, and devaluations are less contractionary than when* θ *is exogenously determined.*

To demonstrate Proposition 8, in panel (d) of Table 5 we present some comparative statics on the value of the parameter τ.

The reason for the contraction generated by a devaluation being smaller than in the case of a fixed and exogenous θ is that for small enough values of τ, the reduction in the degree of product differentiation is large enough to dominate the effect of a reduction in N. Therefore, the cost of credit actually falls significantly enough relative to the case of a fixed θ.

Table 5. "Buffer" and "Amplifier" Effects of Endogenous Product Differentiation: Ratio of Growth Rates for Endogenous θ to Exogenous θ

Panel (a): Effects of degree of competition in banking as measured by N_0

N_0	*Output* (Y)	*Interest on loans* (R)	*Markup* $\frac{(1+R)}{(1+r)}$	*Number of banks* (N)
2	0.98	0.97	0.97	1.02
3	0.99	0.97	0.96	1.02
4	0.99	0.97	0.95	1.02
5	0.99	0.98	0.94	1.02
6	0.99	0.98	0.94	1.02
7	0.99	0.98	0.94	1.02
8	0.99	0.98	0.94	1.02
9	0.99	0.98	0.94	1.02
10	0.99	0.98	0.94	1.02
13	0.99	0.99	0.95	1.02
15	0.99	0.99	0.95	1.02
20	1.00	1.00	0.98	1.02
25	1.00	1.00	1.01	1.02
30	1.01	1.01	1.04	1.02
35	1.02	1.03	1.08	1.03
40	1.04	1.05	1.13	1.03
45	1.06	1.08	1.20	1.03
50	1.11	1.13	1.31	1.04
55	1.24	1.30	1.62	1.07

Panel (b): Effects of devaluation rate as measured by Ω

Ω	Y	R	$\frac{(1+R)}{(1+r)}$	N
1.01	0.99	0.98	0.88	1.01
1.05	0.99	0.98	0.90	1.02
1.1	0.99	0.98	0.92	1.02
1.15	0.99	0.98	0.94	1.02
1.2	0.99	0.99	0.96	1.02
1.25	1.00	0.99	0.98	1.02
1.3	1.00	1.00	1.00	1.02
1.35	1.01	1.01	1.02	1.02
1.4	1.01	1.02	1.05	1.02
1.45	1.02	1.04	1.07	1.03
1.5	1.04	1.06	1.11	1.03
1.75	1.37	1.66	1.86	1.07

Panel (c): Effects of probability of devaluation as measured by p

p	Y	R	$\frac{(1+R)}{(1+r)}$	N
0	1.01	1.01	1.01	1.02
0.05	1.01	1.01	1.01	1.02
0.1	1.01	1.01	1.01	1.02

Table 5. Continued

Panel (c): Effects of probability of devaluation as measured by p

p	Y	R	$\frac{(1+R)}{(1+r)}$	N
0.15	1.01	1.01	1.01	1.02
0.2	1.01	1.01	1.01	1.02
0.3	1.01	1.01	1.01	1.02
0.4	1.00	1.00	1.01	1.02
0.5	1.00	1.00	1.00	1.02
0.6	1.00	1.00	1.00	1.02
0.7	1.00	1.00	0.99	1.02
0.8	0.99	0.99	0.98	1.02
0.9	0.99	0.99	0.96	1.02
0.95	0.99	0.98	0.94	1.02

Panel (d): Effects of cost sensitivity to θ as measured by τ

τ	Y	R	$\frac{(1+R)}{(1+r)}$	N
5	0.72	0.52	0.26	1.39
10	0.88	0.80	0.54	1.16
20	0.94	0.91	0.73	1.08
30	0.96	0.94	0.81	1.05
40	0.97	0.96	0.85	1.04
50	0.98	0.97	0.88	1.03
60	0.98	0.97	0.90	1.03
70	0.98	0.98	0.92	1.02
80	0.99	0.98	0.93	1.02
90	0.99	0.98	0.93	1.02
100	0.99	0.98	0.94	1.02
110	0.99	0.99	0.95	1.01
120	0.99	0.99	0.95	1.01
130	0.99	0.99	0.95	1.01
140	0.99	0.99	0.96	1.01
150	0.99	0.99	0.96	1.01

Panel (e): Effects of external finance share of working capital needs as measured by ϕ

ϕ	Y	R	$\frac{(1+R)}{(1+r)}$	N
0.01	0.99	0.95	0.90	1.02
0.05	0.99	0.98	0.92	1.02
0.1	0.99	0.98	0.94	1.02
0.15	0.99	0.99	0.96	1.02
0.2	1.00	0.99	0.98	1.02
0.25	1.00	1.00	1.00	1.02
0.3	1.01	1.01	1.03	1.02
0.4	1.03	1.05	1.10	1.03
0.5	1.11	1.14	1.26	1.04

5. Conclusions

In this paper we propose and examine a novel channel that is capable of generating twin crises and of explaining their contractionary effects. In our framework banking crises are unrelated to borrowers defaulting on their loans as in the existing literature. Alternatively, the roots of crises can be traced to two other imperfections mainly ignored by previous work: imperfect competition in the banking industry and currency mismatches on the balance sheets of banks themselves.

With this goal in mind we build a DSGE model of a small open economy by introducing currency mismatches in a modified version of the Schargrodsky and Sturzenegger (2000) model of imperfectly competitive banks. Introducing imperfect competition in banking allows us to focus on the changes in the market structure in banking that occur in the aftermath of crises, which previous work is silent about.

In our model currency devaluations result in deeper crises in economies where producers rely more on bank credit, and where devaluation rates are higher and less expected by economic agents. We also show that allowing banks to choose the degree of product differentiation of their financial services tends to amplify the contractionary effects of financial crises. This happens especially when firms are heavily dependent on bank loans, which is likely to be the case in economies of emerging countries.

An insight that arises from our framework, consistent with the concentration-fragility view, is that currency devaluations generate more severe twin crises in economies with less competitive banking sectors. With this insight in mind, we can emphasize the need for prudential regulation that explicitly focuses on market structure in banking. Specifically, to diminish the contractionary effects of devaluations, prudential regulation regarding concentration and product differentiation in the banking sector could be used to encourage the banking sector to be more competitive prior to devaluations. Also, policy makers could foster capital markets and lower the dependence of producers on bank credit.

A potential extension would be to explore the role of hedging in this environment where banks face an incentive to hedge against exchange rate risk. Also, our model could be used to analyze the role on the effects of devaluations of prudential regulations imposing limits on banks' foreign exchange positions.

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Notes

1. By banks competing in the product differentiation dimension, we refer to the fact that banks can target the financial services that they provide together with a loan towards particular sectors of economic activity, and build expertise in the provision of these services only for these sectors. Examples of these services are firm monitoring, valuation of collateral and investment project evaluation. Following the industrial organization literature (e.g. von Ungern-Sternberg, 1988), a

bank that specializes in many sectors of economic activity follows a generalist strategy and offers a "general purpose" product, while a bank specializing in one (or few) sectors follows a specialist strategy and offers a more focused product.

2. The following countries are included in the analysis: Argentina, Bolivia, Brazil, Chile, Colombia, Hong Kong, India, Indonesia, Korea, Malaysia, Mexico, Paraguay, Peru, Philippines, Singapore, Thailand, Uruguay and Venezuela. Bank-level data are from Bankscope of Bureau van Dijk; aggregate data are from the World Development Indicators of the World Bank.

3. Therefore, the interest rate on loans is risk-free.

4. If a bank is targeting sector A and therefore building expertise in valuation of collateral, evaluation of projects, monitoring, etc. in that sector, x is smaller for borrowers in that sector than for borrowers in other sectors. This makes borrowing from that bank cheaper for the former.

5. Using Belgian data, they show that loan rates decrease with the distance between the bank and the borrowing firm, and increase with the distance between the firm and competing banks.

6. This constraint always binds in equilibrium because the firms' discount factor $(1 + r^*)$ is smaller than the gross interest rate on loans.

7. This working paper version is available at http://faculty.lebow.drexel.edu/OliveroM/

8. Available at http://faculty.lebow.drexel.edu/OliveroM/

9. It is clear from (21) that an unexpected shock to S_t lowers $\hat{c}_{it}$ and drives some banks out of business, such that $N_t < N_{t-1}$.

10. By "buffer" and "amplifier", we mean relative to the real effects of devaluations observed for the case of exogenous θ.

11. Recall that $\Omega = 1.15$ in the benchmark simulations of all other parameter values.