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ABSTRACT

THREE ESSAYS IN FINANCIAL LIBERALIZATION

By

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Financial liberalization throughout the world is associated with a rapid increase in lending through banks' subsidiaries abroad. **"Financial Liberalization and the Representation Choice of a Foreign Bank"** uses Horstmann and Markusen's (1996) framework to develop a theoretical model of banking that explains the capital allocation choice of a foreign investor in a host bank market. A foreign bank has two approaches to maintain borrower-lender relationships with borrowers in the host country. It can invest through the domestic banking system and delegate monitoring responsibility to the local bank management, or it can open a subsidiary in the domestic market and internalize its monitoring responsibilities. The paper argues that the risk of negligent monitoring by the domestic bank's management may encourage foreign investors to increase their ownership in a host country banking system. Additional incentives for the foreign investor to enter the banking market include monitoring cost advantage of the foreign investor and small capital endowment of the host economy. The paper finds that foreign bank entry is beneficial in a highly productive host economy with an incumbent bank that can sustain rising pressure of monitoring costs.

Financial liberalization resulted in significant credit dollarization in developing and transition economies. **"Credit Dollarization in Transition Economies: Is it Firms' or Banks' "Fault"?"** investigates the respective contributions of banks and firms to the

dollarization of credit. Whether dollarization comes mainly from the financial sector or from the real sector has important policy implications. First, it indicates whether there are balance sheet mismatches in the economy. Second, it shows in which sector of the economy they are concentrated, and which sector (if any) policy makers should target in order to contain the negative effects of exchange rate depreciation. This paper uses a new dataset for twenty-two transition economies for the period 1990 – 2001. It separates the contributions of banks and firms to credit dollarization by grouping potential determinants into bank- and firm-specific factors. Empirical results provide evidence that bank currency matching is the main driving force of credit dollarization. However, currency mismatches tend to be concentrated in the real sector, and this indirectly exposes the economy to financial crises.

"Currency Mismatches and Banking Crises" is a continuation of the second dissertation chapter. If banks do not match the currency structure of their assets and liabilities, they face exchange rate risk. However, if the currency structure of their assets and liabilities is identical, banks pass the currency risk onto their borrowers. In the end, banks will bear the costs indirectly because they face a higher default risk if the domestic currency depreciates. This paper uses a simple theoretical framework to show that bank runs are determined by currency mismatches in the banking and the real sectors, and unexpected exchange rate depreciation. The econometric results present some evidence that the persistence of banking crises in transition economies is reinforced by too much lending in foreign currency. There is also evidence that banks face direct exchange rate risk even though their open currency positions are very limited.

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PREFACE

Financial liberalization in this dissertation concerns the banking system and indicates that banks are decentralized and allowed to exist as profit maximizing entities in attracting deposits, extending loans, and providing information and other financial services. The most recent and striking examples of financial liberalization occurred in the economies of Eastern Europe and Central Asia. Two-tiered banking systems were created from a centralized bank, the exchange rate, interest rates, and capital flows were liberalized, and banks were allowed to provide a range of financial services rather than simply direct credit to state-owned enterprises.

As financial liberalization created new profit opportunities for foreign and domestic investors, it also raised interesting questions about investors' opportunities to reduce market risk. This dissertation focuses on investors' choices associated with two types of uncertainty: (i) project related -since foreign investors know little about local firms; (ii) macro risk related to the stability of the domestic currency.

The first type of uncertainty raises the issue of how domestic borrowers should be evaluated. Should foreign investors employ local knowledge and delegate evaluation of the financed projects to the domestic banking system? Or should they internalize the agency costs by opening their own subsidiaries and using their skills in project monitoring?

The second question relates to the currency of denomination (domestic or foreign) in which credit to domestic borrowers is extended. Since foreign financing is mostly denominated in foreign currency, the host economy absorbs the exchange rate risk.

However, is it banks or borrowers who bear this risk? Is the banking system safer if firms rather than the banks cover the exchange rate risk?

The first dissertation essay, "Financial Liberalization and the Representation Choice of a Foreign Bank", explores the question of how foreign investors choose to channel capital to a host economy in ways that minimize their information and entry costs. This paper focuses on the foreign banks' choice between correspondent banking and opening a subsidiary in a host economy. Precisely what encourages foreign banks to channel investments through the local banking system or with subsidiaries is a question motivated by an interesting economic phenomenon --there is a clear difference in the pattern of banks' investments in developed and emerging economies. Correspondent banking is the main channel for foreign banks' investment in developed countries, while emerging economies see a larger capital inflow from local subsidiaries of foreign banks than from correspondent banking. However, developed economies have very low barriers to entry in the banking system as compared to developing economies. The question then is why do we see multinational banks entering emerging economies' banking systems and being reluctant to do the same in developed economies?

The choice between internalization and delegation has been explored in detail for the case of a manufacturing company, especially in relation to the behavior of multinational corporations. A multinational company may consider it more costly to initiate production in a host country than an incumbent company because of stringent entry requirements or due to an informational disadvantage about the market. On the other hand, the multinational company may delegate representation to a local contractor and exploit his exclusive information about the market. However, delegation creates the

risk that the agent may choose to serve his own interests first. A cost-benefit analysis of the two options may prove that opening a subsidiary in the host country yields higher profit for the foreign company than contracting with a local agent. Thus, the foreign company has an incentive to enter a host market with ownership. Similar to a multinational corporation, a foreign investor (bank) faces the choice to lend to the host country using correspondent relationships with a domestic bank or opening a subsidiary bank. However, current multinational banking theory is unable to explain this choice.

This paper addresses the following questions. First, how do foreign investors choose the organizational form of representation in a host country, specifically between subsidiary and correspondent banking? Second, what is the effect of this choice on investment and output in the domestic country? Third, what welfare gains are generated by the host economy from foreign bank entrance and correspondent banking?

The paper finds that the foreign investor will choose to enter the domestic banking market when agency costs are relatively higher than competition costs, set up costs are low, and the host economy has a small capital endowment. However, if the foreign investor is at disadvantage in monitoring the borrowers, he will prefer correspondent banking. The analysis shows that correspondent banking with asymmetric information leads to more volatile capital flows than correspondent banking with perfect information. This is consistent with the fact that correspondent banking capital flows are more volatile in emerging (where asymmetric information is a serious problem) than in developed economies. Foreign entrance brings higher volume of capital flows than correspondent banking, but the paper is inconclusive whether these flows are more volatile or not.

The paper also concludes that the domestic economy benefits from foreign bank entrance if the foreign investor does not exploit a monitoring advantage that rapidly depletes domestic banks' profits and if the domestic economy enjoys high capital productivity.

The second and third dissertation chapters "Credit Dollarization in transition economies: Is it Firms' or Banks' "Fault"?" and "Currency Mismatches and Banking Crises" redirect attention from capital flows to the currency of denomination of domestic credit. As emerging (including transition) economies lack domestic capital, they often turn to international markets to finance production. Years of exchange rate instability have also created persistently high deposit dollarization. Thus, banks channel resources to domestic borrowers that are increasingly denominated in foreign currency and often exceed the capacity of the tradable sector to absorb them. These resources create a currency imbalance that increases exchange rate risks for banks and firms and potentially raise the costs of government intervention during financial crises.

Currency mismatches increase financial fragility and make economies more prone to banking crises. Because of high bank liquidity and solvency risks, banks face a higher premium on foreign and domestic capital. This brings multiple and self-enforcing problems to dollarized economies. On one hand, the risk premium worsens firms' balance sheets and tightens their borrowing constraints, so overall credit finance and economic growth are lower than in countries where currency mismatches do not exist. On the other hand, foreign and domestic depositors are more sensitive to news about exchange rate movements in economies with vast currency mismatches. The reason is that depreciation directly and indirectly brings banks' profits down. Thus, dollarized

economies tend to experience abrupt capital reversals and slow recovery from economic downturns.

In "Credit Dollarization in transition economies: Is it Firms' or Banks' "Fault"?" I emphasize that factors explaining credit dollarization also explain why grossly disproportionate currency mismatches exist in small open economies with underdeveloped financial systems. I take a close look at the domestic credit market and examine the risk sharing forces behind credit dollarization. Is credit dollarization the outcome of a unilateral decision made by domestic banks? Or is it driven by domestic firms' integration in the international marketplace?

Currently, only two empirical studies, Arteta (2002) and Barajas and Morales (2003), analyze the determinants of credit dollarization. I extend the existing work on credit dollarization by using a comprehensive, newly-assembled dataset for twenty-two transition economies from Central and Eastern Europe and Central Asia, for the period 1990 – 2001. I estimate and compare the respective contribution of firms and banks to the financial dollarization phenomenon by grouping potential determinants into bank- and firm-specific factors. Bank-specific factors include indicators of asset and liability currency matching. As firm-specific factors, I use measures of real dollarization and access to alternative financing sources.

I estimate a reduced form equation, and use the pooled OLS estimator as a benchmark, and first difference and fixed effects estimators to control for unobserved heterogeneity. Empirical results provide evidence that credit dollarization in transition economies is determined by banks' optimization decisions (asset and liability management variables). Banks match the currency of denomination of their assets and

liabilities, that is, deposit dollarization drives credit dollarization, and net foreign assets represent a substitute for dollar loans to domestic firms. There is limited evidence of firms hedging the currency of their debt and production returns.

However, as long as financial dollarization outpaces real dollarization, and this seems to be the case in transition countries, there is a currency mismatch somewhere in the economy. I show that banks pass the exchange rate risk to firms. This decreases banks' exposure to currency risk, but it increases their exposure to default risk, and ultimately the exposure of the economy to financial crises.

The third dissertation chapter explores the link between currency mismatches and banking crises in the countries of Eastern Europe and Central Asia. This paper builds on the results from the second dissertation essay that identify the sector bearing the concentration of exchange rate risk. It explores whether the concentration of exchange rate risk through mismatched balance sheets has increased the probability of banking crises and whether the transfer of risk away from the banking sector has reduced the threat to the banks. If banks in transition economies have avoided direct exchange rate risk, were they ultimately able to prevent the loss of net worth due to exchange rate fluctuations?

The paper models the case of small open economies, which are unable to borrow externally in their own currency and have poor domestic currency credibility. Depositors determine the currency composition of banks' deposits and firms receive revenues in foreign currency that depend on world prices and external demand. The equilibrium level of credit dollarization depends on firms' and banks' expected revenues in foreign currency and their ability to absorb exchange rate risk. A Diamond-Dybvig (1983) –

style model describes the link between banks' and firms' optimal currency mismatches to poor bank net worth and bank runs.

Currently a few studies have empirically explored the implications of dollarization for financial stability. Arteta (2003) and De Nicolo et al. (2003) look for a direct causality from dollarization to bank losses and crises. Arteta (2003) does not find evidence that dollarization (deposit or credit) has any effects on banking stability or that banking and currency crises are more costly if banks face higher dollarization ratios. De Nicolo et al. (2003) find a direct relationship between dollarization and banking stability but they only consider the effects of deposit dollarization. Instead, I argue that dollarization is not harmful unless it creates a mismatch in either firms' or banks' balance sheets and that mismatches prompt banking crises only in interaction with large unexpected changes in the exchange rate.

The econometric analysis finds strong evidence that banks in transition economies are exposed to default risk related to currency mismatches in firms' balance sheets. With an overall measure of banks' foreign currency positions that includes foreign assets and liabilities, the results show that in addition to default risk, banks also face direct exchange rate risk, even though their open positions are generally very small. There is evidence that foreign exchange and trade liberalization has increased, while institutional development of transition economies banking systems has reduced, the likelihood of banking crises.

The paper's findings have an important policy implication with respect to countries' choice of exchange rate regime, or alternatively about their choice of mechanisms to protect banks from currency risk. The results provide support for the

Calvo and Reinhart's (2002) "fear of floating" idea – the fact that governments are unwilling to let the exchange rate move independently if the economy is heavily indebted in foreign currency because of the high economic cost of exchange rate depreciation. However, the tendency to reduce exchange rate fluctuations may induce firms and banks to maintain even larger currency imbalances, thus raising financial crises costs further yet.

The paper also shows that restrictions on open currency positions do not eliminate the exchange rate risk for banks altogether, since banks transfer the unhedged exchange rate risk onto their borrowers and face a higher default risk. This suggests that a market approach to deal with exchange rate risk may work better to reduce the probability of banking crises than banking regulations and fixed exchange rate.

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1. Introduction

Liberalization of financial services throughout the world fostered a rapid expansion in international banking. With profit opportunities rising across borders many banks increased their investments in other countries. This increase took a variety of forms --acquisition of existing banks in the host country, opening a new branch or subsidiary, or simply channeling funds through the host banking system and extending direct loans to residents in the host country. With so many patterns of capital mobility, it is important to understand what motivates foreign banks' choice of representation in a host economy and the economic impact of this choice.

This paper is focused on the foreign banks' choice between correspondent banking[1] and opening a subsidiary in a host economy. What encourages foreign banks to channel investments through the local banking system or with subsidiaries is a question that is motivated by an interesting economic phenomenon. There is a clear difference in the pattern of banks' investments in developed and developing countries. Correspondent banking is the main channel for foreign banks' investment in developed countries, while developing economies see a larger capital inflow from local subsidiaries of foreign banks than from correspondent banking. However a survey by Barth et al. (2001) indicates that developed economies have very low barriers to entry in the banking system compared to

[1] For the purposes of this paper, correspondent banking relates to agency arrangements in which a bank provides services to another bank for a fee. These services include extending investment credit, credit lines and trade credit, and gathering of information. Also, correspondent banking relates to loans extended by a foreign bank to a domestic bank, where the domestic bank uses the loans to further grant credits to borrowers.

developing economies[2]. Then why do we see multinational banks entering developing economies' banking systems and being shy to do the same in developed economies?

There is some anecdotal evidence about the behavior of multinational banks that show that host countries' institutional characteristics and information (dis)advantages may motivate these banks to choose the form of representation in the host country. The International Finance Corporation (IFC) extends loans to small and medium enterprises in host countries primarily through the domestic banking system. The IFC uses intermediaries to extend long-term loans to these enterprises because direct lending carries high transaction costs. Clearly, delegated lending reduces the costs of loan administration in this case and this channel of investment seems most natural, given that domestic banks have easier access to information about local producers than foreign investors. However, HSBC claims that the reason this British bank maintains a wide international presence through subsidiaries is to take advantage of local knowledge about the host economy. Thus, some foreign investors prefer to internalize information costs since those costs may be lower than the costs of delegation.

The choice between internalization and delegation has been explored in detail for the case of a manufacturing company[3], especially in relation to the behavior of multinational corporations (Horstmann and Markusen, 1987, 1996). A multinational company may consider it costly to initiate production in a host country because of

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[2] For example, Barth et al. (2001) show that the rate of denial of foreign bank applications is 2 percent in developed economies, compared to 29 percent in developing and emerging markets. Only 8 percent of developed countries impose restrictions on foreign ownership of domestic banks and 4 percent impose restrictions on foreign entrance. In developing and emerging economies, the respective numbers are 31 and 17 percent.

[3] Severinov (1999) tackles the question of the organizational form a producer might choose in outsourcing production of inputs. The producer may contract directly with supplier(s) or may delegate some contracting responsibilities to one of the suppliers. Mookherjee and Tsumagari (2001) study a similar problem assuming that the producer may delegate contracting to an informed intermediary rather than a supplier.

stringent entry requirements or because of informational disadvantage about the market compared to an incumbent company. On the other hand, the multinational company may delegate representation to a local contractor and exploit his exclusive information about the market. However, delegation creates the risk that the agent may choose to serve his own interests first. A cost-benefit analysis of the two options may prove that opening a subsidiary in the host country yields higher profit for the foreign company than contracting with a local agent; thus, the foreign company has an incentive to enter a host market with ownership.

Similarly to a multinational corporation, a foreign investor (bank) faces the choice to lend to the host country using correspondent relationships with a domestic bank or opening a subsidiary bank. However, the theory of multinational banking faces a large gap in explaining this choice. Since a major proportion of international capital movements are channeled through the banking system, foreign banks' investment choices may have significant impact on capital accumulation, output, and welfare in the host country.

The choice of the foreign bank is likely to have larger effects in countries with underdeveloped financial systems than in developed countries. For example, in transition economies where the scope of the financial system is limited to banking, and domestic savings provide an insufficient supply of investment funding, multinational banks offer a major source of firm finance. However, because of fixed costs and layered asymmetric information, loans from the subsidiary of a foreign bank, and loans administered by a correspondent domestic bank each potentially have different implications for cross border capital movements.

This paper addresses the following questions. First, how do foreign investors choose the organizational form of representation in a host country, specifically between subsidiary and correspondent banking? Second, what is the effect of this choice on investment and output in the domestic country? Third, what welfare gains are generated by the host economy from foreign bank entrance and correspondent banking?

The paper's approach is related to the internalization theory of the existence of multinational corporations, which states that a foreign company would "prefer outright ownership of complementary assets, rather than bearing the costs of contracting in the open market"[4]. The model presented in this paper borrows a framework from Horstmann and Markusen (1996) of a multinational corporation's choice between an agency contract and a subsidiary, and employs it in a two-period general equilibrium model where a foreign investor chooses between an agency contract with a domestic bank and opening a subsidiary bank. The investor makes this choice so as to minimize his agency costs and costs of entering the host banking system. An agency cost is created by a two-tier asymmetric information problem. This paper applies a form of Townsend's (1979) costly state verification in a model of investment finance and, similarly to Diamond (1984, 1991), uses the costly state verification concept to study the incentives for a financial intermediary in delegated monitoring. Costs of entering the domestic banking system are comprised of a fixed set up cost and losses associated with competition.

The paper finds that the foreign investor will choose to enter the domestic banking market when agency costs are relatively higher than competition costs, set up costs are low, and the host economy has a small capital endowment. The paper also

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[4] Williams (1997), p. 73

concludes that the domestic economy benefits from foreign bank entrance if the foreign investor does not exploit a monitoring advantage that rapidly depletes domestic banks' profits and if the domestic economy enjoys high capital productivity.

The paper is organized as follows. Section 2 describes a general equilibrium model with three types of domestic agents (depositors, project owners, and a bank owner) and a foreign investor. Section 3 derives the conditions under which the foreign investor makes his capital allocation choice. Section 4 analyzes the implications of the model for the domestic economy's welfare. Section 5 presents a summary and conclusions of the paper's findings.

2. The Model

This section develops a two-period general equilibrium model incorporating asymmetric information in the bank-borrower and the bank-foreign investor relationships. The asymmetric information problem introduced in the model's borrower-lender relationship leads to costly state verification, as described by Townsend (1979). Townsend shows that if a principal in a bilateral exchange contract does not obtain free knowledge about the agent's output, the optimal contract must be incentive compatible. He shows that the set of transfers between principal and agent, and the verification region of output must create sufficient incentives for the agent to reveal the actual output. Townsend also proves that stochastic verification dominates deterministic audit. The model presented in this paper assumes that the domestic bank must put forth costly effort to receive a signal about the borrower's true output. Since effort is assumed to be proportional to the probability of receiving a positive signal, this type of verification procedure is very similar to stochastic auditing.

The model combines the asymmetric information effects outlined in Townsend (1979) and Diamond (1984, 1991) to argue why correspondent banking is costly to a foreign investor and uses the framework of Horstmann and Markusen (1996) to present the optimal agency contract. It then goes on to describe the capital allocation choice of the foreign investor.

2.1. Domestic Agents and a Foreign Investor

There are three types of agents in the domestic economy: n depositors (savers), m project owners (firms), and a single bank owner (banker). Depositors, project owners, and the banker consume only in the second period. Project owners and the banker are risk-neutral and have no initial capital endowments. Firms' investment is financed through loans from the bank. The bank raises capital from foreign investors and by selling deposit contracts. Domestically, only depositors have positive initial endowment, ω^o. The second period consumption of a depositor brings utility given by

$$U(c^d),\ U'(c^d) > 0,\ U''(c^d) < 0,\ U'(0) = \infty,\ U'(\infty) = 0.$$

The depositors, as well as all other agents, have access to a safe storage technology, which transforms with certainty a unit of period 1 good into r^s units of period 2 good. They can also deposit their savings with the bank, which pays an interest rate r^d. Depositors maximize expected utility subject to the budget constraints

$$c^d = r^d d + r^s s$$

$$d + s = \omega^o$$

where d denotes deposits and s denotes savings in storage.

Firms are perfectly competitive. They borrow from the bank to finance investment and produce a homogeneous final good using a decreasing-returns-to-scale technology:

$$y = \varepsilon F(k_i),\ F(0) = 0,\ F'(k_i) > 0,\ F''(k_i) < 0,\ F'(0) = \infty,\ F'(\infty) = 0$$

where k_i is the amount of capital utilized in the production process by firm i, while ε is a productivity coefficient introducing uncertainty in the outcome of production. With probability θ, the project yields $F(k_i)$ and thus ε equals one. With probability $(1-\theta)$, the project brings no output, $\varepsilon=0$. The realization of ε is independent across projects and the risk of the projects is either high or low as explained in detail below. The expected profit derived from a single project, which also equals second period consumption, is

$$E(\Pi_i^f) = \theta F(k_i) - \theta r_i k_i$$

r_i is the price of capital paid by firm *i* and it repays a loan only in case of success. The assumption of "limited liability" is necessary so that the project owner has nonnegative consumption.

Actual output is exclusive information for the borrower. So, while firm *i* costlessly observes the realization of ε, the lender would have to put some effort (e_i) to reveal this information. However, if the lender discovers that the firm is dishonest, he chooses the most severe punishment by seizing the whole output of the borrower.

The auditing procedure of the lender has low efficiency in the sense that as the lender devotes time and resources to monitor the firm, his effort only results in a signal about the actual output. If the realized output is 0, then the signal is 0 with probability

one. If the investment project is successful, then the signal is 1 with probability $p(e_i)$ and 0 with probability $1-p(e_i)$. Therefore, if the project owner misreports the output, the lender will be able to collect only $p(e_i)\theta F(k_i)$ on average. The efficiency of the output verifying procedure depends positively on effort and further it is assumed that effort takes values between 0 and 1 and $p(e_i)=e_i^5$. The cost of monitoring is a convex function of effort: $C(e),\ C'(e) \geq 0$ *and* $C''(e) \geq 0$.

Generally, the bank owner is an agent who, like the project owners, has no initial capital endowment and whose delegated role is to monitor the projects. While depositors, or any other lender, could monitor the projects themselves, the total cost of auditing all projects by all depositors would exceed the total output derived from domestic savings. Also, if all depositors verify the yield of every project, the total auditing cost is $n\sum_{i=1}^{m} C(e_i^d)$ and is larger than the auditing cost for the bank owner, $\sum_{i=1}^{m} C(e_i^b)$, given $e^d_j = e^b_j$. Thus, depositors find it beneficial to delegate the output verification to the bank and to take advantage of the scale economies in project monitoring.

Certainly, the bank owner has an incentive to misreport the project returns to his depositors. However, since the number of projects is sufficiently large, the bank is perfectly diversified: it receives a certain positive return on the projects and, as in

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[5] Another way to think about the auditing effort is to assume that the bank owner is endowed with a unit of labor and that the verification technology is linear in the labor factor.

Diamond (1984, 1991), the moral hazard cost of delegation is reduced to zero[6].

A foreign investor (bank) considers extending credit to projects in the domestic economy, for which he could use a correspondent relationship with the domestic bank, he could initiate a subsidiary in the domestic country, or extend direct loans to the project owners. However, the projects may have low (state $\sigma = 1$) or high (state $\sigma = 2$) expected return, and the foreign investor does not have enough information to discern the state of the average project. Ex-ante, he knows that state $\sigma = 1$ occurs with probability ρ_1, and state $\sigma = 2$ with probability ρ_2, $\rho_2 = 1 - \rho_1$. The foreign investor is aware that the average productivity of the projects is higher when $\sigma=2$, $\theta_2 > \theta_1$, and he also knows those productivities.

As in McKinnon and Pill (1998), the model assumes that the bank has an informational advantage over depositors and the foreign investor, and only the banker knows the average quality of the projects at t=0. Thus, if the foreign investor chooses to delegate monitoring to the domestic bank, the bank owner will have an incentive to misreport the return on investment. With asymmetric information, the foreign investor will have to offer a contract that at least compensates the domestic bank for the project verification costs, if the bank is to report honestly.

If the foreign investor chooses to open a subsidiary bank in the host country, he pays a fixed cost, G, for licensing and coverage of other expenses pertaining to domestic banking regulation. However, by doing so, he learns the quality of the projects and can compete with the domestic bank in extending credit and monitoring borrowers. The

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[6] Krasa and Villamil (1991) show that delegation dominates direct investment even when the number of projects is limited but sufficiently large.

investor's cost of monitoring, $C^{FI}(e^{FI})$, may or may not be the same as the cost of the domestic bank.[7]

2.2. Timing of the Events and Equilibrium

At an initial time t=0, the foreign investor calculates the expected rates of return from correspondent banking and from the subsidiary, and makes an investment decision. For the foreign bank to consider any investment option in the domestic country, the investment should yield an expected gross return at least as high as the world rate of return r^*. After the decision is made, the state of the economy is revealed to the domestic bank and the foreign subsidiary, if the subsidiary exists.

If the foreign investor expects a higher rate of return from delegating to the domestic bank, at time t=1, he offers a contract to the correspondent specifying the amount of the investment and a rate of return for the foreign investor in each state of the portfolio return (which also determines the monitoring effort of the bank).

The domestic bank raises capital from the foreign investor and from selling deposits, and allocates the capital to the investment projects. The bank offers loan contracts to the project owners that detail the amount of a loan, interest rate, and verification procedure. These loan contracts must be incentive compatible to induce the borrowers to report zero output only when there is indeed no output.

At time t=2, each firm reports to the bank and repays the loan if it has revenue. Otherwise, the bank initiates bankruptcy of the firm and puts effort to verify if the firm

[7] Direct lending and subsidiary banking are discussed simultaneously in this paper. Direct lending can be interpreted as a case where the foreign investor pays a cost G to find out the average quality of the projects and most likely has a monitoring disadvantage over the domestic bank and a foreign subsidiary.

has reported truthfully. The bank then pays gross interest to the depositors and the foreign investor.

If the foreign investor expects to have higher profit from banking with a subsidiary in the host country, at time $t=1$ he pays the fixed cost, learns the quality of the projects, and enters into competition with the domestic bank for borrowers. The two banks then extend loans to the project owners.

A competitive rational expectations equilibrium for this economy is characterized by: a set of consumption allocations for the depositors, project owners and the bank owner $\{c_1^d, \ldots, c_n^d, c_1^f, \ldots, c_m^f, c^b\}$; a set of capital allocations for the project owners $\{k_1, \ldots, k_m\}$ and the bank owner $\{K\}$; set of savings allocations for the depositors $\{d_1, \ldots, d_n; s_1, \ldots, s_n\}$; interest rate on deposits, on loans extended by the domestic bank and the foreign subsidiary, and interest rate paid to the foreign investor $\{r^d, r^b, r^{FI}, R\}$; and verification effort of the bank owner and the foreign subsidiary $\{e^b, e^{FI}\}$, such that depositors, project owners, the bank owner and the foreign investor maximize expected utility or profits, and goods, deposit, and loan markets clear.

2.3. Loan Contracts with Correspondent Banking

A main assumption in the described model is the monopoly position of the domestic bank[8]. If the bank is competitive, it will have no incentive to profit from its

[8] This assumption is not unrealistic since most emerging markets have very concentrated banking systems. Tests by Mathieson and Schinasi (2001)) show that Latin American countries tend to have monopolistic banks, while the banking structures in Poland, Czech Republic and Turkey are either monopolistic or monopolies.

information advantage over the foreign investor, because any profit will be eroded in the loan contract.

To present the optimal loan contract offer of the domestic bank, it is useful first to focus on the bank's financing. In this case, the bank owner is a monopolist in the deposit market. As long as he offers a certain deposit rate that is at least as high as the storage rate r^s, savers will inelastically provide their whole initial endowment to the bank. Thus, the total financing the bank is able to raise from domestic depositors is $K^d = nd = n\omega^o = \Omega^o$, where Ω^o is the economy-wide endowment of period 1 good. Depositors will agree to put their savings in the bank only if $r^d \geq r^s$. The lowest cost for the bank is to pay depositors exactly r^s per unit deposited.

Since the focus of this paper is on the choice of the foreign investor to enter the banking market of the host country, it is useful to simplify the behavior of the domestic bank. It is assumed that in autarky the bank will use the storage technology and will not grant loans[9], since the marginal cost of the verification effort at zero exceeds its marginal benefit even when the projects have a high expected return, $\theta_2 F\left(\frac{K^d}{m}\right) \leq (1-\theta_2)c'(0^+)$. Thus, because of the small size of the projects, the monitoring cost is prohibitive. As the bank does not lend, the bank profit will be zero in autarky.

Foreign investment increases the size of the domestic projects and makes lending and output verification profitable for the bank, even when the average quality of the projects is in state 1. Since domestic depositors cannot be paid less than r^s, the foreign

[9] For example, the bank may invest in a risk-free government bond.

investor will bear the verification cost that arises from the inflow of capital.

Since the bank owner does not have free information about the outcome of the projects, he offers incentive compatible loan contracts that maximize bank profit. Each contract specifies the amount of capital used in a project and the interest rate on a loan. The bank owner takes as given the rate of return R, and the effort e_i, that he agrees upon with the foreign investor, as well as the total domestic deposits and the minimum interest rate on deposits. The maximization problem of the bank also determines the demand for foreign capital, K^{FI}.

$$\underset{K^{FI},\{k_1,\ldots,k_m\},\{r_1,\ldots,r_m\}}{Max} \quad \sum_{i=}^{m} \theta r_i k_i - RK^{FI} - r^s K^d - \sum_{i=}^{m} (1-\theta) C(e_i)$$

$$s.t \quad \theta F(k_i) - \theta r_i k_i \geq (1-e_i)\theta F(k_i) \qquad (IC)$$

$$\theta F(k_i) - \theta r_i k_i \geq 0 \qquad (IRF)$$

$$\sum_{i=}^{m} \theta r_i k_i - RK^{FI} - r^s K^d - \sum_{i=}^{m} (1-\theta) C(e_i) \geq 0 \qquad (IRB)$$

$$\sum_{i=}^{m} k_i = K^{FI} + K^d$$

The first constraint is incentive compatibility. It requires the profit from each project to be higher if the project owner repays the loan, rather than if he claims that the output is zero when it is actually positive. If the project owner misreports, the bank will start bankruptcy proceedings and will try to verify the outcome of the project. In this case, the bank will seize the whole output if it appears that the borrower was dishonest. However, since the signal received by the bank is not perfect, the bank will collect the

output only with probability e_i[10]. This verification procedure is almost identical to stochastic auditing -- where the banker receives a perfect signal, but chooses to verify the output randomly instead of every time the firm misreports[11].

Because of the imperfect signal, the firm earns profit and the second constraint can be dropped. The fact that a perfectly competitive firm earns profit is only a result of the monopoly position of each project owner in a market for information. With costly state verification, the loan contract generates gains because ε is independent across projects and its realization is not public knowledge. The profit, $(1-e)\theta F(k)$, is the rent to the project owner's exclusive information about his own revenue.

The third constraint guarantees that the bank owner will have nonnegative consumption. The last term in the bank's profit function is the monitoring cost covered by the foreign investor. As all projects are identical ex ante, the bank tailors the same contract for each firm. In symmetric equilibrium ($k_i=k$ and $r_i=r$, $i=1...m$), the first order conditions of the bank maximization problem yield three equations solving for k, r and K^{FI}:

$$e_i\theta F'(k) = R \qquad (1)$$

$$e_i\theta F(k) = \theta rk \qquad (2)$$

$$K^{FI} = mk - K^d \qquad (3)$$

Market clearing requires the demand for foreign capital K^{FI} equal the quantity

---

[10] Monitoring with imperfect signal is introduced in Diamond (1991b). A noisy signal about the quality of the projects that depends on bank effort (screening intensity) is also used by Gehrig (1989) in a model with adverse selection, and by Boadway et. al. (1999) in an adverse selection model where social workers need to determine the type of the agents applying for social benefits.

[11] The main difference is that with stochastic verification the cost always depends on the probability of verification even if $C(e)$ is assumed to be a constant. Also, the assumption of stochastic verification is not very realistic. The bank may be required to initiate an audit of every firm that is in default on a loan. However, the quality of the audit, which depends on effort, can hardly be regulated.

provided by the foreign investor, K^o. Thus, every project receives $k = m^{-1}(K^o + K^d) = m^{-1}K$, where K is the total investment in the economy. The market clearing condition and the equal distribution of capital among all projects imply that the effort the bank must put forth for a loan contract to be incentive compatible is an increasing function of the interest rate paid to the foreign investor, $e_i = [\theta F'(k)]^{-1}R$. Also, the bank devotes the same effort in monitoring every project, $e_i = e$.

Since the investor entrusts monitoring to the bank, the effort requirement is a clause in the offer of the foreign investor to the domestic bank and, as shown below, solves the foreign investor's profit maximization problem.

The maximum profit for the bank is given by:

$$\begin{aligned} \Pi^b &= me\theta F(k) - RK^o - m(1-\theta)C(e) - r^sK^d \\ &= me\theta F(k) - e\theta F'(k)K^o - m(1-\theta)C(e) - r^sK^d. \end{aligned}$$

2.4. Agency Contract with the Correspondent Domestic Bank

The foreign investor suffers an informational disadvantage compared to all domestic agents because he does not know the state of the domestic bank's portfolio return. To see how this imposes a moral hazard cost on the investor, initially suppose that he knows the average return. Then, in a first best contract delegating loan management to the bank, he proposes investment K^o, requires an interest rate R, and implicitly demands monitoring effort e, so as to maximize profit -- given that this profit outweighs the opportunity cost of funds, r^* per unit of capital. Also, the domestic bank must be better off allocating foreign funds than staying in autarky.

$$\underset{R,K^o}{Max}\ RK^o - r^* K^o$$

$$s.t.\ me\theta F\left(\frac{K^o + K^d}{m}\right) - RK^o - (1-\theta)mC(e) - r^s K^d \geq 0$$

$$e = \frac{R}{\theta F'\left(\frac{K^o + K^d}{m}\right)}$$

This problem is equivalent to

$$\underset{K^o,e}{Max}\ e\theta F'\left(\frac{K^o + K^d}{m}\right)K^o - r^* K^o$$

$$s.t.\ me\theta F\left(\frac{K^o + K^d}{m}\right) - e\theta F'\left(\frac{K^o + K^d}{m}\right)K^o - (1-\theta)mC(e) - r^s K^d \geq 0$$

The first order conditions are:

$$w.r.t.\ K^o : \left[\frac{e\theta F''(K^o/m)K^o}{m}\right](1-\lambda) - r^* + e\theta F'(K^o/m) = 0 \quad (4)$$

$$w.r.t.\ e : \theta F'(K^o/m)K^o(1-\lambda) + m\left[\theta F(K^o/m) - (1-\theta)C'(e)\right]\lambda = 0 \quad (5)$$

$$w.r.t.\ \lambda : me\theta F\left(\frac{K^o + K^d}{m}\right) - e\theta F'\left(\frac{K^o + K^d}{m}\right)K^o - (1-\theta)mC(e) - r^s K^d = 0 \quad (6)$$

The first order conditions of this problem show that the bank earns no profit, the marginal cost of the bank verification effort equals the expected project output, and the marginal benefit of the foreign investor's capital equals the world cost of capital.

Proposition 1

Under perfect information, the optimal contract specifies higher capital (K^o), interest rate (R), and effort (e) in state σ=2 compared to state σ=1.

Proof. See Appendix 1

Equations (4) and (5) imply that as projects become safer on average (and θ rises) the optimal verification effort must be higher. This result occurs because verification becomes cheaper on the margin, while the expected product of the investment increases. Also, the foreign investor enjoys an increase in the marginal benefit of effort as the productivity variable enhances the effect of effort on the interest rate R. As effort increases, the gross return for the foreign investor should be higher, as well. In addition, when facing a perfectly elastic supply of capital, the foreign investor has an incentive to invest more capital when the quality of the domestic bank's portfolio is good.

Now consider the profit of the domestic bank in each state σ of its portfolio return, Π_{σ}^{b}. Also consider the profit when σ=2, the foreign investor does not know the state and the banker claims that the average project has poor quality. This is the banker's profit from cheating, Π_{2c}^{b}.

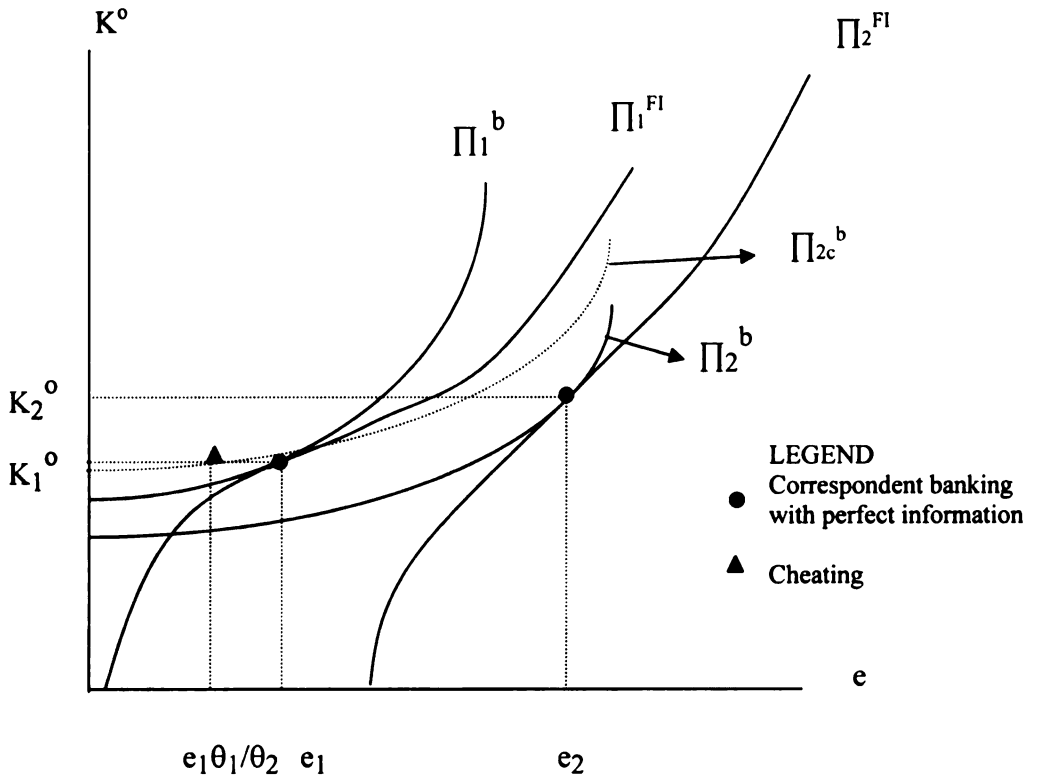
$$\Pi_{\sigma}^{b} = me_{\sigma}\theta_{\sigma}F\left(\frac{K_{\sigma}^{o}+K^{d}}{m}\right) - e_{\sigma}\theta_{\sigma}F'\left(\frac{K_{\sigma}^{o}+K^{d}}{m}\right)K_{\sigma}^{o} - (1-\theta_{\sigma})mC(e_{\sigma}) - r^{s}K^{d} = 0$$

$$\Pi_{2c}^{b} = me_{1}\theta_{1}F\left(\frac{K_{1}^{o}+K^{d}}{m}\right) - e_{1}\theta_{1}F'\left(\frac{K_{1}^{o}+K^{d}}{m}\right)K_{1}^{o} - (1-\theta_{2})mC\left(e_{1}\frac{\theta_{1}}{\theta_{2}}\right) - r^{s}K^{d}$$

$$= (1-\theta_{1})mC(e_{1}) - (1-\theta_{2})mC\left(e_{1}\frac{\theta_{1}}{\theta_{2}}\right) > 0$$

Since the verification cost decreases, as the projects become safer, the bank can earn profit if it receives capital K_{1}^{o}, and puts effort $e_{1}\theta_{1}/\theta_{2}$ when its portfolio has high expected return. Figure 1-1 illustrates this idea.

Figure 1-1: Correspondent Banking with Asymmetric Information



Π_1^b and Π_2^b represent the domestic bank's zero-profit curves in each state. Π_{2c}^b shows the positive profit of the domestic banker when he wrongfully claims that the projects have low quality. Notice that in this case the domestic bank chooses contract (K_1^o, R_1) but puts lower monitoring effort than e_1.

With the potential for moral hazard, the foreign investor constructs profit-maximizing contracts that will reveal the domestic bank's portfolio state through self-selection on the side of the bank. A contract specifies the capital received by the domestic bank, and interest rate paid to the foreign investor (implicitly specifying the effort since $e = [\theta F'(k)]^{-1} R$) in each state. The foreign investor solves the problem

$$\underset{K_1^o, K_1^o, R_1, R_2}{Max} \quad \rho_1\left(R_1 K_1^o - r^* K_1^o\right) + \rho_2\left(R_2 K_2^o - r^* K_2^o\right)$$

s.t.

$$R_1\left(\frac{mF\left(\frac{K_1^o + K^d}{m}\right)}{F'\left(\frac{K_1^o + K^d}{m}\right)} - K^o\right) - (1-\theta_1)mC\left(\frac{R_1}{\theta_1 F'\left(\frac{K_1^o + K^d}{m}\right)}\right) - r^s K^d$$

$$\geq R_2\left(\frac{mF\left(\frac{K_2^o + K^d}{m}\right)}{F'\left(\frac{K_2^o + K^d}{m}\right)} - K^o\right) - (1-\theta_1)mC\left(\frac{R_2}{\theta_1 F'\left(\frac{K_2^o + K^d}{m}\right)}\right) - r^s K^d \qquad (ICB1)$$

$$R_2\left(\frac{mF\left(\frac{K_2^o + K^d}{m}\right)}{F'\left(\frac{K_2^o + K^d}{m}\right)} - K^o\right) - (1-\theta_2)mC\left(\frac{R_2}{\theta_2 F'\left(\frac{K_2^o + K^d}{m}\right)}\right) - r^s K^d$$

$$\geq R_1\left(\frac{mF\left(\frac{K_1^o + K^d}{m}\right)}{F'\left(\frac{K_1^o + K^d}{m}\right)} - K^o\right) - (1-\theta_2)mC\left(\frac{R_1}{\theta_2 F'\left(\frac{K_1^o + K^d}{m}\right)}\right) - r^s K^d \qquad (ICB2)$$

$$R_1\left(\frac{mF\left(\frac{K_1^o + K^d}{m}\right)}{F'\left(\frac{K_1^o + K^d}{m}\right)} - K^o\right) - (1-\theta_1)mC\left(\frac{R_1}{\theta_1 F'\left(\frac{K_1^o + K^d}{m}\right)}\right) - r^s K^d \geq 0 \qquad (IRB1)$$

$$R_2\left(\frac{mF\left(\frac{K_2^o + K^d}{m}\right)}{F'\left(\frac{K_2^o + K^d}{m}\right)} - K^o\right) - (1-\theta_2)mC\left(\frac{R_2}{\theta_2 F'\left(\frac{K_2^o + K^d}{m}\right)}\right) - r^s K^d \geq 0 \qquad (IRB2)$$

$$\rho_1\left(R_1 K_1^o - r^* K_1^o\right) + \rho_2\left(R_2 K_2^o - r^* K_2^o\right) \geq Max\left\{0, \Pi_1^{FI}\right\} \qquad (IRFI)$$

where Π_1^{FI} in the IRFI constraint is the investor's profit from the first best contract when the average project has poor quality. The IRFI constraint implies that if $\Pi_1^{FI} > 0$, there is a possibility for either pooling or separating equilibria, depending on the value of ρ_1. The separating equilibrium is discussed first.

As shown by the incentive compatibility constraints, the state contingent contracts are constructed so that the banker is better off reporting a good quality portfolio rather than receiving K_1^o, paying interest rate R_1, and putting effort $e_1\theta_1/\theta_2$. Similarly, the banker has no incentive to misreport a low quality portfolio. The foreign investor's problem is essentially costly state verification. The cost for the foreign investor (compared to the perfect information contract) is translated into overinvestment and underpricing of capital financing high quality projects and underinvestment in low quality projects.

The foreign investor also faces an interim moral hazard problem since a specified amount of capital K^o and interest rate R implicitly determine the bank owner's effort. Thus, by choosing an incentive compatible agency contract, the banker reveals his loan portfolio, as well as his own future actions.

In the first best contract, the banker earns zero profit. Even with asymmetric information, there is no reason for the foreign investor to allow the bank to profit in the bad state, since this will only reduce his profit. Therefore, constraint IRB1 is binding. However, if the foreign investor does not know the state, the banker will misreport the high quality portfolio and earn a positive payoff. Therefore, in the incentive compatible contract, the bank should be able to gain some information rents, or otherwise, the banker

will cheat. Thus, the bank individual rationality constraint in state $\sigma = 2$ is not binding.

The foreign investor will raise the bank's profit only enough to make the banker indifferent between truthfully announcing state 2 and lying, and thus ICB2 is binding. Also, it can be shown that ICB1 is not necessary since the bank never lies about state 1.

With two binding constraints and since $R = e\theta F'\left(\frac{K^o + K^d}{m}\right)$, the problem of the foreign investor can be reduced to maximization over K_1^o, K_2^o, e_1, and e_2.

$$\underset{K_1^o, K_1^o, e_1, e_2}{Max} \quad \rho_1\left[e_1\theta_1 F'\left(\frac{K_1^o + K^d}{m}\right)K_1^o - r^* K_1^o\right] + \rho_2\left[e_2\theta_2 F'\left(\frac{K_2^o + K^d}{m}\right)K_2^o - r^* K_2^o\right]$$

s.t.

$$me_2\theta_2 F\left(\frac{K_2^o + K^d}{m}\right) - e_2\theta_2 F'\left(\frac{K_2^o + K^d}{m}\right)K_2^o - (1-\theta_2)mC(e_2) - r^s K^d$$

$$= me_1\theta_1 F\left(\frac{K_1^o + K^d}{m}\right) - e_1\theta_1 F'\left(\frac{K_1^o + K^d}{m}\right)K_1^o - (1-\theta_2)mC\left(e_2\frac{\theta_1}{\theta_2}\right) - r^s K^d \quad (ICB2)$$

$$me_1\theta_1 F\left(\frac{K_1^o + K^d}{m}\right) - e_1\theta_1 F'\left(\frac{K_1^o + K^d}{m}\right)K_1^o - (1-\theta_1)mC(e_1) - r^s K^d \quad = 0 \quad (IRB1)$$

$$\rho_1\left[e_1\theta_1 F'\left(\frac{K_1^o + K^d}{m}\right)K_1^o - r^* K_1^o\right] + \rho_2\left[e_2\theta_2 F'\left(\frac{K_2^o + K^d}{m}\right)K_2^o - r^* K_2^o\right]$$

$$\geq Max\left\{0, \Pi_1^{FI}\right\} \quad (IRFI)$$

Proposition 2

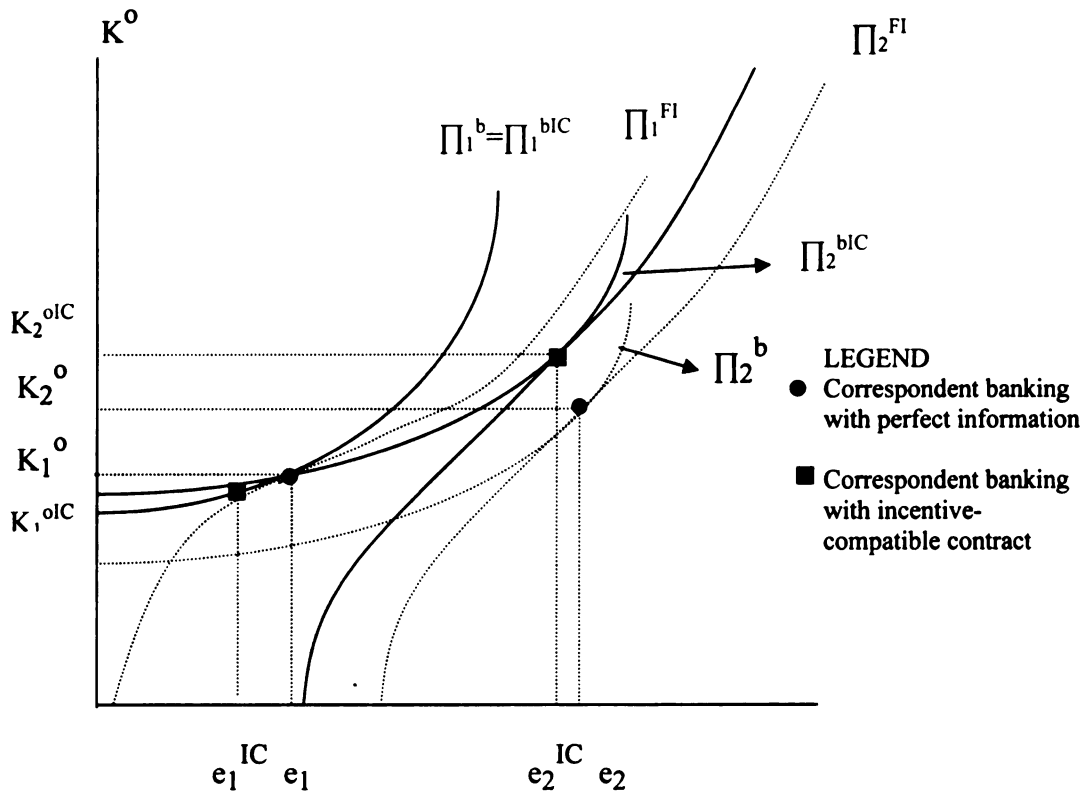
In state $\sigma = 1$, the capital specified in the incentive compatible contract, K_1^{oIC}, is smaller than in the contract with perfect information, while in state $\sigma = 2$, capital K_2^{oIC} is higher. The effort of the domestic bank, e_1^{IC} and e_2^{IC}, is always smaller in the incentive

compatible contract than in the perfect information contract.

Proof. See Appendix 2

Proposition 2 is illustrated in Figure 1-2.

Figure 1-2: Correspondent Banking with Incentive-Compatible Contract



Obviously, in state 2 the foreign investor would have to reward the domestic bank for revealing the quality of its projects by investing more capital at a reduced interest rate. The downward pressure on interest rates will give the bank incentive to lower its effort and save on monitoring costs. Thus, when the quality of the projects is good, there is excessive capital inflow compared to correspondent banking with perfect information. The quality of the monitoring deteriorates in this situation, and it becomes more likely that the project financing will not be repaid.

Since the incentive compatible contract only makes the bank indifferent between truthfully revealing the state and cheating, the foreign investor will also try to make cheating unattractive. Therefore, he will try to bring the new isoprofit curve of the domestic bank as close as possible to the zero profit. The foreign investor could only achieve this if he lowers the amount of capital invested in low quality projects. Since the decrease in capital will lower the marginal benefit of effort, the bank will not be as stringent in monitoring the projects.

Compared to a correspondent banking contract with perfect information, asymmetric information will cause overfinancing of good quality projects and underfinancing of low quality ones. However, the domestic bank will reduce its monitoring effort in each state.

The expected profit of the foreign investor from correspondent banking with separating equilibrium is:

$$\Pi^{FIIC} = m\rho_1\left[e_1^{IC}\theta_1 F\left(\frac{K_1^{oIC}+K^d}{m}\right)-(1-\theta_1)C\left(e_1^{IC}\right)-r^*\frac{K_1^o}{m}\right]$$

$$+m\rho_2\left[e_2^{IC}\theta_2 F\left(\frac{K_2^{oIC}+K^d}{m}\right)-(1-\theta_2)C\left(e_2^{IC}\right)\right.$$

$$\left.-(1-\theta_1)C\left(e_1^{IC}\right)+(1-\theta_2)C\left(\frac{e_1^{IC}\theta_1}{\theta_2}\right)-r^*\frac{K_2^o}{m}\right]-r^s K^d \qquad (7)$$

If ρ_1 is in the neighborhood of 1, then there is a pooling equilibrium. If e_1 is the value of effort and $K_1^{\,o}$ is foreign investor's capital that maximize profits with symmetric information between the foreign investor and the domestic bank, then:

$$\Pi^{FIP} = \Pi_1^{FI} = m\left[e_1 \theta_1 F\left(\frac{K_1^o + K^d}{m} \right) - (1-\theta_1) C(e_1) - r^* \frac{K_1^o}{m} - r^s \frac{K^d}{m} \right] > \Pi^{FIIC}$$

where Π^{FIP} is foreign investor's profit in pooling equilibrium.

Thus, if state $\sigma = 1$ is very likely, the foreign investor may just as well offer the first best contract and let the bank always report a low quality loan portfolio[12].

2.5. Entrance of the Foreign Investor in the Domestic Banking Market

If the foreign investor chooses to open a subsidiary in the host country and invest directly, he pays the fixed cost G and discovers the projects' expected return. It is assumed that the foreign subsidiary does not enter the deposit market and will be financed only with the capital available to the foreign investor from the world capital market, K^{o}[13].

The foreign investor's cost function is $aC(e)$, $a>0$. $a<1$ implies a cost advantage in monitoring. For example, the investor may use foreign staff, which is more experienced and carries long-term knowledge acquired at the investor's subsidiaries abroad. If $a>1$, the domestic bank is relatively more efficient in monitoring the projects than the foreign investor. This paper considers the case when the foreign investor has an efficient monitoring technology but faces very high costs of acquiring information about

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[12] It is assumed that $\Pi_1^{FI}>0$. Otherwise, the market will close whenever the domestic bank announces $\sigma = 1$ and there is no asymmetric information problem.

[13] The model will not change significantly if the foreign investor draws resources from domestic savers. The amount of capital invested in the domestic economy, and the monitoring effort will be the same. The number of firms served by the foreign investor becomes ambiguous and we avoid the ambiguity by imposing this simplification.

the average quality of the projects. In this case, he will prefer to open a subsidiary and collect information in the host country. If he can acquire enough information about the quality of the projects at a low cost, he will prefer to grant direct loans to project owners in the country. These two cases are analyzed simultaneously, as the only difference is in the amount of the entrance cost *G*.

Since both foreign and domestic capital finance the firms, the projects will be large enough to make monitoring worthwhile, even for the domestic bank which, as in autarky, is funded only from deposits.

The foreign investor and the domestic bank grant loans to different firms. Since a firm will choose a debt contract that maximizes its profit, in equilibrium, the domestic and the foreign bank will offer contracts that yield equal profit for the firm. Firms' profit equalization across the debt contracts determines the number of borrowers that will be each bank's customers.

Suppose the equilibrium number of customers of the foreign bank is m^{FI}, $m^{FI} \leq m$. Then the foreign banker will choose an interest rate r^{FI} on a loan, amount k^{FI} per borrower (or the total amount of investment is K^{oFI}), and verification effort e^{FI}, so as to maximize profit given the number of customers, m^{FI}, the world cost of capital r*, and the fixed cost *G;* and subject to the usual minimum profit constraints and the incentive compatibility constraint for the borrower.

$$\underset{r^{FI},k^{FI},K^{o},e^{FI}}{Max} \quad m^{FI}\theta r^{FI}k^{FI} - m^{FI}(1-\theta)aC\left(e^{FI}\right) - r^{*}K^{o} - G$$

$$s.t \quad \theta F\left(k^{FI}\right) - \theta r^{FI}k^{FI} \geq \left(1 - e^{FI}\right)\theta F\left(k^{FI}\right) \qquad (IC - FI)$$

$$\theta F\left(k^{FI}\right) - \theta r^{FI}k^{FI} \geq 0 \qquad (IRF - FI)$$

$$m^{FI}\,k^{FI} \geq K^{o}$$

As before, the incentive compatibility constraint is binding and the expected interest rate equals the expected average product for which the verification is successful, $r^{FI} = e^{FI}F(k^{FI})/k^{FI}$. The foreign investor's capital is evenly distributed among all of his customers, $k^{FI} = K^{oFI}/m^{FI}$, and the marginal product of capital equals the world price of capital

$$e^{FI}\theta F'\left(k^{FI}\right) = r^{*} \qquad (8)$$

The marginal benefit of the auditing effort equals its marginal cost

$$\theta F\left(k^{FI}\right) = (1-\theta)aC'\left(e^{FI}\right) \qquad (9)$$

A similar first order condition is obtained for the domestic bank

$$\theta F\left(k^{b}\right) = (1-\theta)C'\left(e^{b}\right) \qquad (10)$$

where $k^{b}=K^{d}/m^{b}$, m^{b} is the number of domestic bank customers ($m^{b}+m^{FI}=m$), and e^{b} is the effort this bank puts into monitoring.

A firm derives profit $\Pi f^{FI} = (1-e^{FI})\ \theta F(k^{FI})$ from a contract with the foreign subsidiary and $\Pi f^{b} = (1-e^{b})\ \theta F(k^{b})$ from a contract with the domestic bank. The firm will choose a contract with the foreign subsidiary only if its payoff is higher than the payoff from a contract with the domestic bank. As long as the profit of the firm increases

in the amount of capital (and decreases in the number of projects financed by the same bank)[14], there will be equilibrium in the loan market. The firm will gain the same payoff from either contract only if $(1-e^{FI})\ \theta F(k^{FI}) = (1-e^{b})\ \theta F(k^{b})$ or if

$$\left(1-e^{FI}\right)aC'\left(e^{FI}\right)=\left(1-e^{b}\right)C'\left(e^{b}\right) \tag{11}$$

When $a=1$, $e^{FI}=e^{b}$, and $(K^{oFI})/m^{FI} = K^{d}/m^{b} = (K^{oFI}+K^{d})/m$. This implies that the number of projects financed by the foreign investor is $m^{FI} = m(K^{oFI})/(K^{oFI}+K^{d})$. Using (8)-(11), it can be shown that as the monitoring efficiency of the foreign investor decreases (a increases), k^{FI}, k^{b}, e^{FI}, e^{b}, m^{FI} and K^{FI} become smaller, provided that the second order condition for foreign investor's profit maximization is satisfied:

$$-(1-\theta)aC''\left(e^{FI}\right)e^{FI}\theta F''\left(k^{FI}\right)-\left[\theta F'\left(k^{FI}\right)\right]^{2}>0.$$

In addition, when $a>1$, the domestic bank puts more effort into monitoring than the foreign investor, $e^{FI}<e^{b}$ and finances larger projects, $k^{FI} < k^{b}$.

As monitoring becomes costlier on the margin, the foreign investor will reduce both his effort and the total capital inflows. Since his capital share becomes smaller, in equilibrium, fewer firms would receive financing from the foreign subsidiary. If the investor has a cost advantage, he will gain larger market share while putting more effort and investing more capital.

At the initial time $t = 0$, the foreign investor's expected profit from direct investment becomes

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[14] The condition is that $[-C'(e) + (1-e)C''(e)] > 0$.

$$\Pi^{FIDI} = m_1^{FI}\rho_1\left[e_1^{FI}\theta_1 F\left(\frac{K_1^{oFI}+K^d}{m}\right)-(1-\theta_1)aC\left(e_1^{FI}\right)-r^*\left(\frac{K_1^{oFI}+K^d}{m}\right)\right]$$

$$+m_2^{FI}\rho_2\left[e_2^{FI}\theta_2 F\left(\frac{K_2^{oFI}+K^d}{m}\right)-(1-\theta_2)aC\left(e_2^{FI}\right)-r^*\left(\frac{K_2^{oFI}+K^d}{m}\right)\right]-G \qquad (12)$$

Compared to the first best with correspondent banking, this profit differs in the fixed cost, and the efficiency coefficient. As a increases, the investor's profit becomes smaller. This profit is additionally reduced because the foreign investor serves only a section of the market. However, compared to the profit from the agency contract, Π^{FIIC}, Π^{FIDI} is not burdened by a delegation cost.

2.6. Foreign Entrance and Capital Flows

When the foreign investor chooses to open a subsidiary, he eliminates three types of costs that he would incur in correspondent banking: the cost of delegated monitoring, information rents paid to the domestic bank, and repayment of interest to the domestic depositors for using their funds in lending. The delegation cost occurs because the domestic bank must earn at least a zero profit in order to provide services to the foreign investor. This cost is even bigger with asymmetric information. In this case, the foreign investor suffers some misallocation of capital because he must guarantee that the contract with the domestic bank is incentive compatible. The information rents represent a direct payment to the domestic bank for providing information services to the foreign investor.

The agency costs (delegation costs and the information rents) determine the amount of capital that is invested in the domestic economy through correspondent

banking. Should entry of a foreign subsidiary occur (i.e. for G low enough), then in a benchmark case with a=1, the capital channeled through correspondent banking is always smaller than the capital imported by the foreign subsidiary.

Proposition 3

Given a=1, the correspondent banking contract with perfect information always specifies a smaller capital investment and a larger monitoring effort than the ones determined by a subsidiary of the foreign investor, $K^{o}<K^{oFI}$ and $e>e^{FI}$.

Proof. The first order conditions (8) and (9) in the problem of the foreign subsidiary satisfy the equilibrium condition (A1.12), which is described in Appendix 1. Therefore, the foreign subsidiary's allocation lies on the locus of equilibrium points determined in correspondent banking. Moreover, since

$$e\theta F'\left(\frac{K^{oFI}+K^{d}}{m}\right)=r^{*}$$

the foreign subsidiary's allocation is the same as that in correspondent banking, when the foreign investor earns zero profit. Thus, this allocation is to the left of the allocation in the perfect information contract.

Proposition 4

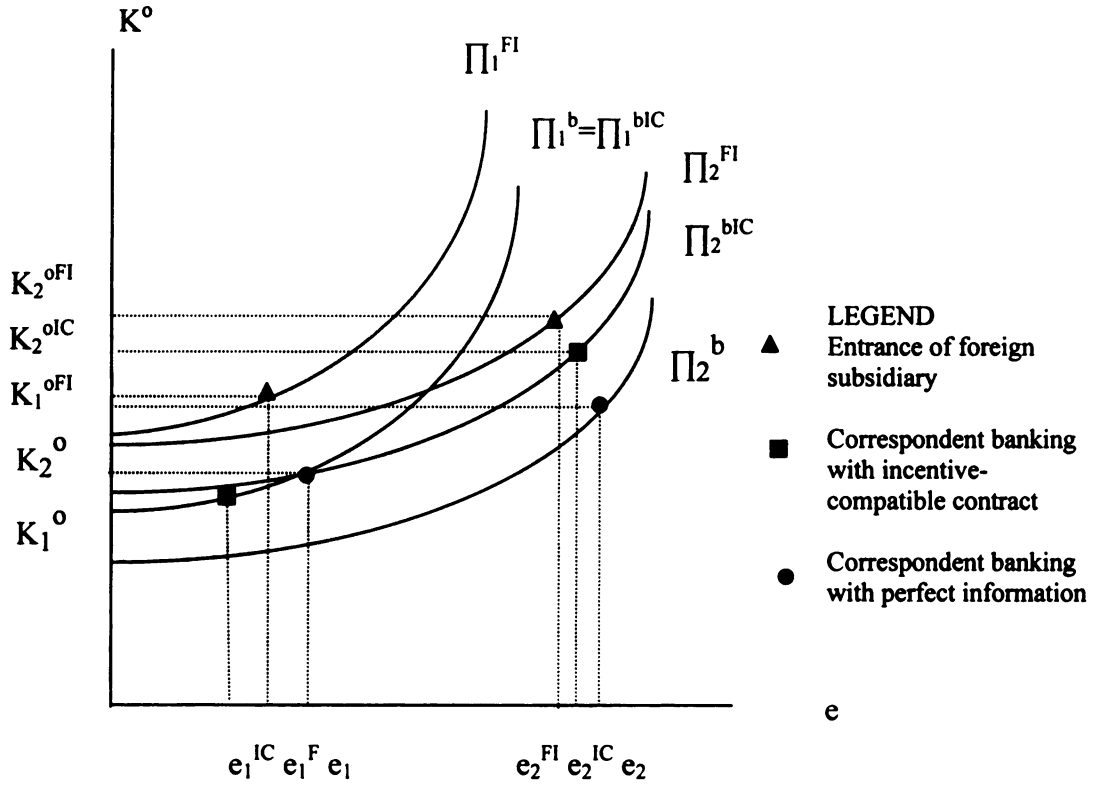
Given a =1, in separating equilibrium the correspondent banking contract with asymmetric information specifies lower capital than the one determined by the foreign subsidiary in every state, $K_1^{oIC}< K_1^{oFI}$ and $K_2^{oIC}<K_2^{oFI}$.

Proof. In state $\sigma=1$, the incentive compatible contract allows smaller investment than the perfect information contract, implying an additional underinvestment compared to the entrance of the foreign subsidiary.

In correspondent banking with asymmetric information, the foreign investor must earn positive profit in state $\sigma = 2$, or there will be no separating equilibrium. Therefore, the capital-effort allocation given by this contract must be to the right of the foreign subsidiary's allocation.

Propositions 3 and 4 are demonstrated on Figure 1-3. In correspondent banking with perfect information, the domestic economy faces a moderate amount of capital inflow in both states. Asymmetric information increases the volatility of capital inflows since the projects enjoy excessive financing in the good state, while the projects are underfunded in the bad state. The foreign subsidiary may or may not increase the volatility of capital, but will bring more of it in every state.

Figure 1-3: Foreign Bank Entrance



Since there is an inverse relationship between the foreign investor's monitoring efficiency and the capital inflow, the conclusions above are reinforced when $a<1$. In this case the equilibrium points presented on the graph will drift up and to the right, thereby increasing both capital and monitoring effort.

3. The Foreign Investor's Choice

The foreign investor chooses the investment option that delivers the highest profit, so his selection depends on the severity of the agency cost, the set up cost G, and the credit market concentration in duopoly that depends on the relative capital endowments of the two banks.

The difference between the profit in direct investment and in correspondent banking, $\Pi^{FIDI} - \Pi^{FIIC}$ shows how large the agency cost is relative to the entrance costs. The agency cost has two components: a cost from misallocation of capital and effort, and information rents:

$$\begin{aligned} Agency\ Cost &= \rho_2 m\left[(1-\theta_1)C\left(e_1^{IC}\right)-(1-\theta_2)C\left(e_1^{IC}\theta_1/\theta_2\right)\right] \\ &+\rho_1\left[\Pi_1^{FIDI}\left(K_1^{oFI},e_1^{FI},m\right)-\Pi_1^{FIDI}\left(K_1^{oIC},e_1^{IC},m,a=1\right)\right] \\ &+\rho_2\left[\Pi_2^{FIDI}\left(K_2^{oFI},e_2^{FI},m\right)-\Pi_2^{FIDI}\left(K_2^{oIC},e_2^{IC},m,a=1\right)\right] \end{aligned}$$

where $\Pi_\sigma^{FIDI}\left(K_\sigma^{oFI},e_\sigma^{FI},m\right)\sigma=1,2$ is the maximum profit of the foreign subsidiary, given that it finances all domestic projects, while $\Pi_\sigma^{FIDI}\left(K_\sigma^{oIC},e_\sigma^{IC},m,a=1\right)\sigma=1,2$ is the profit of the foreign subsidiary evaluated at the allocation in correspondent banking with asymmetric information and $a=1$. $\rho_2 m\left[(1-\theta_1)C\left(e_1^{IC}\right)-(1-\theta_2)C\left(e_1^{IC}\theta_1/\theta_2\right)\right]$ represents the information rents.

The entrance cost consists of reduction in profit due to competition with the domestic bank and the fixed cost of setting up the subsidiary:

$$Entrance\ Cost = \rho_1 m_1^b \left[\theta_1 e_1^{FI} F\left(k_1^{FI}\right) - (1-\theta_1) aC\left(e_1^{FI}\right) - r^* k_1^{FI}\right]$$
$$+ \rho_2 m_2^b \left[\theta_2 e_2^{FI} F\left(k_2^{FI}\right) - (1-\theta_2) aC\left(e_2^{FI}\right) - r^* k_2^{FI}\right] + G$$

The entrance cost becomes larger if the domestic economy owns abundant resources that can be used by the bank to produce loans. K^d reduces the number of projects that can be served by the foreign investor, but does not affect the total capital invested in the country or the equilibrium monitoring effort.

The monitoring efficiency coefficient reduces both the agency cost and the entrance cost. A larger a lowers $\Pi_\sigma^{FIDI}\left(K_\sigma^{oFI}, e_\sigma^{FI}, m\right)$ but does not affect $\Pi_\sigma^{FIDI}\left(K_\sigma^{oIC}, e_\sigma^{IC}, m, a=1\right)$ and thus it may even mitigate the information rents. Also, an increase in a reduces the agency cost by a larger proportion than the entrance cost. Therefore, it is more likely that an investor who faces monitoring disadvantage will choose correspondent banking, while an investor with strong monitoring expertise will prefer direct lending or opening a subsidiary.

If the host economy has negligible capital endowment, small barriers to foreign entry, and a fairly underdeveloped financial system ($a<1$), the foreign investor would prefer to open a subsidiary. This is because the moral hazard costs play a significant role and the foreign investor has monitoring advantage.

A country with small capital endowment, high barriers to entry and an underdeveloped financial system, but a transparent real sector (θ_1 and θ_2 are either known by the foreign investor or are almost equal), will encourage the foreign investor to grant

direct loans rather than open a subsidiary or use correspondent banking.

A country with abundant capital resources and a relatively more developed financial system ($a>1$) would see inflow of capital mostly through correspondent banking.

4. Welfare Implications

Firm profits and the intermediation services provided by the domestic bank are the main sources of welfare gains for the host country. Because of this, the results of the model suggest that the stringency of barriers to entry in the domestic banking system will depend on the efficiency of capital absorption by the firms and the monitoring efficiency of the domestic banking sector.

In autarky, the total welfare in the host country is measured by the utility of the depositors since no other domestic agent has positive consumption, $W^a = nU(r^s d)$. With foreign investment, regardless whether it is correspondent banking or a subsidiary, there is lending and the firm owners earn profits. In addition, with correspondent banking, the domestic banker raises income by providing agency services to the foreign investor. Thus, the total welfare in state $\sigma = 1$ and state $\sigma = 2$, W_1^{IC} and W_2^{IC}, when the domestic bank is entrusted with monitoring is

$$W_1^{IC} = nU\left(r^s \omega^o\right) + m\left(1 - e_1^{IC}\right)\theta_1 F\left(\frac{K_1^{oIC} + K^d}{m}\right) \tag{13}$$

$$W_2^{IC} = nU\left(r^s \omega^o\right) + m\left(1 - e_2^{IC}\right)\theta_2 F\left(\frac{K_1^{oIC} + K^d}{m}\right)$$

$$+ m\left[(1 - \theta_1)C\left(e_1^{IC}\right) - (1 - \theta_2)C\left(e_1^{IC}\theta_1/\theta_2\right)\right] \tag{13'}$$

If the foreign investor sets up a subsidiary, the domestic bank earns profits only from the projects it finances and not from agency. Also, it is assumed that the entire fixed set up cost, *G*, or some of it, is revenue for the domestic economy. This revenue is distributed as a lump sum transfer to the domestic agents and brings additional welfare gain $\Delta W(G)$. Thus, the total welfare of the domestic economy when the foreign investor opens a subsidiary is

$$W_\sigma^b = nU(r^s\omega^o) + m(1-e_\sigma^b)\theta_\sigma F(k_\sigma^b)$$
$$+ m_\sigma^b\left[\theta_\sigma e_\sigma^b F(k_\sigma^b) - (1-\theta_\sigma)C(e_\sigma^b)\right] - r^s K^d + \Delta W^b(G), \qquad \sigma = 1,2 \tag{14}$$

Suppose that there is a government that determines *G* in a way that maximizes total domestic welfare, and that the government does not know the average quality of the projects at t=0, when the fixed cost is announced to the foreign investor. Also, assume that *G* is transferred to the domestic agents in the form of a public good that yields linear utility to everyone. The maximum *G* the government can set without discouraging foreign entrance is

$$\begin{aligned} G = {} & \rho_1\left[\Pi_1^{FIDI}(K_1^{oFI}, e_1^{FI}, m) - \Pi_1^{FIDI}(K_1^{oIC}, e_1^{IC}, m)\right] \\ & + \rho_2\left[\Pi_2^{FIDI}(K_2^{oFI}, e_2^{FI}, m) - \Pi_2^{FIDI}(K_2^{oIC}, e_2^{IC}, m)\right] \\ & - \rho_1 m_1^b\left[\theta_1 e_1^{FI} F(k_1^{FI}) - (1-\theta_1)aC(e_1^{FI}) - r^* k_1^{FI}\right] \\ & - \rho_2 m_1^b\left[\theta_2 e_2^{FI} F(k_2^{FI}) - (1-\theta_2)aC(e_2^{FI}) - r^* k_2^{FI}\right] \\ & + \rho_2 m\left[(1-\theta_1)C(e_1^{IC}) - (1-\theta_2)C(e_1^{IC}\theta_1/\theta_2)\right] + r^s K^d \end{aligned}$$

At *G* -- set so that the foreign investor is indifferent between correspondent banking and entrance -- the expected welfare of the domestic economy with a foreign subsidiary is greatest and it equals

$$E(W^b) = nU(r^s\omega^o) + \rho_1 m(1-e_1^b)\theta_1 F\left(k_1^b\right) + \rho_2 m(1-e_2^b)\theta_2 F\left(k_2^b\right)$$
$$+ \rho_1 m_1^b\left[\theta_1 e_1^b F\left(k_1^b\right) - (1-\theta_1)C(e_1^b)\right]$$
$$+ \rho_2 m_2^b\left[\theta_2 e_2^b F\left(k_2^b\right) - (1-\theta_2)C(e_2^b)\right]$$
$$+ \rho_1\left[\Pi_1^{FIDI}(K_1^{oFI}, e_1^{FI}, m) - \Pi_1^{FIDI}(K_1^{oIC}, e_1^{IC}, m)\right]$$
$$+ \rho_2\left[\Pi_2^{FIDI}(K_2^{oFI}, e_2^{FI}, m) - \Pi_2^{FIDI}(K_2^{oIC}, e_2^{IC}, m)\right]$$
$$- \rho_1 m_1^b\left[\theta_1 e_1^{FI} F\left(k_1^{FI}\right) - (1-\theta_1)aC(e_1^{FI}) - r^* k_1^{FI}\right]$$
$$- \rho_2 m_1^b\left[\theta_2 e_2^{FI} F\left(k_2^{FI}\right) - (1-\theta_2)aC(e_2^{FI}) - r^* k_2^{FI}\right]$$
$$+ \rho_2 m\left[(1-\theta_1)C(e_1^{IC}) - (1-\theta_2)C(e_1^{IC}\theta_1/\theta_2)\right] \qquad (15)$$

The expected welfare with correspondent banking does not depend on the government revenue

$$E(W^{IC}) = nU(r^s\omega^o) + \rho_1 m(1-e_1^{IC})\theta_1 F\left(\frac{K_1^{oIC} + K^d}{m}\right)$$
$$+ \rho_2 m(1-e_2^{IC})\theta_2 F\left(\frac{K_2^{oIC} + K^d}{m}\right)$$
$$+ \rho_2 m\left[(1-\theta_1)C(e_1^{IC}) - (1-\theta_2)C(e_1^{IC}\theta_1/\theta_2)\right] \qquad (16)$$

Proposition 5

Given a=1, the host economy is unambiguously better off allowing entrance of the foreign subsidiary if $e_1^{IC} > e_1^{FI}$ and the government collects the maximum entrance cost.

Proof. See Appendix 3.

Proposition 5, states that if the foreign subsidiary does not put pressure on monitoring costs, then foreign entrance is overall beneficial for the economy. It is important to notice that the government collects the whole amount of the entrance cost. If this is not possible, firms' and the bank's duopoly profits may not be enough to

compensate for the loss in income from bank's agency services[15]. The domestic economy may still gain from entrance if its production technology is very elastic with respect to capital, so the additional capital brought by the foreign subsidiary will boost both firms' and the bank's revenues. Also, the domestic bank should not lose much of its market share.

If the foreign investor puts more effort than the correspondent bank when the quality of the projects is low, the cost of borrowing increases for the projects owners. This also puts pressure on the monitoring cost of the domestic banks, thus making foreign entrance less desirable.

Welfare effects become more ambiguous once the monitoring efficiency of the foreign investor is taken into account. Appendix 4 shows that as long as $\frac{F'(k)k}{F(k)} + \frac{C(e)}{eC'(e)} > 1$ the maximum welfare with a foreign subsidiary increases as the monitoring efficiency of the foreign investor increases. Therefore, as long as domestic output has high elasticity with respect to capital and the monitoring cost has low elasticity with respect to effort, the host economy may benefit from foreign bank participation. More capital is utilized in the country and project owners enjoy significant profits, while the competitiveness of the domestic bank is not harmed.

If this condition is not satisfied, an efficient foreign bank would easily deplete the domestic bank's profit and foreign bank entry may not be as good an option for the country as correspondent banking.

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[15] This would become even more evident if the bank was earning profits in autarky. Autarky profit is the reservation profit that the domestic bank would demand and receive in a correspondent relationship. However, there is no such guarantee when the foreign subsidiary is allowed to enter, so the domestic bank may suffer losses from competition as well.

5. Summary and Conclusions

This paper attempts to formally describe the organizational form (correspondent banking, and foreign bank entrance) of a foreign investor (bank) in a host country. The main assumptions of the paper include a layered asymmetric information problem and a possibility that the foreign investor has a different cost structure from the domestic bank.

The model yields important results about the amount, channel, and welfare effects of capital flows, depending on the characteristics of the host economy and the foreign investor. A very trivial outcome comes from the interaction of the foreign and the domestic bank. As described by, Gehrig (1998), Claessens et al. (1998), Weller (1999, 2000) --who focus on foreign bank entrance and bank competition only -- foreign banks reduce duopoly profits and raise concerns about systemic risk. In the current model, this comparison could be made between correspondent banking and entrance. Entrance reduces the incumbent bank's market share and eliminates its income from agency services and thus it attenuates the host economies' profits in the banking system.

Trivially, the paper concludes that entrants with high monitoring costs and small capital contributions may earn lower profits than domestic banks (as in developed economies), while entrants who have more efficient monitoring would profit relatively more than the incumbent bank (as in developing economies). Such results are empirically shown by Claessens et. al. (1998).

More interesting are the conclusions of the current model about the amount of capital flows. In correspondent banking the economy is prone to overborrowing and pronounced boom-bust cycles. Extensive literature -- Schneider and Tornell (2001),

MacKinnon and Pill (1999), Burnside et al. (2001) -- ascribes overborrowing to the existence of formal or informal bailout guarantees. In this paper, as in Gianetti (1998), bailout guarantees are not necessary to obtain the same result. In the model presented here, overborrowing arises because the domestic bank would only agree to prudently check the outcome of the projects in the good state if the foreign investor rewards it with additional profit. To provide this additional profit, the foreign investor must pour more capital into the projects in the good state and squeeze investments in the bad state. However, those exaggerated cycles are not necessarily bad since, ex-ante, the welfare of the host economy may be higher than in the perfect information case[16].

Another important result of the model is that the welfare of the host economy is affected not only by the amount of capital inflow but also by the effort exerted in the banking system. Since a very efficient foreign entrant would extract the profits of the domestic project owners and will force the domestic bank to suffer high monitoring costs, the host country has a perverse incentive too avoid such entrants even if they bring a lot of capital[17]. The host country benefits from knowledgeable foreign bankers only if the domestic projects have very high capital productivity. This productivity will generate significant profits for both the real and the banking sector. Also, the domestic banks must be able to resist the pressure of rising monitoring costs, and their marginal costs must not be increasing rapidly. From a policy perspective, the host economy may consider that large amount of capital inflow is not necessarily associated with more welfare. Thus, the country may want to discriminate between potential foreign investors.

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[16] In the perfect information case, the domestic bank does not provide information services to the foreign investor and does not earn profits.

[17] Interestingly, the Economist (Sept. 14th, 2002) reports that banks entering the Central European banking markets --the markets that went through the most extensive financial liberalization over the last decade-- are not necessarily the most well established foreign banks.

The paper also presents important implications of the model with respect to the channel of capital flows. McCauley et al. (2002) show that developed countries tend to receive foreign capital mostly through correspondent banking, while developing countries receive through local subsidiaries of foreign banks. This conforms with the result that foreign investors who have relatively more inefficient monitoring technology than the host country bank will prefer correspondent banking, while efficient investors will enter the banking market directly.

The paper raises some interesting questions that require further exploration. If it is true that foreign banks become multinational to "follow-the-customer" and that they tend to skim borrowers off from the domestic credit market, a model with heterogeneous borrowers may give a more comprehensive idea about the real effects of multinational banking. Additional extension could be the introduction of a multi-period model, which may bring other key factors in cross-border banking into play, such as the terms of the contracts, exchange rate variations, learning, etc. Finally, an empirical test of the model could make an important contribution to the understanding of the investment channels in international banking.

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APPENDICES

Appendix 1. Proof of Proposition 1

From (4) and (5) it follows that

$$\lambda = \frac{e\theta F''\left(\frac{K^o + K^d}{m}\right)K^o/m - r^* + e\theta F'\left(\frac{K^o + K^d}{m}\right)}{e\theta F''\left(\frac{K^o + K^d}{m}\right)K^o/m}$$

$$= \frac{\theta F'\left(\frac{K^o + K^d}{m}\right)K^o}{-\left[m\theta F\left(\frac{K^o + K^d}{m}\right) - \theta F'\left(\frac{K^o + K^d}{m}\right)K^o - m(1-\theta)C'(e)\right]} \qquad (A1.1)$$

Since λ must be no less than zero

$$e\theta F''\left(\frac{K^o + K^d}{m}\right)K^o/m - r^* + e\theta F'\left(\frac{K^o + K^d}{m}\right) \le 0 \qquad (A1.2)$$

and

$$m\theta F\left(\frac{K^o + K^d}{m}\right) - \theta F'\left(\frac{K^o + K^d}{m}\right)K^o - m(1-\theta)C'(e) < 0 \qquad (A1.3)$$

Also, if the foreign investor is to have positive profit, $e\theta F'\left(\frac{K^o + K^d}{m}\right) - r^* \ge 0$,

it follows form (4) in the F.O.C. that $\lambda \le 1$ and combined with (5), this implies:

$$\theta F\left(\frac{K^o + K^d}{m}\right) - (1-\theta)C'(e) \le 0 \qquad (A1.4)$$

The profit of the foreign investor is

$$\Pi^{FI} = RK^o - r^* K^o = e\theta F'\left(\frac{K^o + K^d}{m}\right)K^o - r^* K^o$$

After full differentiation

$$d\Pi^{FI} = \theta F'\left(\frac{K^o + K^d}{m}\right)K^o de + \left[e\theta F''\left(\frac{K^o + K^d}{m}\right)K^o / m + e\theta F'\left(\frac{K^o + K^d}{m}\right) - r^*\right]dK$$

$$+ eF'\left(\frac{K^o + K^d}{m}\right)K^o d\theta$$

It follows from (A1.2) and the concavity of F(k) that

$$\frac{dK}{de} = \frac{-\theta F'\left(\frac{K^o + K^d}{m}\right)K^o}{\left[e\theta F''\left(\frac{K^o + K^d}{m}\right)K^o / m + e\theta F'\left(\frac{K^o + K^d}{m}\right) - r^*\right]} > 0 \qquad (A1.5)$$

$$\frac{dK}{d\Pi^{FI}} = \frac{1}{\left[e\theta F''\left(\frac{K^o + K^d}{m}\right)K^o / m + e\theta F'\left(\frac{K^o + K^d}{m}\right) - r^*\right]} < 0 \qquad (A1.6)$$

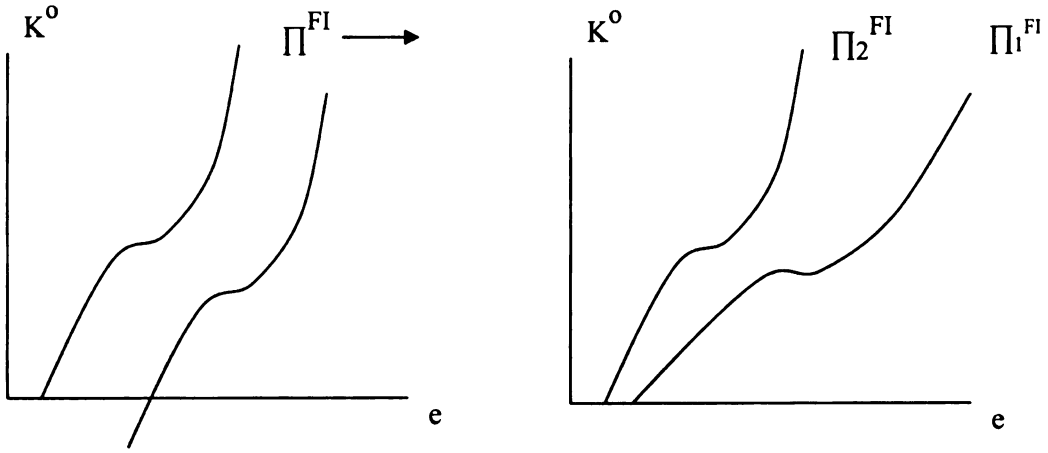
$$\frac{dK}{d\theta} = \frac{-eF'\left(\frac{K^o + K^d}{m}\right)K^o}{\left[e\theta F''\left(\frac{K^o + K^d}{m}\right)K^o / m + e\theta F'\left(\frac{K^o + K^d}{m}\right) - r^*\right]} > 0 \qquad (A1.7)$$

and

$$\frac{d^2K}{de^2} = \frac{\theta F\left(\frac{K^o + K^d}{m}\right)K^o\left[\theta F''(K^o / m)\left(\frac{K^o + K^d}{m}\right)K^o / m + \theta F'\left(\frac{K^o + K^d}{m}\right)\right]}{\left[e\theta F''\left(\frac{K^o + K^d}{m}\right)K^o / m + e\theta F'\left(\frac{K^o + K^d}{m}\right) - r^*\right]^2} \qquad (A1.8)$$

Since $\theta F''(K^o/m)K^o/m+\theta F'(K^o/m)$ may be either positive or negative, the isoprofit curves of the foreign investor may be either convex or concave. In any case, they are monotone increasing, and with steeper slope in state σ=2.

Figure 1-4: Foreign Investor's Isoprofit Curves



The profit of the domestic bank is

$$\Pi^b = me\theta F\left(\frac{K^o+K^d}{m}\right)-RK^o-m(1-\theta)C(e)-r^sK^d$$

$$=me\theta F\left(\frac{K^o+K^d}{m}\right)-e\theta F'\left(\frac{K^o+K^d}{m}\right)K^o-m(1-\theta)C(e)-r^sK^d$$

After full differentiation

$$d\Pi^b=\left[m\theta F\left(\frac{K^o+K^d}{m}\right)-\theta F'\left(\frac{K^o+K^d}{m}\right)K^o-m(1-\theta)C'(e)\right]de$$

$$-\left[e\theta F''\left(\frac{K^o+K^d}{m}\right)K^o/m\right]dK^o+\left[meF\left(\frac{K^o+K^d}{m}\right)-eF'\left(\frac{K^o+K^d}{m}\right)K^o+mC(e)\right]d\theta$$

It follows from (A1.3) and the concavity of F(k) that

$$\frac{dK^o}{de} = \frac{m\theta F\left(\frac{K^o + K^d}{m}\right) - \theta F'\left(\frac{K^o + K^d}{m}\right)K^o - m(1-\theta)C'(e)}{e\theta F''\left(\frac{K^o + K^d}{m}\right)K^o / m} > 0 \qquad (A1.9)$$

$$\frac{dK^o}{d\Pi^b} = \frac{1}{e\theta F''\left(\frac{K^o + K^d}{m}\right)K^o / m} > 0 \qquad (A1.10)$$

$$\frac{dK^o}{d\theta} = \frac{meF\left(\frac{K^o + K^d}{m}\right) - eF'\left(\frac{K^o + K^d}{m}\right)K^o + mC(e)}{e\theta F''\left(\frac{K^o + K^d}{m}\right)K^o / m} < 0 \qquad (A1.11)$$

Also,

$$\frac{d^2K^o}{de^2} = \frac{-m((1-\theta))C''(e)}{e\theta F''\left(\frac{K^o + K^d}{m}\right)K^o / m}$$

$$- \frac{m\theta F\left(\frac{K^o + K^d}{m}\right) - \theta F'\left(\frac{K^o + K^d}{m}\right)K^o - m(1-\theta)C'(e)}{e^2\theta F''\left(\frac{K^o + K^d}{m}\right)K^o / m}$$

$$= -\frac{\left[m\theta F\left(\frac{K^o + K^d}{m}\right) - \theta F'\left(\frac{K^o + K^d}{m}\right)K^o - m(1-\theta)C'(e) + m(1-\theta)C''(e)\right]}{e^2\theta F''\left(\frac{K^o + K^d}{m}\right)K^o / m} \geq 0$$

assuming $C''' \geq 0$ $\qquad (A1.12)$

The isoprofit curves of the domestic bank are monotone increasing, convex, and with smaller slope in state σ=2.

Figure 1-5: Domestic Bank's Isoprofit Curves

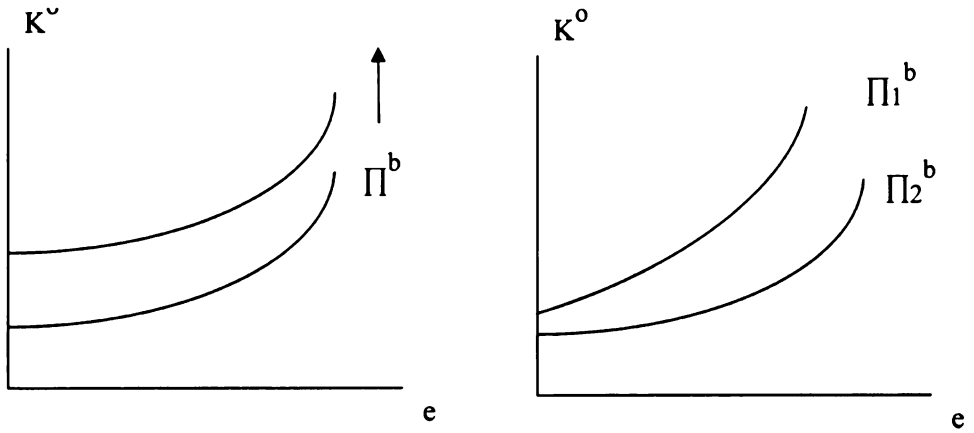
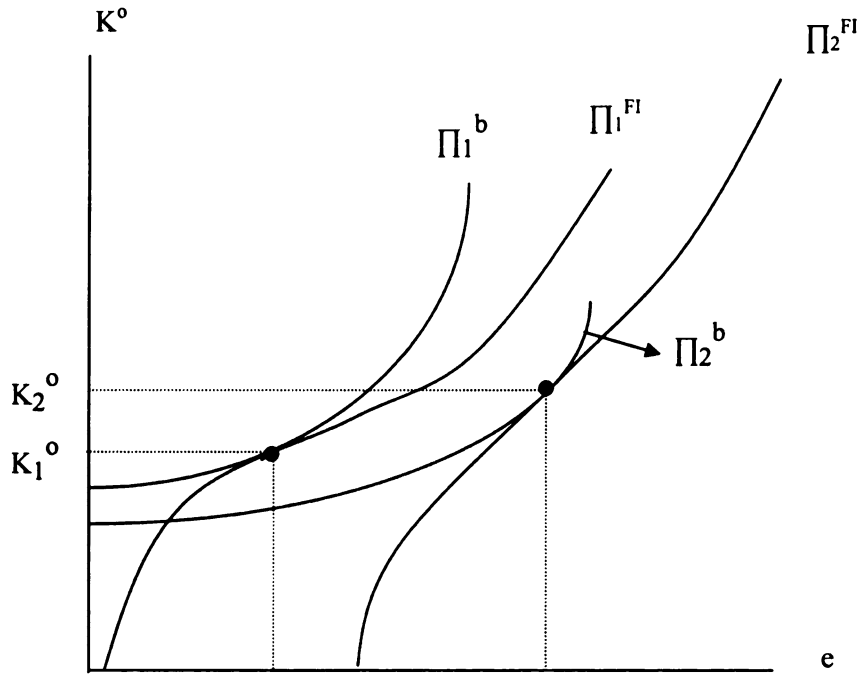


Figure 1-6: Symmetric Information Equilibrium



The curves Π_1^b and Π_2^b are the zero profit curves for the domestic bank. The

curves $\prod_1^{FI}$ and $\prod_2^{FI}$ demonstrate the highest profit that the foreign investor could achieve in each state, given zero profit for the domestic bank. The isoprofit curves of the foreign investor and the domestic bank are tangent in equilibrium.

The point (K_1^o, e_1) determines the equilibrium contract (K_1^o, R_1) when the bank has poor portfolio. In the good state the isoprofit curve of the foreign investor is steeper, while the isoprofit curve of the domestic bank is flatter at K_1^o. Therefore, the equilibrium capital K_2^o is higher when the domestic bank has good loan portfolio.

Since the zero-profit curve for the domestic bank is flatter in the good state, the equilibrium effort, e_2, and the interest rate paid to the foreign investor, R_2, must be higher, as well.

To guarantee existence of the equilibrium when the isoprofit curves of the foreign investor are convex, the slope of the isoprofit curve of the domestic bank must be smaller than the slope of the isoprofit curve for the foreign investor for small e, and larger for large e.

Appendix 2. Proof of Proposition 2

The first order conditions for the problem with asymmetric information are

$$\text{w.r.t.}\, e_1 : \rho_1\left[\theta_1 F'\left(\frac{K_1^o + K^d}{m}\right)K_1^o\right]$$

$$+\left(-\lambda_1 + \lambda_2\right)\left[m\theta_1 F\left(\frac{K_1^o + K^d}{m}\right) - \theta_1 F'\left(\frac{K_1^o + K^d}{m}\right)K_1^o - m(1-\theta_1)C'(e_1)\right]$$

$$-\lambda_1\left[m(1-\theta_1)C'(e_1) - m(1-\theta_2)C'\left(e_1\frac{\theta_1}{\theta_2}\right)\right] = 0 \qquad (A2.1)$$

$$\text{w.r.t.}\, K_1^o : \rho_1\left[e_1\theta_1 F''\left(\frac{K_1^o + K^d}{m}\right)K_1^o / m - r^* + e_1\theta_1 F'\left(\frac{K_1^o + K^d}{m}\right)\right]$$

$$-\left(-\lambda_1 + \lambda_2\right)\left[e_1\theta_1 F''\left(\frac{K_1^o + K^d}{m}\right)K_1^o / m\right] = 0 \qquad (A2.2)$$

$$\text{w.r.t.}\, e_2 : \rho_2\left[\theta_2 F'\left(\frac{K_2^o + K^d}{m}\right)K_2^o\right]$$

$$+\lambda_1\left[m\theta_2 F\left(\frac{K_2^o + K^d}{m}\right) - \theta_2 F'\left(\frac{K_2^o + K^d}{m}\right)K_2^o - m(1-\theta_2)C'(e_2)\right] \qquad (A2.3)$$

$$\text{w.r.t.}\, K_2^o : \rho_2\left[e_2\theta_2 F''\left(\frac{K_2^o + K^d}{m}\right)K_2^o / m - r^* + e_2\theta_2 F'\left(\frac{K_2^o + K^d}{m}\right)\right]$$

$$-\lambda_1\left[e_2\theta_2 F''\left(\frac{K_2^o + K^d}{m}\right)K_2^o / m\right] = 0 \qquad (A2.4)$$

Where λ_1 and λ_2 are the multipliers of ICB1 and IRB2 constraints, respectively.

From (A2.1) and (A2.2) it follows that

$$\frac{\left[-r^{*}+e_1\theta_1F'\left(\frac{K_1^o+K^d}{m}\right)\right]\left[m\theta_1F\left(\frac{K_1^o+K^d}{m}\right)-\theta_1F'\left(\frac{K_1^o+K^d}{m}\right)K_1^o-m(1-\theta_1)C'(e_1)\right]}{e_1\theta_1F''\left(\frac{K_1^o+K^d}{m}\right)K_1^o/m}$$

$$+\frac{\left[e_1\theta_1F''\left(\frac{K_1^o+K^d}{m}\right)K_1^o/m\right]\left[m\theta_1F\left(\frac{K_1^o+K^d}{m}\right)-m(1-\theta_1)C'(e_1)\right]}{e_1\theta_1F''\left(\frac{K_1^o+K^d}{m}\right)K_1^o/m}$$

$$-\frac{\lambda_1}{\rho_1}\left[m(1-\theta_1)C'(e_1)-m(1-\theta_2)C'\left(e_1\frac{\theta_1}{\theta_2}\right)\right]=0 \qquad (A2.5)$$

Since the multipliers must be positive and

$$e_1\theta_1F''\left(\frac{K_1^o+K^d}{m}\right)K_1^o/m<0$$

in state $\sigma=1$, A1.12 is negative in the equilibrium with asymmetric information and thus capital and effort must be smaller than the ones obtained in the perfect information equilibrium ($K_1^{oIC} < K_1^o$ and $e_1^{IC} < e_1$).

To prove the second part of the proposition, we use the second order conditions for the maximization problem with perfect information. The determinant of the bordered Hessian is:

$$-L_{\lambda K^o}\left(L_{\lambda K^o}L_{ee}-L_{\lambda K^o}L_{K^oe}\right)+L_{\lambda e}\left(L_{\lambda K^o}L_{Ke}-L_{K^oK^o}L_{\lambda e}\right)\geq 0$$

Where L_{ij} are the cross derivatives of the Lagrangean from the perfect information problem, $i,j=\lambda, K^o, e$.

Since

$$L_{\lambda K^o} = -e\theta F''\left(\frac{K^o + K^d}{m}\right)\frac{K^o}{m} > 0 \text{ and } L_{\lambda e}$$

$$= m\theta F\left(\frac{K^o + K^d}{m}\right) - \theta F'\left(\frac{K^o + K^d}{m}\right)\frac{K^o}{m} - m(1-\theta)C'(e) < 0$$

it is sufficient to have

$$\left(L_{\lambda K^o} L_{ee} - L_{\lambda K^o} L_{K^o e}\right) < 0$$

and

$$\left(L_{\lambda K^o} L_{Ke} - L_{K^o K^o} L_{\lambda e}\right) < 0$$

The first order conditions with respect to K^o and e from the perfect information problem provide the locus of equilibrium combinations of those two variables from the unrestricted objective function. We need to find the slope of the relationship between K^o and e. Full differentiation of these first order conditions yields:

$$L_{K^o K^o} dK^o + L_{K^o e} de + L_{\lambda K^o} d\lambda = 0$$

$$L_{K^o e} dK^o + L_{ee} de + L_{\lambda e} d\lambda = 0$$

or

$$\left(L_{\lambda K^o} L_{ee} - L_{\lambda K^o} L_{K^o e}\right) de = \left(L_{K^o K^o} L_{\lambda e} - L_{\lambda K^o} L_{Ke}\right) dK^o$$

Therefore, $dK^o/de<0$. This implies that the locus of equilibrium points lies on a negatively sloped curve.

Thus, if the profit of the domestic bank is to increase above zero, the profit of the foreign investor should drop down, more capital should be invested in the domestic economy and the domestic bank should put less monitoring effort. This is what occurs in

state $\sigma=2$ with asymmetric information.

$$\left(\frac{dK^o}{de}\right)^b - \left(\frac{dK^o}{de}\right)^{FI} = \frac{m\theta F\left(\frac{K^o+K^d}{m}\right) - \theta F'\left(\frac{K^o+K^d}{m}\right)K^o - m(1-\theta)C'(e)}{e\theta F''\left(\frac{K^o+K^d}{m}\right)K^o/m}$$

$$- \frac{-\theta F'\left(\frac{K^o+K^d}{m}\right)K^o}{\left[e\theta F''\left(\frac{K^o+K^d}{m}\right)K^o/m + e\theta F'\left(\frac{K^o+K^d}{m}\right) - r^*\right]}$$

$$= \frac{\left[e\theta F''\left(\frac{K^o+K^d}{m}\right)K^o/m + e\theta F'\left(\frac{K^o+K^d}{m}\right) - r^*\right]\left[m\theta F\left(\frac{K^o+K^d}{m}\right) - m(1-\theta)C'(e)\right]}{\left[e\theta F''\left(\frac{K^o+K^d}{m}\right)K^o/m + e\theta F'\left(\frac{K^o+K^d}{m}\right) - r^*\right]\left[e\theta F''\left(\frac{K^o+K^d}{m}\right)K^o/m\right]}$$

$$- \frac{\left[e\theta F'\left(\frac{K^o+K^d}{m}\right) - r^*\right]\left[\theta F'\left(\frac{K^o+K^d}{m}\right)K^o\right]}{\left[e\theta F''\left(\frac{K^o+K^d}{m}\right)K^o/m + e\theta F'\left(\frac{K^o+K^d}{m}\right) - r^*\right]\left[e\theta F''\left(\frac{K^o+K^d}{m}\right)K^o/m\right]}$$

The sign of this difference is determined by

$$-\left[e\theta F'\left(\frac{K^o+K^d}{m}\right) - r^*\right]\left[\theta F'\left(\frac{K^o+K^d}{m}\right)K^o\right]$$

$$+\left[e\theta F''\left(\frac{K^o+K^d}{m}\right)K^o/m + e\theta F'\left(\frac{K^o+K^d}{m}\right) - r^*\right]\left[m\theta F\left(\frac{K^o+K^d}{m}\right) - m(1-\theta)C'(e)\right] =$$

$$= \left[e\theta F'\left(\frac{K^o+K^d}{m}\right) - r^*\right]\left[m\theta F\left(\frac{K^o+K^d}{m}\right) - \theta F'\left(\frac{K^o+K^d}{m}\right)K^o - m(1-\theta)C'(e)\right]$$

$$+\left[e\theta F''\left(\frac{K^o+K^d}{m}\right)K^o/m\right]\left[m\theta F\left(\frac{K^o+K^d}{m}\right) - m(1-\theta)C'(e)\right] \qquad (A1.12)$$

When $e=0$, (A1.12) is negative because of the concavity of $F(k)$. When $e=1$, the term is positive as long as $C'(1) \to \infty$. This proves the existence of equilibrium.

Appendix 3. Proof of Proposition 5

When $a=1$, $k^{FI}=k^b$ and $e^{FI}=e^b$. Therefore, to proof the proposition, it is enough to show that

$$\rho_1 m\left(1-e_1^b\right)\theta_1 F\left(\frac{K_1^{oFI}+K^d}{m}\right)+\rho_1\left[\Pi_1^{FIDI}\left(K_1^{oFI},e_1^{FI},m\right)-\Pi_1^{FIDI}\left(K_1^{oIC},e_1^{IC},m\right)\right]$$

$$>\rho_1 m\left(1-e_1^{IC}\right)\theta_1 F\left(\frac{K_1^{oIC}+K^d}{m}\right) \qquad (A3.1)$$

After some algebraic manipulations, (A3.1) is transformed into

$$m\theta_1\left[F\left(\frac{K_1^{oFI}+K^d}{m}\right)-F\left(\frac{K_1^{oIC}+K^d}{m}\right)\right]-r^*\left(K_1^{oFI}-K_1^{oIC}\right)$$

$$>m(1-\theta_1)\left[C(e_1^{FI})-C(e_1^{IC})\right]$$

Let $K_1^{FI} - K_1^{IC} = h$. Then

$$m\theta_1\left[F\left(\frac{K_1^{oFI}+K^d}{m}\right)-F\left(\frac{K_1^{oFI}-h+K^d}{m}\right)\right]-r^*h>\theta_1 F'\left(\frac{K_1^{oFI}+K^d}{m}\right)h-r^*h$$

$$=\theta_1 F'\left(\frac{K_1^{oFI}+K^d}{m}\right)h-\theta_1 F'\left(\frac{K_1^{oFI}+K^d}{m}\right)h=0$$

Since $m(1-\theta_1)\left[C(e_1^{FI})-C(e_1^{IC})\right]<0$ only if $e_1^{IC}>e_1^{FI}$, this condition guarantees that the domestic welfare will be higher under entrance in state $\sigma=1$. In state $\sigma=2$, $e_2^{IC}>e_2^{FI}$ is always satisfied and entrance is always beneficial.

Appendix 4. Proof of Statement

We need to derive the conditions under which the welfare in the host economy decreases in *a*. Therefore we need to establish the relationship between the monitoring efficiency, *a*, and the entrance cost, *G*, the profit of the domestic bank, $m_\sigma^b\left[\theta_\sigma e_\sigma^b F\left(k_\sigma^b\right) - (1-\theta_\sigma)C(e_\sigma^b)\right]$, and the profit of the project owners, $(1-e_\sigma^b)\theta_\sigma F\left(k_\sigma^b\right)$.

The terms in *G* that are affected by *a,* are given by the profit of the foreign investor. Using the envelope theorem, the profit of the foreign investor decreases in *a*, therefore *G* also decreases in *a*.

Next, we use the previously mentioned result that $de^b/da<0$. Since $(1-e_\sigma^b)\theta_\sigma F\left(k_\sigma^b\right)=(1-e_\sigma^b)(1-\theta_\sigma)C'(e_\sigma^b)$ and given that $-C'(e_\sigma^b)+eC''(e_\sigma^b)>0$, it immediately follows that the profit of the project owners increases in e^b and decreases in *a*.

Also, since $k_\sigma^b = K^d / m_\sigma^b$, then $dm_\sigma^b = -\left(m_\sigma^b/k_\sigma^b\right)dk_\sigma^b$, and since $\theta_\sigma F\left(k_\sigma^b\right)=(1-\theta_\sigma)C'\left(e_\sigma^b\right)$, then $\theta_\sigma F'\left(k_\sigma^b\right)dk_\sigma^b = (1-\theta_\sigma)C''\left(e_\sigma^b\right)de_\sigma^b$.

After full differentiation of the profit of the domestic bank, assuming $d\theta_\sigma=0$:

$$\frac{-(m_\sigma^b/k_\sigma^b)(1-\theta_\sigma)C''(e_\sigma^b)}{\theta_\sigma F'\left(k_\sigma^b\right)}\left[\theta_\sigma e_\sigma^b F\left(k_\sigma^b\right) - (1-\theta_\sigma)C(e_\sigma^b)\right]de_\sigma^b + m_\sigma^b\left[e_\sigma^b(1-\theta_\sigma)C''(e_\sigma^b)\right]de_\sigma^b$$

$$=\frac{m_\sigma^b(1-\theta_\sigma)C''(e_\sigma^b)}{\theta_\sigma F'\left(k_\sigma^b\right)k_\sigma^b}\left[\theta_\sigma e_\sigma^b F'\left(k_\sigma^b\right)k_\sigma^b - \theta_\sigma e_\sigma^b F\left(k_\sigma^b\right)+(1-\theta_\sigma)C(e_\sigma^b)\right]de_\sigma^b$$

$$=\frac{m_\sigma^b(1-\theta_\sigma)C''(e_\sigma^b)\theta_\sigma e_\sigma^b F\left(k_\sigma^b\right)}{\theta_\sigma F'\left(k_\sigma^b\right)k_\sigma^b}\left[\frac{F'\left(k_\sigma^b\right)k_\sigma^b}{F\left(k_\sigma^b\right)}-1+\frac{C(e_\sigma^b)}{e_\sigma^b C'(e_\sigma^b)}\right]de_\sigma^b$$

Therefore, the profit of the domestic bank increases in the effort and decreases in

a if

$$\left[\frac{F'\left(k_\sigma^b\right)k_\sigma^b}{F\left(k_\sigma^b\right)}+\frac{C(e_\sigma^b)}{e_\sigma^b C'(e_\sigma^b)}\right]>1.$$

PART TWO. CREDIT DOLLARIZATION IN TRANSITION ECONOMIES: IS IT FIRMS' OR BANKS' "FAULT"?[18]

1. Introduction

This paper analyzes the respective contributions of banks and firms to the phenomenon of credit dollarization[19] in transition economies. We seek to provide answers to the following questions: Why do domestic banks in these countries lend in foreign currencies? Why do domestic firms borrow domestically in foreign currencies? Is credit dollarization mainly supply or demand-driven? Ultimately, we would like to contribute to a better assessment of the sectoral balance sheet risks associated with financial dollarization.

An issue that currently draws economists' attention is whether credit dollarization increases the riskiness of firms', banks', and governments' balance sheets. In a small open economy which is dependent on foreign capital and external demand for its exports, credit dollarization determines the distribution of currency risk across different sectors of the economy. Overall, an economy may possess dollar earning assets similar to its dollar bearing liabilities and still face widespread defaults as a result of unexpected currency depreciation if one sector bears disproportionately large currency risk. As Allen et al. (2002), Delgado et al. (2002), and others suggest, the concentration of currency imbalances in one sector may lead to a spill-over of financial difficulties throughout the

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[18] This paper is co-authored with Alina C. Luca, Department of Economics and International Business, Drexel University.

[19] Financial dollarization occurs when a significant share of residents' domestic financial contracts (including deposits and loans) are denominated in foreign currencies, not necessarily the US dollar. Dollar deposits and loans denote all foreign currency deposits and loans. In addition, deposit dollarization and credit dollarization refer to the phenomenon of denominating deposits and loans in foreign currencies.

economy.

As emerging (including transition) economies lack domestic capital, they often turn to international markets to finance production. Years of exchange rate instability have also created persistently high deposit dollarization. Thus, banks channel resources to domestic borrowers that are increasingly denominated in foreign currency and often exceed the capacity of the tradable sector to absorb them. These resources create an imbalance that increases market risks for banks and firms and potentially raise the costs of government intervention during financial crises.

The domestic credit market determines whether banks or firms will bear the exchange rate cost of the foreign currency liabilities. Given relative market power and banks' limited hedging opportunities, bank currency matching activities may determine credit dollarization, thus transferring the exchange rate risk onto the borrowers. As a result, a depreciation of the local currency deteriorates borrowers' balance sheets, reduces their creditworthiness, and intensifies asymmetric information problems (see Mishkin (1996)). Balance sheet worsening triggers financial accelerator effects, firms experience reduction in credit supply and production interruption, and the economy is likely to suffer a recession. If firms drive credit dollarization, banks work to cover the exchange rate risk. Depreciation may increase bank exchange rate losses but banks do not necessarily face additional default and information costs. Thus, economic costs associated with firms' and banks mismatches seem to be different and possibly higher if firms rather than banks are first hit by the exchange rate depreciation.

In any case, currency mismatches increase financial fragility and make economies more prone to banking crises. Because of high bank liquidity and solvency risks, banks

face a higher premium on foreign and domestic capital. This brings multiple and self-enforcing problems to dollarized economies. On one hand, the risk premium worsens firms' balance sheets and tightens their borrowing constraints, so overall credit finance and economic growth are lower than in countries where currency mismatches do not exist.

On the other hand, foreign and domestic depositors are more sensitive to news about exchange rate movements in economies with vast currency mismatches. The reason is that depreciation directly and indirectly brings banks' profits down. Thus, dollarized economies tend to experience abrupt capital reversals. Levi-Yeyati (2003) points out that balance sheet currency mismatches amplify the cyclicality of capital flows and slow down the recovery from an economic downturn. Many governments attempt to alleviate this problem by smoothing exchange rate fluctuations – a policy that Calvo and Reinhart (2002) named "fear of floating". However, the tendency to reduce exchange rate fluctuations may induce firms and banks to maintain large currency imbalances, thus raising financial crises costs even further.

To summarize, we believe that the factors explaining credit dollarization also explain why grossly disproportionate currency mismatches exist in small open economies with underdeveloped financial systems. We take a close look at the domestic credit market and examine the risk sharing forces behind credit dollarization. Is credit dollarization the outcome of a unilateral decision made by domestic banks? Or is it driven by domestic firms' integration in the international marketplace?

This work draws on literature concerning the determinants of currency composition of banks' portfolios and corporate debt. Calvo (2001, 2002) proposes bank

currency matching as a possible explanation for the high levels of dollar loans in emerging economies, given that deposits are highly dollarized. Ize and Levy Yeyati (2003) also argue that banks hold foreign exchange matched positions, not only because of regulatory requirements, but also because they are "generally adverse to assuming risk directly" (pg. 8). However, most studies focus on firms' hedging behavior. A portfolio of loans denominated in more than one currency can provide an improved risk and cost position for firms (see Kawai (1981), Cotner (1991)). A number of empirical papers provide evidence that firms borrow in dollars for hedging reasons – larger firms, and firms with exporting activities, borrow more in foreign currencies[20].

The abundance of studies on firms' currency matching incentives stems from the assumption that firms are risk averse, while banks can fully diversify. Thus, credit dollarization depends on the covariance of firms' revenues with the exchange rate. However, when it comes to explaining financial crises a bulk of the balance sheet imbalances literature (Krugman (1999), Cespedes et al. (2000), Gertler et al., (2003), Aghion et al. (2001)) focuses on the mismatch between the size of the tradables sector and foreign currency borrowing. Only a few papers (see Burnside et al. (2000), Choi and Cook (2002)) assume explicitly that banks bear the exchange rate risk by maintaining a mismatched balance sheet. Thus, the questions of whether supply or demand factors determine credit dollarization and which sector faces a higher exchange rate risk are still open.

Currently, only two empirical studies, Arteta (2002) and Barajas and Morales

[20] See Aguiar (2002), and Martínez and Werner (2002), for evidence for firms from developing economies, Keloharju and Niskanen (2001), Kedia and Mozumdar (2002), and Giraldi and Hamaui (1991), for evidence for firms from developed economies.

(2003), analyze the determinants of credit dollarization. Arteta (2002) evaluates the effect of the exchange rate regime on credit dollarization and essentially tests whether banks' hedging incentives (deposit and loan currency matching) are distorted by exchange rate policies. Arteta's assumption is that supply determines credit dollarization and firms' hedging incentives are not considered. Overall, the paper provides evidence that a more flexible exchange rate regime tends to amplify bank currency mismatches as credit dollarization does not change (or it decreases), while deposit dollarization increases. Barajas and Morales (2003) use data on bank- and firm-specific factors, in addition to macroeconomic variables, for fourteen Latin American economies to explore possible biases introduced by domestic monetary policy into the decisions by banks and firms to lend and borrow in dollars. Their results indicate that both bank asset and firm liability allocation decisions are important determinants of dollarization. They also find limited evidence that greater volatility in the exchange rate decreases the level of credit dollarization, at least in the short run.

This paper extends the existing work on credit dollarization, first, by using a comprehensive, newly-assembled dataset for twenty-two transition economies from Central and Eastern Europe and Central Asia, for the period 1990 – 2001.

We estimate and compare the respective contribution of firms and banks to the financial dollarization phenomenon by grouping potential determinants into bank- and firm-specific factors. Bank-specific factors include indicators of asset and liability currency matching. As firm-specific factors, we use measures of real dollarization[21] and

[21] We define real dollarization as the denomination of the returns and costs of production for firms in foreign currencies. That is, firms export the final good and/or use imported intermediate goods in the production of the final good.

access to alternative financing sources. In addition, we include specific indicators of overall hedging opportunities, liberalization and deregulation of the foreign exchange market, uncertainty and lack of credibility of domestic policies, and cost of foreign capital.

We estimate a reduced form equation, and use the pooled OLS estimator as a benchmark. We then extend the analysis and use first difference and fixed effects estimators to control for unobserved heterogeneity. The main results seem to be robust across specifications.

Empirical results provide evidence that credit dollarization in transition economies is determined by banks' optimization decisions (asset and liability management variables). Banks match the currency of denomination of their assets and liabilities, that is, deposit dollarization drives credit dollarization, and net foreign assets represent a substitute for dollar loans to domestic firms.

There is limited evidence of firms hedging the currency of their debt and production returns. A higher ratio of exports to GDP increases, while existence of alternative financing sources (specifically non-bank trade credit) reduces credit dollarization. More generally, the more integrated is the economy in the international goods market, the higher is credit dollarization. This result suggests that integration of international goods and financial markets, real and financial dollarization respectively, move in the same direction. It questions the previous (counterintuitive) finding (see Arteta (2002) and Barajas and Morales (2003)) that the openness of the economy has a negative effect on credit dollarization.

The paper also provides evidence that lack of monetary policy credibility and

macroeconomic uncertainty (measured by the central bank's net foreign reserves) raise dollarization levels.

To summarize, banks in transition economies hedge against exchange rate risk by holding matched foreign exchange positions. However, as Ize and Parrado (2002) point out, as long as financial dollarization outpaces real dollarization, and this seems to be the case in transition countries, there is a currency mismatch somewhere in the economy. We show that banks pass the exchange rate risk to firms. This decreases banks' exposure to currency risk, but it increases their exposure to default risk, and ultimately the exposure of the economy to financial crises.

The remainder of the paper is organized as follows. Section 2 reviews the theoretical background and presents the main hypotheses for the bank- and firm-related effects on credit dollarization. Section 3 outlines the econometric model and the estimation methods and results, while section 4 describes several robustness tests. Section 5 presents the conclusions.

2. Conceptual Framework and Main Hypotheses

To assess the extent to which credit dollarization is mainly a firm or bank phenomenon, we separate potential determinants into 1) factors that affect only the supply of foreign currency credit (relative to domestic currency credit), 2) factors that affect only the demand for foreign currency credit (relative to domestic currency credit), and 3) factors that affect both demand and supply of credit.

We develop a theoretical framework similar to Ize and Levi-Yeyati (2003) that employs the idea of a minimum variance portfolio. However, deposits in this model are

predetermined and the focus is on the credit market. Presumably both firms and banks aim at achieving a minimum variance portfolio allocation. While the assumption of firms' risk aversion is common in the literature, it is usually considered that banks can spread out risks completely. We assume that at low levels of financial development (missing forward markets) agents' ability to diversify risks is limited. Thus, both firms and banks are risk averse.

This is a static short-run model. Firms' long-run production decisions are determined in advance by the availability of capital and firms make short-run financing choices given a desired level of output. This assumption is consistent with the observation that loans in transition economies are of primarily short duration.

Firms trade both as exporters of final product and as importers of inputs. They also sell their output and buy inputs in the domestic market. Thus, firms' profits are imperfectly correlated with the depreciation of the exchange rate.

Banks have access to international capital markets and they can both import and export capital. Banks are perfectly competitive.

Domestic savings are in the hands of domestic consumers. In the short run, consumer's deposits with banks are fixed and the proportion of foreign and domestic currency deposits is predetermined.

These features of the model imply that credit dollarization depends on the world interest rate, the level of domestic deposit dollarization and foreign assets and liabilities of banks, the variability of the exchange rate depreciation, and the correlation between export prices and the exchange rate. Firms' and banks' relative risk aversion and market competitiveness determine the strength of dependence between firm and bank factors and

credit dollarization.

2.1. Firms

Firms are identical and uniformly distributed between 0 and 1. In period 0, firms buy a unit of input at price $w=1$ in the domestic and world markets. The input is used in proportion to capital, which is fixed and completely determines output, Y, in the short run. In period 1, firms sell their output at price p, which is correlated with the exchange rate depreciation, ε, as some of the output is in tradable goods. We assume $E(\varepsilon)=\varepsilon^e$, $Var(\varepsilon)=\sigma_\varepsilon^2$, $E[p]=p^e$, $Var[p]=\sigma_p^2$, $Cov[p(\varepsilon),\varepsilon]=\sigma_{\varepsilon p}$.

Firms maximize expected utility of profits subject to the budget constraint $w=L+L^f$. Their profit function is

$$\Pi^f = pY - w - r_L L - r_L^f (1+\varepsilon) L^f$$

where L denotes domestic currency loans, L^f – foreign currency loans, and r_L and r_L^f denote the interest rates on domestic and foreign currency loans.

With a coefficient of risk aversion, γ, firms have the following preferences:

$$E\left[\Pi^f\right] - \frac{1}{2}\gamma Var\left[\Pi^f\right]$$

Firms' foreign and domestic currency loan demands depend on the covariance between output prices and the exchange rate depreciation, the variability of the exchange rate depreciation, and firms' risk aversion. Upon reworking firms' first order conditions, loan demands become

$$L^f = \frac{-[r_L^f(1+\varepsilon^e) - r_L] + \gamma\sigma_{\varepsilon p}\gamma r_L^f}{\gamma\sigma_\varepsilon^2 r_L^{f\,2}}$$

$$L = 1 - L^f$$

Given a positive spread between domestic and foreign currency loans, firms increase borrowing in foreign currency if they have large revenues in hard currency, if they are not very risk averse, and if the depreciation rate is stable. The expected exchange rate depreciation increases the cost of borrowing in foreign currency and lowers the quantity demanded.

2.2. Banks

N banks compete for depositors and borrowers. Banks attract deposits in domestic and foreign currency from domestic consumers and extend loans in domestic and foreign currency to domestic producers. Banks also have access to the international and domestic interbank market, where they can attract additional deposits in domestic and foreign currency. Each bank's profit function is

$$\Pi^b = r_L l + r_L^f(1+\varepsilon)l^f + r(1+\varepsilon)m^f + r_l m - r_D d - r_D^f(1+\varepsilon)d^f$$

where l denotes domestic currency loans, l^f – foreign currency loans, d – domestic currency deposits, and d^f – foreign currency deposits. The net position of a bank in the interbank market (domestic and international) is $m^f + m = d^f + d - l^f - l$. The total amounts of domestic and foreign currency loans, deposits, and interbank funds are $L=Nl$, $L^f=Nl^f$, $D=Nd$, $D^f=Nd^f$, $M=Nm$, and $M^f=Nm^f$.

Let δ be the coefficient of banks' risk aversion. Banks maximize expected utility from profits

$$E\left[\Pi^b\right]-\frac{1}{2}\delta Var\left[\Pi^b\right]$$

subject to the budget constraint: $m^f + m = d^f + d - l^f - l$.

From the first order conditions, the interest rate on loans and deposits in foreign currency must equal the world interest rate. The rate on domestic currency loans and deposits compensates for the expected domestic currency depreciation and uncertainty.

$$r_L^f = r_D^f = r$$

$$r_L = r_D = r_l$$

and

$$r_L^f\left(1+\varepsilon^e\right)-r_L = \delta r^2\sigma_\varepsilon^2\left[l^f + m^f - d^f\right]$$

The total supply of foreign currency loans is then

$$L^f = \frac{N\left[r_L^f\left(1+\varepsilon^e\right)-r_L\right]}{\delta r_L^{f\,2}\sigma_\varepsilon^2}+\left[D^f - M^f\right]$$

Since the expected rate of devaluation has only an indirect effect through the spread, it disappears when we substitute for the spread in the foreign currency loan demand

$$L^f = \frac{N\gamma}{N\gamma+\delta}\frac{\sigma_{ep}Y}{\sigma_\varepsilon^2 r}+\frac{\delta}{N\gamma+\delta}\left[D^f - M^f\right]$$

The first term on the right hand side shows the effect of firm determinants on loan dollarization. The higher the correlation between output prices and the exchange rate the more likely it is that firms will borrow in foreign currency. Firms with exporting

activities, and thus returns denominated in foreign currencies, are hedged against currency risk if they also borrow in foreign currency. The higher are the exports, relative to domestic production, the more dollarized the economy should be. This result is consistent with studies using firm level data which find evidence that the productive structure matters for the corporate debt currency composition.[22] High pass-through (domestic prices that increase in parallel with the depreciation rate) has the same effect as exports and should increase credit dollarization, as well.

The first difference of loan dollarization with respect to the world interest rate r is negative. The world interest rate increases the cost of foreign currency deposits for banks. With predetermined supply of foreign currency deposits, banks have to pass this cost onto the borrowers. Thus, if output prices are not correlated with the exchange rate, loan dollarization is also predetermined (by the foreign currency constraints of the economy) and the world interest rate has no effect on it. Only the spread increases proportionately to the foreign currency deposits. If output prices are correlated with the exchange rate, the increase in the world rate reduces the relative price of output. Firms substitute domestic currency for dollar loans and the premium on foreign currency loans is not as large. Thus, given that firms are risk averse and their output prices are correlated with the depreciation rate, the world interest rate has only a substitution effect and reduces loan dollarization. This also results from the fact that output is predetermined by the amount of capital.

The loan dollarization equation shows that an increase in the variance of the

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[22] Aguiar (2002) and Martínez and Werner (2002) use data on Mexican firms, and show that exporting firms borrow more in foreign currencies. Kedia and Mozumdar (2002) find that US firms performing foreign operations borrow more in foreign currencies. Keloharju and Niskanen (1997) also find evidence for the hedging explanation using data on Finnish firms. Giraldi and Hamaui (1991) show that the currencies used to settle international trade determine the currency composition of debt for Italian firms.

exchange rate reduces dollarization. Exchange rate volatility affects demand and supply in opposite directions depending on the interest rate spread. The final effect is negative because output prices and the exchange rate are imperfectly correlated. In the extremes when the correlation is zero, or the exchange rate factors out from the output prices (perfect correlation), the volatility does not affect credit dollarization.

Banks influence loan dollarization through currency matching of assets and liabilities. An increase in deposit dollarization D^f increases credit dollarization as banks match the currency of denomination of their deposits and loans. An increase in net foreign assets M^f has a negative effect on credit dollarization as banks substitute foreign currency loans to domestic firms with foreign assets, for a given level of dollar deposits.

The effect of bank concentration on credit dollarization is not straightforward. Concentration emphasizes banks' matching behavior. A more concentrated banking system tends to reduce credit dollarization unless banks have high dollar liabilities that they need to offset. As the number of banks increases, the currency risk spreads among them perfectly and they behave as if they are risk neutral. Thus, the main determinant of credit dollarization becomes real dollarization[23].

Risk aversion shapes the relative importance of banks' and firms' determinants. Matching is relatively more important if banks' risk aversion is larger than firms' risk aversion.

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[23] Catão and Terrones (2000) present a similar argument that higher concentration in the banking industry leads to lower equilibrium dollarization levels. The higher banks' market power, the more they will exercise it in lending. Naturally, banks' market power is higher for borrowers that do not have access to direct borrowing from abroad (denoted below as "external borrowing"). These are borrowers in the non-traded goods sector, or borrowers that do not have traded collateral. Thus, they are more likely to demand domestic currency credit. Therefore, concentration tends to increase lending in domestic currency and reduce lending in dollars.

3. Empirical Analysis

Following the equilibrium level of credit dollarization derived in the theoretical model, we estimate the reduced-form equation

$$\text{Credit dollarization}_{it} = \alpha' \text{Bank variables}_{it} + \beta' \text{Firm variables}_{it} + \gamma' \text{Controls}_{it} + u_{it}.$$

Credit dollarization denotes the ratio of foreign currency loans to total bank loans. *Bank variables* stands for the set of variables related to the banking sector, described further in this section and in more details in Table 2-1 in the Appendix, which identify the supply-side of credit dollarization. *Firm variables* denotes the set of variables related to the real sector, which measure the demand-side of credit dollarization. *Controls* measures all other factors that affect both demand and supply of dollar credit, or which capture country-specific effects. Finally, u is a disturbance term.

We use pooled OLS (POLS) as the benchmark. We then extend the analysis and use the first difference (FD) and fixed effects (FE) estimators to control for missing country-specific effects and check the robustness of our results to alternative specifications. The results obtained using the random effects (RE) estimator are also reported. However, we believe that missing country-specific effects are more likely to be correlated with our regressors, so we mainly rely on the results obtained using the FD and FE estimators.

We have constructed a new unbalanced panel dataset for twenty-one transition economies from Central and Eastern Europe and Central Asia covering the period 1990 - 2001. Data on credit dollarization are annual, and were collected from various central bank publications. For some countries, data starts in the early 1990s. However, for most

countries, data covers the second half of the 1990s (see Table 2-2). The other variables come from various sources, mainly the International Monetary Fund's International Financial Statistics, the World Bank's World Development Indicators, and the European Bank for Reconstruction and Development Transition Reports (see the Table 2-1).

Credit dollarization is the ratio of foreign currency credit to total credit, from domestic banks to domestic (non-bank) enterprises. As bank variables, measures of deposit dollarization and bank net foreign assets are used. Deposit dollarization denotes the ratio of foreign currency deposits to total deposits held by residents at domestic banks. Bank net foreign assets denote the ratio of domestic banks' net foreign assets, to total deposits held by residents at domestic banks.

As firm measures we use exports, expressed as the ratio to GDP, correlation of export prices and the exchange rate, and correlation of domestic prices and the exchange rate. Based on the theoretical model, we need to control for the exchange rate volatility and the foreign interest rate. However, since we use measures of the stock (rather than the flow) of loans, [24] deposits, and bank foreign assets, we also include the rate of devaluation of the exchange rate to control for the valuation effects. Standard errors in the POLS, FE, and FD estimations are adjusted for heteroskedasticity and serial correlation, to further account for any persistence problems.

Table 2-3 reports descriptive statistics of the dependent and main explanatory variables used in the estimations. The average level of credit dollarization in transition economies is 38.2 percent, with a minimum of 1.7 percent in the Slovak Republic in

[24] We use stock measures due to data availability. However, we argue that this is a sensible measure, since bank loans in transition economies have a shorter maturity than in most developed economies. For example, the average credit period for bank loans (denominated in either domestic or foreign currency) for a sample of large firms for the period 1990 – 2001 is 70 days. The median credit period is even lower: 49.5 days.

1992, and a maximum of 84.8 percent in Albania in 2001. In general, the former Soviet Union and the South-Eastern European countries tend to be more dollarized then the (more developed) Central European countries.

In Table 2-4, a simple data analysis shows positive correlation of deposit and credit dollarization (0.582, P-value of 0.000). Net foreign assets, on the other hand, do not seem to be correlated with credit dollarization (-0.042, P-value of 0.607). On the firm side, exports seem to be negatively correlated with the level of financial dollarization (-.121, P-value of .131 for credit dollarization, and -.176, P-value of .020 for deposit dollarization), which is the opposite of what one would expect. A higher correlation of domestic prices and exchange rate is associated with more dollar loans, as expected (.198, P-value of .019), while the correlation of export prices and the exchange rate is not (.099, P-value of .243).

The estimation results are summarized in Table 2-5.[25] Regardless of the estimation method, bank asset and liability management are the main determinants of dollarization. Deposit dollarization has a large positive effect, while net foreign assets have a negative effect on credit dollarization. A one percentage point increase in deposit dollarization increases credit dollarization by .75 - .83 percentage points with the POLS and FE estimators, and by .44 - .57 percentage points with the FD and RE estimators. A one percentage point increase in net foreign assets decreases credit dollarization by .15 - .23 percentage points. It seems to be the case that domestic banks use dollar deposits to

[25] In addition to the regressors described before, we use a dummy variable in the POLS estimation, which takes the value one for Croatia, zero otherwise. According to Bonin (2001), most loans in Croatia are indexed to the German mark/Euro. These loans are equivalent to foreign currency loans for the purpose of this paper, but are instead recorded as domestic currency loans. This explains why in Croatia the average level of deposit dollarization is 68.6 percent, while credit dollarization is only 27.3 percent. Alternatively, we estimate the model without data on Croatia, and obtain very similar results for all our specifications.

"create" dollar loans, and foreign assets as a substitute for domestic dollar loans.

There is also evidence of a positive effect of exports on credit dollarization. Initially, with the POLS estimator, exports have a positive, but insignificant effect. This result and the initial negative correlation between exports and credit dollarization (see Table 2-4) suggest that this variable is correlated with unobserved country specific effects, and proxies for the overall level of development of the economy. Once we control for unobserved country effects, exports have a positive and very significant effect on credit dollarization. Thus, our results overturn the counterintuitive findings of previous papers (Arteta, 2003, and Barajas and Morales, 2003) that a higher level of trade and openness of the economy decrease the levels of dollar loans. These studies seem to suggest that partial dollarization is mainly an outcome of uncertainty. We show that dollarization is also driven by integration in the international good markets, and we expect it to persist even after uncertainty has been curbed.

The other firm-related measures are very insignificant, but have also very large standard errors, which suggest possible measurement problems. The exchange rate volatility and the foreign interest rate have the negative sign suggested by the model for three out of four estimations, although they are not significant. The rate of devaluation of the exchange rate is positive and mostly significant. It probably captures a valuation rather than a substitution effect.[26]

So far, we have identified the demand and supply side of the market for dollar loans, and have shown that both firm and bank variables are determinants of credit dollarization. Since the ultimate goal of the paper is to say something about the relative

[26] The level and volatility of the rate of devaluation of the exchange rate are highly correlated (.587, P-value of .000). However, no results change when one is dropped from the estimations.

importance of the two sets of factors, we compare the joint significance of firm and bank variables. In all cases, the F-statistic (or Chi-square, for the RE estimation) is higher for the bank factors relative to firm factors. Currency matching is therefore the main driving force of dollarization.[27]

4. Robustness Tests

There are two methodological issues that need to be further considered when estimating the above equation: the identification problem and endogeneity.

In order to be able to correctly identify and separate demand and supply factors, we need (at least) one demand-specific measure that does not affect the supply of foreign currency credit, and (at least) one supply-specific measure that does not affect the demand for foreign currency credit. Based on the theoretical model, we use measures of comovement of export (and domestic) prices and the exchange rate, as well as the ratio of exports to GDP. The comovement measures are very imprecise, and have no significant effects. Arguably, the exports, which turn out to have a strong positive and significant effect on credit dollarization might just measure an overall openness of the economy, and capture some bank effect as well. In the next set of estimations, reported in Table 5, we add a measure of the non-bank external trade credit, which we believe identifies the firm sector. On average, trade credit used by firms in transition economies is 3.23 percent of GDP, compared to total bank credit which is 19.85 percent of GDP. Firms that have access to alternative sources of external finance are expected to rely less on credit from

[27] One issue to point out is that while some year dummies are also significant, the country dummies are always very significant. This might indicate that dollarization levels vary widely across countries. Second, it might also be the outcome of country initial conditions and characteristics that are not explicitly measured. And third, it is the cross-section rather than the time dimension of the panel dataset that we explore, and not surprisingly the country dummies will be more significant than the time dummies.

domestic banks. Hence, we expect firms' trade credit from abroad to have a negative effect on credit dollarization, since we believe that external loans are a substitute for foreign currency loans from domestic banks.

We also use additional controls: an index of foreign exchange and trade liberalization, which should have a positive effect on credit dollarization, and a dummy variable for the existence/ development of forward exchange market, which presumably should reduce credit dollarization, as both banks and firms could use forward exchange contracts to hedge against exchange rate risk.[28] The ratio of net foreign reserves (held by the central bank) to GDP is used, together with the volatility of the devaluation rate, to proxy for the expectations about the future exchange rate. A higher level of reserves will signal higher sustainability of domestic currency/ less uncertainty with respect to the exchange rate (see also Ize and Parrado (2002)).

The new set of results is presented in Table 2-6. Trade credit has a negative and significant effect (with the FE, FD, and RE estimators) on credit dollarization, as expected, suggesting that firms use external trade credit as a substitute for dollar credit from domestic banks. This is consistent with Barajas and Morales (2003) who show that external credit is a substitute for the domestic foreign currency credit in Latin American economies.

The effects of other firm and bank variables do not change: more exports still lead to more loans denominated in dollars, while deposit dollarization still increases and net foreign assets reduce credit dollarization. Note that bank variables have a higher joint

[28] Burnside et al. (2000) argue that the forward market can be used to alleviate the bank currency mismatches, and banks can borrow in dollars, and lend in domestic currency. A similar argument applies to exporting firms: they can borrow in domestic currencies, and hedge against the currency risk using derivatives.

significance than the firm variables in all four estimations.

There is also a positive effect coming from the rate of devaluation, and a negative effect coming from its volatility. Net foreign reserves significantly reduce dollar loans. A one percentage point increase in net foreign reserves to GDP reduces credit dollarization by 0.8 – 1.1 percentage points with the POLS, FE, and RE estimations, and by .5 percentage points with the FD estimator. This last result is surprising since we expect uncertainty to decrease credit dollarization. Potential explanations link the use of financial instruments denominated in foreign currencies to costs associated with uncertainty and lack of credibility in domestic currency/ domestic macroeconomic policies. Jeanne (2001) argues that the uncertainty with respect to domestic monetary policy increases the cost of borrowing/lending in domestic currency (the so called "peso effect"), and therefore leads to more borrowing/lending in dollars. Similarly, Delgado et al. (2002) argue that uncertainty about potentially high future depreciation associated with a high real interest rate for domestic currency lending makes foreign currency lending more attractive, regardless of the risks involved.

Overall, higher liberalization of trade and foreign exchange operations leads to more dollar loans, but this effect is mostly insignificant. There does not seem to be any significant effect from the forward market indicator either.[29]

A second issue is the problem of endogeneity. Mainly, the measures of asset and liability management for banks and liability management for firms might be endogenous.

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[29] Transition economies countries are a good choice for studying determinants of dollarization beyond regulatory measures, since there does not seem to be too much variation in regulations: average level of the index of liberalization of trade and foreign exchange operations is 3.33 (with a range from 1, highly regulated, to 4.3, fully liberalized). Furthermore, the foreign exchange market is underdeveloped (if extant at all) in most countries: the average is .28 for the forward market dummy (a value of 1 indicating that the market exists and it is functional).

In the theoretical model we assume that deposit dollarization and bank net foreign assets are exogenously determined. This might not be the case, if firms maintain correspondent deposits with the banks that grant the loans. In addition, since we use low frequency data, the newly issued loans might temporarily increase the volume of firms' deposits. To verify that our results are not plagued by these problems, instead of the total deposit dollarization measure that includes both households and firms, we use only household deposit dollarization. Arguably, household deposit dollarization can be assumed to be supply-determined, and thus exogenous in this analysis.

Based on the simplified theoretical model, it is the net measure of foreign assets rather than its components, foreign assets and foreign liabilities, which matters.[30] But it can be argued that while foreign assets are more likely endogenous, foreign liabilities of domestic banks can be treated as exogenous, as they are mainly supply-determined. Separating net foreign assets into foreign assets and foreign liabilities will shed some light on these effects.

We believe that the estimated trade credit effect is not biased by endogeneity problems. Underdeveloped financial markets and few financing sources prompt firms to extensively employ trade credit as a cheaper alternative to bank credit. However, trade credit is constrained only to cross-border transactions and we can assume that it is predetermined in the loan demand equation.

For exports and the comovements, we use the same measures. If anything, the coefficient on exports might be biased upward, if firms depend on external finance (dollar loans) to finance exports.

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[30] Since the external interest rate is the same for assets and liabilities, only the net position matters.

These new results with the alternative bank measures are summarized in Tables 2-7 and 2-8. Notice first that the sample size is smaller, and that some countries (Georgia, the Kyrgyz Republic, Lithuania, and Macedonia) drop from the analysis. Nevertheless, bank variables are still significant with the FE, FD, and RE estimators: more household dollar deposits and foreign liabilities, and less dollar assets, lead to more dollar loans. Moreover, the effect of foreign liabilities is relatively larger than that of foreign assets.[31] Overall, bank variables are jointly significant in seven out of the eight estimations.

Firm measures, on the other hand, are only marginally significant. Exports are significant in one estimation only, while trade credit, although negative, is significant only in the FE estimation. The co-movement measure of export prices and exchange rate has now a negative but not always significant effect. This is a (country invariant) measure of primary commodity export prices (aggregated over all developing economies). Since transition economies are not major primary commodity exporters (except for the three big oil exporters), we think this variable may capture instead some import price effect. This would justify the negative effect. Overall, firm variables are jointly significant in only two out of the eight estimations.

Similar results are obtained if one-period lagged firm and bank variables are used instead of their contemporaneous values.

Other sensitivity tests performed involve further exploration of the uncertainty measures.[32] Results obtained so far seem to suggest that higher uncertainty of the future exchange rate leads to more credit dollarization. However, when the net foreign reserve

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[31] We compute the standardized coefficients for the FE and FD estimations. A one percent standard deviation increase in foreign assets reduces credit dollarization by .193 (.127) percent standard deviation in the FE (FD) estimation. A one percent standard deviation increase in foreign liabilities raises dollarization by .479 (.402) percent standard deviation in the FE (FD) estimation.

[32] These results are not presented in the paper, but are available upon request from the authors.

and rate of devaluation measures are combined into one "fear of floating" index a la Hausman et al. (2003) and Calvo and Reinhart (2003), the effect becomes insignificant. Thus, while the level of reserves does seem to matter a lot, the volatility measure, taken separately or combined with the exchange rate volatility, is insignificant.

The majority economists' view (see, for example, Burnside et al. (2000), Mishkin (1996), and Obstfeld (1998)) is that a fixed exchange regime offers implicit guarantees (implicit exchange rate insurance) and eliminates the need to hedge against the currency risk, provided that it is credible. This implies that over time a more flexible exchange rate should reduce credit dollarization. It also suggests that across countries the levels of dollarization should be higher in countries with fixed exchange rate regimes, when controlling for any credibility issues. The empirical evidence is mixed: Martinez and Werner (2002) find support for this hypothesis; Arteta (2003), on the other hand, shows that credit dollarization does not vary across exchange rate regimes, and higher flexibility exacerbates rather than ameliorates banking mismatches. When we use dummies for the "de facto" exchange rate regime (following Reinhart and Rogoff, 2004), we see a mixed picture. Limited flexibility exchange rate regimes will be less dollarized than the pegged ones, but the freely floating exchange rate regimes experience more dollarization.[33]

Summing up, all the evidence presented suggests the same conclusion: currency matching by banks of their assets and liabilities is the main driving force of credit dollarization. We have also identified two effects coming from the firm side: (i) firms hedge against exchange rate risk by denominating costs and revenues in the same currency, and (ii) firms use dollar loans as an alternative to external trade credit.

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[33] However, since only Albania has a freely floating exchange rate regime according to the classification we use, and it is also a highly dollarized economy, we are cautious about the implications of this result.

5. Conclusions and Future Extensions

Domestic banks in emerging markets and transition economies often grant to residents dollar instead of domestic currency credit. Is this credit dollarization phenomenon coming mostly from the financial side (banks), or from the real side (firms)? In the presence of financial dollarization without real dollarization, there exist balance sheet mismatches somewhere in the economy and the economy is highly exposed to financial and currency crises.

This paper analyzes the respective contributions of banks and firms to credit dollarization. We group potential determinants into bank- and firm-specific (financial and mainly real) factors, and use a newly-assembled database for twenty-two transition economies. We show that bank currency matching is the main driving force of credit dollarization. We find some evidence that real dollarization also causes financial dollarization, but this effect is relatively small. There are currency mismatches in these economies, and they seem to be concentrated in the real sector. Banks, who are supposed to do a better job at internalizing the exchange rate risk, just pass it over to firms. This decreases bank exposure to currency risk, but it increases their exposure to default risk, and ultimately the exposure of the economy to financial crises.

Not surprisingly, our findings suggest that one way to reduce dollarization is to reduce macroeconomic uncertainty and the lack of monetary policy credibility. Otherwise, as long as domestic deposits are highly dollarized, and banks want to match the currencies of their assets and liabilities, restrictions placed on dollar loans will most likely lead to "exports" of deposits and overall reduction in domestic credit.

This paper is one of the first attempts to empirically study credit dollarization. There are several possible extensions that deserve further consideration. First, we would like to extend the analysis to include other developing economies, especially Latin American countries where dollarization reaches very high levels. That would provide not only more data, but also suggest the generality of the conclusions. Transition economies are a good starting point as they provide a lot of variation in data; this can also be a downside, since it is sometimes hard to separate one effect from the others.

Second, using disaggregated data, such as individual loan data, would provide better insights into the effect of firm and bank characteristics on financial dollarization.

Third, more empirical work in general is necessary to better identify both the determinants and the effects of financial dollarization, and to evaluate policy implications and the exchange rate exposure of various economic agents and the overall economy.

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APPENDIX

Table 2-1 Data Definitions and Sources

VARIABLE	DEFINITION	SOURCE
Credit dollarization	Foreign currency denominated credit to total credit, from domestic banks to domestic enterprises, calculated as a percent. Data for a few countries include credit to individuals, financial enterprises and/or government.	CB
Deposit dollarization	Foreign currency denominated deposits to total deposits held by residents at domestic banks, calculated as a percent.	CB
Household deposit dollarization	Household foreign currency denominated deposits to total household deposits with the domestic banks, calculated as a percent.	CB
Bank net foreign assets	Bank foreign assets minus bank foreign liabilities (line 21...ZF... - line 26C...ZF), as a percent of total bank deposits.	IFS, CB
Exports	Total exports of goods and services as a percent of GDP.	WDI
Index of export prices	The index of primary commodity export prices for all developing countries (1995=100).	IMF_CP
Correlation of export prices and exchange rate	Annual correlation of monthly changes in the index of primary commodity export prices and the monthly rate of devaluation of the end-of-period dollar exchange rate	IMF_CP, IFS
Correlation of domestic prices and exchange rate	Annual correlation of monthly domestic inflation and the monthly rate of devaluation of the end-of-period dollar exchange rate	IFS
Exchange rate volatility	Annual standard deviation of the monthly rate of devaluation of the exchange rate	IFS
Foreign interest rate	Libor interest rate on the three-month USD denominated deposits	Economagic
Rate of devaluation of the exchange rate	Percentage change of the annual end-of-period exchange rate (expressed as domestic currency per USD, line RF..ZF...).	IFS
Net foreign reserves	Net reserves of the central bank as a percent of GDP (line 1L..DZF...*100/GDP).	IFS

Table 2-1 (Continued)

VARIABLE	DEFINITION	SOURCE
Foreign exchange and trade liberalization	Index of trade and foreign exchange rate system liberalization, =1 if widespread import and/or export controls or very limited legitimate access to foreign exchange, =2 if some liberalization of import and/or export controls, almost full current account convertibility in principle but with a foreign exchange regime that is not fully transparent (possibly with multiple exchange rates), =3 if removal of almost all quantitative and administrative import and export restrictions, almost full current account convertibility, =4 if removal of all quantitative and administrative import and export restrictions (apart form agriculture) and all significant export tariffs, insignificant direct involvement in exports and imports by ministries and state-owned trading companies, no major non-uniformity of customs duties for non-agricultural goods and services, full current account convertibility, =4.3 if standards and performance norms of advanced industrial economies, removal of most tariff barriers, WTO membership.	EBRD
Forward market liberalization	Dummy variable=1 if a forward market for foreign exchange exists and is functional, =0 if it does not exist or is underdeveloped.	AREAER
Peg Limited flexibility Managed float Free float Free fall	Dummy variables differentiating between pegged, limited flexibility, managed float, freely floating, and freely falling exchange rate regimes, according to Reinhart and Rogoff (2004) classification. These are all measures of the "de facto" regimes, classifies using information on parallel exchange markets.	Reinhart and Rogoff (2004)

Abbreviations: AREAER: IMF *Annual Report on Exchange Arrangements and Exchange Restrictions* (various issues). CB: Central Banks publications (various issues). IFS: International Monetary Fund *International Financial Statistics*. IMF_CP: IMF *Commodity Prices*. WDI: World Bank *World Development Indicators*. EBRD: European Bank for Reconstruction and Development *Transition Reports* (various issues). BIS: Bank of International Settlements *International Banking Statistics*.

Table 2-2 Country and Dollarization Data Coverage

Country	Data Availability
Albania	1998 – 2001
Armenia	2000 – 2001
Azerbaijan	2000 – 2001
Bulgaria	1990 – 2001
Croatia	1993 – 2001
Czech Republic	1993 – 2001
Estonia	1993 – 2001
Georgia	1997 – 2001
Hungary	1992 – 2001
Kazakhstan	1996 – 2001
Kyrgyz Republic	1999 – 2001
Latvia	1994 – 2001
Lithuania	1993 – 2001
Macedonia	1995 – 2001
Moldova	1999 – 2001
Poland	1997 – 2001
Romania	1990 – 2001
Russia	1996 – 2001
Slovak Republic	1992 – 2001
Slovenia	1991 – 2001
Ukraine	1992 – 2001

Table 2-3 Summary Statistics

VARIABLE	Credit dollarization	Deposit dollarization	Household dep. dollarization	Bank foreign assets	Bank foreign liabilities
Mean	38.192	36.689	35.921	40.117	32.691
Median	35.656	34.960	26.650	33.203	20.377
Std. Dev.	22.439	18.432	24.298	28.803	42.059
Minimum	1.689	3.598	0	6.265	0
Maximum	84.777	85.665	94.584	169.415	274.575
No. obs.	156	172	132	167	167

VARIABLE	Exports	Corr exp. prices and exch. rate	Corr dom. prices and exch. rate	Trade credit
Mean	41.133	.028	.151	3.232
Median	39.821	-.010	.181	1.699
Std. Dev.	17.497	.306	.375	3.977
Minimum	7.225	-.813	-1	.001
Maximum	91.140	1	1	22.696
No. obs.	249	197	190	168

Table 2-4 Correlation Matrix

	Credit dollarization	Deposit dollarization	Bank net foreign assets	Exports	Corr exp. prices and exch. rate	Corr dom. prices and exch. rate	Exch. rate volatility	Foreign int. rate
Deposit dollarization	.582 (156, .000)							
Bank net foreign assets	-.042 (154, .607)	.090 (167, .245)						
Exports	-.121 (156, .131)	-.176 (172, .020)	-.101 (167, .193)					
Corr. exp. prices and exch. rate	.099 (141, .243)	.036 (157, .656)	.071 (154, .382)	-.154 (197, .031)				
Corr. dom. prices and exch. rate	.198 (141, .019)	.094 (157, .243)	-.213 (154, .008)	-.051 (190, .482)	.183 (190, .011)			
Exch. rate volatility	-.025 (149, .763)	-.030 (165, .702)	-.481 (161, .000)	.180 (205, .010)	-.017 (197, .809)	.179 (190, .013)		
Foreign int. rate	-.050 (156, .538)	-.091 (172, .232)	.070 (167, .370)	-.170 (249, .007)	-.066 (197, .353)	-.000 (190, .995)	-.089 (205, .203)	
Devaluation rate	.002 (153, .979)	.050 (167, .524)	-.124 (165, .113)	-.055 (201, .435)	.068 (185, .359)	.005 (182, .458)	.587 (192, .000)	-.026 (204, .713)

Number of observations and P-values in parenthesis.

Table 2-5 Basic Model Estimation Results

	POLS	FE	FD	RE
Deposit dollarization	.839***	.753***	.440***	.570***
	(.150)	(.268)	(.147)	(.105)
Bank net foreign assets	-.218***	-.228***	-.149***	-.150***
	(.065)	(.072)	(.030)	(.035)
Exports	.027	.800***	.335**	.206*
	(.259)	(.294)	(.141)	(.112)
Correlation of export prices and exchange rate	-.257	.654	1.279	.728
	(6.183)	(4.698)	(2.078)	(2.820)
Correlation of domestic prices and exchange rate	2.377	-2.213	.189	.932
	(3.065)	(3.881)	(2.031)	(1.924)
Volatility of depreciation	-.209	-.142	.024	-.009
	(.193)	(.143)	(.087)	(.077)
Foreign interest rate	-2.197	-1.162	1.681**	-3.770*
	(3.346)	(2.099)	(.757)	(2.264)
Rate of depreciation of the exchange rate	.016	.018	.018*	.015**
	(.017)	(.012)	(.009)	(.006)
Obs.	141	141	120	141
No. countries	21	21	21	21
R-squared	.591	.777	.418	.383
Joint significance of bank variables	15.95	6.41	17.27	45.00
	(.000)	(.002)	(.000)	(.000)
Joint significance of firm variables	.23	2.69	3.50	4.30
	(.875)	(.050)	(.034)	(.231)

Robust standard errors in parentheses (adjusted for heteroskedasticity and serial correlation) for POLS, FE, and FD. Adjusted R-squared for POLS and FE, overall R-squared for RE.
For the joint significance tests, p-values are reported in parentheses.
Also included in the regressions are year dummies and a constant term.
***** Significant at 1%**
**** Significant at 5%**
*** Significant at 10%**

Table 2-6 Extended Regressions

	POLS	FE	FD	RE
Deposit dollarization	.762***	.693***	.479***	.579***
	(.206)	(.185)	(.158)	(.120)
Bank net foreign assets	-.211***	-.180***	-.118***	-.141***
	(.044)	(.042)	(.036)	(.038)
Exports	.082	.576**	.371*	.242**
	(.255)	(.279)	(.187)	(.115)
Correlation of export prices and exchange rate	-8.533	-.402	1.521	.969
	(7.922)	(3.848)	(3.337)	(3.258)
Correlation of domestic prices and exchange rate	1.334	.346	.365	1.537
	(4.295)	(3.316)	(2.428)	(2.275)
Trade credit	-.245	-2.499**	-2.474*	-1.621**
	(.697)	(1.113)	(1.366)	(.650)
Volatility of depreciation	-.279*	-.213*	-.055	-.069
	(.156)	(.113)	(.051)	(.086)
Foreign interest rate	-.352	-.069	1.101***	-.018
	(.611)	(.400)	(.352)	(.450)
Rate of depreciation of the exchange rate	.027*	.023*	.013	.015**
	(.015)	(.012)	(.009)	(.007)
Net foreign reserves	-1.119**	-1.134***	-.519*	-.829***
	(.429)	(.404)	(.288)	(.259)
Foreign exchange and trade liberalization	7.257*	2.377	-.723	-.083
	(3.630)	(2.982)	(1.597)	(2.547)
Forward market liberalization	1.838	-8.848		-3.261
	(5.788)	(9.705)		(5.582)
Obs.	119	119	84	119
No. countries	21	21	21	21
R-squared	.657	.872	.461	.414
Joint significance of bank variables	13.32	11.95	14.38	36.21
	(.000)	(.000)	(.000)	(.000)
Joint significance of firm variables	.53	1.85	3.61	11.48
	(.718)	(.128)	(.023)	(.022)

Robust standard errors in parentheses (adjusted for heteroskedasticity and serial correlation) for POLS, FE, and FD. Adjusted R-squared for POLS and FE, overall R-squared for RE.
For the joint significance tests, p-values are reported in parentheses.
Also included in the regressions are year dummies and a constant term.
***** Significant at 1%**
**** Significant at 5%**
*** Significant at 10%**

Table 2-7 Basic Model with Household Deposit Dollarization

	POLS	FE	FD	RE
Household deposit dollarization	.267	.459***	.278***	.275***
	(.166)	(.163)	(.091)	(.101)
Bank foreign assets	-.025	-.251	-.100*	-.083
	(.173)	(.161)	(.047)	(.059)
Bank foreign liabilities	.253	.387*	.269**	.251***
	(.188)	(.222)	(.106)	(.069)
Exports	-.188	.666*	.277	.090
	(.305)	(.339)	(.164)	(.136)
Correlation of export prices and exchange rate	-2.240	-5.957	1.178	.107
	(8.150)	(6.863)	(2.446)	(3.266)
Correlation of domestic prices and exchange rate	-1.536	-5.976	-2.114	-1.788
	(3.369)	(4.820)	(2.086)	(2.056)
Volatility of depreciation	.455*	.607	.270	.294*
	(.222)	(.379)	(.256)	(.159)
Foreign interest rate	-9.498***	-7.031***	3.375***	-5.396**
	(3.267)	(2.621)	(1.005)	(2.294)
Rate of depreciation of the exchange rate	.048**	.012	.017	.022**
	(.021)	(.025)	(.017)	(.011)
Obs.	117	117	100	117
No. countries	17	17	17	17
R-squared	.530	.768	.470	.325
Joint significance of bank variables	6.23	2.74	5.35	21.53
	(.005)	(.049)	(.010)	(.000)
Joint significance of firm variables	.19	2.19	1.26	1.01
	(.900)	(.095)	(.320)	(.799)

Robust standard errors in parentheses (adjusted for heteroskedasticity and serial correlation) for POLS, FE, and FD. Adjusted R-squared for POLS and FE, overall R-squared for RE.
For the joint significance tests, p-values are reported in parentheses.
Also included in the regressions are year dummies and a constant term.
***** Significant at 1%**
**** Significant at 5%**
*** Significant at 10%**

Table 2-8 Extended Regressions with Household Deposit Dollarization

	POLS	FE	FD	RE
Household deposit dollarization	.221	.263**	.204	.182
	(.196)	(.124)	(.213)	(.119)
Bank foreign assets	-.027	-.196*	-.058	-.048
	(.145)	(.112)	(.044)	(.069)
Bank foreign liabilities	.209	.146	.143*	.165**
	(.165)	(.095)	(.081)	(.083)
Exports	-.116	.289	.370	.107
	(.327)	(.283)	(.330)	(.149)
Correlation of export prices and exchange rate	-16.676**	-10.291*	-1.179	-3.749
	(6.851)	(5.556)	(3.624)	(3.885)
Correlation of domestic prices and exchange rate	-3.827	-1.436	-.625	-.907
	(3.880)	(3.320)	(2.122)	(2.548)
Trade credit	-.765	-3.057*	-2.130	-1.687**
	(.889)	(1.605)	(1.658)	(.792)
Volatility of depreciation	.293	.283	.356	.368
	(.389)	(.362)	(.324)	(.280)
Foreign interest rate	-6.922**	-.792	.297	-.825
	(2.567)	(.522)	(.423)	(.516)
Rate of depreciation of the exchange rate	.052***	.050***	.024	.027
	(.017)	(.015)	(.020)	(.017)
Net foreign reserves	-1.057	-.767*	-.186	-.497*
	(.654)	(.443)	(.347)	(.296)
Foreign exchange and trade liberalization	.318	4.132	-.840	-1.625
	(6.671)	(4.596)	(1.955)	(3.726)
Forward market liberalization	-2.441	-16.087*		-7.353
	(8.192)	(9.543)		(6.065)
Obs.	98	98	69	98
No. countries	17	17	17	17
R-squared	.612	.865	.512	.367
Joint significance of bank variables	4.23	2.05	5.84	6.99
	(.022)	(.117)	(.007)	(.072)
Joint significance of firm variables	2.26	2.50	.66	6.05
	(.108)	(.052)	(.625)	(.195)

Robust standard errors in parentheses (adjusted for heteroskedasticity and serial correlation) for POLS, FE, and FD. Adjusted R-squared for POLS and FE, overall R-squared for RE.
For the joint significance tests, p-values are reported in parentheses.
Also included in the regressions are year dummies and a constant term.
***** Significant at 1%, ** Significant at 5%, * Significant at 10%**

PART THREE. CURRENCY MISMATCHES AND BANKING CRISES

1. Introduction

Many economies in Eastern Europe and Central Asia experienced banking instability in the 1990s[34]. Prolonged banking crises extended for most of the decade and in many cases they were result of the inability of the central bank to maintain credibility in the domestic currency. As incidents of free falling exchange rate peaked and were followed by a peak in the occurrence of banking crisis, it is likely that large exchange rate depreciation may have resulted in banking crises in transition economies, or made them more severe. Given that these countries had underdeveloped financial markets and had not yet established strict banking regulations for monitoring exchange rate risk, balance sheet currency mismatches[35] were a possible channel for transmission of exchange rate shocks to the banking system.

This paper explores the link between currency mismatches and banking crises in the countries of Eastern Europe and Central Asia. Balance sheet currency mismatches have been blamed for financial crises in Asian and Latin American countries during the 1990s. Mishkin (1997) suggested that differences in the currency structure of firms' and banks' revenues and debt reinforced the Mexican banking crisis. Krugman (1999) stated that currency mismatches in firms' balance sheets deepened the Asian banking crises with the onset of currency crises. Considering the experience of Asian and Latin American countries, it is likely that currency mismatches have made exchange rate instability more harmful for the banking systems in transition, as well.

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[34] See Appendix 1 and 2.

[35] A currency mismatch exists when assets and liabilities have different currency structures.

Central bank weakness and lack of credibility in the early 1990s forced many savers to prefer foreign over domestic currency deposits. Domestic capital was scarce and foreign capital entered the countries as bank deposits in foreign currency. With high deposit dollarization[36] and limited options to diversify their portfolios, banks granted a larger proportion of their loans in foreign currency. Reduction in trade barriers and the prospects of selling in the world markets also fostered the increase in foreign currency loans.

However, financial markets in transition economies lacked a scope of services and instruments, and economic agents had limited ability to insure themselves against different types of risks. Thus, unhedged open currency positions were common for both banks and firms. Even when restrictions on open currency positions were introduced to limit banks' direct exchange rate risk, they brought about an additional source of loan default when banks transferred the unhedged exchange rate risk to their borrowers.

With no markets to spread the risk, banks and firms were likely to exhibit risk aversion and only mismatch to the extent that they have covered the expected exchange rate risk. Thus, if firms had stronger risk aversion than banks, the level of credit dollarization would resemble firm's revenue pattern and vise versa. Luca and Petrova (2004) find that the two most important factors of credit dollarization in transition economies were banks' foreign currency deposits and net foreign assets. There is very weak evidence that trade might have had an impact on credit dollarization. These facts suggest that banks tended to be more risk averse or under stricter obligation to match

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[36] Financial dollarization occurs when a significant share of residents' domestic financial contracts (including deposits and loans) are denominated in foreign currencies, not necessarily the US dollar. Dollar deposits and loans denote all foreign currency deposits and loans. Deposit dollarization and credit dollarization refer to the phenomenon of denominating deposits and loans in foreign currencies.

their assets and liabilities. In any case, they had stronger incentives to avoid direct exchange rate risk. However, the transfer of this risk did not eliminate it, it transformed it into default risk. Since most borrowers were state-owned enterprises, banks may have been further induced to transform risk because of governments' implicit guarantees on claims to these enterprises, while direct exchange rate losses were much less tolerated. Thus, banks were willing to take on higher default risk while avoiding exchange rate risk altogether.

This paper builds on the results from Luca and Petrova (2004) that identify the sector bearing the concentration of exchange rate risk. It explores whether the concentration of exchange rate risk through mismatched balance sheets has increased the probability of banking crises and whether the transfer of risk away from the banking sector has reduced the threat to the banks. If banks in transition economies have avoided direct exchange rate risk, were they ultimately able to prevent the loss of net worth due to exchange rate fluctuations?

The paper models the case of small open economies which are unable to borrow externally in their own currency and have poor domestic currency credibility. Depositors determine the currency composition of banks' deposits and firms receive revenues in foreign currency that depend on world prices and external demand. The equilibrium level of credit dollarization depends on firms' and banks' expected revenues in foreign currency and their ability to absorb exchange rate risk. Thus, in a partial equilibrium analysis, the paper combines two strands of the currency (mis)matching literature. The first focuses on firms' incentives to reduce exposure to exchange rate risk (Kawai (1981), Giraldi and Hamaui (1991), Cotner (1991)). Matching firms' revenues and debt currency

structures occurs if firms have no access to hedging opportunities through the forward market (Kawai (1981)). The second strand of the literature describes banks' currency matching incentives. Banks match their deposit and loan currency structures as long as they are not protected from exchange rate risk in some way, e.g. a fixed exchange rate (Ize and Levy-Yeyati (2003)).

If banks' risk aversion dominates, banks avoid exchange rate risk. However, by doing so, banks may create a currency mismatch in firms' balance sheets and face higher default risk on their portfolios. On the other hand, if firms' matching dominates, banks accommodate the currency structure of borrowers' revenues and debt payments and absorb the increased exchange rate risk[37]. A Diamond-Dybvig (1983) – style model describes the link between banks' and firms' optimal currency mismatches to poor bank net worth and bank runs.

A common approach used in the theoretical literature to connect currency mismatches to banking crises is to assume that firms' and banks' hedging incentives are distorted by regulations or macroeconomic policy. Mismatches (and financial crises, respectively) occur because government intervention (guarantees to foreign investors) fosters overborrowing in foreign currency by the non-tradable sector (Burnside et. al. (2000), Schneider and Tornell (2000), MacKinnon and Pill (1998)). Chang and Velasco (1998) show that banking crises (more specifically, panics) are more likely in a country with limited foreign currency reserves if the exchange rate regime is fixed rather than

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[37] Levy-Yeyati (2003) and De Nicolo et al. (2003) discuss some additional balance sheet effects related to currency matching in the banking sector. Even if banks match the currency structure of their assets and liabilities, there is a risk inflicted by foreign currency denominated government debt when the government receives revenues in domestic currency only. If banks are primary holders of this type of debt, they face default risk if the currency depreciates. Delgado et al. (2002) point out that an increased default risk may prompt additional currency risk if banks set aside loan-loss provisions on foreign currency loans, thus turning a covered position into an open currency one.

floating.

In this paper the degree of risk aversion summarizes distortionary regulation. Thus, the emphasis is not to look for the culprit of banking crises, but to identify whether currency mismatches have served as a transmission channel of exchange rate shocks to the banking system. However, the implications raise questions whether the government should implement policies that (while protecting investors) enforce firms' and banks' risk taking behavior.

The paper contributes to the financial dollarization literature, which has recently turned its focus on the implications of dollarization for financial stability. Arteta (2003) and De Nicolo et al. (2003) look for a direct causality from dollarization to bank losses and crises. Arteta (2003) does not find evidence that dollarization (deposit or credit) has any effects on banking stability or that banking and currency crises are more costly if banks face higher dollarization ratios. De Nicolo et al. (2003) find a direct relationship between dollarization and banking stability but they only consider the effects of deposit dollarization. Instead, it is argued here that dollarization is not harmful unless it creates a mismatch in either firms' or banks' balance sheets and that mismatches prompt banking crises only in interaction with large unexpected changes in the exchange rate[38].

Secondly, this paper contributes to the less explored area of the determinants of banking crises in transition economies. Although it does not claim that currency mismatches have been the main reason for the occurrence of banking crises in these

[38] While not looking for an effect of currency mismatches on the probability of banking crises, Demirgüç-Kunt and Detragiache (2002) and Beck at al. (2003) attempt to control for banks' exchange rate risk. Both studies include exchange rate depreciation and the ratio of M2 to foreign exchange reserves in their estimations and find a positive relation between depreciation and banking crises. However it is significant only in Demirgüç-Kunt and Detragiache (2002).

countries[39], it certainly shows that currency mismatches have prolonged the crises.

This study uses a panel data set for 21 transition economies. The benchmark econometric model used in the paper is probit but the results are compared to a linear probability model. The main findings of the econometric analysis are:

- There is strong evidence that banks in transition economies are exposed to default risk related to currency mismatches in firms' balance sheets. This result is obtained when currency mismatches are measured with credit, deposit and real dollarization levels.
- With an overall measure of banks' foreign currency positions that includes foreign assets and liabilities, the results show that in addition to default risk, banks also face direct exchange rate risk, even though their open positions are generally very small.
- There is evidence that foreign exchange and trade liberalization has increased, while institutional development of transition economies banking systems has reduced, the likelihood of banking crises.

The paper is organized as follows. Section 2 provides a theoretical framework relating currency mismatches to the possibility of banking crises and bank runs and discusses its empirical implications. Section 3 defines the econometric model and estimation methods. Section 4 describes the data. Estimation results are presented in Section 5. Section 6 discusses some policy implications and concludes the analysis.

[39] Inarguably, institutional factors are far more important.

2. A Simple Model

If foreign currency deposits are predetermined or exogenously determined by capital inflow and exports depend on external demand, the possibility of an economy-wide currency mismatch raises the question whether banks can avoid losses resulting from domestic currency depreciation. This Diamond and Dybvig (1983)- style model of bank runs shows that a mismatch in either banks' or firms' balance sheets can channel exchange rate shocks to the banking system and increase the probability of a banking crisis.

There is an infinite number of depositors, each of whom owns a unit of savings. A proportion d^f of the depositors holds foreign currency, while a proportion $d=1-d^f$ holds local currency.

Depositors live for two periods. With probability ϕ, they will consume only in the first period, while with probability $1-\phi$, they will consume and need liquidity only in the second period. At time 0 depositors – and any other market participant – know only the probability ϕ, but not whether an individual depositor is an early or late consumer.

Depositors have access to a safe storage technology that yields 1 in periods 1 and r in period 2 on both domestic and foreign currency savings. Depositors face a prohibitive cost of monitoring producers and, in the absence of financial intermediation, will prefer to put their savings in the storage technology.

There is an infinite number of firms distributed between 0 and 1, each of whom owns a unit of capital and has access to a Leontief technology. Firms use a second input in fixed proportion to capital to produce output Y in period 2. They finance the purchase of the input with loans in foreign, l^f, and domestic, l, currency. Firms' revenues are

realized in period 2 in either domestic or foreign currency, in period 1 firms earn 0. A proportion n^f of the output (determined by foreign demand) is exported and yields revenue $n^f p^*(1+\varepsilon_1)(1+\varepsilon_2)Y$. The rest sells in the domestic market and brings return equal to npY. It is assumed that purchasing power parity holds at period 0, $p^*=p$, and $p^*Y>r$. ε_1 and ε_2 denote the depreciation rate of the real exchange rate of local currency with respect to the U.S. dollar between periods 0 and 1 and between periods 1 and 2, respectively. It is assumed that ε_1 and ε_2 are independently distributed and $E_0(\varepsilon_1)=E_0(\varepsilon_2)=0$, $Var_0(\varepsilon_1)=Var_0(\varepsilon_2)=\sigma_\varepsilon^2$.

Firms' second period profit function is

$$\Pi^f = n^f p^*(1+\varepsilon_1)(1+\varepsilon_2)Y + npY - r_L l - r_L^f(1+\varepsilon_1)(1+\varepsilon_2)l^f$$

They maximize expected utility of profits

$$E\left[\Pi^f\right] - \frac{1}{2}\gamma Var\left[\Pi^f\right]$$

and their demand for foreign and domestic currency loans is

$$l^f = \frac{-[r_L^f(1+\varepsilon^e) - r_L] + \gamma 2\sigma_\varepsilon^2 n^f p^* Y r_L^f}{\gamma 2\sigma_\varepsilon^2 r_L^{f\,2}} = \frac{-[r_L^f(1+\varepsilon^e) - r_L]}{\gamma 2\sigma_\varepsilon^2 r_L^{f\,2}} + \frac{n^f p^* Y}{r_L^f}$$

$$l = 1 - l^f$$

where r_L and r_L^f denote the interest rates on domestic and foreign currency loans, and γ is firms' coefficient of risk aversion.

A single bank accepts deposits and extends loans in both domestic and foreign currency and faces no monitoring cost. Its second period profit function is

$$\Pi^b = r_L l + r_L^f (1+\varepsilon_1)(1+\varepsilon_2) l^f - r_D d - r_D^f (1+\varepsilon_1)(1+\varepsilon_2) d^f$$

where r_D and r_D^f denote the interest rates on domestic and foreign currency deposits.

The bank is risk averse and maximizes

$$E[\Pi^b] - \frac{1}{2}\delta Var[\Pi^b]$$

where δ denotes banks' degree of risk aversion.

The supply of foreign currency loans is

$$l^f = \frac{[r_L^f (1+\varepsilon^e) - r_L]}{\delta 2\sigma_\varepsilon^2 r_L^{f\,2}} + d^f$$

In equilibrium interest rates on loans and deposits in the same currency are equal, but there is a premium on foreign currency loan and deposit interest rates.

$$r_L^f = r_D^f = r$$

$$r_L = r_D = r[1 - 2r\delta\sigma_\varepsilon^2 (l^f - d^f)]$$

The equilibrium loan dollarization level in this economy is

$$l^f = \frac{\gamma}{\gamma+\delta}\frac{n^f p^* Y}{r} + \frac{\delta}{\gamma+\delta} d^f$$

Thus, the more risk averse sector has a larger impact on the degree of credit dollarization, while the other bears the exchange rate risk.

Depositors will use bank services if at time 0 they expect that the bank will be liquid in period 1 and solvent in period 2. To ensure that it has enough liquidity in the first period, the bank invests a proportion ϕ of the domestic and foreign currency deposits in the storage technology. Therefore, depositors will invest in the bank if

$$(1-\phi)\left\{r\left(l^f-d^f\right)+r(l-d)\left[1-2r\delta\sigma_\varepsilon^2\left(l^f-d^f\right)\right]\right\}=(1-\phi)\left\{2\delta\sigma_\varepsilon^2 r^2\left(l^f-d^f\right)^2\right\}\geq 0$$

which is always satisfied.

Depositors learn in period 1 whether they are early or late consumers. However, this information is not revealed to the bank and late consumers may run on the bank if they expect that it may become insolvent in period 2. The bank is expected to be solvent in period 2 if its expected net worth is positive

$$\begin{aligned}&E_1[W_2]=(1-\phi)min\left\{p^*Y\left(n^f(1+\varepsilon_1)E_1[1+\varepsilon_2]+n\right)\right.\\&\left.r\left(l^f(1+\varepsilon_1)E_1[1+\varepsilon_2]+l\left[1-2r\delta\sigma_\varepsilon^2\left(l^f-d^f\right)\right]\right)\right\}\\&-(1-\phi)r\left[d^f(1+\varepsilon_1)E_1[1+\varepsilon_2]+d\left[1-2r\delta\sigma_\varepsilon^2\left(l^f-d^f\right)\right]\right]\geq 0\end{aligned}$$

The first term in this expression is the gross repayment by the firms. It depends on the proportion of exported output, credit dollarization and the realized and expected depreciation. If the gross interest payment is larger than firms' revenues, it is assumed that the bank can appropriate firms' revenues without a cost[40]. The second term is the repayment to late consumers in domestic and foreign currency.

2.1. Demand Driven Credit Dollarization (δ=0)

Firms would prefer to borrow in the currency in which they receive their revenues in order to avoid the exchange rate risk. Consequently, if the bank can hedge against the exchange rate risk, it may consider matching the currency of borrowers' revenues and expenditures to minimize loan defaults. Thus, the bank absorbs the currency risk and

[40] The maximum amount that the bank is able to collect from a borrower in case of default is the borrower's gross return.

offers foreign currency contracts in proportion to exports. Dollarization of bank's assets is entirely driven by the openness of the real economy and the demand for foreign currency loans.

$$l^f = \frac{n^f p^* Y}{r}$$

Thus, firms' and banks' currency mismatches are

$$n^f - l^f = n^f \left(1 - \frac{p^* Y}{r}\right)$$

$$l^f - d^f = n^f \frac{p^* Y}{r} - d^f$$

and the banks' expected net worth becomes

$$E_1[W_2] = (1-\phi) min\left\{\left(n^f p^* Y - l^f r\right)\left[(1+\varepsilon_1)E_1[1+\varepsilon_2]-1\right] + p^* Y - r, 0\right\}$$
$$+ (1-\phi)\left(l^f - d^f\right) r\left[(1+\varepsilon_1)E_1[1+\varepsilon_2]-1\right]$$
$$= (1-\phi)\left(n^f \frac{p^* Y}{r} - d^f\right) r\left[(1+\varepsilon_1)E_1[1+\varepsilon_2]-1\right]$$

When the domestic currency depreciates and is expected to depreciate in the second period, the expected net worth of the bank increases when it has relatively more dollarized loans than deposits. To avoid banking crisis with certainty, the depreciation rate and the bank currency mismatch need to move in the same direction. However, if the bank has a negative foreign currency position, such that $n^f p^* Y/r - d^f < 0$, any increase in the depreciation reduces bank's net worth.

2.2. Bank Currency Asset and Liability Matching

The bank matches its assets and liabilities if firms are risk averse or if there are restrictions on banks' open foreign currency positions[41]. However, should a bank maintain the same proportion of foreign currency assets and liabilities, it passes the exchange rate risk onto its borrowers. In this case, the bank becomes exposed to default risk when producers are not able to meet their obligations due to large exchange rate fluctuations. Therefore, the banks may have to cope with reduced net worth and the possibility that depositors will run even though it is not exposed to exchange rate risk.

The banks' and firms' currency mismatches equal

$$l^f - d^f = 0$$

$$n^f - l^f = n^f - d^f$$

while the expected net worth change is

$$E_1[W_2] = (1-\phi)min\left\{\left[n^f p^* Y - l^f r\right](1+\varepsilon_1)E_1[1+\varepsilon_2]-1] + p^* Y - r, 0\right\}$$
$$+(1-\phi)\left(l^f - d^f\right)r[(1+\varepsilon_1)E_1[1+\varepsilon_2]-1]$$
$$= (1-\phi)min\left\{\left[n^f p^* Y - d^f r\right](1+\varepsilon_1)E_1[1+\varepsilon_2]-1] + p^* Y - r, 0\right\}$$

In this case, the critical expected depreciation rate still moves in the direction of the mismatch. If deposits are more dollarized than firms' revenues, the critical depreciation rate becomes

$$\{(1+d_1)E_1(1+d_2)-1\} = -\frac{p^* Y - r}{n^f p^* Y - d^f r}$$

This equality shows that the higher capital productivity relative to the real interest rate and the higher the exports, the higher the depreciation that the bank will be able to

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[41] By 1999 most transition economies have adopted restrictions on open currency positions.

overcome.

This model has some important empirical implications. First, deposit or loan dollarization, per se, does not affect the stability of the banking system. There must be a mismatch in the currency structure of the banks' balance sheets or in the real sector for dollarization to have an effect on bank solvency. Second, even if a mismatch exists, it would not pose a threat for the banks unless the exchange rate fluctuates. Therefore, any effect of the open position in foreign currency or of the deposit or credit dollarization on the probability of a banking crisis should be jointly examined with the effect of the changes in the exchange rate.

3. Econometric Model and Estimation Methods

This theoretical framework is used to develop an econometric model to test whether currency mismatches in the real and the banking sector affect the stability of the banking system. The probability of a banking crisis is defined as

$$Prob(bcrisis \mid cd,\ dd,\ rd,\ deprate,\ other\ controls\ )$$
$$= g(cd,\ dd,\ rd,\ deprate,\ other\ conrols)$$

where *bcrisis* is 1 if there is a banking crisis, and zero otherwise. Variable *cd* is the ratio of dollar credit to total firm credit, *dd* is the ratio of dollar deposits to total deposits in the banking system, and *rd* measures real dollarization or the ratio of the exports to GDP. $G(\cdot)$ is the conditional probability function of a banking crisis. Other controls include variables that shape the banking system structure, and the regulatory and macroeconomic environment.

The primary econometric model used here is probit. Specifically, the sign of the

latent variable, net worth, indicates whether there is a banking crisis or not. Following the theoretical model

$$Prob(bcrisis=1 \mid net\ worth<0)$$

where negative net worth is defined as

$$-(net\_worth) = \beta_1 + \beta_2 deprate + \beta_3 mismatch + \beta_4 mismatch * deprate + \xi_1' other\_controls + u_1$$

β_4 is expected to take negative values as predicted by the theoretical model[42]. The sign of β_2 will depend on the level of mismatch at which the effect of depreciation is estimated. For positive values of the mismatch, the depreciation rate should have a negative coefficient, while for negative values of the mismatch, the effect of real depreciation should be positive. Similarly, the sign of β_3 depends on the rate of depreciation at which the effect of the mismatch is estimated.

Due to the use of panel data, there might be significant country effects. A second issue that arises from the data set and the selection of countries is persistence in the dependent variable. Some transition economies (Czech Republic, Slovakia, Romania) have struggled with problems in the banking system throughout the 1990's. To resolve this issue, onset of banking crisis can be used as a dependent variable[43]. However, multiple triggers of a banking crisis may exist and, even if not causing a crisis itself, they

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[42] The econometric model actually defines the negative net worth as a latent variable, and so all coefficients should have an opposite sign from the one in the theoretical model.

[43] Glick and Hutchison (2000), Domaç and Martinez-Peria(2001), Arteta (2003) and others have adopted this approach. Demirgüç-Kunt and Detragiache (1998, 2002) throw out all observations after the initial onset of the banking crisis. In a study of the effect of concentration on banking crises, Beck et al. (2003) use the second approach as a benchmark. They compare the benchmark results to the results obtained when all observations after the initial onset date are considered to be crisis periods, and when all observations after the initial date are considered to be non-crisis periods. In their study, the method does not have an effect on the main conclusions.

may contribute to its persistence after the onset. Moreover, using only the onset of banking crises will not provide any interesting insights on the incidence of such events in transition economies. For this reason it is important to maintain the entire period of a banking crisis in the sample data.

Ideally, a full set of country dummies should be included in the probit model to control for the country effects. However, the data set does not support the use of probit with country dummies, since some countries were in a banking crisis during the whole sample period[44], while others experienced no banking crisis at all[45]. A linear probability model (LPM) with full set of dummies is used in parallel with the probit model[46] to control for the individual country effects.

Since a banking crisis may occur at any time during the year, while all stock variables and variables controlling for regulations are reported at the end of the year, all independent variables are taken with a lag.

4. Data

This paper conducts empirical analysis using an unbalanced panel dataset. The data used in the panel are annual for the period 1990-2001. Tables 3-1 and 3-2 in the Appendix present data description and sources while Figure 3-2 shows data summary statistics.

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[44] Azerbaijan, Czech Republic, Latvia, Romania, and Slovak Republic.

[45] Armenia, Georgia, Kazakhstan, Kyrgyz Republic, Macedonia, and Moldova.

[46] One drawback of using LPM is that the errors are undoubtedly heteroskedastic and the standard errors must be corrected. A second issue with using LPM is the functional form. Equation (3) in the theoretical model shows that the net worth is linear in the variables for currency mismatch and in the interactions between them and the depreciation rate. The probability of a banking crisis is certainly not linear in these variables. However, the goal is not to predict banking crises but rather to find whether there is evidence that currency mismatches contribute to the incidence of banking crises.

Information about the incidence of systemic banking crises is obtained from World Bank studies. The most comprehensive source is Caprio and Klingebiel (2003). A banking crisis is defined as systemic if most or all of the banking system capital is eroded (Caprio and Klingebiel, 1999).[47] Compiled this way, the sample contains 121 observations with 54 periods of existing banking crises and 6 episodes of onset of banking crises.

4.1. Variables Specified in the Theoretical Model

Real dollarization is measured as the ratio of exports to GDP in percentage terms. Deposit dollarization is the ratio of foreign currency denominated deposits to total deposits. Credit dollarization is the ratio of non-bank sector foreign currency credit to non-bank sector total credit. Banks' currency mismatch is measured by the difference in credit and deposit dollarization, while firms' currency mismatch is the difference between real and credit dollarization. Measured this way, the currency mismatch in banks' balance sheets represents the difference in the currency structure of bank loans and deposits. The firms' mismatch measures the difference in the currency structure between firms' revenues and firms' bank loans.

The depreciation rate measures the change in the end of period exchange rate to the US dollar. The depreciation rate of the real exchange rate is calculated from the nominal rate by correcting for domestic inflation. Currency crises dates are calculated from monthly end of period exchange rates. A currency crisis is any occasion when the

[47] Crisis dates from Tang et al. (2000) are used where data are missing from Caprio and Klingebiel (2003). Data for Moldova are from annual reports of the central bank. Although fairly underdeveloped as rated by the EBRD, the banking system of Moldova seems to have avoided major distress including during the Russian crisis of 1998.

local currency depreciates in real terms per month by more than two standard deviations from the average monthly depreciation in any month of the year, or the monthly depreciation is more than 15 percent and 10 percentage points higher than the previous month. With these requirements it is insured that the currency crises are truly unusual and significant events.[48].

4.2. Other Determinants of Banking Crises

The theoretical model presented in this paper treats only issues related to the currency and structure of the banks' balance sheets, and shows how the mismatch may trigger instability. However, there are some institutional and macroeconomic factors that must be controlled for. In transition economies – where the institutional framework is still being built and consistent macroeconomic policies are still being established – the structure of the banking sector, regulations, and policy measures may have much larger effects on the stability of the banking system than banks' portfolio choices. In fact, it is likely that the institutional framework dictates banks' balance sheet management choices[49].

In the early transition years, most banks were state owned: spawned from a few highly specialized banks or from a single bank responsible for government financing and the distribution of credit resources to state owned enterprises. The newly established

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[48] I also compared the dates with the rule given by Frankel and Rose (1996) – 25 % annual depreciation of the average exchange rate and more than 10% change in the depreciation rate. Since a currency crisis may be a very short-term event, the dates determined on a monthly basis is the preferred method here. However, these dates do not differ significantly from the ones determined using Frankel and Rose rule.

[49] A survey of bank regulations and supervisions compiled by Barth et al. (2001) gave rise to a significant amount of literature studying the effects of institutions on bank performance. Unfortunately, the survey data cover only 1998 and/or 1999 and are not appropriate for use with the panel data in this paper.

banks inherited their asset portfolios from the previous regime. They were often coerced by the government to lend to specific sectors or enterprises and in most cases, bank management was unwilling or unable to deal with the severe asymmetric information problems they faced. These institutional problems translated into weak balance sheets and the subsequent depletion of banks' net worth in most transition economies[50]. Only after governments divested from the state-owned banks, and rules on capital adequacy, currency positions, and limits on credit to single borrowers and related parties were imposed and enforced, did the incidence of banking crises decrease.

To control for institutional and regulatory development of the banking system, an index of banking reform is included in the regressions. An index of foreign exchange and trade liberalization controls for liberalization of banking services in the capital account.

Concentration in the banking sector plays a role in systemic stability. High concentration allows for large profit margins and having a few large banks provides banks with a buffer against adverse shocks. Beck et al. (2003) find strong empirical evidence for this idea[51]. On the other hand, large banks tend to be central banks' favorites when it comes to last resort lending. Also, governments in transition economies often substitute large commercial banks' bad loan portfolios for safe government bonds. This government appropriation of risk only exacerbates the adverse risk taking behavior of bank managers and makes it more likely for banks to fail. Thus, the sign of the concentration variable cannot be predicted in advance. A measure of the three largest banks' assets as a percent of total bank assets controls for concentration.

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[50] Tang (2000), Koford and Tschoegl (1997)

[51] However, as a common practice in current empirical literature, the study does not include transition economies.

Similarly to concentration, explicit deposit insurance schemes create incentives for banks' risk taking behavior, and thus may increase banking fragility. Demirgüç-Kunt and Detragiache (2002) find strong evidence that deposit insurance increases the probability of banking crises. A binary variable indicating the existence of formal deposit insurance is included in the estimations.

Macroeconomic and Development Indicators

Macroeconomic policies contribute to banks' systemic health. Generally, consistent attempts to boost economic growth and improve productivity bring high pay-offs for the banks[52]. A government that pursues non-inflationary policies also creates a safe environment for banks' operations because it protects the real value of debt, and thus the real net worth of banks.

Gross domestic product per capita is used to control for overall economic development. Macroeconomic uncertainty is measured with the change in the consumer price index. The growth rate of GDP controls for the possibility of lending booms. Domestic credit to enterprises to GDP controls for the level of financial development since more developed financial systems tend to be more stable.

Trend, Time, and Regional Effects

Trend and year dummies are included in the analysis to control for any development in the banking system apart from the adoption of new regulations.

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[52] Demirgüç-Kunt and Detragiache (2002) and Beck et al. (2003) find that real GDP growth is always significant and has negative effect on the probability of banking crises.

Dummies separating the countries into four main regions –Central Europe[53], the Baltic countries[54], South Eastern Europe (SEE)[55] and the Commonwealth of Independent States (CIS)[56] are used as an attempt to capture country effects.

5. Estimation Results

The paper investigates the effect of banks' and firms' currency mismatches first by looking at the overall effect of currency mismatches. Then, currency mismatches are analyzed only when there is a large depreciation of the real exchange rate. Finally, the effect of depreciation in the real exchange rate is examined for a range of plausible bank and real sector currency mismatch values.

In all cases the interaction term between currency mismatches and the depreciation rate uses the deviation of the depreciation rate from its sample mean. Thus, the currency mismatch coefficient can be used to obtain the marginal effect of mismatches at the average level of depreciation (rather than zero depreciation).

Table 3-3 presents the results from the probit and linear probability models not taking currency crises into consideration. When currency mismatches in both the real and the banking sector and their interactions with real depreciation are included, these variables have no obvious effects on the probability of banking crises. To avoid possible multicollinearity between the variables, the effect of mismatches in the banking and the

[53] Includes Czech Republic, Hungary, Poland, Slovakia, and Slovenia.
[54] Includes Estonia, Latvia, and Lithuania.
[55] Includes Albania, Bulgaria, Croatia, Macedonia, Romania, and Yugoslavia.
[56] Includes Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyz Republic, Moldova, Russia, and Ukraine.

real sector are included in separate regressions[57]. Only the interaction term between bank currency mismatch and real depreciation seems to have a marginally significant positive effect. The positive sign is opposite from the expected one if banks are facing exchange rate risk, which suggests that the captured effect may be default risk rather than direct exchange rate risk. The probit model including only mismatches in the real sector gives some indication that an increase in the real economy's dollar revenues during an exchange rate depreciation will reduce the probability of banking crises.

In the linear probability model the interaction terms have the correct signs when both banks' and firms' mismatches are included. When only banks' mismatches are used in the regression, the sign is positive. This indicates again that the coefficient may be capturing the default risk.

Table 3-4 presents the results of interactions between a dummy for the incidence of currency crises and real depreciation, currency mismatches, and their joint effects. The probit model estimation shows that an increase of 1 percentage point in banks' currency mismatch raises the probability of a banking crisis by 3.4 percent at the average depreciation rate in a currency crisis. Additional increase in this probability will occur if the currency mismatch increases simultaneously with real depreciation. Once again, it appears that the marginal effect of bank currency mismatch captures default rather than direct exchange rate risk. In the estimation that includes only real sector mismatches, the interaction term is significant and provides evidence that a simultaneous increase in dollar net revenues in the real sector and real depreciation reduce the likelihood of

[57] The correlation coefficient between the real depreciation and the interaction term with banks' mismatch is 0.74, while with firms' mismatch is -0.56. The correlation coefficient between the two interaction terms is -0.8.

banking crises.

There is little evidence that banks' or firms' currency mismatches affect the probability of banking crises when currency crises are not taken into consideration. However, when the real exchange rate becomes extremely high, increases in those mismatches provide evidence that banks face increased default risk.

The results shown in Tables 3-3 and 3-4 also provide evidence that banking crises have institutional origins and depend on the level of banking system development. The index measuring existence and enforcement of regulations in the banking system has a strong negative impact on banking crises in the probit model. In the linear probability model, this effect is still negative but insignificant.

Concentration and foreign exchange and trade liberalization appear to increase the probability of a banking crisis. They are marginally significant in the linear probability model. Bank concentration in transition economies is highly correlated with banks' state ownership and thus it reflects the degree of bank deregulation and the inefficiency of state owned banks[58]. The index of foreign exchange and trade liberalization simply presents the fact that an increase in the scope of the financial system, besides bringing new profitable opportunities, carries inherent risks for banking stability[59].

The depreciation of the real exchange rate may change significance depending on

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[58] Beck et al. (2003) find that concentration reduces the probability of banking crises in a sample that does not include transition economies. However, they also conclude that tighter entry restrictions increase banking fragility. Bonin et al. (2003) find that large banks in transition economies are less efficient and explain this with the fact that large banks are more likely to be state-owned. State ownership is not included as a control variable in the main regressions since it significantly reduces the sample size.

[59] Demirgüç-Kunt and Detragiache (1998) provide evidence that financial liberalization increases instability of the banking system, less so in banking systems with sound institutions. However, as in previous studies, they associate financial liberalization strictly with the liberalization of real interest rates. Here the index of foreign exchange and trade liberalization is more likely to indicate increases in the risk of banks' non-interest income. Financial liberalization in this sense is discussed by Edwards and Mishkin (1995) and Chami et al. (2003).

the level of mismatch in the banking or real sector. Figures 3-2 and 3-3 present the marginal effects of real depreciation on the probability of banking crises when the level of mismatch is varied within the interval of existing mismatches[60]. The marginal effect of real depreciation is significant for positive values of the banks' currency mismatch – between 40 and 60 percentage points in the probit model[61] and between 10 and 60 in the linear probability model. At 60 percentage points mismatch in banks' balance sheets, a percentage point increase in real depreciation increases the probability of a banking crisis by 2.7 percentage points. The result is scaled down in the linear probability model to 0.4 percentage points, which indicates the importance of the country effects included in this model.

When the currency mismatch in the real sector is varied instead, the marginal effect of real exchange rate depreciation is largest for the negative values of the mismatch. In the linear probability model the marginal effect is significant in the (-60, 0) percentage points range of the mismatch. These results provide additional support to the evidence that banks face default risk as a result of real exchange rate depreciation. At -60 percentage points of the mismatch, a percentage point increase in real depreciation increases the probability of a banking crisis by .6 percentage points in both models.

5.1. Alternative Specifications

To check the sensitivity of the results, some important alterations in the specifications are made. First, nominal depreciation rather than real exchange rate

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[60] In these estimations, the interaction term includes the deviation of the currency mismatch from a selected level, at which the effect of real depreciation is evaluated.

[61] However, the underlying coefficient is still significant at 50 and 60 percentage points.

depreciation is used. Second, the overall bank currency mismatch scaled to total banks' assets is used instead of the difference between credit and deposit dollarization. Third, instead of an index of banking system reform, more institutional variables are included in the estimations.

Nominal Depreciation

Although, it is most appropriate to use the real exchange rate in calculating currency crises dates, periods of rapid nominal exchange rate depreciation may also affect the banking system. The magnitude of this effect depends on the way banks account for inflation expectations when setting deposit and loan interest rates. Also state-owned borrowers, who received the largest share of loans to enterprises in transition economies, tended to have controlled prices and thus their loan repayment ability may have been hurt during large nominal depreciation of the currency. Therefore, nominal instead of real depreciation is used.

Table 3-5 presents the estimation results and Figures 3-2 and 3-3 show the marginal effects of nominal depreciation. The probit model yields results that are very similar to the ones obtained when using real depreciation. The currency mismatch in the banking sector and its interaction with the depreciation rate increase the probability of banking crises, while the mismatch in the real sector and its interaction with the depreciation rate decrease it. However, the signs change and the significance disappears once country effects are taken into account. In both probit and linear probability models, the marginal effects of nominal depreciations suggest that banks face significant default risk.

Overall Bank Currency Mismatch

The exchange rate risk that banks face may be better controlled with an overall measure of currency mismatch rather than the difference between credit and deposit dollarization. This overall currency mismatch is calculated as the difference between foreign currency assets (foreign assets and foreign currency loans) and foreign currency liabilities (foreign liabilities and foreign currency deposits) and it is scaled to the level of total bank assets. Results are presented in Table 3-6. Although the overall currency mismatch seems to increase the probability of banking crises at the average depreciation rate, its joint effect with the depreciation rate has a negative sign. In fact, once country effects are accounted for, only the joint effect is marginally significant. These results disappear in the probit and the linear probability models when the real depreciation rate, the currency mismatch, and their joint effect are taken only in periods of currency crises.

Figure 3-4 shows the marginal effect of depreciation at different levels of overall currency mismatch. Clearly, banks face exchange rate risk even at low levels of currency mismatch. According to the probit estimations, the marginal effect of the depreciation rate is significant and positive when the mismatch is in the (-20, 10) range. In the linear probability model, the depreciation rate is significant for the whole negative range of the mismatch.

Therefore, if only deposit and credit dollarization are taken into account, default risk seems to have a dominant effect. However, it becomes evident that banks face exchange rate risk when their overall currency mismatch is used in the estimations.

Institutional Factors

To separate the effects of different institutional factors, specific regulations can be used as controls instead of the index of banking system development. Three new variables are used to measure regulations and structure of the banking system. Entrance of foreign banks may have either benefits or drawbacks depending on whether foreigners succeed in bringing new expertise in banking technology and thus increase banking efficiency, or their profits suffer because of informational disadvantages. Also because foreign banks may drain good customers from the existing local banks, their presence may contribute to banking system fragility[62]. Foreign bank entrance is measured with the ratio of foreign banks to total number of banks[63]. Binary variables for the existence of capital adequacy requirements and restrictions on open currency positions control for regulation of banks' risk taking behavior and should have negative effects on banking crises.

Two variables control for regulations in the corporate sector[64]. A dummy for the existence of bankruptcy law allows an assessment of how easily banks are able to recover unpaid loans. Another binary variable for the adoption of International Accounting Standards measures banks' ability to evaluate borrowers' credit worthiness and truthful presentation of financial results. Lack of accounting standards subjects banks to both adverse selection and moral hazard problems.

The de facto exchange rate regime provided by the IMF is also included in the

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[62] Claessens (1998) and Bonin (2003) empirically support the idea that foreign banks improve efficiency. However, Beck et al. (2003) do not find a connection between foreign ownership and banking crises.

[63] Claessens et al. (1998) use this variable to measure foreign participation in the banking system. Barth at al. (2001) and Beck et al. (2003) use foreign ownership in asset terms. However, there is no single and complete source for foreign ownership of banks in transition economies.

[64] These include both banks and non-bank companies.

regressions to control for the possible implicit guarantee of the fixed exchange rate regimes and compare the results with flexible regimes.

Tables 3-7 and 3-8 provide results for these extended regressions. Banks' currency mismatch and its interaction with real depreciation become significant in the probit model even when a currency crisis is not accounted for. However, the interaction term still shows a positive sign. Once the currency crisis is accounted for, the significance of the joint effects becomes even more pronounced.

The extended regressions provide some insights into the institutional characteristics of transition economies that affect their banking stability. The existence of capital adequacy requirements is significant in the probit and linear probability models and indicates a reduction in the probability of a banking crisis. The existence of a deposit safety net enters with a positive sign after country effects are accounted for. This result is consistent with the hypothesis that deposit insurance creates incentives for banks to take on more risk. The restrictions on open foreign currency positions reduce the probability of a banking crisis but this variable is only marginally significant.

The percentage of foreign banks to the total number of banks reduces the probability of banking crises in both probit and linear probability models. The result is consistent with previous studies that find a positive relationship between foreign participation and bank efficiency[65].

Among regulations directed at both banks and firms, international accounting standards have a very significant and negative effect, which is maintained in all

[65] Claessens et al. (1998) find that foreign bank share (number of foreign banks to total number of banks) reduces both bank profitability and banks' overhead costs. They conclude that foreign bank entrance increases competition but it also raises efficiency. Bonin et al. (2003) find that foreign banks, especially the ones owned by institutional investors, have increased profits and efficiency.

estimations. The adoption of international accounting standards allows banks to better evaluate their customers creditworthiness. Also, use of these standards forces banks to realistically assess their own financial state. As a result banks' financial health becomes more apparent and easily comparable to other banking institutions, thus providing more information to shareholders and depositors.

5.2. Endogeneity

One serious criticism of these results comes from the fact that banking crises in transition economies have been very persistent and the explanatory variables may be affected by a feedback from the endogenous variable. A way to reduce the problem is by using only the onset of banking crises. However, with the available data set, only a few onset dates enter the estimation sample[66].

Another method is using instrumental variables in the linear probability model to account for the unobserved country effects and correct for persistence. Possible instrumental variables for the real depreciation, the bank and real sector currency mismatches are real growth rate of advanced or European Union countries, LIBOR, membership in WTO, and international price indices (price index for metals, energy, or oil products). However, these instrumental variables are very weak and do not produce any significant results even though the instrumental variable estimation maintains the sign of the variables.

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[66] There are only six onset dates that enter in the sample data set used in the estimations. Alternative dependent variable can be composed of the dates when banking crises are recognized by depositors, markets, or the government. This variable may be a closer measure of bank runs as determined in the theoretical framework. However, there are still only 10 observations with such dates that can be used in the estimations.

6. Policy Implications and Conclusions

This paper investigates whether direct and indirect sources of exchange rate risk have been a reason for the occurrence and persistence of banking crises in transition economies. The paper presents a simple theoretical model to derive testable empirical implications about the link between currency mismatches in banks' and firms' balance sheets and banking crises. Generally, if the real exchange rate and the open currency positions move in the same direction, there should not be a risk to the banking system.

The empirical investigation takes two approaches. First, the effects of currency mismatches are explored in the context of a currency crisis. Second, the effect of the real exchange rate is tested at different levels of banks' and firms' currency mismatch. Estimations with the level of firms' currency mismatch show that the depreciation rate increases the probability of banking crises when credits are more dollarized than firm's revenues. This is evidence of the indirect exchange rate risk (default risk) that banks face as a result of real depreciation.

When the bank currency mismatch is measured by the difference between credit and deposit dollarization, an increase in the mismatch paired with an increase in the depreciation rate, increases the probability of banking crises. This outcome hints that the mismatch indicator overwhelmingly measures the default rather than the direct exchange rate risk for the banks. When the measure of mismatch is substituted with the banks' total open currency positions, which also includes net foreign assets and is scaled to banks' assets, the results present evidence of existing exchange rate risk. Specifically, real depreciation is more likely to increase the probability of banking crises when banks

have a negative open position.

There are several aspects in which the analysis needs improvement. First, although there is no strong evidence of endogeneity in depreciation and mismatches, a better assessment of the effects can be made if the dependent variable is also measured with the onset of banking crises rather than the existence of banking crises. Without better data for mismatches for the first period of the 1990's such analysis cannot be carried out. However, this paper proposes an approach that can be used to test the effect of currency mismatches in a larger set of countries.

Second, the paper's findings have important policy implications with respect to countries' choice of exchange rate regime, or alternatively about their choice of mechanisms to protect banks from currency risk. The results provide support for the "fear of floating" idea – the fact that governments are unwilling to let the exchange rate move independently if the economy is heavily indebted in foreign currency. Although this paper does not find evidence that the exchange rate regimes have an effect on the probability of banking crises, a further investigation is necessary. The analysis should take into consideration the joint effect of mismatches and exchange rate regimes. Domaç and Martinez-Peria (2000) study this link but their measure of mismatch (the ratio of foreign liabilities and assets) is incomplete and covers only the banking sector.

Finally, since the effects of mismatches and real depreciation depend on countries' institutional characteristics, the analysis should include a measure of the approaches transition economies have adopted to resolve the problems in the banking system.

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APPENDIX

Table 3-1 Data Definitions and Sources

VARIABLE	DEFINITION	SOURCE
Banking Crisis	Binary response variable =1 in the existence of a systemic banking crisis, 0 otherwise	C&K , Tang et al., Beim, CB
Currency Crisis	Dummy variable = 1 if the monthly depreciation rate of the real exchange rate is higher than two standard deviations above the monthly average in any month of the year, or if it is more than 15 % and 10 percentage points above the previous month, =0 otherwise. Calculated from the end of period exchange rate	IFS, CB
Exports/GDP	Total exports of goods and services, as a percent of GDP	WDI, IFS
Deposit Dollarization	Foreign currency denominated deposits to total deposits held by residents at domestic banks, calculated as a percent	CB
Credit Dollarization	Foreign currency denominated credit to total credit from domestic banks to domestic enterprises, calculated as a percent. Data for a few countries include credit to individuals, financial enterprises and/or government.	CB
Net foreign assets	Banks' foreign assets minus banks' foreign liabilities (line 21...ZF... - line 26C...ZF), as a percent of total bank deposits (total bank credit, or total bank assets).	IFS, CB
Depreciation Rate	Percentage change of the average exchange rate (expressed as domestic currency per USD, line RF..ZF...)	IFS
Bank Concentration	Assets of the three largest banks as percent of the total assets of banks reported by Banscope.	WB, original data from BankScope
Number of Foreign Banks	Number of foreign banks as percent of total number of banks.	EBRD
Bankruptcy Law	Dummy variable, =1 if □ankruptcy law is enforced, =0 otherwise	EBRD
Capital Adequacy	Dummy variable, =1 if capital adequacy requirement is enforced, =0 otherwise	EBRD
Deposit Insurance	Dummy variable, =1 if there is an explicit deposit insurance scheme, =0 otherwise	WB, Local Authorities

Table 3-1 (Continued)

VARIABLE	DEFINITION	SOURCE
International Accounting Standards	Dummy variable, =1 if IAS are adopted, = 0 otherwise	Tang et al., IASC, WB
Open Position	Dummy variable for open foreign exchange position limits =1 if there are limits, = 0 otherwise	AREAER
Index of banking reform (IXBR)	Index of banking reform and interest rate liberalization, =1 if little progress beyond establishment of a two tier system, =2 if significant liberalization of interest rates and credit allocation, =3 if substantial progress in establishment of bank solvency and of a framework for prudential supervision and regulation, full interest rate liberalization with little preferential access to cheap refinancing, significant lending to private enterprises and significant presence of private banks, =4 if significant movement of banking laws and regulations towards BIS standards, well functioning banking competition and effective prudential supervision, significant term lending to private enterprises, substantial financial deepening, =4.3 if standards and performance norms of advanced industrial economies, full convergence of banking laws and regulations with BIS standards, provision of full set of competitive banking services.	EBRD

Table 3-1 (Continued)

VARIABLE	DEFINITION	SOURCE
Index of foreign exchange and trade liberalization (IXFTL)	Index of trade and foreign exchange rate system liberalization, =1 if widespread import and/or export controls or very limited legitimate access to foreign exchange, =2 if some liberalization of import and/or export controls, almost full current account convertibility in principle but with a foreign exchange regime that is not fully transparent (possibly with multiple exchange rates), =3 if removal of almost all quantitative and administrative import and export restrictions, almost full current account convertibility, =4 if removal of all quantitative and administrative import and export restrictions (apart form agriculture) and all significant export tariffs, insignificant direct involvement in exports and imports by ministries and state-owned trading companies, no major non-uniformity of customs duties for non-agricultural goods and services, full current account convertibility, =4.3 if standards and performance norms of advanced industrial economies, removal of most tariff barriers, WTO membership.	EBRD
GDP per capita	GDP at market prices (current USD) per capita	WDI
Exchange rate regime	Discrete variable for exchange rate regime, =0 if fixed, =1 if intermediate, =2 if floating	AREAER
Freely Falling Exchange Rate Regime	A dummy variable =1 if the twelve month rate of inflation exceeds 40 %, or the six months after a currency crisis (measured in a Frankel and Rose (1996) variant) marking the transition from a fixed to floating exchange rate regime, =0 otherwise.	Reinhart and Rogoff (2003)
Inflation Rate	Percentage change in the consumer price index	EBRD
Domestic credit	Domestic credit to enterprises as a percent of GDP.	CB

Notation:
AREAER – IMF Annual Report on Exchange Arrangements and Exchange Restrictions
C&K – Caprio and Klingebiel (2003)
CB – Central banks
EBRD – European Bank for Reconstruction and Development Transition Reports
IASC – International Accounting Standards Commission
IFS – International Financial Statistics, IMF
WDI – World Development Indicators, World Bank

Table 3-2 Banking and Currency Crises in Transition Economies

Country	Banking Crisis	High Real Exchange Rate Depreciation[67]	Free Falling Exchange Rate
Central Europe			
Czech Republic	1989-2001	1998-1999	-
Hungary	1991-1995	1994, 1997	-
Poland	1990-1998	1989, 1991-1992	1989, 1991-1992
Slovak Republic	1991-2001	1993, 1999	-
Slovenia	1992-1994	1992-1993, 1995	1991-1992
Average Length of a Banking Crisis	**8 years**		
South Eastern Europe			
Albania	1992-2001	1992, 1997	1991-1992, 1997
Bulgaria	1995-1997	1990, 1994, 1996-1997	1990-1996
Croatia	1996	1995, 1997	1993-1994
Macedonia	1993-1994	1997	1993-1994
Romania	1990-2001	1991-1992, 1997	1990-2000
Yugoslavia	1989-2001		
Average Length of a Banking Crisis	**7 years**		
Baltic Countries			
Estonia	1992-1995	-	1991-1992
Latvia	1995-2001	1992	1991-1993
Lithuania	1995-1996	1992	1991-1994
Average Length of a Banking Crisis	**4 years**		

[67] High real exchange rate depreciation is defined as monthly depreciation in excess of two standard deviations from the mean depreciation rate for the country, or depreciation higher than 15 % and more than 10 points higher than the previous month.

Table 3-2 (Continued)

Country	Banking Crisis	High Real Exchange Rate Depreciation[68]	Free Falling Exchange Rate
Commonwealth of Independent States			
Armenia	1994-1996	1993-1994	1992-1995
Azerbaijan	1995-2001	1998-1999	1993-1995
Georgia	1991-1997	1998-1999	1991-1996
Kazakhstan	1994-1996	1994, 1999	1991-1995
Kyrgyz Republic	1991-1999	1996, 1998	1991-1999
Moldova	-	1998	1998-1999
Russia	1995, 1998-1999	1992, 1998	1992-1996, 1999
Ukraine	1997-1998	1993-1994, 1998	1991-1996
Average Length of a Banking Crisis	**4 years**		

Sources:
Banking Crises
Caprio and Klingebiel (2003), Tang et al. (2001) for Georgia and Kazakhstan, Central Banks for Moldova and Yugoslavia.
Real Exchange Rate Depreciation
IFS, Central Banks

Free Falling Exchange Rate
Reinhart and Rogoff (2003)

[68] High real exchange rate depreciation is defined as monthly depreciation in excess of two standard deviations from the mean depreciation rate for the country, or depreciation higher than 15 % and more than 10 points higher than the previous month.

Figure 3-1: Annual and Sample Variable Means

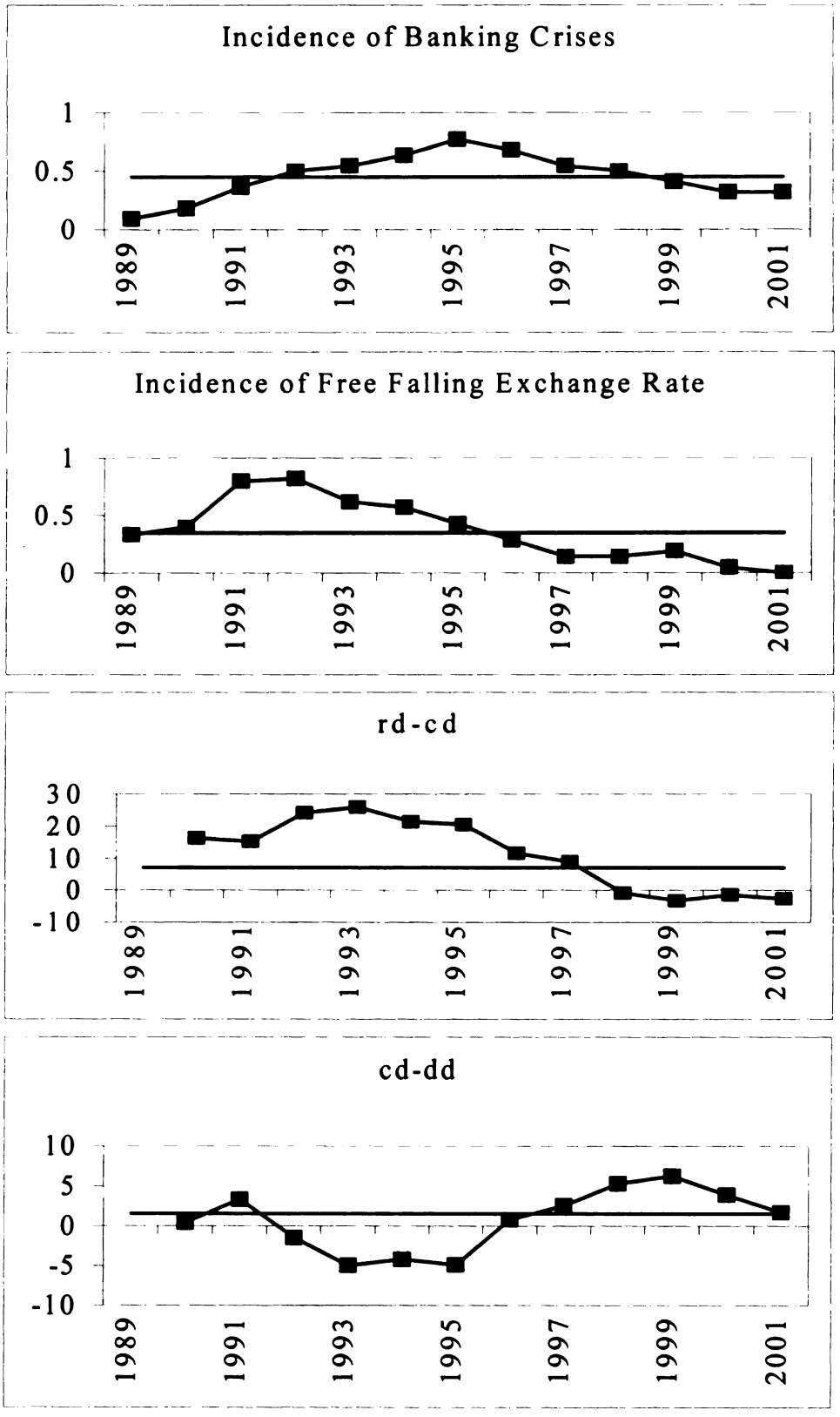


Figure 3-1 (Continued)

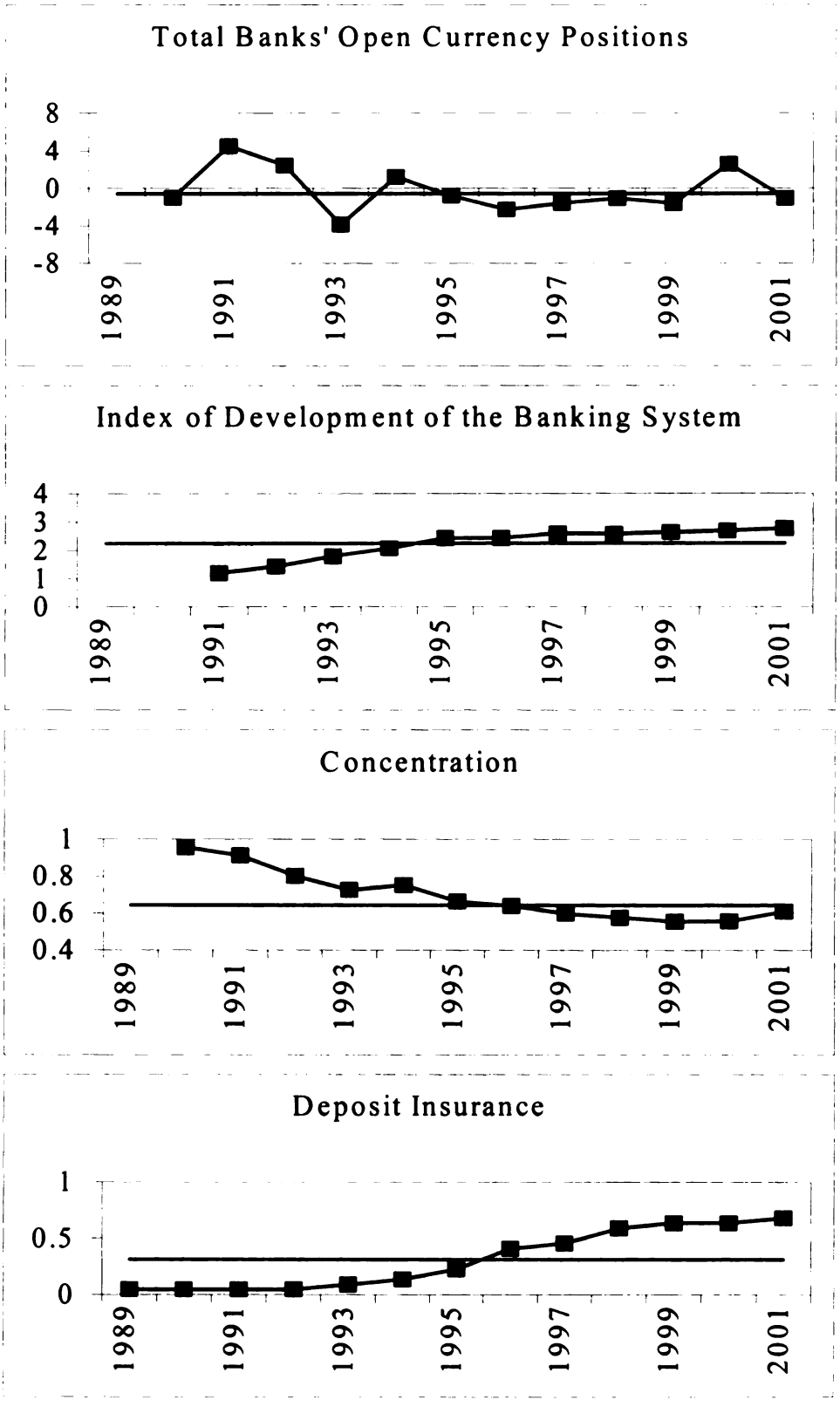
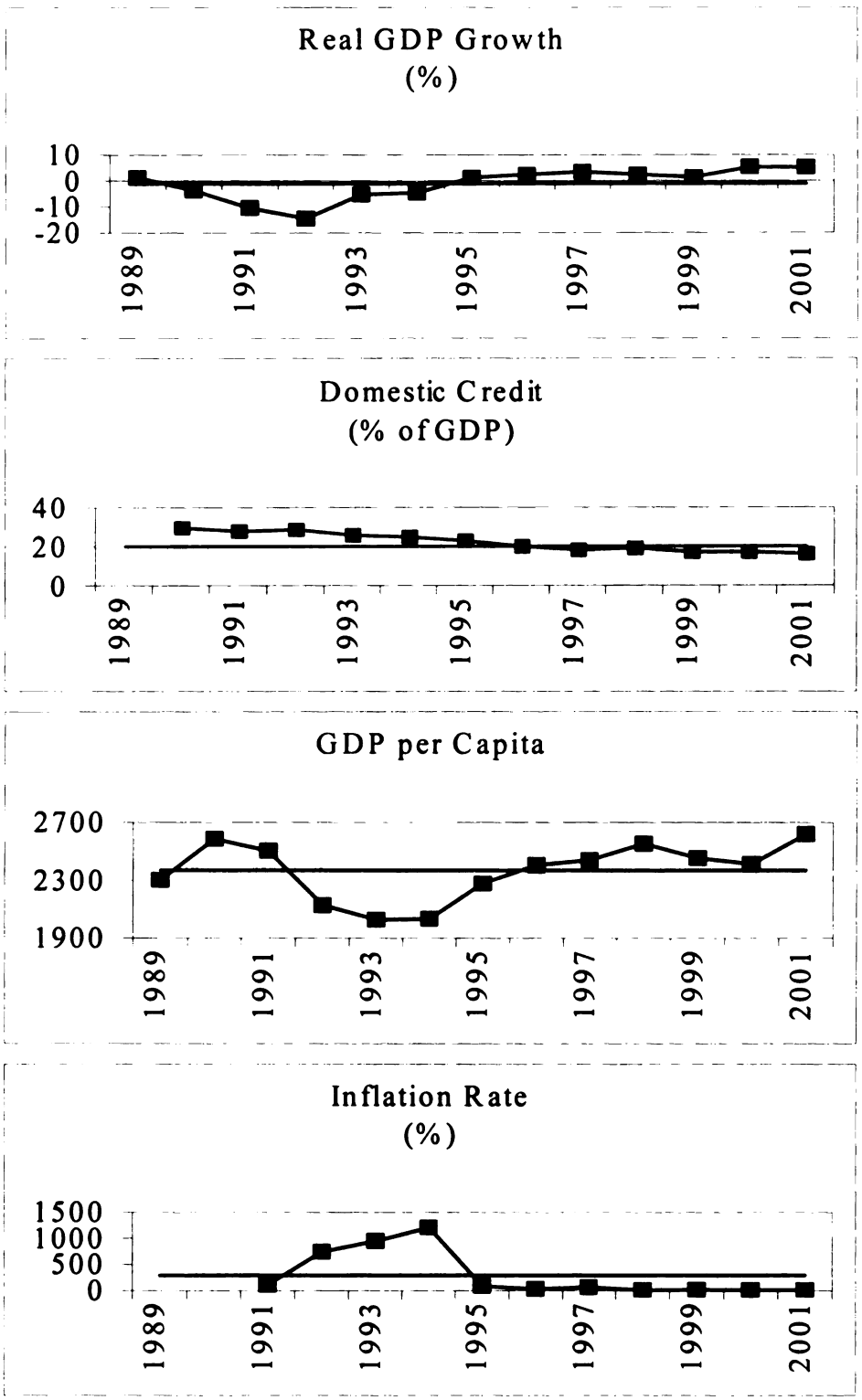


Figure 3-1 (Continued)



Note:
Graphs present annual averages across countries. The straight line shows the sample mean.

Table 3-3 Overall Effect of Real Depreciation and Currency Mismatches

Dependent Variable: Banking Crisis	1 Probit	2 Probit	3 Probit
Depreciation	0.1166	0.1446	0.3917
	(0.4289)	(0.4212)	(0.3759)
Banks' Currency Mismatch	-0.0008	0.0004	
	(0.0052)	(0.0050)	
(bank mismatch)*(depreciation)	0.0456 **	0.0398 *	
	(0.0219)	(0.0210)	
Firms' Currency Mismatch	-0.0007		-0.0005
	(0.0036)		(0.0036)
(firm mismatch)*(depreciation)	0.0066		-0.0030
	(0.0117)		(0.0078)
Concentration	0.1049	0.0723	0.1222
	(0.4634)	(0.4559)	(0.4512)
Deposit Insurance	-0.1555	-0.1418	-0.1708
	(0.1623)	(0.1448)	(0.1620)
IXBR	-0.6700 ***	-0.6564 ***	-0.6090 ***
	(0.1807)	(0.1902)	(0.1611)
IXFTL	0.1159	0.1359	0.1163
	(0.2024)	(0.1773)	(0.2095)
Domestic Credit	0.0042	0.0040	0.0038
	(0.0067)	(0.0064)	(0.0073)
GDP/Capita	-0.0001 ***	-0.0001 ***	-0.0001 ***
	(0.0001)	(0.0001)	(0.0001)
Inflation Rate	-0.0023	-0.0023	-0.0019
	(0.0017)	(0.0016)	(0.0019)
Real GDP Growth	-0.0173	-0.0143	-0.0141
	(0.0163)	(0.0157)	(0.0176)
Baltic Countries	-0.3322	-0.3183	-0.3481
	(0.1894)	(0.1798)	(0.1872)
CIS	-0.6975 ***	-0.6616 ***	-0.7014 ***
	(0.1947)	(0.1737)	(0.1879)
SEE	-0.5757 ***	-0.5323 ***	-0.5869 ***
	(0.1872)	(0.1589)	(0.1742)
Trend	-0.0187	-0.0186	-0.0145
	(0.0367)	(0.0353)	(0.0327)
Number of Observations	123	123	123
Number of Countries	21	21	21

Table 3-3 (Continued)

Dependent Variable: Banking Crisis	1 LPM	2 LPM	3 LPM
Depreciation	0.2280 **	0.2089	0.1706 *
	(0.1016)	(0.1373)	(0.0989)
Banks' Currency Mismatch	-0.0027	-0.0028	
	(0.0053)	(0.0031)	
(bank mismatch)*(depreciation)	-0.0057	0.0036	
	(0.0065)	(0.0052)	
Firms' Currency Mismatch	-0.0014		0.0008
	(0.0044)		(0.0026)
(firm mismatch)*(depreciation)	-0.0101 *		-0.0076 *
	(0.0053)		(0.0042)
Concentration	0.6993 **	0.6352 **	0.6886 **
	(0.2958)	(0.2933)	(0.3219)
Deposit Insurance	0.0439	0.0556	0.0626
	(0.1282)	(0.1201)	(0.1232)
IXBR	-0.2186	-0.1796	-0.2202
	(0.1440)	(0.1477)	(0.1296)
IXFTL	0.3029 **	0.2569 **	0.2862 ***
	(0.1085)	(0.1148)	(0.1012)
Domestic Credit	-0.0040	-0.0045	-0.0051
	(0.0071)	(0.0066)	(0.0063)
GDP/Capita	-0.0001	-0.0001	-0.0001
	(0.0001)	(0.0001)	(0.0001)
Inflation Rate	-0.0001	-0.0001	-0.0001
	(0.0001)	(0.0001)	(0.0001)
Real GDP Growth	0.0033	-0.0005	0.0036
	(0.0072)	(0.0076)	(0.0071)
Baltic Countries			
CIS			
SEE			
Trend	-0.0211	-0.0299	-0.0265
	(0.0175)	(0.0204)	(0.0163)
Number of Observations	123	123	123
Number of Countries	21	21	21

Table 3-3 (Continued)

Notes: Standard errors in parentheses are robust for serial correlation
*** - significant at the 1% level, ** - significant at the 5 % level, * - significant at the 10 % level
Marginal effects and their standard errors are presented for the probit model. Significance is for the underlying coefficient.
Depreciation is calculated around the mean value of 0.93 in the interaction term with mismatch.
All explanatory variables are lagged one period.
LPM includes a full set of country dummy variables. In all regressions, they are jointly significant at the 1 % level.

Table 3-4 Effect of Real Depreciation and Currency Mismatches in the Existence of a Currency Crisis

Dependent Variable: Banking Crisis	4 Probit	5 Probit	6 Probit
Depreciation	-2.0678	-1.2431 ***	-0.2081
	(1.3069)	(0.6033)	(0.2633)
Banks' Currency Mismatch	0.0329 **	0.0173 *	
	(0.0187)	(0.0125)	
(bank mismatch)*(depreciation)	0.1450 *	0.0709 ***	
	(0.0775)	(0.0287)	
Firms' Currency Mismatch	0.0085 ***		0.0033
	(0.0028)		(0.0036)
(firm mismatch)*(depreciation)	0.0261		-0.0206 ***
	(0.0161)		(0.0073)
Concentration	0.0797	0.1219	0.1147
	(0.3428)	(0.3881)	(0.4341)
Deposit Insurance	-0.0770	-0.0920	-0.1110
	(0.1152)	(0.1276)	(0.1364)
IXBR	-0.4378 ***	-0.4852 ***	-0.5190 ***
	(0.1477)	(0.1510)	(0.1569)
IXFTL	0.0751	0.0806	0.1090
	(0.1554)	(0.1723)	(0.1755)
Domestic Credit	0.0015	0.0021	0.0026
	(0.0052)	(0.0058)	(0.0062)
GDP/Capita	-0.0001 ***	-0.0001 ***	-0.0001 ***
	(0.0000)	(0.0000)	(0.0000)
Inflation Rate	-0.0021	-0.0023	-0.0021
	(0.0010)	(0.0012)	(0.0014)
Real GDP Growth	-0.0073	-0.0100	-0.0129
	(0.0135)	(0.0149)	(0.0163)
Baltic Countries	-0.2237	-0.2684	-0.3067
	(0.1360)	(0.1465)	(0.1680)
CIS	-0.5017 ***	-0.5631 ***	-0.6231 ***
	(0.1545)	(0.1525)	(0.1598)
SEE	-0.3935 ***	-0.4549 ***	-0.5068 ***
	(0.1489)	(0.1480)	(0.1534)
Trend	-0.0156	-0.0125	-0.0065
	(0.0234)	(0.0254)	(0.0270)
Number of Observations	122	122	122
Number of Countries	21	21	21

Table 3-4 (Continued)

Dependent Variable: Banking Crisis	4 LPM	5 LPM	6 LPM
Depreciation	-0.2544	-0.2359	0.0092
	(0.2251)	(0.2126)	(0.1480)
Banks' Currency Mismatch	-0.0014	0.0001	
	(0.0048)	(0.0043)	
(bank mismatch)*(depreciation)	0.0187	0.0246 *	
	(0.0121)	(0.0124)	
Firms' Currency Mismatch	-0.0018		-0.0012
	(0.0025)		(0.0018)
(firm mismatch)*(depreciation)	-0.0073		-0.0130 **
	(0.0052)		(0.0062)
Concentration	0.6397 *	0.6321 *	0.6781 **
	(0.3235)	(0.3299)	(0.3007)
Deposit Insurance	0.0657	0.0677	0.0644
	(0.1120)	(0.1102)	(0.1144)
IXBR	-0.1673	-0.1540	-0.1929
	(0.1484)	(0.1423)	(0.1430)
IXFTL	0.2716 *	0.2490 *	0.2799 **
	(0.1357)	(0.1221)	(0.1326)
Domestic Credit	-0.0050	-0.0053	-0.0052
	(0.0072)	(0.0068)	(0.0070)
GDP/Capita	-0.0001 *	-0.0001 *	-0.0001 *
	(0.0001)	(0.0001)	(0.0001)
Inflation Rate	-0.0002 **	-0.0002 **	-0.0002 *
	(0.0001)	(0.0001)	(0.0001)
Real GDP Growth	0.0002	0.0002	0.0010
	(0.0078)	(0.0075)	(0.0073)
Baltic Countries			
CIS			
SEE			
Trend	-0.0290	-0.0309	-0.0283
	(0.0227)	(0.0224)	(0.0206)
Number of Observations	122	122	122
Number of Countries	21	21	21

Table 3-4 (Continued)

Notes: Standard errors in parentheses are robust for serial correlation
*** - significant at the 1% level, ** - significant at the 5 % level, * - significant at the 10 % level
Marginal effects and their standard errors are presented for the probit model. Significance is for the underlying coefficient.
Depreciation is calculated around the mean value of 1.09 during currency crises in the interaction term with mismatch.
All explanatory variables are lagged one period.
LPM includes a full set of country dummy variables. In all regressions, they are jointly significant at the 1 % level.

Table 3-5 Effect of Nominal Depreciation and Currency Mismatches

Dependent Variable: Banking Crisis	7 Probit	8 Probit	9 Probit
Depreciation	0.6052 **	0.6426 *	0.5287 **
	(0.3260)	(0.3696)	(0.2376)
Banks' Currency Mismatch	0.0166	0.0223 *	
	(0.0146)	(0.0126)	
(bank mismatch)*(depreciation)	0.0211	0.0287 **	
	(0.0159)	(0.0143)	
Firms' Currency Mismatch	-0.0077		-0.0144 *
	(0.0117)		(0.0085)
(firm mismatch)*(depreciation)	-0.0103		-0.0180 **
	(0.0120)		(0.0084)
Concentration	0.1380	0.1587	0.1287
	(0.4564)	(0.4741)	(0.4381)
Deposit Insurance	-0.2534	-0.2521	-0.2360
	(0.1899)	(0.1947)	(0.1803)
IXBR	-0.7867 ***	-0.7778 ***	-0.7090 ***
	(0.1852)	(0.1985)	(0.1632)
IXFTL	0.1944	0.2051	0.1462
	(0.2173)	(0.1892)	(0.1947)
Domestic Credit	0.0036	0.0048	0.0032
	(0.0081)	(0.0082)	(0.0078)
GDP/Capita	-0.0002 ***	-0.0002 ***	-0.0002 ***
	(0.0001)	(0.0001)	(0.0001)
Inflation Rate	-0.0040 ***	-0.0038 ***	-0.0040 ***
	(0.0013)	(0.0013)	(0.0013)
Real GDP Growth	-0.0108	-0.0121	-0.0121
	(0.0196)	(0.0192)	(0.0170)
Baltic Countries	-0.3309	-0.3315	-0.3304
	(0.1990)	(0.2216)	(0.1770)
CIS	-0.7571 ***	-0.7835 ***	-0.7212 ***
	(0.1477)	(0.1270)	(0.1368)
SEE	-0.6695 ***	-0.7032 ***	-0.6229 ***
	(0.1484)	(0.1285)	(0.1293)
Trend	-0.0028	-0.0043	-0.0054
	(0.0375)	(0.0372)	(0.0324)
Number of Observations	123	123	123
Number of Countries	21	21	21

Table 3-5 (Continued)

Dependent Variable: Banking Crisis	7 LPM	8 LPM	9 LPM
Depreciation	0.0053	0.0191	0.0225
	(0.0612)	(0.0646)	(0.0832)
Banks' Currency Mismatch	-0.0041	-0.0007	
	(0.0056)	(0.0032)	
(bank mismatch)*(depreciation)	0.0045	0.0033 *	
	(0.0030)	(0.0017)	
Firms' Currency Mismatch	-0.0043		-0.0006
	(0.0061)		(0.0041)
(firm mismatch)*(depreciation)	0.0006		-0.0017
	(0.0043)		(0.0033)
Concentration	0.7489 **	0.8033 **	0.7995 **
	(0.3183)	(0.3266)	(0.3558)
Deposit Insurance	0.0376	0.0774	0.0894
	(0.1253)	(0.1086)	(0.1106)
IXBR	-0.1580	-0.1723	-0.1926
	(0.1550)	(0.1437)	(0.1359)
IXFTL	0.1646	0.1970	0.2311
	(0.1584)	(0.1523)	(0.1597)
Domestic Credit	-0.0036	-0.0047	-0.0064
	(0.0081)	(0.0074)	(0.0075)
GDP/Capita	-0.0001	-0.0001	-0.0001
	(0.0001)	(0.0001)	(0.0001)
Inflation Rate	0.0000	0.0000	-0.0001
	(0.0002)	(0.0002)	(0.0003)
Real GDP Growth	0.0015	0.0021	0.0019
	(0.0082)	(0.0085)	(0.0084)
Baltic Countries			
CIS			
SEE			
Trend	-0.0194	-0.0224	-0.0263
	(0.0202)	(0.0192)	(0.0179)
Number of Observations	123	123	123
Number of Countries	21	21	21

Table 3-5 (Continued)

Notes: Standard errors in parentheses are robust for serial correlation
*** - significant at the 1% level, ** - significant at the 5 % level, * - significant at the 10 % level
Marginal effects and their standard errors are presented for the probit model. Significance is for the underlying coefficient.
Depreciation is calculated around the mean value of 0.94 in the interaction term with mismatch.
All explanatory variables are lagged one period.
LPM includes a full set of country dummy variables. In all regressions, they are jointly significant at the 1 % level.

Table 3-6 Effect of Total Bank Currency Mismatch

Dependent Variable: Banking Crisis	Overall Effect of Real Depreciation and Currency Mismatches		Effect of Real Depreciation and Currency Mismatches in the Existence of a Currency Crisis	
	10 Probit	10 LPM	11 Probit	11 LPM
Depreciation	1.3684 ***	0.3172 ***	-0.0497	0.2522
	(0.4484)	(0.0389)	(0.2585)	(0.1462)
Banks' Currency Mismatch	0.0393 ***	0.0023	0.0000	-0.0148 *
	(0.0083)	(0.0066)	(0.0129)	(0.0072)
(bank mismatch)*(depreciation)	-0.0899 ***	-0.0359 *	-0.0907	-0.0341
	(0.0311)	(0.0169)	(0.0809)	(0.0568)
Concentration	-0.1477	0.7206	0.3617	0.7887 *
	(0.8385)	(0.4885)	(0.6819)	(0.3886)
Deposit Insurance	-0.0843	-0.0868	0.0251	-0.0417
	(0.2105)	(0.0939)	(0.2155)	(0.0882)
IXBR	-0.9271 ***	-0.1152	-0.5595 ***	-0.0919
	(0.3239)	(0.1127)	(0.1864)	(0.1235)
IXFTL	0.6022 **	0.0727	0.5851 **	0.0676
	(0.2417)	(0.1525)	(0.2269)	(0.1766)
Domestic Credit	0.0328 ***	0.0000	0.0112	-0.0065
	(0.0081)	(0.0083)	(0.0077)	(0.0073)
GDP/Capita	-0.0001	-0.0002 ***	-0.0001 **	-0.0002 ***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Inflation Rate	-0.0006 **	-0.0004 *	-0.0014 *	-0.0005 **
	(0.0003)	(0.0002)	(0.0008)	(0.0002)
Real GDP Growth	-0.0058	-0.0039	-0.0151	-0.0100
	(0.0184)	(0.0101)	(0.0165)	(0.0112)
Baltic Countries	0.4128		-0.0312	
	(0.3004)		(0.3560)	
SEE	0.0032		-0.3820	
	(0.4425)		(0.2951)	
Trend	-0.1162 **	0.0031	-0.0713 *	0.0069
	(0.0592)	(0.0191)	(0.0401)	(0.0227)
Number of Observations	89	89	89	89
Number of Countries	15	15	15	15

Notes: Standard errors in parentheses are robust for serial correlation
*** - significant at the 1% level, ** - significant at the 5 % level, * - significant at the 10 % level
Marginal effects and their standard errors are presented for the probit model.
Significance is for the underlying coefficient.
Depreciation is calculated around the mean value of 0.93 and 1.09 during currency crises in the interaction term with mismatch.
All explanatory variables are lagged one period.
LPM includes a full set of country dummy variables. In all regressions, they are jointly significant at the 1 % level.

Table 3-7 Overall Effect of Real Depreciation and Currency Mismatches—Alternative Specification

Dependent Variable: Banking Crisis	1 Probit	2 Probit	3 Probit
Real Depreciation	0.1650	0.6598	0.7393 **
	(0.5649)	(0.5676)	(0.3560)
Banks' Currency Mismatch	-0.0133 **	-0.0058	
	(0.0064)	(0.0056)	
(bank mismatch)*(depreciation)	0.0964 ***	0.0586 *	
	(0.0346)	(0.0322)	
Firms' Currency Mismatch	-0.0121 ***		-0.0071
	(0.0043)		(0.0051)
(firm mismatch)*(depreciation)	0.0160		-0.0016
	(0.0155)		(0.0116)
Concentration	-0.8318	-0.8641	-0.5891
	(0.5586)	(0.5880)	(0.5637)
Foreign Banks	-0.0061	-0.0027	-0.0029
	(0.0082)	(0.0067)	(0.0072)
Capital Adequacy	-0.4981 ***	-0.4809 **	-0.5461 ***
	(0.1145)	(0.1608)	(0.0970)
Deposit Insurance	-0.4811 *	-0.2646	-0.3281
	(0.2360)	(0.2480)	(0.2484)
Open Positions	-0.3720	-0.5334 **	-0.1694
	(0.1947)	(0.1379)	(0.2359)
Bankruptcy Law	0.3458	0.0461	0.0728
	(0.2553)	(0.3000)	(0.2885)
IAS	-0.8143 ***	-0.7296 ***	-0.8191 ***
	(0.1000)	(0.1141)	(0.1012)
IXFTL	0.3625	0.4277 *	0.3766
	(0.2435)	(0.2447)	(0.2507)
Domestic Credit	0.0069	0.0027	0.0000
	(0.0086)	(0.0074)	(0.0085)
Exchange Rate Regime	-0.0092	0.0274	0.0290
	(0.1299)	(0.1226)	(0.1097)
GDP/Capita	-0.0002 ***	-0.0002 ***	-0.0001 **
	(0.0001)	(0.0001)	(0.0000)
Inflation Rate	-0.0013	-0.0010	-0.0007
	(0.0022)	(0.0018)	(0.0010)
Real GDP Growth	0.0016	0.0089	0.0235
	(0.0235)	(0.0255)	(0.0227)
Baltic Countries	-0.0804	0.0686	-0.0081
	(0.4437)	(0.3846)	(0.3752)
CIS	-0.8626 ***	-0.6598 ***	-0.7409 ***
	(0.0836)	(0.0843)	(0.1329)
SEE	-0.4664	-0.2682	-0.3027
	(0.2855)	(0.2835)	(0.2389)
Trend	0.0899 *	0.0560	0.0513
	(0.0524)	(0.0440)	(0.0429)

Table 3-7 (Continued)

Dependent Variable: Banking Crisis	1 LPM	2 LPM	3 LPM
Real Depreciation	-0.0354	0.0334	-0.0430
	(0.2014)	(0.1836)	(0.1128)
Banks' Currency Mismatch	-0.0029	0.0041	
	(0.0034)	(0.0025)	
(bank mismatch)*(depreciation)	-0.0009	0.0060	
	(0.0114)	(0.0078)	
Firms' Currency Mismatch	-0.0081 **		-0.0063 **
	(0.0038)		(0.0023)
(firm mismatch)*(depreciation)	-0.0107		-0.0099 *
	(0.0068)		(0.0048)
Concentration	0.5482	0.5068	0.5200
	(0.3380)	(0.4104)	(0.3561)
Foreign Banks	-0.0135 ***	-0.0118 ***	-0.0134 ***
	(0.0028)	(0.0025)	(0.0026)
Capital Adequacy	-0.2457	-0.2375	-0.2508
	(0.1579)	(0.1558)	(0.1594)
Deposit Insurance	0.0953 *	0.1192 *	0.0942
	(0.0550)	(0.0635)	(0.0568)
Open Positions	-0.0872	-0.0735	-0.0866
	(0.1726)	(0.2044)	(0.1767)
Bankruptcy Law	0.0247	0.0411	0.0362
	(0.1530)	(0.1608)	(0.1478)
IAS	-0.3649 **	-0.3353 **	-0.3694 **
	(0.1560)	(0.1588)	(0.1514)
IXFTL	0.3717 ***	0.3042 ***	0.3647 ***
	(0.1109)	(0.0698)	(0.0911)
Domestic Credit	-0.0138 **	-0.0162 ***	-0.0152 **
	(0.0059)	(0.0056)	(0.0054)
Exchange Rate Regime	0.0325	0.0124	0.0251
	(0.0683)	(0.0578)	(0.0622)
GDP/Capita	-0.0002 *	-0.0002 *	-0.0002 *
	(0.0001)	(0.0001)	(0.0001)
Inflation Rate	-0.0008 ***	-0.0008 ***	-0.0008 ***
	(0.0002)	(0.0003)	(0.0002)
Real GDP Growth	0.0107	0.0042	0.0106
	(0.0102)	(0.0094)	(0.0097)
Baltic Countries			
CIS			
SEE			
Trend	0.0524 ***	0.0266	0.0477 **
	(0.0183)	(0.0206)	(0.0175)
Number of Observations	109	109	109
Number of Countries	21	21	21

Table 3-7 (Continued)

Notes: Standard errors in parentheses are robust for serial correlation
*** - significant at the 1% level, ** - significant at the 5 % level, * - significant at the 10 % level
Marginal effects and their standard errors are presented for the probit model. Significance is for the underlying coefficient.
Depreciation is calculated around the mean value of 0.93 in the interaction term with mismatch.
All explanatory variables are lagged one period.
LPM includes a full set of country dummy variables. In all regressions, they are jointly significant at the 1 % level.

Table 3-8 Effect of Real Depreciation and Currency Mismatches in the Existence of a Currency Crisis – Alternative Specification

Dependent Variable: Banking Crisis	4 Probit	5 Probit	6 Probit
Real Depreciation	-2.2883 ***	-2.1558 ***	-0.1967
	(0.8450)	(0.6164)	(0.2974)
Banks' Currency Mismatch	0.0174	0.0108	
	(0.0113)	(0.0106)	
(bank mismatch)*(depreciation)	0.1670 ***	0.1366 ***	
	(0.0499)	(0.0289)	
Firms' Currency Mismatch	0.0042		0.0081 *
	(0.0030)		(0.0047)
(firm mismatch)*(depreciation)	0.0166		-0.0330 ***
	(0.0104)		(0.0111)
Concentration	-0.5704	-0.5716	-0.5577
	(0.5391)	(0.5497)	(0.5513)
Foreign Banks	-0.0018	-0.0017	-0.0024
	(0.0056)	(0.0057)	(0.0063)
Capital Adequacy	-0.6109 ***	-0.6123 ***	-0.4907 ***
	(0.1482)	(0.1523)	(0.1518)
Deposit Insurance	-0.1791	-0.1921	-0.2039
	(0.2426)	(0.2476)	(0.2206)
Open Positions	-0.4423 *	-0.4538 *	-0.3557
	(0.2449)	(0.2331)	(0.2444)
Bankruptcy Law	0.1304	0.1308	0.0907
	(0.2054)	(0.2091)	(0.2418)
IAS	-0.7369 ***	-0.7500 ***	-0.7212 ***
	(0.1393)	(0.1326)	(0.1314)
IXFTL	0.5498 ***	0.5576 ***	0.4786 **
	(0.2043)	(0.2077)	(0.1991)
Domestic Credit	-0.0021	-0.0021	-0.0012
	(0.0071)	(0.0072)	(0.0075)
Exchange Rate Regime	0.0802	0.0830	0.0491
	(0.1355)	(0.1371)	(0.1150)
GDP/Capita	-0.0002 ***	-0.0002 ***	-0.0002 ***
	(0.0001)	(0.0001)	(0.0001)
Inflation Rate	-0.0020 **	-0.0021 **	-0.0016 *
	(0.0009)	(0.0009)	(0.0009)
Real GDP Growth	0.0136	0.0133	0.0149
	(0.0201)	(0.0205)	(0.0197)
Baltic Countries	0.0522	0.0512	0.0032
	(0.3499)	(0.3541)	(0.3322)
CIS	-0.5002 ***	-0.5157 ***	-0.5791 ***
	(0.1055)	(0.0976)	(0.0997)
SEE	-0.2270	-0.2394	-0.2194
	(0.2198)	(0.2223)	(0.2142)
Trend	0.0558	0.0610	0.0567
	(0.0438)	(0.0442)	(0.0380)
Number of Observations	109	109	109
Number of Countries	21	21	21

Table 3-8 (Continued)

Dependent Variable: Banking Crisis	4 LPM	5 LPM	6 LPM
Real Depreciation	-0.6561 *	-0.5191 *	-0.2579
	(0.3495)	(0.2766)	(0.1802)
Banks' Currency Mismatch	-0.0006	0.0006	
	(0.0034)	(0.0034)	
(bank mismatch)*(depreciation)	0.0227	0.0312 *	
	(0.0188)	(0.0153)	
Firms' Currency Mismatch	-0.0023		-0.0017
	(0.0029)		(0.0026)
(firm mismatch)*(depreciation)	-0.0144		-0.0188 **
	(0.0097)		(0.0083)
Concentration	0.6922 *	0.6492	0.7028 *
	(0.3841)	(0.3874)	(0.3771)
Foreign Banks	-0.0139 ***	-0.0121 ***	-0.0143 ***
	(0.0037)	(0.0028)	(0.0037)
Capital Adequacy	-0.2449	-0.2170	-0.2418
	(0.1557)	(0.1482)	(0.1534)
Deposit Insurance	0.1532 **	0.1411 **	0.1695 **
	(0.0710)	(0.0651)	(0.0677)
Open Positions	-0.0297	-0.0642	-0.0014
	(0.1855)	(0.2022)	(0.1927)
Bankruptcy Law	0.0040	0.0009	-0.0014
	(0.1710)	(0.1726)	(0.1625)
IAS	-0.2690 *	-0.2888 **	-0.2628
	(0.1410)	(0.1270)	(0.1613)
IXFTL	0.3859 ***	0.3222 ***	0.4033 ***
	(0.1235)	(0.0823)	(0.1186)
Domestic Credit	-0.0140 **	-0.0140 **	-0.0134 **
	(0.0054)	(0.0052)	(0.0053)
Exchange Rate Regime	0.0404	0.0232	0.0408
	(0.0664)	(0.0630)	(0.0574)
GDP/Capita	-0.0002	-0.0002	-0.0002 *
	(0.0001)	(0.0001)	(0.0001)
Inflation Rate	-0.0012 ***	-0.0010 ***	-0.0011 ***
	(0.0003)	(0.0003)	(0.0003)
Real GDP Growth	0.0029	0.0018	0.0037
	(0.0109)	(0.0110)	(0.0095)
Baltic Countries			
CIS			
SEE			
Trend	0.0399	0.0355	0.0396 *
	(0.0233)	(0.0261)	(0.0210)
Number of Observations	109	109	109
Number of Countries	21	21	21

Table 3-8 (Continued)

Notes: Standard errors in parentheses are robust for serial correlation
*** - significant at the 1% level, ** - significant at the 5 % level, * - significant at the 10 % level
Marginal effects and their standard errors are presented for the probit model. Significance is for the underlying coefficient.
Depreciation is calculated around the mean value of 1.09 during currency crises in the interaction term with mismatch.
All explanatory variables are lagged one period.
LPM includes a full set of country dummy variables. In all regressions, they are jointly significant at the 1 % level.

Figure 3-2 Effect of Depreciation on the Probability of Banking Crises at Different Levels of Currency Mismatch in the Banking Sector

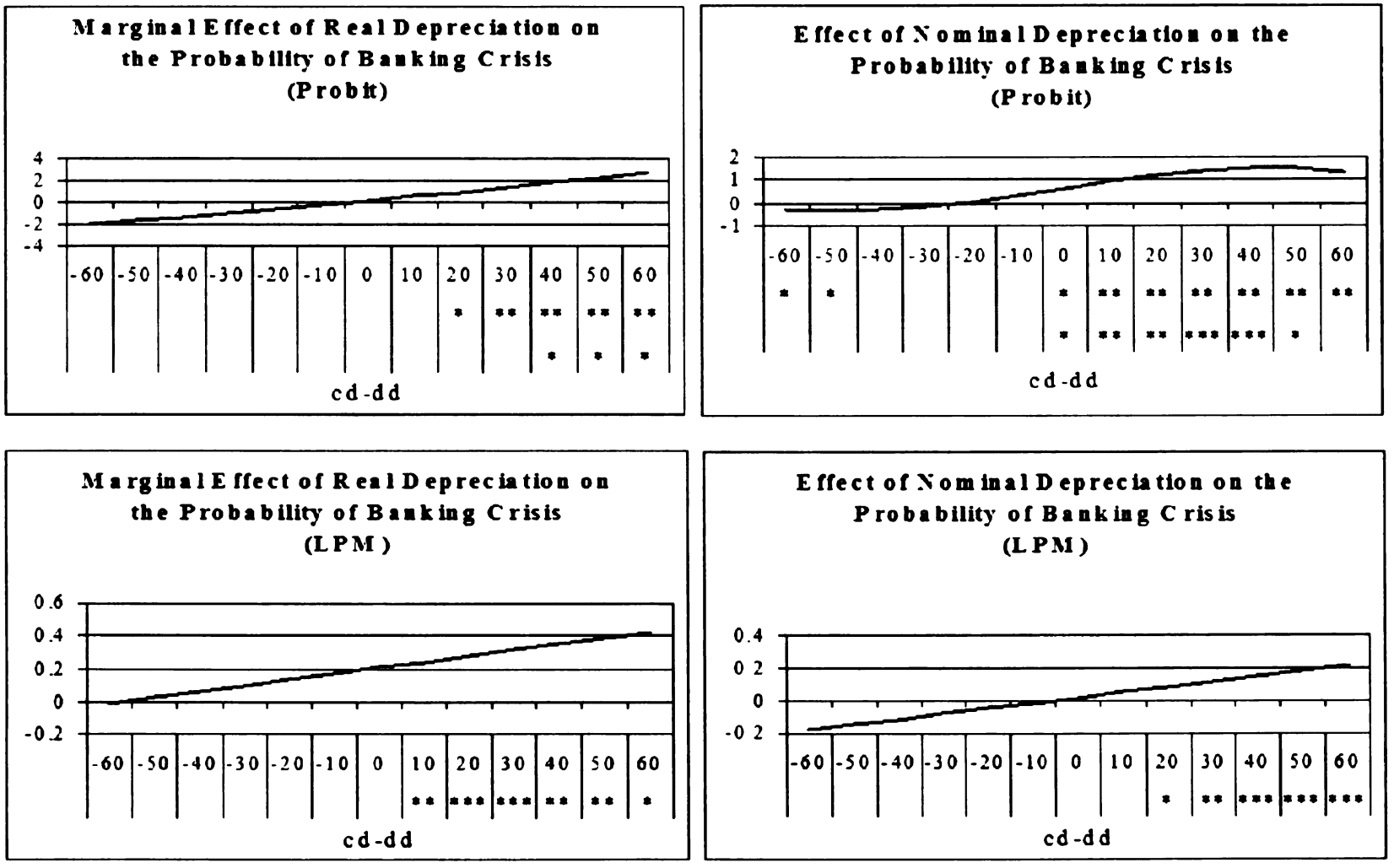


Figure 3-3 Effect of Depreciation on the Probability of Banking Crises at Different Levels of Currency Mismatch in the Real Sector

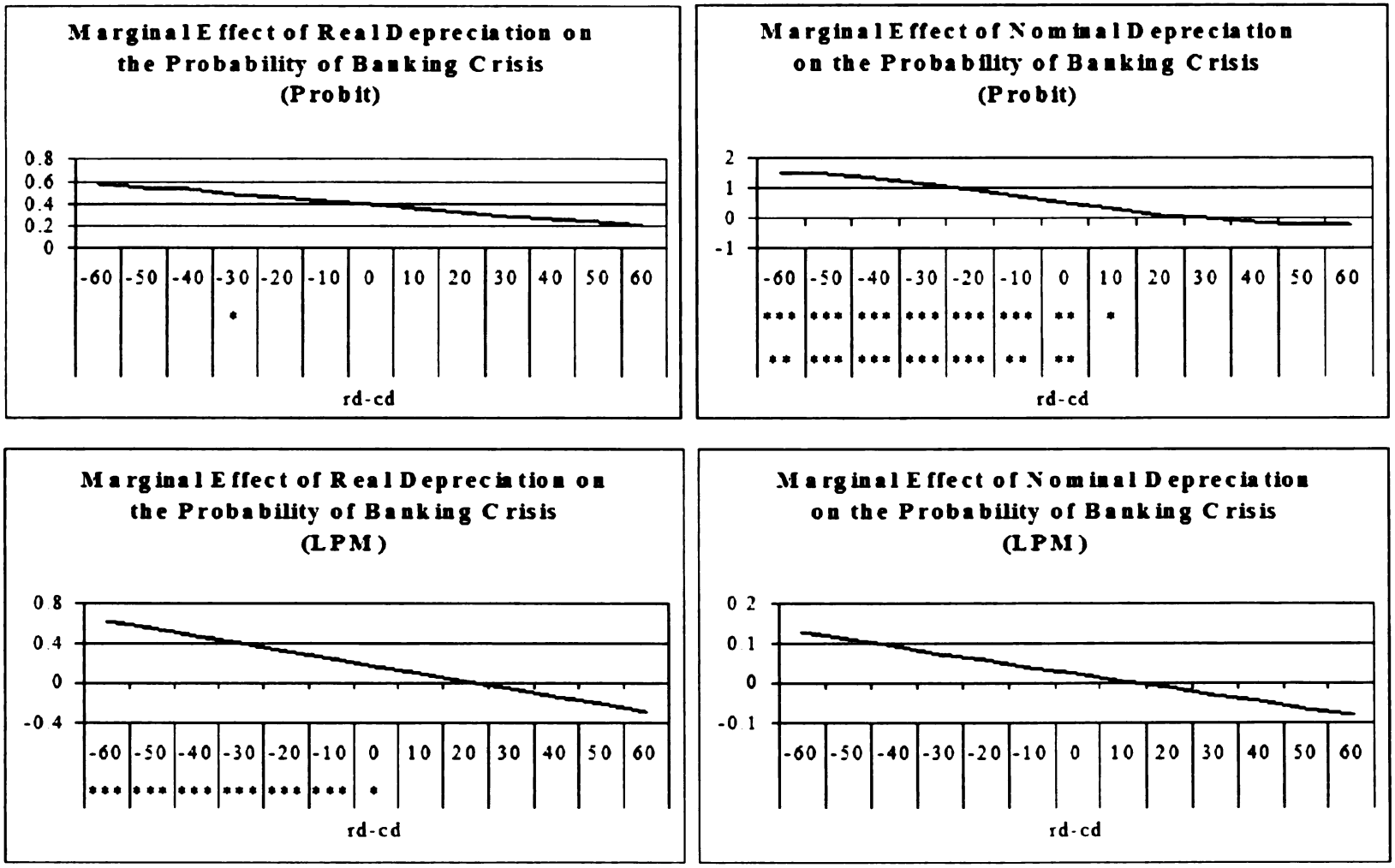
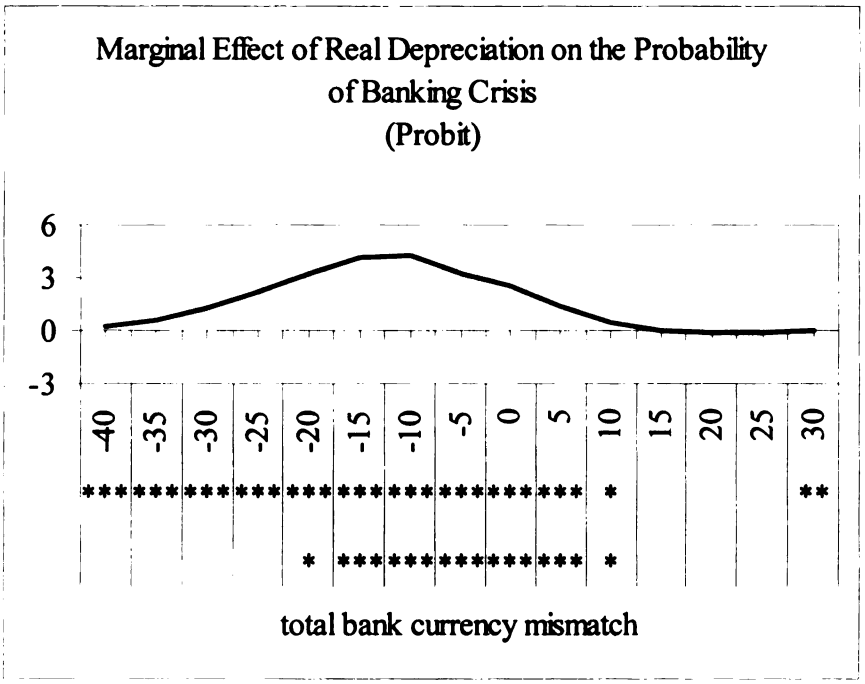
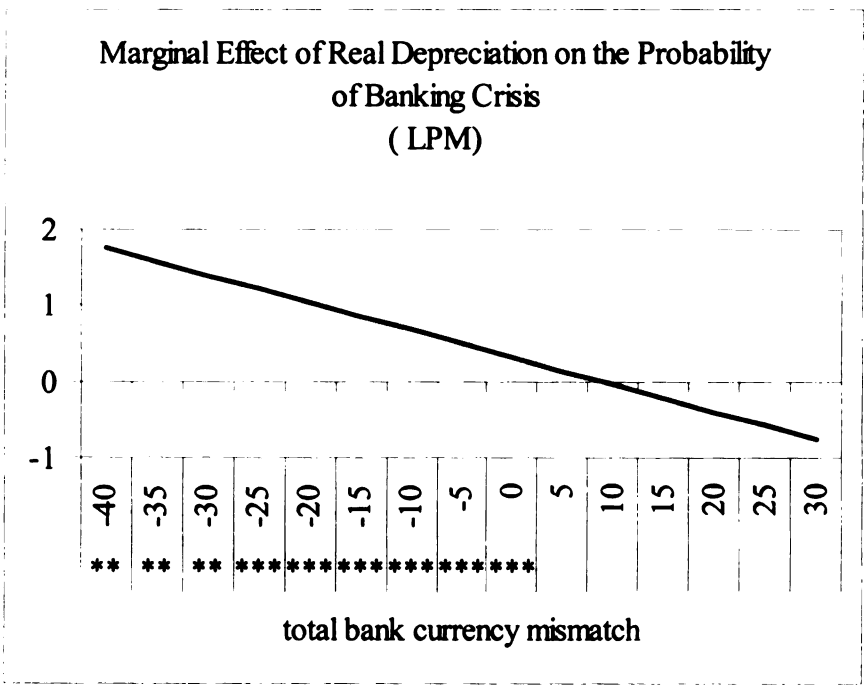


Figure 3-4 Effect of Real Depreciation on the Probability of Banking Crises at Different Levels of Total Currency Mismatch in the Banking Sector





Notes to tables 3-2 to 3-4

In the probit model: First row presents significance of the underlying coefficient. Second row presents significance of the marginal effect.

*** - significant at the 1% level, ** - significant at the 5 % level, * - significant at the 10 % level