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Banks and Monetary Shocks in Emerging Markets: How Far Can We Go With the "Credit View"?

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Banks and Monetary Shocks in Emerging Markets: How Far Can We Go With the "Credit View"?

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Abstract

This paper examines the propagation of monetary shocks in a two-good optimizing macromodel where domestic banking activity is costly and the non-tradable sector is highly dependent on domestic bank credit, as in most emerging market economies. The model develops the Bernanke-Blinder "credit view" of the monetary transmission mechanism along classical lines, with no Keynesian rigidities being imposed and the only sources of "imperfection" arising from deposit and credit-in-advance constraints. Using numerical simulations, we show that such a relatively simple model goes a long way toward explaining some key "stylized facts" of recent financial crises.

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I. Introduction

Banks have recently played a prominent role in the unfolding of business cycles in emerging markets. In the early 1990s, brisk economic growth and exchange rate stability in most of Asia and Latin America were associated with unparalelled credit bonanza, declining intermediation spreads, and a large build-up of bank debt. Conversely, as the large devaluations and interest rate shocks of end-1994/early 1995 in Latin America and of 1997–98 in Asia eroded banks' deposit base and led to a sharp rise in non-performing loans, domestic credit came to a halt, helping intensify and prolong the recession well beyond what appeared to be warranted by the initial monetary tightening[2] In both occasions, the ensuing output losses and bank solvency problems in the countries affected proved to be far more severe than those observed during previous financial crises in industrial economies.[3]

These events beg the question of what is different about banks in emerging markets. Aside from obvious differences in regulatory frameworks, one striking contrast between financial systems in industrial economies and in emerging markets is the dominant role banks continue to play among the latter group of countries in the provision of working capital and project financing to domestic firms. Reflecting the relatively underdeveloped state of equity and private bond markets in these countries as well as the extensive information asymmetries that prevent local firms from tapping international capital markets, equity and bond issues have remained relatively unimportant sources of financing for most the business sector.[4]

This has been particularly the case for small and medium-sized enterprises catering for local markets and producing mostly non-tradable goods. As documented in a number of studies (Catão, 1997; Domaç and Ferri, 1999; Gelos and Werner, 1999; Krueger and Tornell, 1999), such enterprises tend to be extremely dependent on local banking credit, having little access to other source of finance besides bank credit. In this context, where bank loans and bonds are highly imperfect substitutes on the liability side of domestic firms, the impact of interest rate shocks on output is prone to be magnified by the so-called *credit channel*. As shown in Bernanke and Blinder (1988), to the extent that firms cannot substitute equities or bonds for bank loans on the liability side of their balance sheets, and banks try to reduce the less liquid interest-bearing component of their portfolio under tighter monetary conditions,

[2]A common pattern observed in recent boom and bust cycles in emerging markets is that of bank credit remaining depressed for several months after the initial shock, even after deposits, interest and exchange rates having returned to their pre-crisis levels. See, for instance, Ghosh and Ghosh (1999), and Lane et al. (1999) on the recent East Asia experience, and Catão (1997) and Krueger and Tornell (1999) on the cases of Argentina and Mexico, respectively.

[3]On the proximate magnitude of output losses during the "Tequila" and the 1997-98 Asian crises, see IMF (1999). For a comparison between the severity of financial crises in developing and developed over the last century or so, see Bordo and Eichengreen (1999).

[4]Rojas-Suárez and Weisbrod (1995) provide a discussion of why banks continue to play a dominant role in financial intermediation in Latin America.

the interest spread between bank loans and more liquid items (such as deposits and government bonds) will widen; this, in turn, will impart an additional contractionary impulse to the initial monetary tightening. Depending on the context, the effects on output and employment can be far more severe than those envisaged by the pure "money channel" traditionally embedded in IS-LM models.[5]

Two other factors contribute to make the "credit channel" a powerful monetary transmission mechanism in emerging markets. One is the marked cyclical pattern in international capital flows. Be it due to "pull" factors associated with domestic macroeconomic policy and electoral cycles, or to "push" factors related to the level of "world" interest rates (Calvo, Leiderman and Reinhart, 1993), foreign investment into emerging markets has been specially volatile in recent years.[6] Due to the key role of domestic banks in intermediating these flows, banks have witnessed sharp fluctuations in their lending capacity over the business cycle. During "good" times, when banking liquidity is abundant and external interest rates lower, banks tended to embark upon a lending euphoria, lowering spreads and raising the ratio of loans to deposits, thus magnifying the impact of favorable external conditions on domestic output and employment. During "bad" times, when capital inflows dry up and external interest rates are higher, banks have had to raise their lending spreads and cut down on loans, leading to a marked contraction in overall credit supply.

The other factor behind the greater volatility of credit supply in emerging markets is costly banking. International comparisons indicate that operating expenses (measured as a percentage share of total loans) have been up to three to five times higher in some emerging markets compared with advanced economies (Catão, 1998). Higher operating expenses and reserve requirements entail higher interest spreads which, in turn, increase loan riskiness (Stiglitz and Weiss, 1981; Stiglitz and Jaffee, 1990). Higher loan provisioning associated with riskier lending will then tend to feedback on operating costs, pushing them further up. In this vein, Edwards and Végh (1997) have shown that wherever the Bernanke-Blinder type of "credit channel" plays a prominent role in the transmission of monetary fluctuations, the output effect of interest or exchange rate changes is greatly enhanced by costly banking activity. Thus, the combination of highly volatile capital inflows with costly banking is bound to induce marked fluctuations in intermediation spreads and in the supply of bank credit over the cycle.

This paper examines the effects of a monetary shock in a small open economy where banking activity is costly and the bank credit channel is at the centerstage of the monetary transmission mechanism. In particular, we analyse the impact of exogenous shifts in the

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[5]To be sure, the so-called "money view" of the monetary transmission mechanism encompasses a wide variety of approaches. Besides the standard IS-LM framework, certain dynamic general equilibrium models (e.g. Lucas, 1990; Christiano and Eichenbaum, 1992) can also reproduce some real business cycle features by postulating distinct forms of imperfect price adjustment in a two-asset world, consisting of money and bonds and no bank loans.

[6]See, for instance, IMF (1999) Chapter 2.

sovereign bond interest rate or the country's exchange rate in a representative agent optimizing model where production and consumption are dependent on bank activity through credit- and deposit-in-advance constraints. The model extends in two areas previous theoretical work on the credit channel in emerging markets by Agénor (1997), Agénor, Aizenman and Hoffmaister, (1998), and Edwards and Végh (1997). First, the one-good general equilibrium model of Edwards and Végh (1997) is extended to a two-good setting where tradable and non-tradable goods are both produced and consumed domestically. Moreover, in light of the above-mentioned fact that the non-tradable sector in emerging market economies is generally more dependent on domestic credit than its tradable counterpart, we explicitly model this distinction regarding the use of domestic financing between the two sectors. As will be shown below, this is bound to have important implications for the type of balance-of-payment adjustment as well as for the magnitude and sectoral composition of output and employment losses a country experiences following a monetary shock.

Second, we undertake a variety of numerical simulations to assess the extent to which our model accounts for actual developments in output, employment and the trade balance in a typical emerging market during "good" and "bad" times. On the one hand, this will help us answer the question posed at the beginning – namely, of how far we can explain recent business cycles in emerging markets with a mainly supply-side oriented, credit view approach. On the other hand, the numerical simulations will allow one to gauge the sensitivity of the results to changes in key structural parameters of the model, some of which may be under the control of policy makers. This provides us with firmer grounds to assess the effectiveness of counter-cyclical monetary policy tools such as changes in reserve requirements on banks.

The remainder of the paper is divided into four sections as follows. Section II presents some "stylized facts" about domestic intermediation spreads, bank credit and the business cycle in two large emerging market economies – Argentina and Mexico – which have been subject to dramatic monetary shocks in recent years. Section III lays out the theoretical model which aims to capture these main stylized facts and derives its main predictions. Section IV reports a number of simulation exercises aiming at quantifying, on the basis of the proposed model, the impact of monetary shocks on key macroeconomic and financial variables. The extent to which the model succeeds in reproducing the "stylized facts" highlighted in section II, and what a role counter-cyclical monetary policies can have in this framework are then discussed. Section V summarizes the paper's main findings.

II. Some Stylized Facts

Evidence on the key role of domestic banks in propagating external shocks is well illustrated by the experiences of Argentina and Mexico during the so-called "Tequila" crisis of late 1994-95 as well as by developments in Argentina in the wake of the Russian financial crisis of mid-1998. Figure 1 plots two benchmark measures of "world" interest rates facing emerging market economies – the London interbank interest rate ("LIBOR") and the emerging market bond index ("EMBI").[7] Due to the gradual tightening in monetary policy in the US and in other advanced countries in the course of 1994, both international interbank interest rates as well as sovereign bond spreads facing emerging markets rose sharply. Faced with higher external borrowing costs, domestic banks in both Argentina and Mexico raised their interest rate on domestic loans. The gradual rise in domestic interest rates in both countries culminated with the financial panic triggered by the devaluation of the Mexican peso in December 1994. Between early November 1994 and March 1995 world interest rates and spreads facing emerging markets climbed well above levels observed earlier in the decade. Faced with tigther financing conditions and large deposit outflows triggered by the adverse macroeconomic environment, both the absolute value of deposit and lending rates and also the spread between the two rates widened markedly (Figure 2). This close association between domestic bank spreads and external interest rates could be also observed later in the decade, when the EMBI index - triggered by Russia's default in August 1998 - virtually returned to its 1995 peak, driving up intermediation spreads in the domestic banking system of both Argentina and Mexico, albeit to a lesser extent than earlier in the decade.

How were these fluctuations in external interest rates and in banking spreads propagated through these economies? In Argentina, the impact of higher domestic interest rates on private sector credit began to be felt as early as the second half of 1994 when bank lending slowed down in real terms (Figure 5). Following the peak in lending rates in March 1995, and with domestic monetary conditions remaining tight by the government's continued adherence to a currency board arrangement,[8] credit growth turned negative in the second half of the year and did not recover until late 1996. As a consequence, the ratio of credit to private sector deposits – after rising in tandem with the outflow of deposits during the first quarter of 1995[9] declined steadily through mid-1997, when it finally stabilized (Figure 6).

Given what we already noted about the overwhelming importance of bank loans in the provision of firms' working capital as well as in household spending decisions in a typical emerging economy, it is hardly surprising that the impact of this credit squeeze on output was readily felt. As shown in Figure 3, real GDP dropped for four consecutive quarters through early 1996. As one would expect, the drop in economic activity was all the more dramatic in sectors which are traditionally more reliant on bank credit, such as construction and commerce, i.e., sectors where output typically consists of non-tradable

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[7]The EMBI index consists of a weighted average of interest spreads (over the US Treasury bond) on sovereign bonds issued by main emerging market countries.

[8]Argentina's currency has been pegged to the US dollar since end-March 1991, when a radical anti-inflationary program (the so-called "convertibility plan") was launched and a currency board arrangement was introduced.

[9]Between December 1994 and March 1995, Argentina lost some 18 percent of its banking system deposits and about a third of its international reserves held at the Central Bank.

Figure 1. LIBOR and Emerging Market Bond Spread
(Percent a Year)

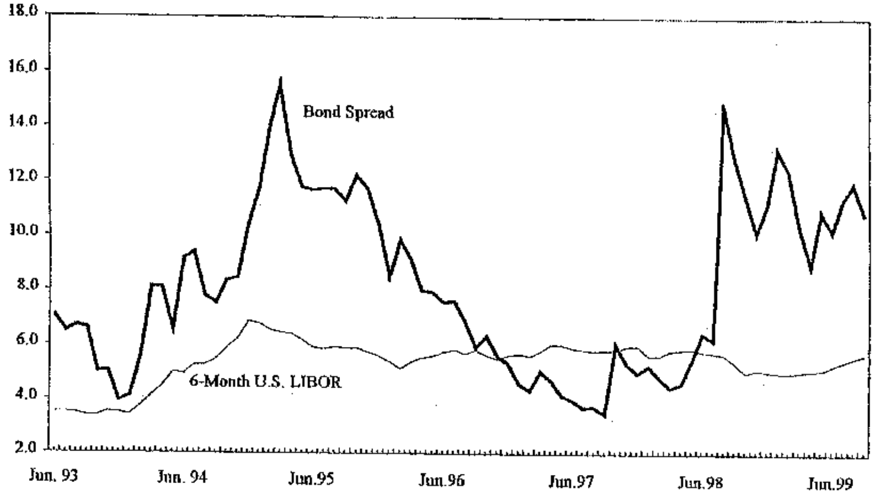
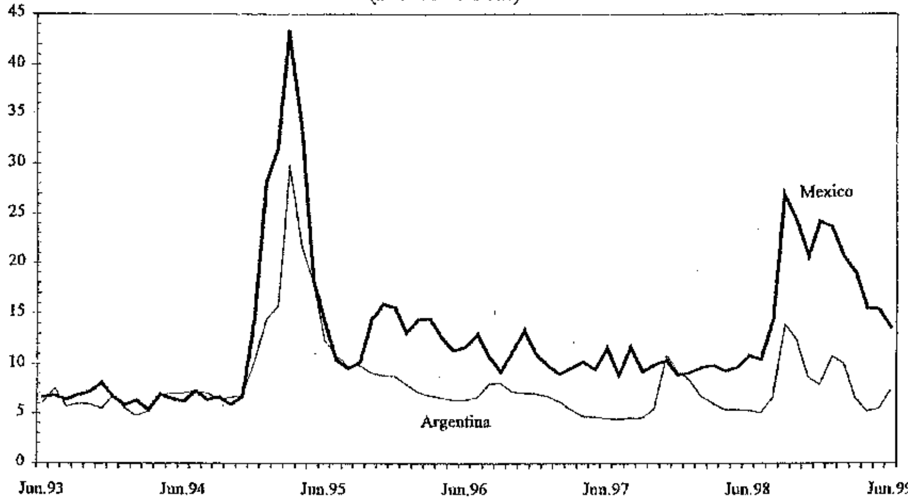


Figure 2. Mexico: Interest Rate Spread in the Banking System[1]
(Percent a Year)



[1] Average lending note to prime borrowers minus average interest rate on bank deposits.

Figure 3. Argentina: Growth of Real GDP
(Percent a Year)

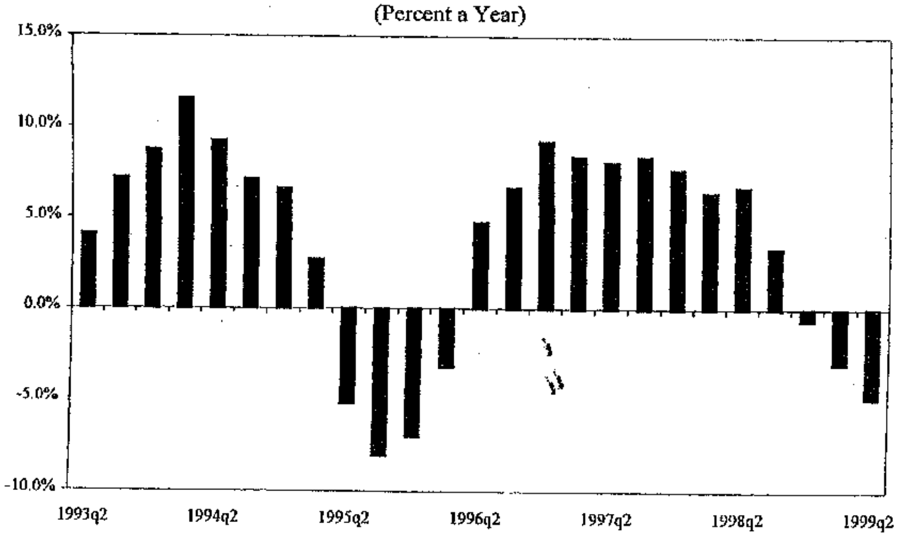


Figure 4. Mexico: Growth of Real GDP
(Annual Percentage)

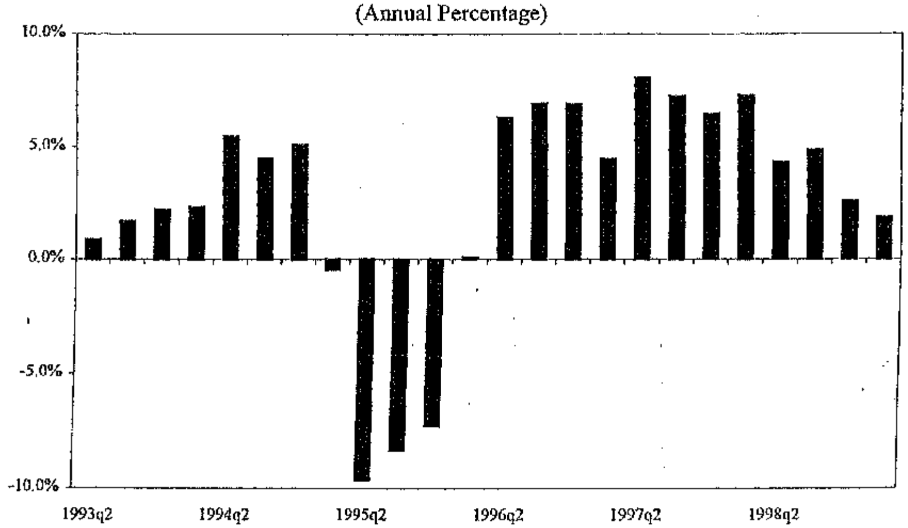
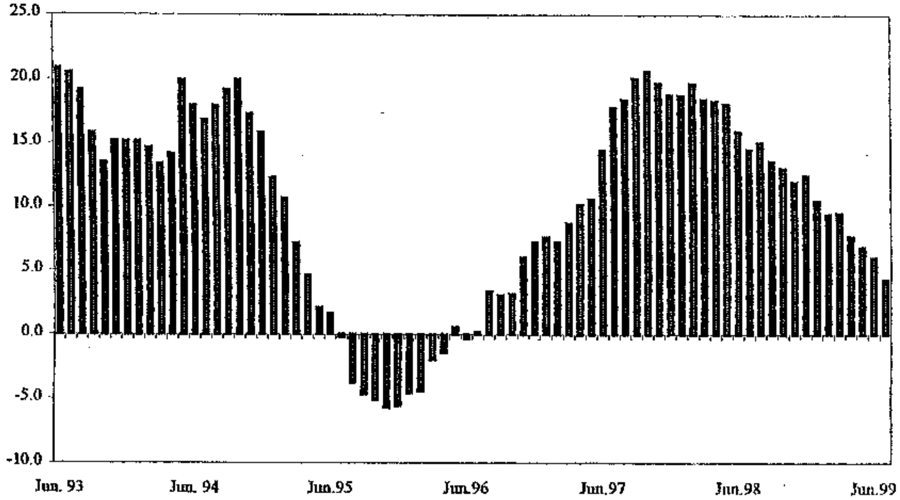


Figure 5. Argentina: Domestic Credit to the Private Sector[1]
(Percent a Year)



[1] Deflated by the consumer price

Figure 6. Argentina: Ratio of Domestic Bank Credit to Deposits

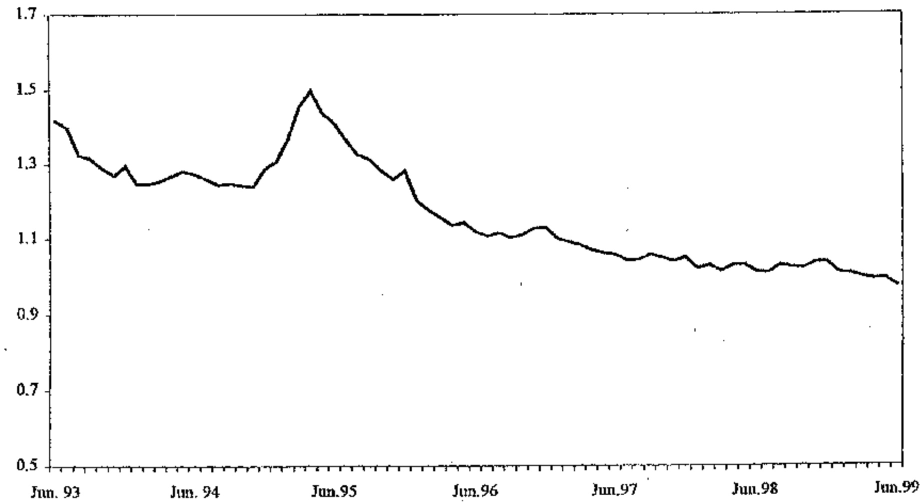
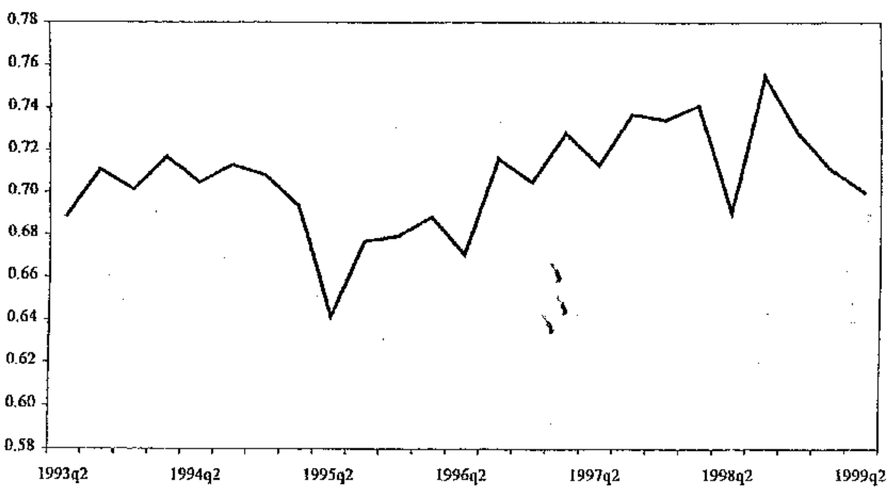
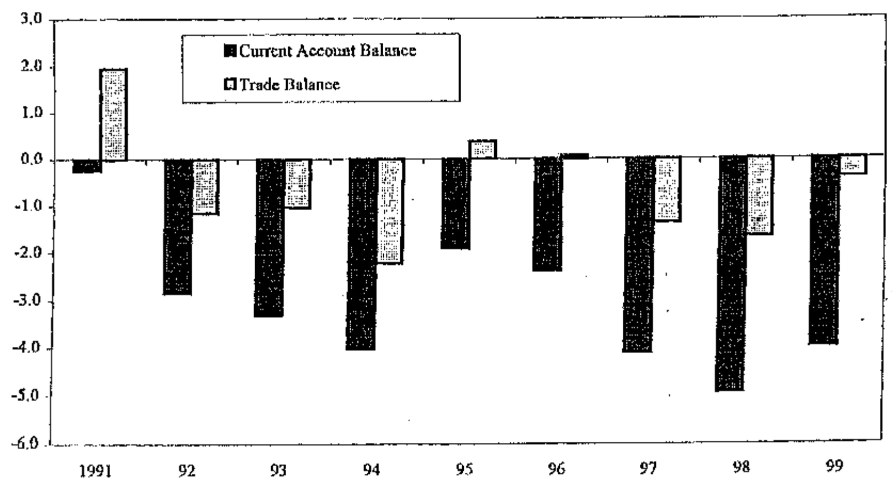


Figure 7. Argentina: Ratio of Non-tradeable to Tradeable Output[1]



[1] Output in construction and commerce divided by agriculture and manufacturing.

Figure 8. Argentina: Current Account and Trade Balance
(Percent of GDP)



goods. Figure 7 highlights the magnitude of output contraction in non-tradable sectors relative to that of tradables (such as agriculture and manufacturing industry) during the Tequila crisis. While non-tradable output grew faster than of tradables during the "good times" of mid-1991 to mid-1994, it dropped more than that of tradables in response to the sharp rise in banking spreads and lending rates in early 1995; not until late 1996 did its percentage share in output return to the pre-crisis levels.

To the extent that non-tradable production also tends to be more labor intensive than the production of tradable goods, a domestic credit crunch is bound to generate significant employment losses. Aggregate employment dropped during the Tequila crisis in 1995, despite the fact that an important segment of the tradable sector—namely, exports—expanded rapidly during the period, and the unemployment rate peaked at 18 percent. Meanwhile, the external trade balance turned positive (Figure 8).

The Mexican story has some striking parallels with the Argentine experience.[10] The sharp increase in lending rates following the country's abandonment of its pegged exchange rate regime in December 1994, as well as the restrictive monetary policy from the beginning of 1995, was translated into a marked contraction in bank credit to the private sector (Figure 9). As in the Argentine case, credit continued to decline for months after the initial shock and took even longer to start recovering. Also similar to the Argentine case was the evolution pattern of the credit-to-deposit ratio following the shock (Figure 10). In tandem with the surge capital outflows, deposits declined sharply in the first three months of 1995, inducing an incipient increase in the credit-to-deposit ratio. However, as banks responded to this erosion of their deposit base by contracting credit, the ratio begins to decline gradually through the rest of 1995. New policy measures to restore confidence were put in place and deposits began to flow back, but as banks continued to cope with a high share of non-performing loans in their portfolio and found difficult to raise extra capital, credit took much longer to recover; as a result, the ratio of the credit-to-deposits continued to decline and did not level-off until two years later.

As in Argentina, the credit squeeze led to sharp contraction in output, and the more so in the non-tradable sector (Figure 11). In fact, as domestic spending plunged and the relative price of tradables rose with the devaluation, the resulting intersectoral transfer of resources appears to have been quite large; by early 1999, the ratio of non-tradable to tradable output had not yet recovered its pre-crisis level. Needless to say, the impact of the crisis on labor market was substantial and employment did not return to pre-crisis before late 1996. At the same time, the contraction in domestic demand and the relatively rapid recovery in tradable production improved the trade balance and reduced in the current account deficit (Figure 12), similarly to what happened in Argentina.

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[10]Useful overviews can be found in Gelos and Werner (1999) and Krueger and Tornell (1999).

Figure 9. Mexico: Domestic Bank Credit to the Private Sector
(12-month percent change)

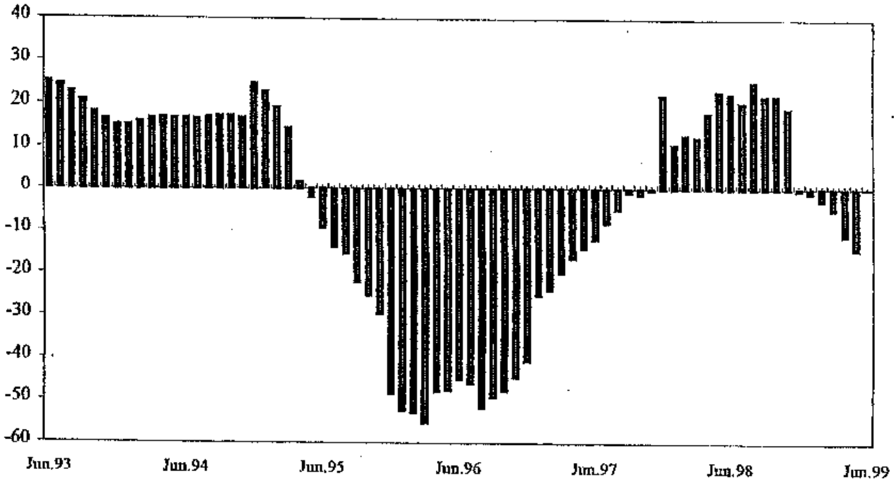


Figure 10. Mexico: Ratio of Domestic Bank Credit to Deposits

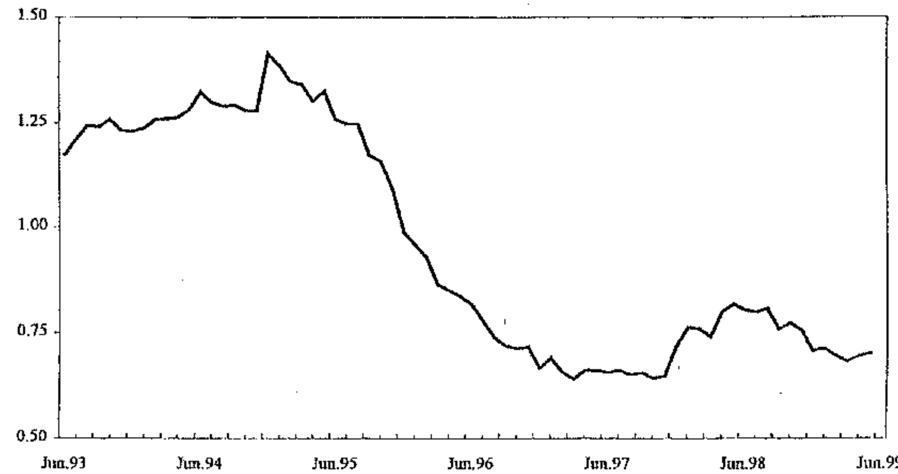


Figure 11. Mexico: Ratio of Non-Tradable to Tradable Output

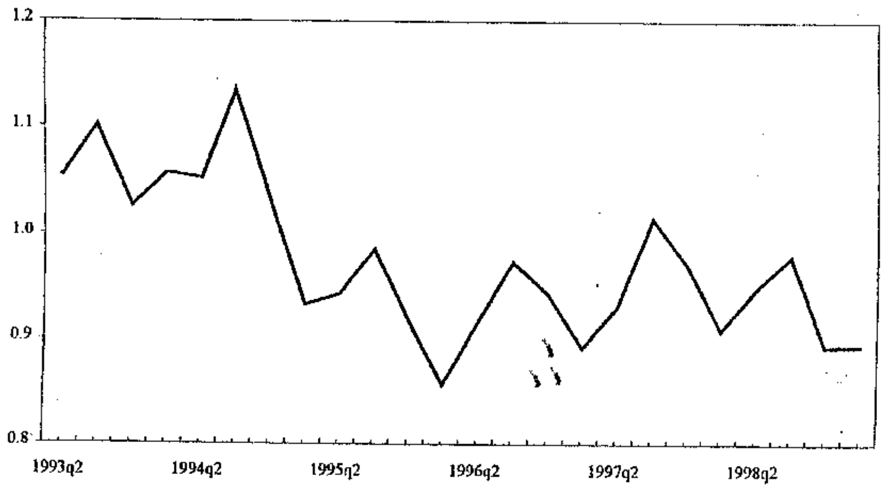
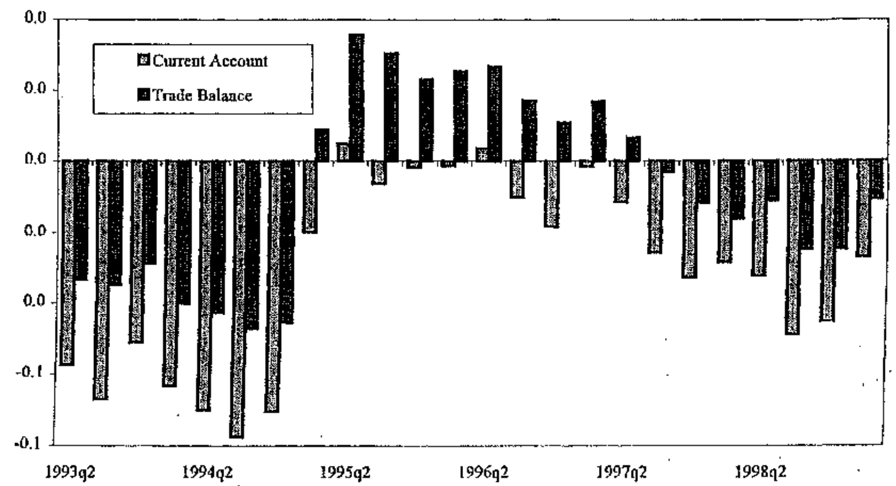


Figure 12. Mexico: Current Account and Trade Balance
(Percent of GDP)



III. The Model

Consider a small open economy consisting of four sectors – households, firms, banks, and the government – and two types of non-storable goods, one tradable and the other non-tradable. The infinitely-living representative household owns firms and banks, and faces an exogenously given world real interest rate r defined as nominal interest rate i* minus the world inflation ($\varkappa^*$), i.e., $r = i^* - \varkappa^*$.

Perfect capital mobility ensures that the representative bank and the firm producing the tradable good also face the world real interest rate r. In contrast, the non-tradable producer can only borrow from domestic banks at an interest rate i_l. All agents hold a tradable bond that pays a nominal interest rate i. Perfect international arbitrage in the bond market implies that i will always be equivalent to the world nominal interest rate i* plus the rate of exchange rate devaluation (ε), i.e., $i = i^* + \varepsilon$. The nominal exchange rate E (defined as the foreign currency price of a unit of the domestic currency)[11] is set by the government, which accommodates shifts in the supply and demand for foreign currency by exchanging foreign for domestic money at the pre-set exchange rate. The government, in addition, runs fiscal policy subject to an intertemporal budget constraint and sets reserve requirements on banks.

Under this set of assumptions, the optimization problem faced by each sector and the general equilibrium conditions are as follows.

A. Households

The representative household's lifetime utility is given by:

$$U = \int_0^\infty \left[\frac{C^{1-1/\sigma}}{1-1/\sigma} + \frac{X^{1-1/\chi}}{1-1/\chi}\right]\exp(-\beta t)dt \tag{1}$$

where C_t, and X_t denote consumption and leisure, respectively, $\beta(>0)$ is the subjective discount rate, σ stands for the intertemporal elasticity of substitution of consumption, and χ for the price elasticity of leisure.

The typical consumption basket C comprises tradables and non-tradable goods (C_T, C_N) inter-related according to CES preferences:

$$C = [q^{1/\theta} C_T^{\frac{\theta-1}{\theta}} + (1-q)^{1/\theta} C_N^{\frac{\theta-1}{\theta}}]^{\frac{\theta}{\theta-1}} \tag{2}$$

[11]This means that an increase in E implies a nominal appreciation of the domestic currency while a drop in E corresponds to a nominal depreciation.

where q defines the participation share of each good in total consumption and θ is the (intra-temporal) elasticity of substitution between the two goods.

The household pays in advance for the consumption of either good by drawing down its demand deposits. This cash-in-advance constraint implies that the stock of demand deposits is proportional to expenditure at every period:

$$d_t = \rho Z_t = C_T + eC_N \qquad (3)$$

where ρ is a constant and Z stands for total spending. Throughout this paper, the price of the tradable good will be used as numeraire and set to one. Hence, total spending will be measured by $(C_T + eC_N)$, where e is the price of non-tradables relative to the tradable good or the real exchange rate.

The household holds two types of assets – bank deposits (d) and internationally traded bonds (b^h). In addition, the household earn wages (w), receives government transfers (τ) as well as profits accruing from banks (Ω^B) and firms (Ω^F) it owns. Accordingly, the household flow constraint is given by:

$$\dot{a}_t^h = ra_t^h + w_t L_{Tt} + e_t w_t L_{Nt} + \Omega_t^{Tf} + \Omega_t^{Nf} + \Omega_t^b + \tau_t - Z_t - (i_t - i_t^b)d_t \qquad (4)$$

The corresponding intertemporal budget constraint (expressed in terms of the price of the tradable good) can thus be written as

$$a_0^h + \int_0^\infty [w_t L_{Tt} + e_t w_t L_{Nt} + \Omega_t^{Tf} + \Omega_t^{Nf} + \Omega_t^b + \tau_t - Z_t - (i_t - i_t^d)d_t]\exp(-rt)dt = 0 \qquad (5)$$

where r is the real rate of return on assets, i_t is the nominal return on the internationally traded bond, whereas i_t^d represents the nominal return paid on demand deposits. Thus, the spread between the bond and the deposit interest rate $(i - i^d)$ represents the opportunity cost of holding demand deposits.

The household's optimization problem consists of maximizing (1) subject to the constraints given by equations (2), (3), and (5). As usual, its solution can be broken down into two parts – namely, the intertemporal problem of allocating consumption and leisure over time and that of allocating consumption intra-temporally between the two goods. Assuming away Ponzi schemes and setting the subjective discount rate (β) equal to the real interest rate r,[12] first-order conditions for the inter-temporal problem yield:

[12]As usual in this type of problems, we assume that $\beta = r$ to eliminate unwanted dynamics and ensure the existence of a steady-state.

$$C_t = \frac{1}{\{P\lambda[1+\rho(i_t - i_d)]\}^{\sigma}} \tag{6}$$

$$X_t = \frac{1}{\lambda^{\chi} w^{\chi}} \tag{7}$$

where λ is the Lagrange multiplier associated with the intertemporal budget constraint given by (4), which corresponds to the marginal utility of wealth.

The intra-temporal optimization problem consists of maximizing (2) subject to the spending constraint given by equation (3). The respective first order conditions yield:

$$C_{T_t} = \frac{qZ_t}{q+(1-q)e_t^{1-\theta}}; \quad C_{N_t} = \frac{(1-q)Z_t e_t^{-\theta}}{q+(1-q)e_t^{1-\theta}}; \quad \frac{C_{N_t}}{C_{T_t}} = \frac{(1-q)e_t^{-\theta}}{q} \tag{8}$$

The equations above relate the quantities consumed of either good to total spending Z. But since Z=PC, it is possible to write the equations on C_T and C_N in terms of total consumption C, once we characterize the functional form of the price index P. The price index associated with a CES consumption index, such as in (3), is given by[13]

$$P = [q+(1-q)e^{1-\theta}]^{1/1-\theta} \tag{9}$$

Plugging (8) back into the expressions for C_T and C_N in (7) and into (5) allows us to express the optimal consumption of either good as well as total consumption as a function of the relevant relative prices:

$$C_{T_t} = C_t[q+(1-q)e_t^{1-\theta}]^{\theta/1-\theta} \tag{10}$$

$$C_{Nt} = C_t(1-q)e_t^{-\theta}[q+(1-q)e_t^{1-\theta}]^{\theta/1-\theta} \tag{11}$$

$$C_t = \frac{[q+(1-q)e_t^{1-\theta}]^{-\sigma/(1-\theta)}}{\lambda^{\sigma}[1+\rho(i_t - i_d)]^{\sigma}} \tag{12}$$

B. Firms

Firms in this economy produce either tradable or non-tradable goods using labor as the sole input. The respective outputs of tradable and non-tradable goods are thus given by

[13] For a formal derivation, see Obstfeld and Rogoff (1996, p.227).

$$y_{T_t} = \phi L_{T_t}^{\alpha}; \qquad y_{N_t} = \psi L_{N_t}^{\beta} \tag{13}$$

where ϕ and ψ stand for total factor productivities, and α and β are the income shares of labor in each sector.

In the tradable sector, firms' real financial wealth (a_t^{Tf}) is represented by their holdings of the international bond (b_t^{Tf}) and is defined by:

$$a_t^{Tf} = b_t^{Tf} \tag{14}$$

Firms' flow constraint is simply:

$$\dot{a}_t^{Tf} = ra_t^{Tf} + y_{Tt} - w_t L_{Tt} - \Omega_t^{Tf} \tag{15}$$

where w_t represent the real wage in terms of the tradable good and Ω_t^{Tf} denotes profits transferred to households. Integrating forward Equation (15) and imposing the no-Ponzi games condition, the present discounted value of firms' profits can be expressed as:

$$\int_0^{\infty} \Omega_t^{Tf} \exp(-rt)dt = a_0^{Tf} + \int_0^{\infty} (y_{Tt} - w_t L_{Tt}) \exp(-rt)dt \tag{16}$$

Under perfect competition, first order conditions for profit maximization in tradables yield the labor demand in that sector:

$$w_T = \phi \alpha L_T^{\alpha - 1} \tag{17}$$

$$L_T = \left[\frac{\phi \alpha}{w} \right]^{1/1-\alpha} \tag{18}$$

As mentioned above, the non-tradable firm can only finance its working capital and labor expenses through domestic bank credit through a credit-in-advance constraint, i.e.,[14]

[14]Alternatively, we could have introduced credit in the production function taking the form of intermediate capital, as in Chari, Jones, and Manuelli (1995), without changing the predictions of the model. A different approach would be to introduce credit through a credit in advance constraint faced by households to buy durable goods, as in Alvarez, Diaz-Gimenez, Fitzgerald, and Prescott (1992). The latter approach emphasizes the demand side of economic fluctuations, whereas the main focus of the present paper is on the supply-side effects of bank credit.

$$z = \gamma w L_N \tag{19}$$

where γ is a proportionality factor ($\gamma > 0$) and z stands for total bank credit in this economy (denominated in units of the tradable good). Perfect labor mobility ensures that the wage rate paid by the non-tradable firm is the same as that paid in the tradable sector, w. Firms' financial wealth (a_t^{Nf}) in real terms is determined by:

$$a_t^{Nf} = b_t^{Nf} - z_t \tag{20}$$

where b_t^{Nf} represents firms' holdings of the international bond and credit is considered a liability. The flow constraint for this type of firms is given by:

$$\dot{a}_t^{Nf} = r a_t^{Nf} + e_t y_{Nt} - w_t L_{Nt} - (i_{lt} - i_t) z_t - \Omega_t^{Nf} \tag{21}$$

where $i_{l\,t}$ is the lending rate per unit of credit and $(i_{lt} - i_t) z_t$ represents the financial cost firms have to pay for using credit. Ω_t^{Nf} stands for profits transferred to households. Integrating forward equation (21), imposing the no-Ponzi games condition, and taking into account the credit in advance constraint, the present discounted value of profits for firms in this sector can be expressed as:

$$\int_0^\infty \Omega_t^{Nf} \exp(-rt)dt = a_0^{Nf} + \int_0^\infty \{e_t y_{Nt} - w_t L_{Nt}[1 + \gamma(i_{lt} - i_t)]\} \exp(-rt)dt \tag{22}$$

Recalling that $y_{N_t} = \psi L_{N_t}^{\beta}$, the first order condition for profit maximization resulting from deriving (22) relative to L_N yields the labor demand by the non-tradable firm:

$$w = \psi e \beta L_T^{\beta-1} \tag{23}$$

$$L_N = \left\{ \frac{\psi \beta e}{w[1 + (i_L - i)\gamma]} \right\}^{1/1-\beta} \tag{24}$$

Total labor demand by the two sectors is therefore:

$$L^D = L_T + L_N = \left\{ \frac{\psi \beta e}{w[1 + (i_L - i)\gamma]} \right\}^{1/1-\beta} + \left[\frac{\phi \alpha}{w} \right]^{1/1-\alpha} \tag{25}$$

C. Banks

The banking industry is assumed to be perfectly competitive. The representative bank finances their lending operations by borrowing demand deposit from the public (for which they pay an interest rate i_t^d) and/or by selling bonds. It is forced by the regulatory authorities to comply with reserve requirements and capital adequacy rules. The former establishes that banks need to maintain a fraction δ of deposits as required reserves which are held at the central bank paying no interest. The capital adequacy regulation establishes that a fraction p of its loans needs to be set aside as (general) provisioning, which is assumed not to yield interest either.[15] Banks lend to firms in the form of credit and charge a lending rate per unit of credit of i_{lt}. The net asset position of the representative bank is thus given by:

$$a_t^b = b_t^b + z_t + R_t - d_t \tag{26}$$

and

$$R_t = \delta d_t + p z_t \tag{27}$$

where a_t^b represents the real stock of financial assets or bank's capital, b_t^b stands for holdings of the internationally traded bond, z_t is credit, R_t are required reserves, and d_t denotes demand deposits.

Following Baltersperger (1980) and many others, we assume that, in addition to regulatory costs associated with reserve and provisioning requirements, banks incur *operating* costs represented by $\eta(z_t, d_t)$, where the function $\eta(.)$ is strictly increasing and convex, ruling out the presence of economies of scale.[16] On the basis of these assumption, the bank's flow budget constraint is:

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[15]In an imperfect foresight framework where bank loans are subject to a default risk, p can be thought of as the mean percentage of non-performing loans that the bank would expect to arise out of new lending. In this case, the percentage share of loan losses could be modelled as a function exogenous macroeconomic shocks (as in Agénor, Aizenman, and Hoffmaister (1998) and Catão (1998)), or be endogenously determined by the interest rate on the riskless bond and firms' debt-to-asset ratio (as in Freixas and Rochet (1997), chapter 8). As discussed later, we regard these as important extensions to the present model but do not pursue them in this paper.

[16]In practice, banks' operating costs include many other variables such as employment, wages, number of branches and the value of deposits per account; see Freixas and Rochet (1997) for a concise review of the literature. In the particular context of this model, one could think of including labor as another input to the banks' production function. We have abstained from doing so on two grounds. First, the share of wages in overall banking costs has declined in recent years with the dissemination of computer and information technology

$$\dot{a}_t^b = ra_t^b + (i_{lt} - i_t)z_t + (i_t - i_{dt})d_t - i_t R_t - \eta(z_t, d_t) - \Omega_t^b \tag{28}$$

where the perfect competition assumption entails zero profits.[17] Banks' objective is to maximize the present value of its profits. Integrating (28) forward and imposing the usual transversality condition, we can write the former as

$$\int_0^\infty \Omega_t^b \exp(-rt)dt = a_o^b + \int_0^\infty [(i_{lt} - i_t)z_t + (i_t - i_{d_t})d - i_t R_t - \eta(z_t, d_t)]\exp(-rt)dt \tag{29}$$

Maximizing (29) subject to the reserve and provisioning requirement constraints (27) yields

$$i_{lt} = (1+p)i_t + \eta_z(z_t, d_t) \tag{30}$$

$$i_{dt} = (1-\delta)i_t - \eta_d(z_t, d_t) \tag{31}$$

$$i_{lt} - i_{d_t} = (\delta + p)i_t + \eta_z(z_t, d_t) + \eta_d(z_t, d_t) \tag{32}$$

which express the lending and deposit rates in terms of the exogenous variables i, p, and δ, as well as the volume of deposits and credit demanded by firms. Equation (32), in particular, establishes that the lending-deposit spread $(i_l - i_d)$ is a linear function of the bank's marginal costs of capturing deposits and supplying loans and the opportunity cost of prudential requirements.

D. Government

In this economy government conducts monetary and fiscal policy. It issues a single liability, monetary base (m_t).[18] Monetary base is held by the banking system in the form of required reserves which pay no interest. In addition, the government also controls the devaluation rate (ε_t), the reserve requirement ratio (δ) and loan provisioning requirements (p).

(ATMs, internet banking), which helped reduce the share of labor employed in the domestic banking sector relative to that in the non-financial business sector. Second, the introduction of a third market for labor (in addition to those generated by tradable and non-tradable firms) would not alter the basic results while diverting attention away from the main focus of the model - namely, the intersectoral allocation of goods and labor between tradable and non-tradable firms and output losses resulting from an exogenous monetary shock.

[17]Despite the zero profit condition, the profit term Ω_t^b is left in the equation for the sake of generality.

[18]Households hold no cash. Inclusion of cash will alter the consumer's portfolio decisions and complicate the tractability of the model, but the main conclusions of the exercise will not change.

Government revenues come from the real return on its international assets (rb_t^g) and the growth of the monetary base. Its expenditures take the form of lump-sum transfers to households. Following Edwards and Végh (1997) and Gupta (1999), we include the financial proceeds stemming from banking costs as an income flow to the government on the assumption that these proceeds accrue to the the public sector first, before returning to households as lump-sum transfers.[19] The government accounting just described is captured by the following flow constraint:

$$\dot{b}_t^g = rb_t^g + \dot{m}_t + \varepsilon_t m_t + \eta(z_t, d_t) - \tau_t \tag{33}$$

The government's lifetime budget constraint, once the no-Ponzi games condition has been imposed, is given by:

$$\int_0^\infty \tau_t \exp(-rt)dt = b_0^g + \int_0^\infty [\dot{m}_t + \varepsilon_t m_t + \eta(z_t, d_t)] \exp(-rt)dt \tag{34}$$

E. Equilibrium Conditions

Labor Market

Labor market equilibrium implies that the supply of labor equals the demand for labor by tradable and non-tradable firms. For any given unit of time, labor supply is inversely related to leisure so that $L_t + X_t = 1$. Substituting the latter in equation (7) yields

$$L_t^s = 1 - \frac{1}{\lambda^x w^x} \tag{35}$$

Combining (35) and (25) yields the following equilibrium relationship between wages, the real exchange rate and the lending spread

$$1 = \frac{1}{\lambda^x w^x} + \left\{ \frac{\psi \beta e}{w[1 + \gamma(i_L - i)]} \right\}^{\frac{1}{1-\beta}} + \left(\frac{\phi \alpha}{w} \right)^{\frac{1}{1-\alpha}} \tag{36}$$

[19] As noted in Edwards and Végh (1997), this can be thought of as the benefit accrued by some federal agency in exchange for monitoring banking services. In practical terms, the assumption is instrumental in preventing the banking cost function from appearing in the economy's aggregate budget constraint, which would make the current account unrealistically dependent on the size of the domestic banking sector. An alternative approach would be to have the respective banking cost term as part of household income flow. However, since the cost of banking depends on the volume of deposits and the latter depend, in turn, on the household's consumption decisions via the deposit-in-advance constraint, the introduction of the banking cost function in the household budget constraint would mess up the algebra considerably, without changing the model's main results.

Goods Market

Equilibrium in the non tradable sector requires consumption of tradables to be equal to production of tradables:

$$c_t^N = y_t^N \tag{37}$$

The optimal supply of non-tradables can be obtained by substituting (18) in (13), whereas the demand for non-tradables is given equations (11) and (12). The resulting expression for the equilibrium in the non-tradable market is

$$\psi\left\{\frac{\psi\beta e}{w[1+\gamma(i_t - i)]}\right\}^{\frac{\beta}{1-\beta}} = \frac{(1-q)e^{-\theta}[q+(1-q)e^{1-\theta}]^{\frac{\theta-\sigma}{1-\theta}}}{\lambda^{\sigma}[1+\rho(i-i_d)]^{\sigma}} \tag{38}$$

In the market for tradables, demand is given by combining (10) and (11) which yield

$$c_T = \frac{q[q+(1-q)e^{1-\theta}]^{\frac{\theta-\sigma}{1-\theta}}}{\lambda^{\sigma}[1+\rho(i-i_d)]^{\sigma}} \tag{39}$$

In a small open economy, the consumption of tradables need not coincide with the supply at a given point of time. In other words, the country can run temporary trade and current account surpluses (deficits) whenever the supply exceeds demand (demand exceeds supply). However, once Ponzi-schemes are ruled out, the country cannot accumulate external assets or external debt indefinitely. The economy's accumulation of foreign assets is given by adding up the flow constraints of all agents in the economy. The flow constraint of households, firms, banks and government are given by (4), (15), (21), (28) and (33), respectively. Thus, the overall economy flow constraint or current account is given by:

$$\dot{k}_t = rk_t + y_{Tt} - c_{Tt} \tag{40}$$

where $k(\equiv b^h + b^f + b^b + b^g)$ denotes the economy's stock of international assets. Integrating forward equation (40), noting that $y_{T_t} = \phi L^{\alpha}{}_{T_t}$, where L_T is given by (18), and imposing the appropriate no-Ponzi game condition we obtain the economy's resource constraint:

$$a_0^k + \int_0^{\infty} \phi\left(\frac{\phi\alpha}{w}\right)^{\frac{\alpha}{1-\alpha}} \exp(-rt)dt = \int_0^{\infty} c_T \exp(-rt)dt \tag{41}$$

which states that the present value of consumption of tradables must be equal to the initial value of international assets plus the present value of the production of tradables.

Credit Markets

Following most of the empirical literature on banking costs,[20] we assume the operating cost function for the representative bank have a translog functional form on deposit and loans:

$$\eta = v_0 z^{(v_1 + v_2 \ln z - v_3 \ln d)} d^{(v_4 + v_5 \ln d)} \tag{42}$$

which follows the desired properties of a bank's cost function discussed above, i.e., of being strictly increasing, convex and linearly homogeneous. The respective marginal costs are given by

$$\eta_z = \frac{\eta}{z}\left(v_1 + 2v_2 \ln z - v_3 \ln d\right) \tag{43}$$

$$\eta_d = \frac{\eta}{d}\left(v_4 + 2v_5 \ln d - v_3 \ln z\right) \tag{44}$$

We can thus re-write equations (30) and (31) as

$$(i_l - i) = ip + \frac{\eta}{z}\left(v_1 + 2v_2 \ln z - v_3 \ln d\right) \tag{45}$$

$$(i - i_d) = i\delta + \frac{\eta}{d}\left(v_4 + 2v_5 \ln d - v_3 \ln z\right) \tag{46}$$

Recalling (42) we can re-write (45) as a function of z, thus defining the credit supply equation

$$z^s = \left\{ \frac{[i_l - i(1+p)]}{v_o d^{(v_4 + v_5 \ln d)} [v_1 + \ln(z^{2v_2} / d^{v_3})]} \right\}^{\frac{1}{v_1 + \ln(z^{v_2}/d^{v_3}) - 1}} \tag{47}$$

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[20]See, e.g., Berger and DeYoung (1997) and Dick (1996). The above cost function has the desirable property of yielding a convex relationship between lending spreads and the supply of bank credit for typical values of the parameters v's, while also allowing the presence of a strong complementary between loans and deposits postulated in the literature (see, e.g., Fama, 1985). In contrast, the cost function used in Edwards and Végh (1997) and Gupta (1999) fails to yield such a convexity, implying that the lending spread will increase proportionally less than the credit supply as loans grow large, what is clearly at odds with well-established "stylized facts" about the working credit markets (see, e.g., Stiglitz and Jaffee, 1990).

Equation (47) shows that credit supply is clearly a positive function of the lending spread. The relationship between credit supply and deposits, however, is ambiguous. On the one hand, the term $d^{(\nu_4+\nu_5 \ln d)}$ in the denominator points to a negative relationship between deposits and credit associated with the fact that a fall (increase) in deposits, by reducing (increasing) costs, tends to increase (decrease) credit supply. On the other hand, the term $\ln(z^{2\nu_2}/d^{\nu_3})$ in the denominator as well as the exponential term $\ln(z^{\nu_2}/d^{\nu_3})$ capture the cost complementarity between deposit and loans in the bank's production function, indicating that increases in loans which are not accompanied by a concomitant increase in deposits tend to increase banking costs, *ceteris paribus*.[21] Which effect predominates is ultimately an empirical question, and will depend on estimates of the cost parameters, the ν's.

On the demand side, bank credit in this economy is determined by combining equations (19) and (24), i.e.,

$$z^d = \gamma w \left\{ \frac{\psi \beta e}{w[1+(i_L - i)\gamma]} \right\}^{1/1-\beta} \tag{48}$$

which combined with the credit supply equation yields the credit market equilibrium. The demand for deposits is, in turn, determined by equations (3) and (8):

$$d_t = \frac{\rho[q+(1-q)e^{1-\theta}]^{1/1-\theta}}{\lambda^{\sigma}[1+\rho(i_t - i_d)]^{\sigma}[q+(1-q)e_t^{1-\theta}]^{\sigma/1-\theta}} \tag{49}$$

Hence, the equilibrium rate of bank credit to deposit is:

$$x = \frac{z}{d} = \frac{\gamma\beta(\psi\beta e)^{\frac{\beta}{1-\beta}}\lambda^{\sigma}[1+\rho(i-i_d)]^{\sigma}}{\{w[1+\gamma(i_L - i)]\}^{\frac{\beta}{1-\beta}}\{\rho[q+(1-q)e^{1-\theta}]^{\frac{1-\sigma}{1-\theta}}\}} \tag{50}$$

[21]This can be seen more clearly for the particular case where $\nu_3 = 2\nu_2$. Under this assumption we can re-write (47) as

$$z^s = \left\{ \frac{(i_l - i)}{\nu_o d^{(\nu_4+\nu_5 \ln d)}[\nu_1 + \nu_3 \ln x]} \right\}^{\frac{1}{\nu_1+\nu_3 \ln(x)-1}}$$

where x = z/d, i.e. the ratio of credit to deposits

F. Perfect Foresight Equilibrium and Exogenous Monetary Shocks

Assume that all agents in this economy have perfect knowledge about the time path of the exogenous $(i_t, \delta, \varepsilon_t)$ variables for time $t \in [0, \infty]$. Thus, along a perfect foresight equilibrium path, equations (36), (38), (39), (41), (45), (46), and (50) describe the behavior of the main endogenous variables of the model $\{c_T, \lambda, e, w, i_l, i_d, x\}$. Once these are determined, the remaining variables of interest $\{c_{NT}, L^s\}$ can be readily derived from equations (8) and (35).

In the model, monetary shocks can stem from three different sources, namely: (i) shocks to the world interest rate i*; (ii) shocks to the nominal exchange rate E (or to the pre-set devaluation rate, ε; and (iii) shocks to the reserve requirement coefficient δ. As the uncovered interest parity condition (UIP) holds continuously, shocks to i* or ε, will map into a shock to the domestic benchmark interest rate (i.e. that paid on the tradable bond), i. As our main concern in this paper are exogenous shocks to the domestic bond rate, i, rather that shocks to reserve requirements (which, under most circumstances are strictly under policy makers' control), let us consider how such shocks propagate through the economy according to the model.

To make the exposition simpler, assume that the monetary authorities stick to the pre-existing foreign exchange parity (i.e., ΔE=0), as in Argentina during the 1995 and 1997-98 financial crises. In this case, the interest rate on the benchmark domestic currency-denominated bond will rise in tandem the external interest rate, i.e., $\Delta i_t = \Delta i_t^*$. A glance at equation (46) indicates that the deposit spread will widen on impact (proportionally to the reserve requirement δ), and that this "first round" effect may be reinforced or offset depending on what happens to the ratio of credit to deposits, x. Similarly, equation (45) shows that changes in the lending spread and, hence, the net impact of i on i_l will also depend on the behavior of x. Although the direction of changes in x cannot be established unequivocally for all possible values of the model's parameters, a wide range of simulation exercises that we have undertaken (see below) show that, under sensible assumptions for the actual value of these parameters, both the deposit and lending spreads will invariably increase (decrease) as i rises (falls).

On this basis, the way this stylized open economy will adjust to a higher world interest rates can be illustrated by the following sequence of developments in credit, labor and goods markets, depicted in Figure 13. From equation (6) we know that, as the deposit spread $(i_t - i_{dt})$ is higher, consumption will be lower. If consumption is lower, so will be deposits by the virtue of the deposit-in-advance constraint (3). In other words, faced with a higher opportunity cost of present consumption relative to holding bonds, households will engage in intertemporal substitution, reducing their current demand for consumer goods and, hence, for bank deposits. Given the complementarity between credit and deposits in banks' cost function, lower deposits will raise the marginal cost of lending. So, from the initial equilibrium where the upward slopping credit supply schedule [equation (45)] meets with the downward slopping credit demand curve [equation (48)] at A, the fall in deposits will shift the z^s schedule upward. This implies that at a higher level of the lending spread (point B), credit supply now exceeds credit demand.

What happens then to credit demand? From the credit-in-advance constraint [equation (19)] we know that overall credit demand in this economy is directly related to non-tradable output. By virtue of the market clearing condition (37), non-tradable output will depend on household demand for non-tradable goods. As illustrated in the top right-hand side panel of Figure 13, the increase in the deposit spread leads to a downward shift in total consumer demand which, given the imperfect substitutability between tradables and non-tradables, will lead to a downward shift in the demand curve for home goods. On the other hand, the non-tradable supply curve will also shift leftwards with the rise in interest costs. Whether the demand effect predominates over the supply contraction will depend on the relative magnitude of the model's parameters. As will be seen later, numerical simulation exercises indicate that, under reasonable calibration assumptions, the demand effect predominates, i.e., the final equilibrium will move to point C, where the relative price of non-tradables is lower, i.e., the exchange rate depreciated in real terms. Mapping this back into the credit market diagram, a lower exchange rate implies that the credit demand curve (z^d) will shift downwards. In the new equilibrium C, the lending spread is higher and credit is lower.

What happens to employment and labor market equilibrium? As the exchange rate depreciates, and since the wage rate w paid by the non-tradable producer ought to be the same as that of the tradable producer (by the assumption of perfect labor mobility)[22] the ratio of output prices to wage (e/w) shifts against non-tradable producers. This pulls output down and, hence, demand for labor in the non-tradable sector. As a result, the overall labor demand curve will shift upwards, producing an incipient decline in employment and wages, moving the equilibrium to point B. However, insofar as the marginal utility of wealth, λ, decreases with the rise in interest rates (i.e. household witness a gain in their bond holdings, or non-labor income), labor supply contracts. The resulting equilibrium at point C is one where both employment and wage are lower.

To see the impact of these adjustments on the external current account, consider what happens to output and the consumption of tradable goods, as depicted in the bottom right panel of figure 13. Recall that the representative tradable firm does not depend on bank credit, and so is not "crowded out" by the rise in the lending spread. Moreover, it benefits from the decline in the wage rate in the economy stemming from lower demand for labor by non-tradable firms. As a result, tradable production increases along the Y_T^s curve to point C. At the same time, however, we know that, as the overall demand for consumer goods declines and tradables and non-tradables are imperfect substitutes in the aggregate consumption basket, the C_T curve will shift leftwards. At the level of real wage w_F, the demand of tradables will decline to B. The excess supply of tradables (Y_{T1}-C_{T1}) will be exported. Thus, the trade balance moved from the initial equilibrium position at locus A, to a surplus. In other words, the recession in the home good markets and the contraction in

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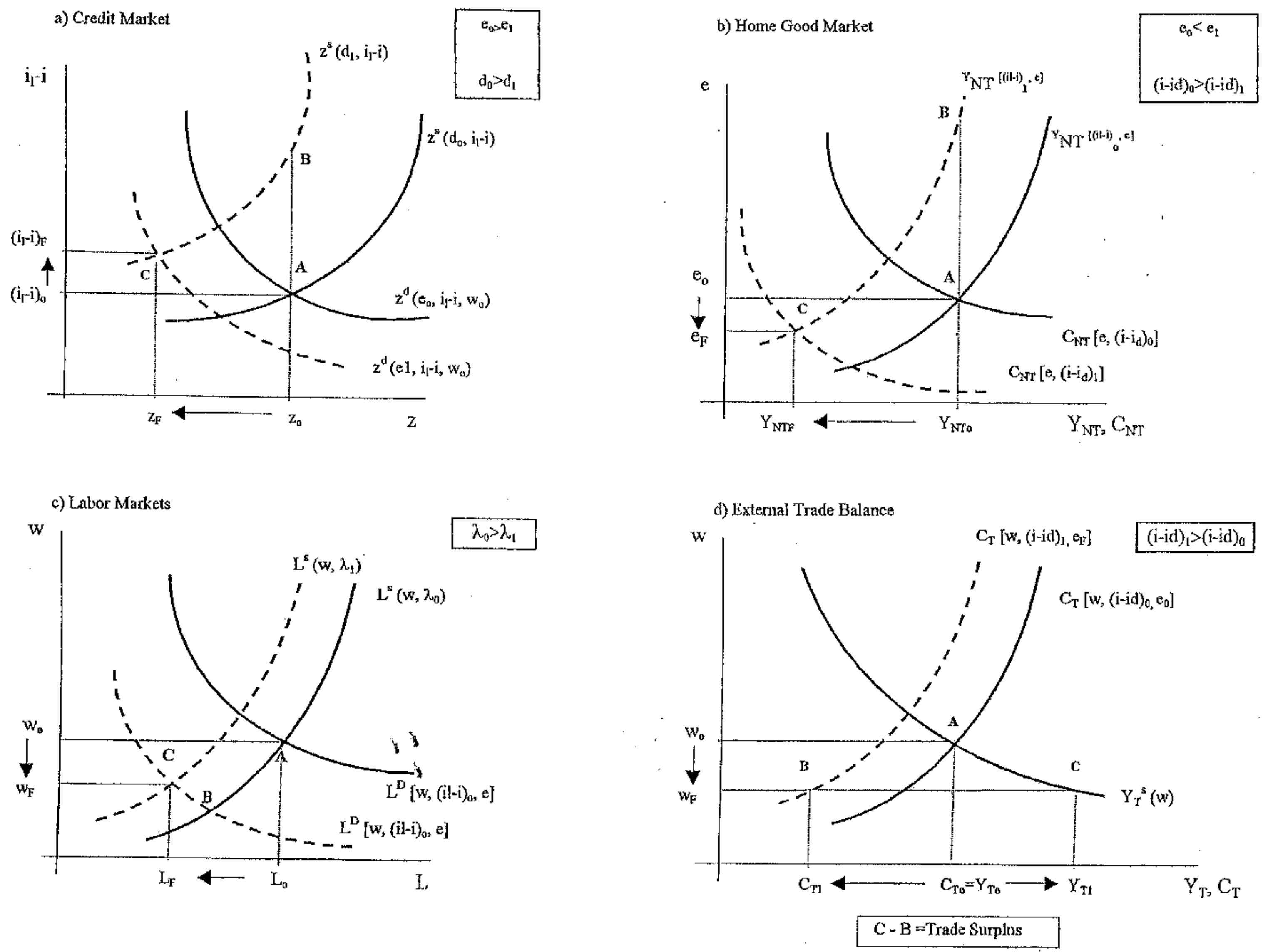
[22]In other words, the non-tradable producer cannot lower the wage rate (denominated in units of tradable goods) without loosing labor to tradable firms.

FIGURE 13. Effects of an Exogenous Interest Rate Shock



aggregate consumption caused by the initial increase in external interest rate will improve the external trade balance.

To summarize this sequence of changes leading to the new higher interest rate equilibrium, the model thus postulates that:

- in the *financial sector*, lending and deposit spreads will both increase, while deposits and credit (both in absolute terms as well as relative to GDP) will be lower;
- on the *production side*, output in the tradable industries will rise but that in non-tradables will fall;
- on the *employment* front, given the more labor-intensive nature of production in the non-tradable sector and that the latter is especially affected by the credit crunch, aggregate employment and real wages will both decline, despite the recovery in the tradable sector;
- on the *external sector*, as the production of tradable goods increases but their domestic consumption decreases, the difference will be exported, leading to an improvement in the trade balance.

As seen in section II, this direction of changes predicted by the model are in line with developments in Argentina and Mexico following different episodes of interest rate shocks in the 1990s. It remains to be seen, however, whether the direction of the changes portrayed above can be reproduced numerically and the extent to which their magnitude approaches those observed in practice, once the model's parameters are calibrated with values reasonably close to their "real world" counterparts.

IV. NUMERICAL SIMULATIONS

Assume that at a given point in time the economy faces an *unanticipated* temporary increase in either i_t*, ε_t, or δ.[23] The shock last for a period T which is set to one. Under annualized values for the interest rate variables, this can be thought as equivalent to one year.

Table 1 reports the parameter values used to calibrate the model in a conservative *baseline* case. The share of tradables in the overall consumption basket (q=0.4) and the income shares of labor in the two sectors $(\alpha = 0.4; \beta = 0.7)$ are similar to those used in various studies and uncontroversial (see, e.g., Rebelo and Végh (1995)). An intertemporal elasticity of consumption (σ) of 0.5 is also well within the range reported in empirical

[23]We shall not discuss here the cases where such changes are anticipated. This is not only because of space limitations but also because business cycle developments in the countries mentioned above appear to have been triggered mostly by "unanticipated" changes, which are therefore more closely related to the focus of the paper.

studies, such as Ceglowsky (1991), Kimbrough (1992), and Reinhart and Végh (1995).[24] With regard to the price elasticity of labor (or its inverse, leisure), estimates vary quite widely in the literature, from zero to slightly above unity (MaCurdy, 1983); thus, the mid-point value of 0.7 appears to be a sensible as a benchmark. In setting the deposit-in-advance constraint parameter ρ to 0.8, we implicitly assume that about 20 percent of the population can finance domestic consumption out of other sources than domestic bank deposits (such as offshore bank accounts or external borrowing not channelled through domestic banks). This seems like a reasonable guess for a number of countries. It also seems reasonable to assume that the tradable sector is substantially more productive than the non-tradable sector in emerging market economies and, accordingly, that total factor productivity parameter ϕ in tradable production is about twice as high as its counter-part for non-tradables, ψ. Turning to financial sector variables, the nominal and real interest rates, reserve requirements, and banks' operating costs are all based on the corresponding average values observed in recent years in the Argentine economy, as reported in Catão (1998); the general provisioning ratio of 5 percent corresponds to existing regulations in Argentina for non-collateralized bank loans with potential risk.[25]

Starting with this baseline parametrization, Table 1 reports the respective percentage changes in the main macroeconomic and financial variables following a *temporary* negative shock to the exogenous interest rate denominated in domestic currency, i. The values of i during "good" and "bad" times correspond to the money market interest rate in Argentina just prior to the December 1994 Mexican devaluation and its peak in March 1995, respectively. They confirm the direction of the distinct variables' response to an interest rate shock described in Figure 13: in "bad" times, lending and deposit rates, as well as the interest rate spread increases; banks' deposits fall and so does credit supply. On the production side, higher lending rates imply a higher cost of hiring labor in the non-tradable sector, which reduces employment and output in that sector. The contraction in labor demand in the non-tradable sector is translated into a reduction in real wage and a reallocation of employment towards the tradables sector. The economy thus experiences a recession in the non-tradable sector and an expansion in the tradable sector. However, as the non-tradable sector is larger and more labor-intensive, both real GDP and aggregate employment fall as a result of the recession in non-tradables. The output expansion and the consumption contraction in tradables are translated into an improvement in the trade balance, which move from an initial balance to a surplus of 1 percent of GDP.

The exercise reported in Table 2 is similar, except that now the *elasticity of intertemporal substitution in consumption* is raised to 1.0, from 0.5 in the baseline scenario.

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[24]Ceglowski (1991), for instance, estimates the intertemporal elasticity of substitution for domestic consumption goods in the 0.3 to 0.4 range, whereas that for the imported consumption good is estimated between 0.8 to 0.9 depending on the specification. Once the two categories of consumption goods are aggregated over, 0.5 seems an appropriate point estimate to start working with.

[25]See Banco Central de la República Argentina (1998), p.14.

As expected in the case of a temporary shock, the demand response is stronger and the consumption of tradables drops by 2 3/4 percent, up from 1 ¾ percent in the previous simulation. Employment effects are stronger and so is the contraction of monetary aggregates, as the intermediation spread rises by nearly 600 basis points.

If, on the other hand, in addition to a higher inter-temporal elasticity, the intra-temporal elasticity of substitution between the two goods rises – as shown in Table 3, then output and employment effects are weaker. The two goods will become closer to perfect substitutes and the crowding out of non-tradable firms by higher interest rates will tend to be offset by higher production by the tradable firms. Note that the contraction in employment in the non-tradables is of a similar magnitude as previously (3 percent) but a larger share of this falling labor demand is now absorbed by tradable firms and total employment falls less than in the previous exercise. This indicates that the strength of the output and employment effects of a monetary shock in this stylized economy partly hinges on the weak substitutability between the two goods, as one would intuitively expect.

Given that banks' costs are subject to wide variations across emerging markets and that they can be higher than that assumed in the baseline case, Table 4 reports simulation results for the case where average and marginal operating costs of domestic banks are higher. One obvious implication is that, for the same increase in the benchmark interest rate, intermediation spreads are now higher to begin with, and rise further after the shock. As a consequence, the crowding out of non-tradable firms is now somewhat stronger and employment in the non-tradable sector falls by some 3.6 percent. The contraction in the monetary aggregates is also much stronger and real GDP and tradable consumption decline by close to 3 percent.

Table 5 builds on the preceeding results and assume that provisioning requirements are doubled to reach 10 percent of total loans.[26] This is consistent with recent crisis developments in emerging markets, where the marked increase in the share of non-performing loans in banks' portfolio led, under the stick of the banking supervisory authorities, to such an increase in loan provisioning. In this case, the effects on credit contraction, output, employment and intersectoral resource shifting are even stronger. The magnitude of the decline in bank credit is similar to that observed in Argentina in 1995, while the percentage declines in GDP and consumption are somewhat below but not far off the mark.[27]

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[26]To highlight the realism of this figure, non-performing loans (as a share of aggregate bank credit to the non-financial private sector) peaked at 17 percent in Argentina during the 1995 "Tequila" crisis. Meanwhile provisioning approached 10 percent of total loans.

[27]An even more pronounced can be obtained if the intertemporal elasticity of labor substitution is higher - for instance, approaching one. Results on this and other simulations using a number of alternative parametrizations are not reported due to space reasons, but are available from the authors upon request.

Finally, a question of interest is what monetary policy can do to try and offset the impact of such exogenous monetary tightening. In the context of this model, an obvious instrument is the reserve requirement on banks. So far, we have worked with the baseline case where the reserve requirement coefficient is 20 percent. Table 6 provides evidence on the counter-cyclical effects of halving reserve requirements when the economy is faced with the same interest rate shock. Instead of contracting by nearly 3 percent as in table 5, real GDP contracts by just under 1 percent. The main reason is that intermediation spreads rise by much less when reserve requirements are eased, as one can see by comparing the last row of table 6 with the last row of Table 5. The decline in both employment and wages are considerably mitigated; on the other hand, the trade balance improves only marginally. Thus, wherever banks retain the monopoly of credit over a substantial part of the domestic economy, these simulation results confirm that reserve requirements are a powerful counter-cyclical tool at hand.

V. Conclusions

This paper has developed a two-good general equilibrium model of a small open economy where the domestic banking sector plays a central role in propagating and amplifying exogenous monetary shocks, in the spirit of the Bernanke-Blinder (1988) "credit view". While previous authors – notably Edwards and Végh (1997) - have developed one-good models along similar lines to show that costly banking tends to magnify the impact of monetary shocks on output and employment in developing countries, this paper extends this basic framework on three fronts. First, we allow for the existence of a sizeable non-tradable sector in these economies which is more dependent on bank credit than its tradable counterpart. Second, we model banks' cost function in a way that is not only flexible enough to nest alternative assumptions about the sensitivity of banks' costs to changes in the demand for loans and in the supply of deposits, but also appears to yield changes in interest spreads closer to those observed in practice. Third, we quantify the effects of monetary shocks on output, employment, and external balances by simulating the model numerically and testing the sensitivity of the results to alternative scenarios.

Despite its relative simplicity, the proposed model was able to explain key stylized facts about recent financial crises, such as the rise in domestic intermediation spreads as external interest rates go up, the outflow of deposits from local banks and a decline in the credit-GDP ratio following the shock, a contraction in output and employment in the non-tradable sector, and an improvement in the foreign trade balance. We have also showed that in contexts where banks have some monopoly power over domestic financial intermediation, reserve requirements can play a powerful counter-cyclical role against monetary shocks.

Needless to say, there are a number of directions in which this model can be extended. These include the introduction of default risk in banks' supply function, nominal rigidities, and moral hazard in bank lending. To the extent these constitute important complements to the supply-side effects highlighted above, the introduction of these features into the model is likely to enhance its explanatory power. However, even abstracting from these important real world features, this paper has sought to show that a relatively simple supply-side/credit-view approach goes a long way toward explaining the observed changes in key financial and macroeconomic variables following monetary shocks in emerging markets.

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Table 1. Effects of a Monetary Shock with Baseline Parameters

Parameter		"Good Times"	"Bad Times"	% Change
	Instrument			
	Interest Rate	7.0%	28.0%	300.00
	Real Sector			
q= 0.4	Production of Tradables	0.65	0.65	0.62
θ= 0.5	Consumption of Tradables	0.65	0.64	-1.69
α= 0.4	Consumption of Non-Tradables	0.45	0.45	-1.49
β= 0.7	Real GDP (in units of tradables)	2.75	2.71	-1.30
ϕ= 2.1	Price Index	2.85	2.84	-0.31
γ= 1.0	Real Exchange Rate	4.61	4.59	-0.41
ψ= 1.1	Wage (in units of tradables)	4.87	4.83	-0.92
σ= 0.5	Employment Tradables	0.05	0.05	1.56
χ= 0.7	Employment Non-tradables	0.28	0.28	-2.01
$\delta 0$= 0.2	Total Employment	0.34	0.33	-1.44
ρ= 0.8	Trade Balance/GDP	0.00	0.01	...
v0= 0.1				
v1= 0.2	**Financial Sector**			
v2= 0.7	Bank Deposits	2.20	2.16	-1.73
v3= 1.0	Bank Credit	1.38	1.34	-2.90
v4= 0.1	Credit/Deposits	0.63	0.62	...
v5= 0.3	Operating Cost	0.15	0.15	-1.97
p= 0.05	Operating Cost/Loan	0.11	0.11	...
a0= 0.0%	Lending Rate	13.3%	35.5%	...
rir= 5.0%	Deposit Rate	3.9%	20.5%	...
	Lending Spread	6.3%	7.5%	...
	Deposit Spread	3.1%	7.5%	...
	Spread	9.4%	15.0%	...

Table 2. Effects of Monetary Shock with Higher Intertemporal Elasticity of Substitution

			"Good Times"	"Bad Times"	% Change
		Instrument			
		Interest Rate	7.0%	28.0%	300.00
		Real Sector			
$q=$	0.4	Production of Tradables	0.64	0.65	0.94
$\theta=$	0.5	Consumption of Tradables	0.64	0.63	-2.80
$\alpha=$	0.4	Consumption of Non-Tradables	0.45	0.44	-2.24
$\beta=$	0.7	Real GDP (in units of tradables)	2.73	2.66	-2.34
$\phi=$	2.1	Price Index	2.87	2.84	-0.87
$\gamma=$	1.0	Real Exchange Rate	4.65	4.60	-1.14
$\psi=$	1.1	Wage (in units of tradables)	4.95	4.88	-1.40
$\sigma=$	**1.0**	Employment Tradables	0.05	0.05	2.37
$\chi=$	0.7	Employment Non-tradables	0.28	0.27	-3.05
$\delta0=$	0.2	Total Employment	0.33	0.32	-2.19
$\rho=$	0.8	Trade Balance/GDP	0.00	0.01	...
v0=	0.1				
v1=	0.2	**Financial Sector**			
v2=	0.7	Bank Deposits	2.18	2.11	-3.21
v3=	1.0	Bank Credit	1.37	1.31	-4.38
v4=	0.1	Credit/Deposits	0.63	0.62	...
v5=	0.3	Operating Cost	0.15	0.15	-3.31
p=	0.05	Operating Cost/Loan	0.11	0.11	...
a0=	0.0%	Lending Rate	13.4%	35.6%	...
rir=	5.0%	Deposit Rate	3.9%	20.5%	...
		Lending Spread	6.4%	7.6%	...
		Deposit Spread	3.2%	7.5%	...
		Spread	9.5%	15.2%	...

Table 3. Effects of a Monetary Shock with Higher Intra- and Inter-temporal Elasticity of Consumption

			"Good Times"	"Bad Times"	% Change
		Instrument			
		Interest Rate	7.0%	28.0%	300.00
		Real Sector			
$q=$	0.4	Production of Tradables	0.78	0.78	0.72
$\theta=$	**0.9**	Consumption of Tradables	0.78	0.75	-3.08
$\alpha=$	0.4	Consumption of Non-Tradables	0.39	0.38	-2.30
$\beta=$	0.7	Real GDP (in units of tradables)	2.10	2.06	-1.72
$\phi=$	2.1	Price Index	2.10	2.09	-0.56
$\gamma=$	1.0	Real Exchange Rate	3.35	3.32	-0.90
$\psi=$	1.1	Wage (in units of tradables)	3.72	3.68	-1.08
$\sigma=$	**1.0**	Employment Tradables	0.08	0.09	1.82
$\chi=$	0.7	Employment Non-tradables	0.23	0.22	-3.04
$\delta 0=$	0.2	Total Employment	0.31	0.31	-1.74
$\rho=$	0.8	Trade Balance/GDP	0.00	0.01	...
v0=	0.1				
v1=	0.2	**Financial Sector**			
v2=	0.7	Bank Deposits	1.68	1.63	-3.04
v3=	1.0	Bank Credit	0.86	0.82	-4.21
v4=	0.1	Credit/Deposits	0.51	0.50	...
v5=	0.3	Operating Cost	0.10	0.10	-4.85
p=	0.05	Operating Cost/Loan	0.12	0.12	...
a0=	0.0%	Lending Rate	14.8%	37.0%	...
rir=	5.0%	Deposit Rate	2.1%	18.8%	...
		Lending Spread	7.8%	9.0%	...
		Deposit Spread	4.9%	9.2%	...
		Spread	12.7%	18.2%	...

Table 4. Effects of a Monetary Shock with Higher Intertemporal Elasticity
and More Costly Banking

Parameter	Value		"Good Times"	"Bad Times"	% Change
		Instrument			
		Interest Rate	7.0%	28.0%	300.00
		Real Sector			
q=	0.4	Production of Tradables	0.64	0.65	1.04
θ=	0.5	Consumption of Tradables	0.64	0.62	-3.28
α=	0.4	Consumption of Non-Tradables	0.44	0.43	-2.58
β=	0.7	Real GDP (in units of tradables)	2.73	2.65	-2.80
ϕ=	2.1	Price Index	2.91	2.87	-1.10
γ=	1.0	Real Exchange Rate	4.73	4.66	-1.44
ψ=	1.1	Wage (in units of tradables)	4.99	4.91	-1.54
σ=	**1.0**	Employment Tradables	0.05	0.05	2.63
χ=	0.7	Employment Non-tradables	0.27	0.26	-3.58
$\delta 0$=	0.2	Total Employment	0.32	0.31	-2.59
ρ=	0.8	Trade Balance/GDP	0.00	0.01	...
v0=	**0.2**				
v1=	**1.5**	**Financial Sector**			
v2=	**0.7**	Bank Deposits	2.18	2.10	-3.67
v3=	**2.0**	Bank Credit	1.36	1.29	-5.15
v4=	**0.5**	Credit/Deposits	0.62	0.61	...
v5=	**0.3**	Operating Cost	0.28	0.27	-3.24
p=	0.05	Operating Cost/Loan	0.20	0.21	...
a0=	0.0%	Lending Rate	14.8%	37.1%	...
rir=	5.0%	Deposit Rate	1.0%	16.7%	...
		Lending Spread	7.8%	9.1%	...
		Deposit Spread	6.0%	11.3%	...
		Spread	13.8%	20.4%	...

Table 5. Effects of a Monetary Shock with Higher Intertemporal Elasticity, More Costly Banking, and Higher Loan Provisioning During "Bad Times"

	"Good Times"	"Bad Times"	% Change
Instrument			
Interest Rate	7.0%	28.0%	300.00
Real Sector			
Production of Tradables	0.64	0.65	1.22
Consumption of Tradables	0.64	0.62	-3.51
Consumption of Non-Tradables	0.44	0.43	-2.93
Real GDP (in units of tradables)	2.73	2.65	-2.85
Price Index	2.91	2.88	-0.92
Real Exchange Rate	4.73	4.67	-1.21
Wage (in units of tradables)	4.99	4.90	-1.80
Employment Tradables	0.05	0.05	3.08
Employment Non-tradables	0.27	0.26	-5.35
Total Employment	0.32	0.31	-4.01
Trade Balance/GDP	0.00	0.01	...
Financial Sector			
Bank Deposits	2.18	2.10	-3.78
Bank Credit	1.36	1.27	-6.13
Credit/Deposits	0.62	0.61	...
Operating Cost	0.28	0.27	-3.94
Operating Cost/Loan	0.21	0.21	...
Lending Rate	14.8%	38.3%	...
Deposit Rate	1.0%	16.5%	...
Lending Spread	7.8%	10.3%	...
Deposit Spread	6.0%	11.5%	...
Spread	13.9%	21.8%	...

$q=$	0.4
$\theta=$	0.5
$\alpha=$	0.4
$\beta=$	0.7
$\phi=$	2.1
$\gamma=$	1.0
$\psi=$	1.1
$\sigma=$	**1.0**
$\chi=$	0.7
$\delta0=$	0.2
$\rho=$	0.8
v0=	**0.2**
v1=	**1.5**
v2=	**0.7**
v3=	**2.0**
v4=	**0.5**
v5=	**0.3**
$p_l=$	**0.1**
a0=	0.0%
rir=	5.0%

Table 6: Use of Reserve Requirements to Countervail a Monetary Shock when the Intertemporal Substitution Elasticity of Consumption is High, Banking is Very Costly, and Loan Provisioning Doubles Relative to Baseline[1]

			"Good Times"	"Bad Times"	% Change
		Instrument			
		Interest Rate	7.0%	28.0%	300.00
		Real Sector			
q=	0.4	Production of Tradables	0.64	0.64	0.67
θ=	0.5	Consumption of Tradables	0.64	0.63	-1.53
α=	0.4	Consumption of Non-Tradables	0.44	0.43	-1.56
β=	0.7	Real GDP (in units of tradables)	2.73	2.70	-0.99
φ=	2.1	Price Index	2.91	2.91	0.05
γ=	1.0	Real Exchange Rate	4.74	4.74	0.06
ψ=	1.1	Wage (in units of tradables)	4.99	4.94	-1.00
σ=	**1.0**	Employment Tradables	0.05	0.05	1.69
χ=	0.7	Employment Non-tradables	0.27	0.27	-2.23
δ0=	0.2	Total Employment	0.32	0.32	-1.61
ρ=	0.8	Trade Balance/GDP	0.00	0.01	...
v0=	**0.2**				
v1=	**1.5**	**Financial Sector**			
v2=	**0.7**	Bank Deposits	2.18	2.15	-1.33
v3=	**2.0**	Bank Credit	1.35	1.31	-3.18
v4=	**0.5**	Credit/Deposits	0.62	0.61	...
v5=	**0.3**	Operating Cost	0.28	0.27	-1.79
p=	**0.1**	Operating Cost/Loan	0.21	0.21	...
a0=	0.0%	Lending Rate	15.1%	38.0%	...
rir=	5.0%	Deposit Rate	1.0%	19.9%	...
δ1=	**0.10**	Lending Spread	8.1%	10.0%	...
		Deposit Spread	6.0%	8.1%	...
		Spread	14.1%	18.1%	...

[1] Reserve requirements are lowered from 20% to 10% during the year when the shock occurred.