Essays on Capital Flows and Exchange Rates

by

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Abstract

This thesis studies capital flows and exchange rates. Chapter 1 presents a brief introductory essay to the issues that will be discussed.

Chapter 2 provides empirical support of contagion in emerging markets using secondary market debt prices and country credit ratings. It shows that fundamentals are unable to explain the cross-country comovement of creditworthiness in Latin American countries. It also shows that contagion cannot be explained by "big news" events, such as Brady announcements, and that it is asymmetric, being stronger for negative innovations in creditworthiness. In contrast, using a "control group" composed by US corporate bond prices and credit ratings of a group of medium size OECD countries, the chapter shows that fundamentals explain all the observed correlation. The essay presents a simple model trying to explain this puzzle. It combines illiquid countries with investors who potentially need liquidity in order to change their portfolio. The basic intuition is that if investors require liquidity and they do not find it in one country, then they will seek funds in a second country. Under two alternative equilibrium definitions the model shows that the probability of repayment of one country is negatively affected by the degree of illiquidity of other countries —an apparently country-specific characteristic.

Chapter 3, joint with Ilan Goldfajn, develops a model of external crises focusing on the interaction between the liquidity created by financial intermediaries and foreign exchange collapses. The intermediaries' role of transforming maturities is shown to result in larger movements of capital and a higher probability of crises. This resembles the observed cycle in capital flows: large inflows, crises and abrupt outflows. The model highlights how adverse productivity and international interest rate shocks can be magnified by the behavior of individual foreign investors linked together through their deposits in the intermediaries. An eventual collapse of the exchange rate can link investors' behavior even further.

Chapter 4, co-authored with Ilan Goldfajn, empirically analyzes a broad range of real exchange rate appreciation episodes. The cases are identified after compiling a large sample of monthly multilateral real exchange rates from 1960 to 1994. The objective is twofold. First, the essay studies the dynamics of appreciations, avoiding the sample selection of analyzing exclusively the crisis (or devaluation) cases. Second, the essay analyzes the mechanism by which overvaluations are corrected. In particular, we are interested in the proportion of the reversions that occur through nominal devaluations, rather than cumulative inflation differentials. We calculate the probability of undoing appreciations without nominal depreciations for various degrees of misalignment. The overall conclusion is that it is very unlikely to undo large and medium appreciations without nominal devaluations.

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Chapter 1

Introduction

Capital flows to developing countries and exchange rate collapses have been two main subjects in International Finance during the last decade. Starting in 1989, after several years of being excluded from voluntary markets, Latin American and other emerging economies had a new wave of capital inflows. These inflows have been surprisingly widespread and largely independent from past performance and state and depth of structural reforms. As for exchange collapses, there have been several major episodes during the 90's. The crises in Italy, Spain, and the UK in 1992 put enormous pressure on the European Monetary System and the future monetary union. The collapses in Finland in 1992 and Mexico in 1994 showed that there are deep connections among the volatility and size of capital flows, the financial system health, and the exchange rate.

This thesis studies three issues of capital flows and exchange rates collapses. First, it analyzes whether fundamentals explain the new wave of capital inflows to emerging markets or if there are contagion effects. After showing that there is evidence of cross-country contagion, it develops a simple model to try to explain this puzzle. Second, it develops a model showing how financial intermediation can increase capital inflows to a country, but, at the same time, make the country more vulnerable to shocks. This second model explains exchange rate collapses as an outcome of small disturbances that are greatly amplified by the financial system and country illiquidity in general. Third, it presents an empirical study of real exchange rate appreciation episodes. The study evaluates the claim that an overvaluation invariably causes a large nominal exchange rate devaluation and characterizes the dynamics of appreciation episodes.

An evident explanation for why capital inflows and creditworthiness are correlated across emerging economies is that the fundamental determinants of these flows comove. In fact, many authors have proposed that the world interest rate —the short run interest rate in the US in particular— is the key variable driving capital flows and creditworthiness in developing countries. However, using secondary market debt prices and country credit ratings, chapter 2 provides evidence that there are contagion effects in Latin American countries; fundamentals are not able to explain all the comovement of creditworthiness. This chapter also shows that contagion cannot be explained by major "news events," such as Brady deal announcements, the Brazilian moratorium, and the Citibank announcement of new provisions for bad loans. Even when these events are taken into account, there is a significant comovement of countries' creditworthiness. Moreover, the chapter shows that contagion is asymmetric. Negative innovations in creditworthiness (after controlling for the effect of fundamentals) have a higher correlation than positive innovations.

The question of whether excess comovements in creditworthiness is a standard feature in other settings is addressed using two "control groups." Chapter 2 analyzes bond (debenture) prices of large US corporations. It concludes that after controlling for the effect of nominal interest rates (US government bond prices), there is no comovement in prices; contagion disappears if one considers the effect of fundamentals. As for country credit ratings, the chapter analyzes the correlation of a group of medium-size OECD countries. The conclusion, again, is that fundamentals explain all the cross-country correlation.

Finally, in an attempt to explain the puzzle of contagion in emerging markets, chapter 2 develops a simple model of portfolio allocation in which liquidity considerations give a rationale for contagion. If investors need liquidity —e.g., because they are changing their portfolio— and they do not find it in one country, they will seek funds in a second country. Thus, apparent country-specific characteristics matter for the creditworthiness of *other* countries. Under two alternative equilibrium definitions, the model shows that the probability of repayment in one country is negatively affected by the degree of illiquidity of other counties. The key assumption in the model is the existence of contracts that make the country illiquid under certain circumstances. Two examples of potentially illiquid situations are the fixation of the exchange rate with limited international reserves and financial intermediation.

Traditional models of external crisis based on unsustainable policies do not account for important facts observed during major currency collapses. Financial system disruption, lack of liquidity, and run against domestic assets even after the crisis, are all characteristics of major collapses (e.g., Chile 1982, Finland 1992, and Mexico 1994). Moreover, it is usually observed that countries experience capital inflow surges during the years preceding the crises, that these flows are mainly concentrated in short term instruments (*hot money*), and that financial intermediation increases during that time. Chapter 3 studies the role of liquidity and financial intermediation in attracting capital inflows, and, at the same time, making the economy more vulnerable to balance of payment crises. It develops a complementary view to the traditional approach in which collapses occur because of mismanagement.

The model in chapter 3 is one in which the intermediaries' role of transforming maturities results in larger movements of capital and a higher probability of crises. It replicates the observed cycles in capital flows: After large inflows there is potentially a crisis and abrupt outflows. It is shown that small shocks in productivity or international interest rates can be magnified by an illiquid financial sector and may result in massive capital outflows and an exchange rate collapse. The intuition behind the model is similar to the problem of a bank run. Illiquidity makes investors compete for cashing-in claims, and therefore small shocks are amplified. An eventual collapse of the exchange rate links investors' behavior even further. Knowing that a devaluation is coming, investors try to cash-in even more resources.

The leading explanation behind exchange rate crises is that the real exchange rate was previously overvalued. A potential implication is that overvaluations invariably end in large nominal exchange rate devaluations. Analyzing a sample of exchange rate crises episodes, however, is not the correct method to evaluate such a claim.

There are potentially many overvaluation cases that have been resolved without large devaluations. Similarly, knowing that before a crisis the real exchange rate is always overvalued does not answer questions such as what is the probability that a country facing a 25% of overvaluation will have a currency crisis?

Chapter 4 studies a broad range of real exchange rate appreciations. The objective is twofold. First, the chapter studies the characteristics and dynamics of appreciations without the sample selection problem of having only crisis-cases. Second, the chapter analyzes the mechanism by which the overvaluations are corrected. In particular, it studies the proportion of the reversions that occur through nominal devaluations rather than cumulative inflation differentials. Operationally, the appreciation episodes are identified as PPP deviations after compiling a large sample of multilateral real exchange rates from 1960 to 1994. The conclusions are that it is very unlikely to undo large and medium size appreciations without nominal devaluations, and that appreciations have asymmetric behavior in the build-up and return-to-equilibrium phases. In particular, it is found that there are no cases that return to equilibrium without devaluations in the sample of appreciations of 35% or more. Moreover, for a given period of time, it is always more likely to undo the appreciation completely than to undo it partially. The probability of collapse (that is, large devaluation) increases steadily with the level of appreciation. Finally, the build-up period has longer duration than the return-to-equilibrium phase and appreciations are more likely to occur with fixed exchange rate regimes and during the second half of our sample.

Chapter 2

Emerging Markets Contagion: Evidence and Theory

2.1 Introduction

After several years of being excluded from voluntary capital markets, Latin American and other developing countries received sizable capital inflows between 1990 and 1994. The funds involved in these transactions are even higher than those the region received during 1977–82.[1] A remarkable fact about these inflows is that despite important differences in past performance, state and depth of structural reforms, and macroeconomic stability, they were quite widespread, with almost all countries seeing improvements in their capital balances. Figure 2-1 presents data of net capital inflows to major Latin American countries. It turns out that 7 out of 8 countries show a clear expansion of capital inflows after 1990 when compared to the situation in 1988–1989. Other indicators also make this surge evident. For example, Calvo et al. (1993) report that there was a widespread rise of both secondary market debt

[1]Its composition, however, is different. During 1977–1982 net foreign direct investment and net portfolio investment accounted for 26% of the total net capital inflows; during 1990–94 these type of flows account for more than 95% of the total (IMF ,1995). The size of the inflows has been such that the recent experiences of Chile, Colombia and Mexico have been studied as a policy *problem*. See, e.g., Schadler et al. (1993). The net external financing received by the Western Hemisphere in 1990–1993 is approximately equal to 35% of its external debt in 1989.

prices and total reserves between 1990 and 1993. Other emerging markets such as Asian countries have also received substantial inflows. More recently, the impact of the Mexican crisis at the end of 1994 on domestic interest rates in emerging markets gives further evidence about this comovement phenomenon.[2] The subject of this paper is precisely to study one puzzling aspect of these capital flows that has to do with comovements in creditworthiness not explained by movements in fundamentals —what will be called *contagion.*

The comovement phenomenon is not new. Both before and after the 1982 crises net capital movements to Latin America were highly correlated across countries. Figure 2-1 shows that all 8 countries had inflow surges before 1982. Some countries saw the end of the inflows before others, but, in general, almost all countries experienced a sudden shutdown in external financing, and actually started to see capital outflows. A similar situation happened during the 1920s, when movements in bond prices appeared highly correlated across countries.

An obvious explanation for why capital flows to developing countries are correlated is that the fundamentals determining these flows comove. In particular, changes in the world capital supply may explain the correlation. For example, Calvo et al. (1993) and Chuhan (1994) consider the low interest rates in the US as the leading explanation for the recent surge of capital inflows in Latin America and Asia.[3] In the same way, one expects that the cross-country correlation of variables such as terms of trade and fiscal discipline may help to explain the comovements.

The objective of this chapter is twofold. First, it investigates the existence of contagion in emerging markets. For that purpose I empirically assess whether fundamentals are able to explain the observed comovement of capital flows, more specifically, of creditworthiness of a group of Latin American countries. In particular, I analyze the behavior of both debt prices in the secondary market and country credit ratings, and try to relate it to the behavior of fundamentals.[4] The main conclusion is

[2]See, e.g., IMF (1995).

[3]Fernandez-Arias (1994) claims that country-specific factors are important explanatory variables.

[4]There are several reasons to choose debt prices and ratings rather than capital flows themselves in order to analyze the issue of contagion. See section 2.3.1.

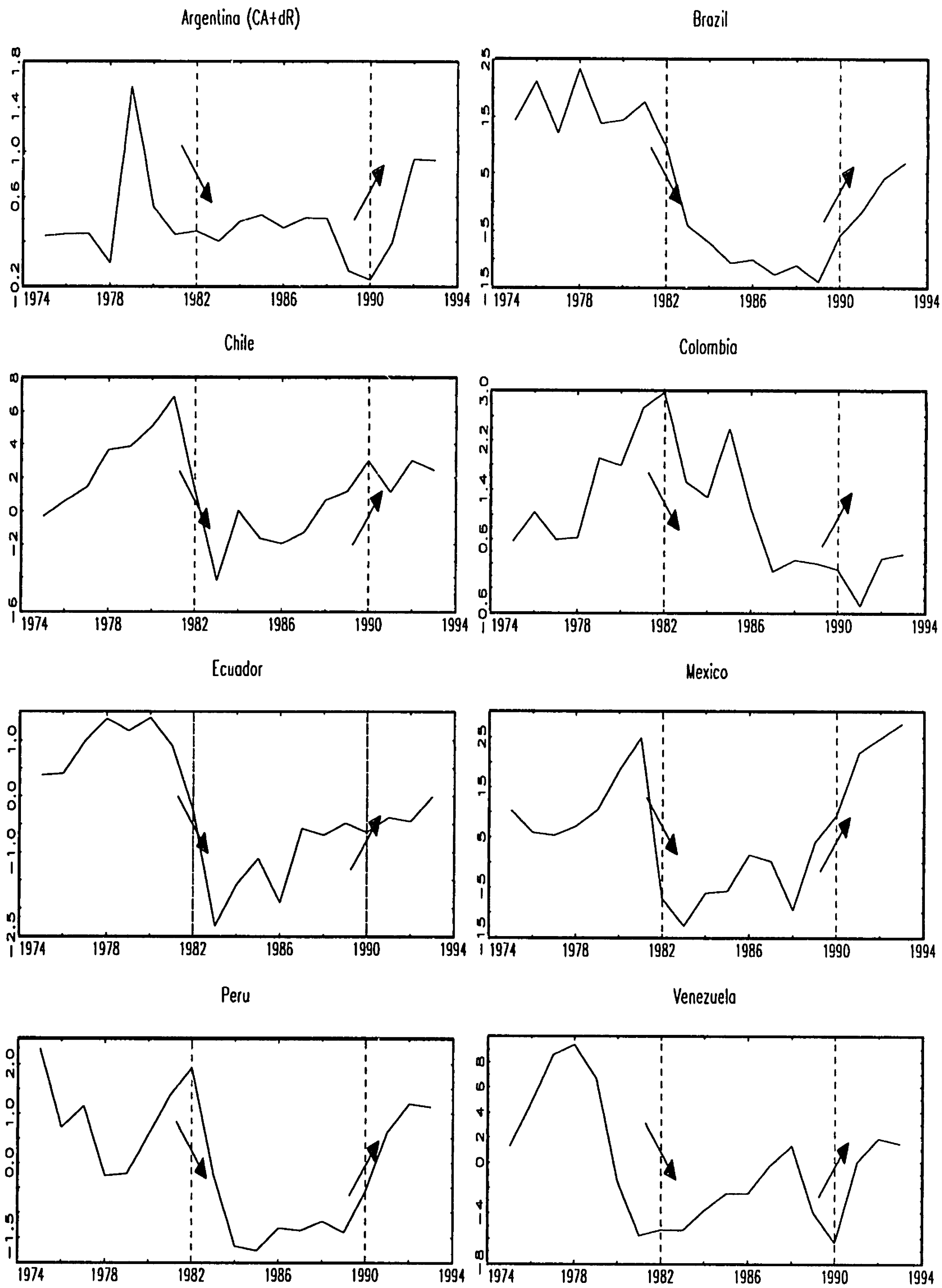

Figure 2-1: Capital Flows to Latin America: 1974–94 (Source: IFS)

that there are significant contagion effects. I also attempt to characterize the form of contagion, specifically investigating whether there are asymmetries between positive and negative contagion and whether "big news" episodes in the international market explain the excess comovement phenomenon. The conclusions in this case are that "big news" events do not explain contagion, and that there is evidence of stronger contagion of negative innovations in creditworthiness.

Second, the chapter attempts to provide a rationale for the existence of contagion based on liquidity considerations. For that purpose I present a simple model in which changes in apparently country-specific fundamentals in fact do affect the creditworthiness of other countries. The central hypothesis is that comovement is a natural consequence of the interaction of investors who are subject to liquidity needs and who invest in a group of potentially "illiquid" assets that promise certain return —as opposed to an irrational phenomenon.

Understanding whether and why there is capital movements contagion is an important aspect of international finance, especially regarding the role of international financial institutions. In fact, if there is contagion, information disclosure standards and other kinds of intervention may be desirable. Contagion is also a very important issue in the context of an optimizing economy that tries to smooth out transitory shocks. It is well known that credit constraints, for example, originating because of problems of sovereign risk, can completely change the result of the simple dynamic optimization problem, making a buffer stock desirable. Contagion goes further in that credit constraints may change throughout time without apparent justification, probably increasing the need for saved funds that can act as a buffer.

The chapter is organized as follows. Section 2.2 reviews some related literature about contagion. Section 2.3 presents empirical evidence about the existence of contagion, analyzing both debt prices in the secondary market and country credit ratings. It also discusses the existence of asymmetries in the contagion process and the role of "big news" episodes in explaining contagion. The question of how special is the contagion phenomenon to emerging markets is addressed by analyzing the comovement of US corporate bond prices and OECD country credit ratings as benchmarks. The result is that fundamentals explain all the observed comovement in these "control groups." Section 2.4 presents a simple model of capital flows and liquidity shocks in which comovements in repayment prospects emerge even after pure country-specific shocks. It also discusses reasons for having contagion as an emerging markets phenomenon and other alternative explanations. Finally, Section 2.5 presents some concluding remarks.

2.2 Contagion Literature

Contagion has primarily been defined and investigated in the context of the banking industry. It has been argued that imperfect information about the quality of a bank's portfolio from the part of depositors may support not only runs against that bank but also contagion among banks. In particular, if an investor encounters a "line" in a particular bank she could extract a signal about the bank's assets quality and decide to withdraw. The signal could be completely false —for example if the people "in line" needed more liquidity than expected rather than having negative information about the assets— but a run against the bank could start.[5] Liquidity problems in a particular bank can then spread to other banks if the banks are financially (directly) related. This type of contagion has been called institutional. But contagion effects go further than the direct effect that a failing unit may have on a financially exposed unit. Financial difficulties of a particular bank may induce runs against solvent banks because depositors lack bank-specific information. Thus, signals (possibly incorrect) about the quality of a bank portfolio may trigger a withdrawal decision from a second (institutionally unrelated) bank if the signal conveys information about the quality of the assets of the second bank. In fact, this type of contagion has been observed empirically. In a study of US bank panics, Park (1991) finds that these panics were stopped by the authority mainly by providing bank-specific financial information rather than liquidity. In these models, while lack of liquidity alone can start a run against a particular bank, its propagation to other banks requires some degree of

[5]See, e.g., Chari and Jagannathan (1988).

imperfect information.

More in an international context, studying the stability of the Eurocurrency inter-bank market, Sounders (1987) has focused on potential contagion among international banks, both informational and institutional. Informational contagion includes the effects of a failing bank on how investors and depositors evaluate the riskiness of other banks. Institutional contagion includes both direct bank relations —in which a bank may withdraw deposits to pay to others— and settlement risk —that accounts for problems that arise from "undelivered" funds. Among other things, he examines evidence about contagion by checking the behavior of spreads and rationing. As for spreads, he looks at the correlations between LDCs' and developed countries' both pre- and post-debt crisis, and in a time-moving window. If there were contagion, one would expect spreads to be correlated across both types of countries. His conclusion is that there are no signs of contagion, except for the months immediately surrounding the Mexican 1982 moratorium. As for rationing, he tests for correlation among the capital movements to major borrowing groups, such as geographic areas and banking centers. He also analyzes the principal components of these flows. The conclusion, again, is that there has been no contagion in the inter-bank market.

Contagion among banks in an international context has also been investigated using event studies and excess returns in equities of US banks. In the case of the Mexican announcement, which happened at a time when there were no mandatory disclosures about exposure levels, studies have reached different conclusions. For instance, Smirlock and Kaufold (1987) provide evidence that the market was strong-form efficient (which is equivalent to say that there was no contagion). They showed that only banks *with* exposure showed negative excess returns after the announcement and the negative returns were proportional to the level of exposition. Schoder and Vankudre (1986), on the other hand, conclude that there was no relation between excess return and exposure, showing therefore existence of contagion effects. In the case of the Brazilian 1987 default, which happened when disclosure was mandatory, studies have also given conflicting evidence. Musumeci and Sinkey (1990), on one hand, find no evidence of contagion; exposed banks showed negative returns proportional to their level of exposition. They also find no evidence of *cross-country* contagion —the subject of this paper— since negative returns "appear mainly related to Brazilian exposure."[6] Karafiath and Smith (1991), on the other hand, find some evidence of bank contagion effects related to size.

Few studies have tried to provide direct evidence of *cross-country* contagion. Doukas (1989) attempts to test whether innovations in a creditworthiness indicator of a sovereign borrower affects the spread charged to other countries. Using monthly data between 1978 and 1982 from Argentina, Brazil and Mexico, he concludes that, indeed, there were contagious effects of the innovations.[7] The problem with this conclusion, however, is that he does not control for an eventual correlation in the innovations across countries. Also, spreads can potentially be a very poor indicator of the capital supply a country faces if credit constraints are binding. In particular, it is straightforward to show that the expected repayment of a risky loan may decrease with the spread charged if the likelihood of repayment decreases rapidly enough with the size of the repayment due to, for instance, sovereign default.

Lee (1993), in a study of the determinants of the credit ratings assigned by bankers, finds that there is a group *level* effect by region. More specifically, he finds that the inclusion of dummy variables for geographical location of the borrower yield highly significant coefficients in panel regressions using annual data. He does not test, however, whether innovations in the credit rating of one country are correlated to innovations in credit rating of other countries. His finding, rather, shows the existence of geographical fixed-effects in the assignment of credit risk.

More oriented toward developed countries, Shiller (1989) studies the comovements in stock prices of the US and the UK, using Shiller-type tests in which prices and

[6]Karafiath and Smith (1991) criticize this paper on three gounds. The standard errors might be biased (they use OLS); both the size and the date of the windows are too restictive; and other explanatory variables are not included. Another explanation for the cross-country result is the high correlation (0.95) between Brazilian and other Latin American countries exposure across banks (which in the limit of perfect correlation makes the identification impossible).

[7]In this study creditworthiness is measured by an index of production of the major exportable commodities (proxying for future growth opportunities that, in turn, would determine default decisions). Innovations are the residuals of an equation of a production index and changes in the domestic price level, the import price level, and the nominal money supply. Interestingly, the paper shows that only innovations —and not production itself— matter in the determination of the spread.

dividends movements are analyzed. Although there is some evidence of excess comovement, he considers that these are not conclusive results.

Finally, Calvo and Reinhart (1996) study the existence of contagion using stock market data, Brady bond prices, and actual capital flows. The analysis of stock and Brady bonds prices focuses on the impact of the Mexican crises of late 1994 on other countries. Using weekly data they show that the cross-country correlation of prices increased after the Mexican shock. They interpret this as contagion, showing that this pattern is stronger in Latin America. They derive the same conclusion using factor analysis of weekly stock market prices. The principal shortcoming of this evidence, however, is that they do not control for the effect of fundamentals, which potentially can explain all the observed comovement. Moreover, they do not test whether the correlations (and their changes) are statistically significant.[8] As for capital flows, they test the existence of contagion spillovers from large to small Latin American countries using yearly data. They estimate a reduced form equation of annual flows for two group of countries —large and small— as a function of the US interest rate and a lagged indicator of capital inflows to the other group. The conclusions are that flows are very sensitive to the interest rate, and that flows to large countries influence flows to small ones, but not conversely. However, despite being an interesting result, it does not address the question of contagion among large and medium size emerging markets, which is the focus of this chapter.

2.3 Empirical Evidence of Contagion: The Case of Latin America

2.3.1 Methodology

In order to test whether there is contagion in emerging markets I examine the comovement of a group of Latin American secondary market debt prices and country

[8] Appendix A.1.1 shows that, using monthly data between 1991 and 1994, the cross-country correlation of stock returns in Latin America is not statistically different from zero.

credit ratings separately. Secondary market prices proxy for default riskiness and can be considered as an indicator of capital movements. Country ratings, on the other hand, attempt to measure directly the risk that the market assigns to each country in terms of the prospects of repaying capital flows.

By analyzing debt prices and credit ratings, one would be indirectly studying contagion of capital movements as long as capital flows depend on the markets' repayment risk assessment. Appendix A.1.2 shows that this is the case indeed: capital flows do depend on repayment risk assessments. Using semi-annual flows data for Argentina, Brazil, and Mexico, the appendix shows that credit ratings are an important determinant of capital flows (controlling for the effect of international interest rates).

There are several reasons to examine debt prices and credit ratings rather than actual capital flows. First, capital flows data is only published annually for most of the countries under study, and for the purpose of my analysis I need several data points per country. Second, any estimation involving capital flows has the problem of the existence of two regimes for capital movements due to sovereign default risk. In one regime the country receives the desired amount and in the other it is constrained.[9] These two regimes pose several difficulties to any estimation attempt, especially because the constraint depends upon the stock of debt. Finally, recorded capital flows do not necessarily coincide with "actual" flows. This is particularly important during capital flight episodes and exceptional financing cases.

Another indicator of capital movements is spread data. As mentioned before, however, spreads can potentially be a very poor proxy of the supply of credit. In particular, they do not need to increase with default riskiness if a country is credit constrained.

In testing for excess comovement I follow a similar methodology to the one used by Pindyck and Rotemberg (1990, 1993), where they study the existence of excess comovement of world commodity prices and US stock prices, respectively. In particular, I test whether pairwise correlations of the variables under analysis are significantly different from zero, and check whether the correlation matrix of these variables is

[9] This point is made in Eaton and Gersovitz (1981). They attempt to estimate the two regimes.

statistically different from the identity matrix. These procedures are carried out both using the original data and after controlling for the effect of fundamentals, which basically are those variables that determine the likelihood of repayment of external debt or repatriation of flows in general. These fundamentals include variables that may affect both sovereign default and solvency.[10]

I use two tests in order to verify whether groupwise correlations are significant. The first one is a likelihood ratio test in which, under the null hypothesis of no groupwise correlation, the statistic $-N \log |R|$ has a χ^2 distribution with $.5p(p-1)$ degrees of freedom. Here $|R|$ is the determinant of the correlation matrix, N the number of observations and p the number of series under analysis (see Pindyck and Rotemberg, 1990). The second one is a Lagrange multipliers test originally designed to check correlation among cross-equation residuals. In this case the statistic $N \sum_{i=2}^{p} \sum_{j=1}^{i-1} r_{ij}^2$ has the same χ^2 distribution as before under the null, where the r_{ij}^2 are the pairwise correlations (see Breusch and Pagan, 1980).

In order to assess whether the contagion phenomenon is a common phenomenon I also analyze the behavior of the price of some US corporate bonds and OECD country credit ratings during the same period and frequency as LDC's debt prices and ratings. I check the comovement of both the original data and prices after controlling for the effect of fundamentals in these cases as well.

2.3.2 Debt Prices in the Secondary Market

Several LDCs' debt has been traded in secondary markets since March of 1986, with banks and speculators being the most important agents in this market.[11] Since transactions are private, only bid and ask prices are known. Following the standard practice in the secondary market of debt literature, I focus here on the average between the two prices as the representative transaction price. I use monthly average prices from March of 1986 to August of 1994. Three months are missing during the first year

[10]Direct relations among countries may eventually affect the correlations because of institutional contagion. This effect is disregarded given that the cross-country investment was very small in Latin America during the sample period.

[11]See World Bank (1993) for a description of the market operation.

Table 2.1: Correlation Matrix of Debt Price Changes
Secondary Market (March 1986–August 1994)

	ARG	BRA	CHL	ECU	MEX	PER
BRA	.363					
CHL	.354	.339				
ECU	.403	.354	.396			
MEX	.547	.606	.440	.420		
PER	.451	.317	.299	.421	.313	
VEN	.552	.519	.584	.527	.748	.397
LR test for identity matrix = 289.10 [$\chi^2(21)$]						

Measured as first differences of logs
95% pairwise correlation critical value = .193
95% critical value for identity matrix = 32.67

of observations. I use the last value recorded as the value for each of these months respectively. Prices are measured as percentage points of face value. The most important characteristics of the traded debt are that it is long run bank debt, a very high proportion of it has been contracted at a floating rate, and the quoted price represents "benchmark issues," so prices are comparable throughout time.

I analyze debt prices of seven Latin American countries. They are Argentina (ARG), Brazil (BRA), Chile (CHL), Ecuador (ECU), Mexico (MEX), Peru (PER) and Venezuela (VEN). This group represented around 90% of the volume of trade in the secondary market of debt during 1987–1988. Since Colombian debt started to be traded only after 1990 it was left out from the analysis. Table 2.1 presents the correlation matrix of the first difference of the log of debt prices. As expected, the correlations of the prices in levels are much higher, of order of 0.85 to 0.95.[12]

The correlations in table 2.1 are significantly positive in all 21 cases, and above

[12]I chose to analyze the first differences of (the log of) prices rather than levels because when I attempt to control for fundamentals, OLS regressions in levels have residuals with gigantic autocorrelation, probably indicating non-stationary prices. Considering that these are assets prices, this non-stationarity seems reasonable.

0.40 many times. Moreover, the likelihood ratio test rejects the hypothesis of the correlation matrix being equal to the identity matrix at all standard confidence levels.[13] Further evidence of this comovement is given by the correlation of each country's price with a weighted average of the other countries' prices. Using the population in 1990 as weights these correlations are 0.38 for Argentina, 0.60 for Brazil, 0.44 for Chile, 0.46 for Ecuador, 0.66 for Mexico, 0.37 for Peru, and 0.65 for Venezuela.

Controlling for Fundamentals

As discussed above, comovements in the country risk perception —proxied here by debt prices— do not imply contagion if fundamentals are driving this comovement. Some of the determinants of creditworthiness are common across countries (e.g. interest rates) and others may be correlated (e.g. terms of trade and reserves). The question therefore becomes whether there is co-movement *after* controlling for the effect of these fundamentals.

Several variables affect countries' ability and willingness to pay back loans and other capital inflows. In terms of the sovereign debt literature, the "prize" of an eventual default is what the country saves, namely debt and interests.[14] Both a higher debt level and interest rates will make more likely a default scenario worsening creditworthiness and depressing debt prices. The "cost" of an eventual default depends on what supports international lending. If direct punishment is what allows sovereign countries to borrow (deterring default as the dominant strategy as in Bulow and Rogoff, 1989b), then the main determinants of the cost of default will be related to the costs of an eventual interference with trade. In particular, a higher volume of exports and higher terms of trade improve creditworthiness. If threats of exclusion from the credit market is what sustains international lending, then default will imply that the country has to finance any project it has by itself. A steeper income stream

[13]Interestingly, this is not only a Latin American phenomenon. The correlations of Philippines' debt prices are also significantly correlated to those of Latin American countries. The pairwaise correlations are 0.20 (ARG), 0.29 (BRA), 0.32 (CHL), 0.28 (ECU), 0.41 (MEX), 0.26 (PER), and 0.48 (VEN).

[14]See, e.g., Sachs (1984) and Eaton et al. (1986).

—given for instance by higher growth— and a higher income variability would improve creditworthiness.[15] In terms of solvency, difficulties in raising taxes to keep a relative balanced government budget may indicate problems regarding the likelihood of paying external debts because of the so-called internal transfer problem. In the same way, the stock of reserves matters because it makes the net debt smaller. It also provides the liquidity that would otherwise be provided by extra debt (in turn increasing the default prize). I also consider the real exchange rate as a fundamental measuring the international valuation of the country as an asset.

Since I am using monthly data, I am interested in (and restricted to) high frequency fundamentals.[16] In particular I consider the short term interest rate (Libor), the long term interest rate, the stock of reserves, a terms of trade index, inflation, and the real exchange rate. A complete description of data construction and sources is presented in appendix A.2.1. [17]

The functional form I estimate is the first difference of the log of debt prices as a linear function of the first difference of the log of the fundamentals (except the interest rate and inflation). I also include the interest rate in levels because, as with any asset, one expects total returns to be associated with the level of return of alternative assets. The final conclusions, in any case, are exactly the same if one estimates an equation in levels or uses the logistic transformation of debt prices. I include trends in the form of time and time squared so as to control for eventual trends that may not be captured by the fundamentals mentioned before (e.g. lending banks capitalization as in Buckberg, 1993). Thus, the equation to be estimated for each country i is:

[15] See, e.g., Eaton and Gersovitz (1981).

[16] Notice that although I do not control for medium frequency fundamentals such as growth, the market does not observe it either with a monthly frequency. In the next section, which studies credit ratings, I take care of medium and low frequency fundamentals.

[17] There is a delicate issue regarding simultaneity of reserves and the real exchange rate with capital inflows, and therefore, with markets' risk assessments. This problem disappears if one assumes that it takes time for capital flows to materialize. In any case, the results reported here do not change if one uses lagged reserves and real exchange rates as instruments. Moreover, I am interested in checking whether fundamentals can explain the observed correlation of risk assessment rather than in the structural form interpretation of the coefficients.

$$
\begin{aligned}
d\log(p_{it}) &= \beta_0 + \beta_{1i}(\text{Libor}_t) + \beta_{2i}d(\text{Long-Run Interest}_t) + \\
&\quad \beta_{3i}d\log(\text{Reserves}_{it}) + \beta_{4i}d\log(\text{T. of Trade}_{it}) + \\
&\quad \beta_{5i}d(\text{Inflation}_{it}) + \beta_{6i}d\log(\text{RER}_{it}) + \beta_{7i}T + \beta_{8i}T^2 + \varepsilon_{it}
\end{aligned}
$$

where p_{it} is the debt price and where under the null hypothesis (no contagion) the ε_{it}'s are stochastic errors uncorrelated across countries. Notice that under the null hypothesis of no cross-country correlation the estimation country by country is efficient. The results of the estimation are presented in table 2.2. They are OLS and maximum likelihood estimations corrected for autocorrelation in the residuals.

Only the interest rate (in first differences) coefficient has consistently the expected sign and it is usually significant.[18] The interest rate in levels always has the expected sign —both the fact of being a substitute of international bonds and the direct effect of interest rates on repayment prospects depress the prices— but it is not significant. The reserves coefficient has the expected sign in 6 out of the 7 cases, but it is significant only for Argentina. Inflation and the real exchange rate coefficients usually have the correct sign, but are not significant. Terms of trade coefficients behave more erratically and are insignificant. Cohen and Portes (1990) reach similar conclusions regarding both the interest rate and terms of trade. Trends are not significant at all. Note that R^2's are quite high if one considers that I am explaining asset price changes. In the case of Pindyck and Rotemberg (1990), R^2's are of the same order of magnitude. Finally, all the results, including the high R^2's and coefficient values, do not change if the trends are left out of the regressions.

Using the residuals of the regressions one can test again for the presence of excess comovement. Table 2.3 presents the correlation matrix of these residuals.

The comovement effect of debt prices is still present even after controlling for the effect of fundamentals. All 21 pairwise correlations are still significantly positive, varying from a high of .739 (Mexico-Venezuela) to a low of .212 (Mexico-Peru). It is

[18]This is a surprising result if one considers that the majority of the debt is at a floating rate. The use of US debt prices (e.g. treasury bonds) instead of the interest rate worsens the adjustment.

Table 2.2: Debt Price Regressions
(Dependent Variable: First Difference of log of Debt Price)

	ARG	BRA	CHL*	ECU*	MEX*	PER	VEN*
Constant	2.78	1.89	0.21	-3.03	-0.74	2.04	-5.98
	(6.47)	(7.21)	(1.50)	(4.56)	(5.03)	(8.30)	(2.88)
Libor (6months)	-0.09	-0.06	-0.00	-0.07	-0.02	-0.14	-0.00
	(0.07)	(0.08)	(0.01)	(0.09)	(0.04)	(0.15)	(0.06)
Long Run Rate	-0.27	-0.72	-0.14	-0.88	-0.18	-0.71	-0.50
	(0.31)	(0.38)	(0.11)	(0.35)	(0.16)	(0.50)	(0.20)
Reserves	2.88	0.67	0.72	0.10	0.44	0.64	-1.19
	(0.51)	(1.07)	(0.66)	(0.08)	(0.33)	(1.75)	(0.78)
T. of Trade	-0.57	-0.34	-0.08	0.65	0.15	-0.37	1.27
	(1.45)	(1.46)	(0.38)	(0.98)	(1.11)	(1.98)	(0.63)
Inflation	-0.01	-0.01	-0.05	-0.15	0.00	-0.03	-0.01
	(0.01)	(0.01)	(0.07)	(0.19)	(0.01)	(0.03)	(0.06)
RER	-0.55	3.99	0.07	1.24	1.55	0.48	0.26
	(0.86)	(2.73)	(1.66)	(1.54)	(2.38)	(1.40)	(0.46)
Trend (÷10)	0.21	-0.03	0.06	0.23	0.10	0.31	1.33
	(0.14)	(0.22)	(0.08)	(0.18)	(0.88)	(0.28)	(1.11)
$Trend^2$(÷100)	-0.20	0.00	-0.00	-0.19	-0.01	-0.03	-0.01
	(0.14)	(0.02)	0.01	(0.19)	(0.01)	(0.03)	(0.01)
R^2	0.33	0.08	0.10	0.20	0.12	0.11	0.21
D.W. ($\hat{\rho}$ if AR(1))	2.03	1.80	0.18	0.17	0.16	1.75	0.23

(*): MLE with AR(1) disturbances.

All coeficients are (÷10). All variables are first differences (but Libor)

All variables in logs (but interest rates and inflation).

Standard errors in parenthesis.

Table 2.3: Correlation of Debt Price Residuals
After Controlling for Fundamentals

	ARG	BRA	CHL	ECU	MEX	PER
BRA	.324					
CHL	.366	.316				
ECU	.311	.341	.278			
MEX	.436	.557	.435	.317		
PER	.432	.225	.240	.325	.212	
VEN	.465	.502	.559	.361	.739	.306
LR test for identity matrix = 236.51 [$\chi^2(21)$]						
LM test for identity matrix = 344.99 [$\chi^2(21)$]						

Measured as first differences of logs
95% pairwise correlation critical value = .193
95% critical value for identity matrix = 32.67

important to remark that I am controlling for the effect of terms of trade. In particular, the high correlation between Venezuela and Mexico cannot be explained by changes in oil prices (at least monthly changes). Notice also that all 21 pairwise correlations decrease once I control for the effect of fundamentals. Groupwise correlation is also smaller, but still significant. Both LR and LM tests confirm that the total correlation is different from zero at any standard confidence level. In sum, there is an important degree of contagion in the secondary market of debt, even after controlling for the effect of fundamentals.

Whether fundamentals matter in explaining cross-country correlations can be evaluated by examining the correlation of predicted debt price changes. This exercise is presented in table 2.4. It turns out that, as expected, predicted price changes are highly correlated. In fact, the groupwise correlation is considerable higher than the original data's. This correlation, however, is not strong enough to rule out contagion as shown in table 2.3.

There are three interesting issues that arise from the significant correlation of debt

Table 2.4: Correlation of Predicted Debt Prices
Effect of Fundamentals

	ARG	BRA	CHL	ECU	MEX	PER
BRA	.350					
CHL	.195	.383				
ECU	.370	.674	.551			
MEX	.338	.497	.675	.721		
PER	.471	.727	.455	.738	.638	
VEN	.390	.382	.642	.677	.746	.520
LR test for identity matrix = 437.02 [$\chi^2(21)$]						
LM test for identity matrix = 638.59 [$\chi^2(21)$]						

Measured as first differences of logs
95% pairwise correlation critical value = .193
95% critical value for identity matrix = 32.67

prices. First, are "big news" episodes responsible for the correlations one observes, or is it a more generalized phenomenon? Second, are the comovements symmetric in terms of positive and negative contagion? And third, is this a common phenomenon in bond markets? I try to address these questions in the following subsections.

The Role of "Big News"

A reasonable explanation for the contagion I have found in LDC debt prices is the existence of "big news" episodes that what I have regarded as fundamentals are not accounting for. This section attempts to isolate some of those episodes and re-evaluate the existence of contagion.

I consider eight events during the period 1986–1994 that potentially affected debt prices. These events are: the Brazilian moratorium of 1987; the Citibank loan loss reserve announcement of 1987; the announcement of the Brady plan; the Venezuelan riots of 1989; the Mexican Brady agreement; and talks about Brady agreements of Argentina, Brazil, and Venezuela. A complete description of the timing of the events is presented in appendix A.1.3.

The methodology I use here is as follows. When an event is not country specific I include a dummy variable for the month(s) of the event in all 7 countries. When the event is country specific I check for unusual changes in debt prices of the country generating the news around the month(s) of the event. Then I assign to all other countries a dummy variable for the months of unusual change times the actual change in the log of the price of the debt of the country where the event took place.[19] I also include as fundamentals all the variables included in table 2.2.

The results of the regressions controlling for these events are presented in table A.3 of appendix A.1.3. Although the coefficients usually have the expected sign, the majority of the coefficient turns out to be statistically insignificant. All significant coefficients, however, have the expected sign. Particularly important events are the Citibank announcement and the Mexican Brady agreement. The Brazilian moratorium has the correct sign in all countries and the Brady plan announcement mixed impacts.[20] Interestingly, the Venezuelan riots affected positively the countries that later on signed Brady agreement and negatively those who did not. Finally, Brazilian conversations about a Brady deal highly and positively affected Ecuador and Peru, both countries that at that time did not have Brady deals but that could have benefited from one. After controlling for these events (and fundamentals) I test again for cross-country comovement. Table 2.5 presents the correlation matrix of the residuals of these regressions.

The results show that even after controlling for "big news" events there is cross-country contagion. Although pairwise correlations usually decrease and the groupwise correlation is smaller than that of the exercise without controlling for events, all correlations are still significantly different from zero. Contagion, therefore, cannot be

[19]Since I do not observe when the market receives news, nor the flow at which they arrive, I use price data to proxy for the timing of the news. I scale each country-specific news dummy by the size of the price reaction of the country generating the news. This does not produce any bias because I do not use the constructed variable in the regressions of the country that I use to construct the variable (which is the country generating the news).

[20]Both the Citibank and Brady plan announcements are considered in Cohen and Portes (1990) with similar conclusions.

Table 2.5: Correlation of Debt Price Residuals
After Controlling for Fundamentals and Events

	ARG	BRA	CHL	ECU	MEX	PER
BRA	.318					
CHL	.354	.337				
ECU	.329	.331	.270			
MEX	.469	.517	.471	.375		
PER	.459	.209	.261	.370	.218	
VEN	.497	.423	.542	.385	.659	.264
LR test for identity matrix = 220.62 [$\chi^2(21)$]						
LM test for identity matrix = 339.26 [$\chi^2(21)$]						

Measured as first differences of logs
95% pairwise correlation critical value = .193
95% critical value for identity matrix = 32.67

disregarded.

Asymmetric Contagion

An interesting question is whether contagion is symmetric in terms of positive and negative innovations.[21] In fact, one possible characterization of the excess comovement is that contagion exists when there are negative innovations, and not when there are positive developments. This subsection tries to shed some light about the characterization of contagion, and more specifically about the existence of asymmetries.

In order to search for the existence of asymmetries I regress the residuals of each country (that is change in the log of debt prices controlled for fundamentals) against

[21] There is another asymmetry question regarding how small and large countries interact. Although I do not investigate that question here, it is interesting to note that there is some evidence that bigger countries are "more contagious." In fact, the correlations between countries' debt prices and the weighted average of the other countries' presented in the beginning of this section show that the bigger countries —Brazil and Mexico— have a higher correlation with the rest. Also, see Calvo and Reinhart (1996) for some evidence of contagion from large to small countries.

the residuals of another country and a dummy variable times those same residuals.[22] The dummy variable takes the value of one when the residuals of this other country are positive. Asymmetric contagion will exist whenever the coefficient of the interactive dummy variable is significant. The results of the regressions of the 21 possible pairs are presented in table A.4 in appendix A.1.4. Although several cases do not show asymmetric contagion, some pairs do show a marked asymmetry. In fact, in all 6 cases when the interactive dummy variable is significantly different from zero, it is positive. Insignificant coefficients are both positive and negative. I conclude then that there is some evidence of asymmetric contagion, and, in particular, that negative contagion is stronger than positive contagion. Fitted and actual values of debt price change for the 6 pairs of countries in which the dummy variable is statistically different from zero are presented in figure 2-2.

A Benchmark: US Corporate Bonds

In order to explore whether bond prices are usually correlated I repeat the same exercise as before using bonds of some US corporations of different industries. Although imperfect as a control group, the exercise provides evidence that price contagion is not a systematic characteristic of debt instruments.[23]

I analyze bonds issued by the four biggest US corporations according to the Fortune 500 ranking published in 1994 by *Fortune* magazine. The bonds have similar characteristics: debentures with nominal coupons and maturity around the year 2001. The contracted nominal interest rate differs considerable across bonds, from $5\frac{1}{2}$ to $10\frac{1}{4}$ percent. The companies are Exxon, General Motors, IBM and Phillip Morris. Interestingly enough, these bonds have very different ratings, varying from AAA (Exxon) to BBB (GM) in the Standard and Poor's nomenclature. The ratings also vary considerably through time. The period of analysis is the same as in the case of LDC

[22]Of course, in this exercise I am not claiming any causation between the two residuals; it is just an exercise to check for asymmetries. As such, the parameters do not have any meaningful interpretation other than "degree of relationship."

[23]Interestingly, there is no evidence of stock markets contagion in Latin America. Returns are not significantly correlated in these countries. See table A.1 in appendix A.1.1.

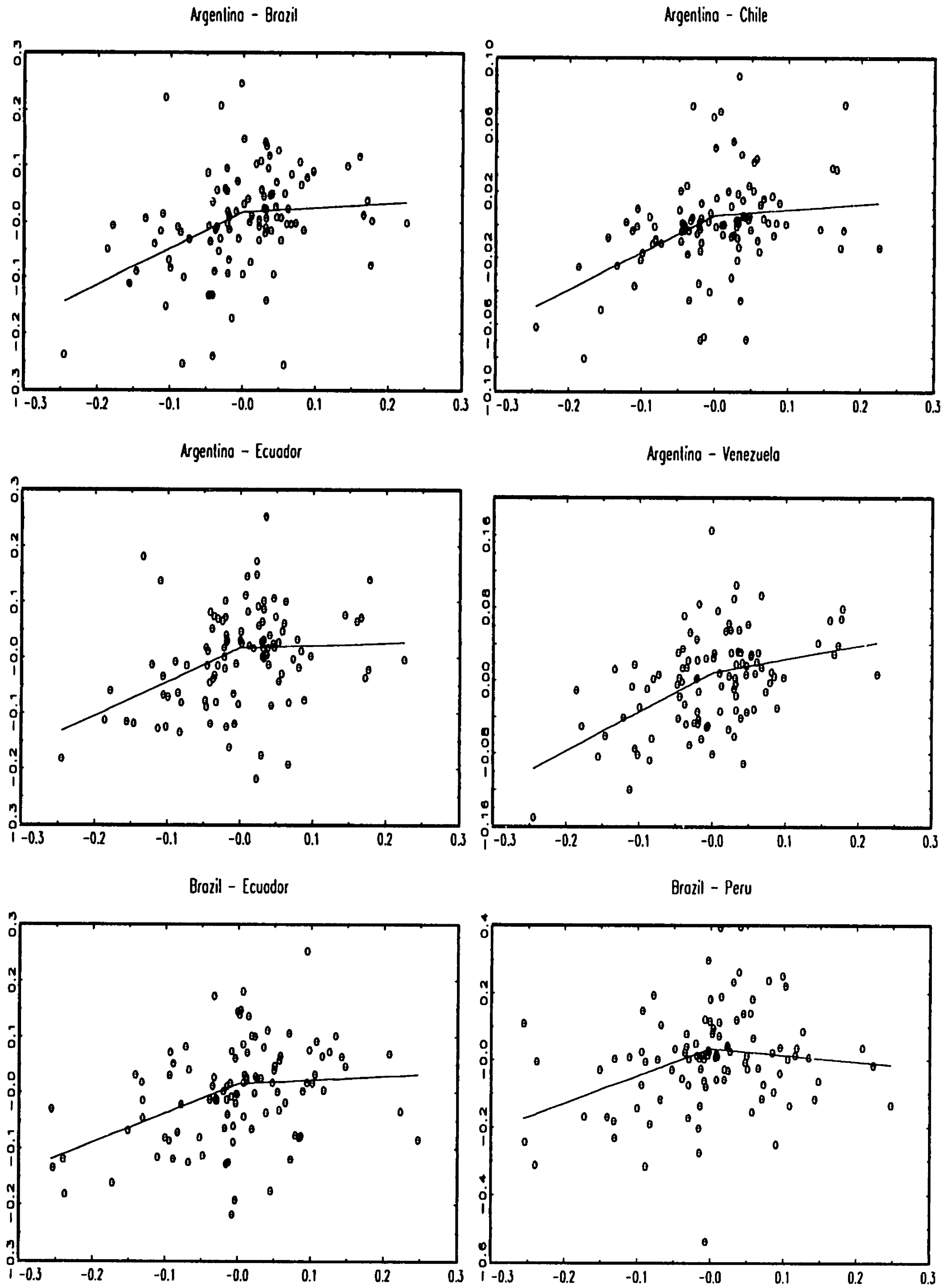

Figure 2-2: Asymmetric Contagion

Table 2.6: US Corporate Bonds Correlations
March 1986–August 1994

	Exxon	G.Motors	IBM
General Motors	.737		
IBM	.611	.635	
Phillip Morris	.786	.747	.663
LR test for identity matrix = 264.61 [$\chi^2(6)$]			

Measured as first differences of logs
95% pairwise correlation critical value = .193
95% critical value for identity matrix = 12.59

debt, namely March of 1986 to August of 1994. The original data (first differences of logs) correlations are presented in table 2.6.

As expected, given that they are nominal, US corporate bond price changes are highly correlated across firms. Both pairwise and groupwise correlations are significant. However, once one controls for fundamentals, the story is quite different. I regard as fundamental the price change of a government bond with similar maturity (a Treasury bond). Changes in the interest rate are expected to affect both government and corporate bonds. Table A.5 in appendix A.1.5 presents the results of regressions of (the log) change in corporate bond prices as a function of changes in government bond prices. High t-values and R^2's are expected given that all the bonds are nominal claims and therefore their prices are directly affected by changes in the nominal interest rate. The correlation matrix of the residuals of these regressions is presented in table 2.7.

The cross-firm correlations of the US corporate bonds completely disappear after one controls for the effect correlation of fundamentals. In particular, the 6 pairwise correlations and the groupwise correlation are not significantly different from zero. I conclude then that excess comovement is not an ordinary phenomenon in debt instruments. One potential explanation for this is the interaction of the liquidity of

Table 2.7: Bond Price Residuals Correlations
After Controlling for Fundamentals

	Exxon	G.Motors	IBM
General Motors	.175		
IBM	.055	.149	
Phillip Morris	.133	.052	.089
LR test for identity matrix = 8.09 $[\chi^2(6)]$			
LM test for identity matrix = 9.64 $[\chi^2(6)]$			

Measured as first differences of logs
95% pairwise correlation critical value = .193
95% critical value for identity matrix = 12.59

these instruments. I will investigate this further in section 2.4.

2.3.3 Further Evidence: Country Credit Ratings

The second test I perform to check whether there are contagion effects is based on country credit ratings. This exercise gives a somewhat different perspective from the previous one both because the frequency of the data is different —thus allowing us to control for different fundamentals— and because credit ratings measure more directly the market's perception about country risk. I use the ratings that *Institutional Investor* magazine has been publishing since the end of 1979. The ratings are calculated twice a year (March and September) and are based on a survey of more than 100 commercial banks that operate internationally. Banks evaluate each country (except each bank's own country of origin) in a 0–100 scale and the results are averaged across banks.[24]

[24]There are basically three country credit ratings in the literature. The other two are the *Euromoney* rating and the *Economist Intelligence Unit* rating. The *Institutional Investor* rating is the only one that does not follow a predetermined linear formula, measuring directly the market perception through bank surveys. By definition, fundamentals have to explain all the correlation if the rating is just a (linear) formula of observed fundamentals. See Haque et al. (1996) for a description of these credit ratings.

Table 2.8: Credit Rating Correlation Matrix
September 1979–September 1994

	ARG	BRA	CHL	COL	ECU	MEX	PER
BRA	.858						
CHL	.734	.500					
COL	.883	.923	.557				
ECU	.925	.960	.527	.945			
MEX	.933	.789	.790	.810	.865		
PER	.825	.857	.501	.965	.919	.787	
VEN	.926	.957	.643	.934	.969	.899	.886
LR test for identity matrix = 564.75 [$\chi^2(28)$]							

Logistic transformation of ratings
95% pairwise correlation critical value = .341
95% critical value for identity matrix = 41.30

The analysis focuses on the same 7 Latin American countries analyzed before with the addition of Colombia. Since the data covers from September of 1979 to September of 1994 there are only 31 data points per country. The correlation matrix of the (logistic transformation of) original data is presented in table 2.8. Appendix A.1.6 presents the correlations of the first differences of the credit ratings.

Pairwise correlations are in all cases significantly positive. Besides Chile, all 21 pairwise correlations are above 0.80, and several are above 0.90. All 7 correlations with Chile are above 0.50. Correspondingly, the likelihood ratio test rejects the hypothesis of groupwise zero correlation at any conventional level of confidence.[25] As in the case of debt prices, I also calculate the correlations between each country's rating and a population-weighted average of the other countries' ratings. The results are 0.45 for Argentina, 0.68 for Brazil, 0.42 for Chile, 0.79 for Colombia, 0.54 for Ecuador, 0.65 for Mexico, 0.45 for Peru, and 0.81 for Venezuela.

[25]This is not a Latin American phenomenon only. The pairwaise correlations of the Philippines' credit rating with those of Latin Americans countries are 0.92 (ARG), 0.86 (BRA), 0.82 (CHL), 0.86 (COL), 0.84 (ECU), 0.87 (MEX), 0.77 (PER), 0.91 (VEN).

Table 2.9: OECD Credit Rating Correlations
September 1979–September 1994

	ITA	FRA	SPA
FRA	.371		
SPA	.530	.779	
UK	.103	−.484	−.646
LR test for identity matrix = 81.27 [$\chi^2(6)$]			

Logistic transformation of ratings
95% pairwise correlation critical value = .341
95% critical value for identity matrix = 12.59

In order to address the question of whether credit ratings are normally correlated across countries I also analyze the behavior of the ratings of four OECD countries. These are France (FRA), Italy (ITA), Spain (SPA), and the UK. Table 2.9 presents the correlation matrix of the (logistic transformation) of these credit ratings. The results are interesting in two respects. First, both the pairwise correlations among OECD countries and the groupwise correlation are highly significant. And second, the case of the UK is very different in that it has negative and significant correlations with the other countries.

As in the case of debt prices I need to control for the effect of fundamentals before concluding that there is contagion. As before, I assume that the interest rate is a key determinant of riskiness. I also consider here the own country growth rate (which affects solvency), the growth rate of the world (proxied by the US, Germany and Japan), the real exchange rate level (which proxies the international valuation of the country), and the appreciation rate of the last 6 months as possible determinants of the credit rating. In the case of Latin American countries, I also include the level of external debt as a ratio to GDP (which proxies for both the default prize and insolvency), the interest rate times the level of debt as a ratio to GDP (which affects both solvency and liquidity), exports scaled by terms of trade as a ratio of GDP, the reserves-imports ratio, last year's inflation as an indicator of fiscal distress and a dummy variable for those countries with Brady agreements. In both OECD and Latin American countries I include a time trend to capture possible changes in overall risk perception.

The functional form I use in order to control for the effect of fundamentals is the same as the one used by Lee (1993) in his study of the determination of credit ratings. It corresponds to the logistic transformation of the dependant variable as a linear function of the *level* of the fundamentals. Ozler (1993) and Edwards (1984) also assume that the logistic transformation of the probability of default is a linear function of the fundamentals in levels in their studies of the determination of spreads. In any case, if the exercise is done using the log of the fundamentals, the conclusion presented below about contagion does not change. Since I have only 31 data points per country an estimation country by country has only 22 degrees of freedom. To gain efficiency I estimate a fixed-effects model assuming the same parameters across countries (but the intercept). This strategy also requires the normalization of some variables so that country-specific fundamentals are comparable across countries; hence, I express some of the fundamentals as ratio of GDP and imports. I estimate the following equation for Latin American countries:

$$\begin{aligned}
\log(\mathrm{CR}_{it}/ \quad &= \beta_0 + \beta_1 \text{Interest Rate}_t + \beta_2 \text{Growth}_{it} + \beta_3 \text{G-3 Growth}_t + \\
(1 - \mathrm{CR}_{it})) \quad & \beta_4 \text{RER}_{it} + \beta_5 \text{Apprec.}_{it} + \beta_6 \text{Trend} + \beta_7 \text{Debt/GDP}_{it} + \\
& \beta_8 \text{Int. Rate} \times \text{Debt/GDP}_{it} + \beta_9 \text{ Reserves/Imports}_{it} + \\
& \beta_{10} \text{Inflation}_{it} + \beta_{11} \text{Brady Dummy} + \nu_{it}
\end{aligned}$$

where CR is credit rating and ν_{it} is assumed to be a stochastic error uncorrelated across countries under the null. The basic results of the estimation are presented in table 2.10. The estimation corrects for autocorrelated disturbances using the Prais-Winsten FGLS method.

In the case of Latin America, the coefficients usually have the expected sign and are significant. Growth, the debt to GDP ratio, and exports times terms of trade all have the expected signs and are significant. Interestingly, the interest rate affects

Table 2.10: Credit Rating Regression
(Dependent Variable: Logistic Transformation of Rating)

	L. America	OECD
Interest Rate (Libor)	0.51	0.09
	(0.11)	(0.04)
Growth	0.04	0.18
	(0.02)	(0.08)
G-3 Growth	–0.39	0.02
	(0.11)	(0.09)
Real Exchange Rate	0.03	0.16
	(0.01)	(0.02)
Real Appreciation Rate	–1.75	–0.08
	(0.64)	(0.02)
Trend	–0.11	0.10
	(0.05)	(0.06)
Debt/GDP	–7.09	
	(2.18)	
Libor×Debt/GDP	–0.90	
	(0.20)	
T. of Trade×Exports/GDP	0.08	
	(0.02)	
Reserves/Imports	–0.02	
	(0.58)	
Inflation	0.03	
	(0.06)	
Brady Deal	0.84	
	(0.06)	
$\bar{R}^2$	.61	.57

Fixed-effects coefficients not shown. Prais-Winsten FGLS.
All coefficients ÷10. Standard errors in parenthesis.

negatively the rating in countries with debt to GDP ratios higher than 55 %. Several Latin American countries had ratios higher than this threshold throughout the period of study. Two fundamentals present puzzling signs: G-3 growth and reserves appear to negatively affect the ratings. While the reserves coefficient is not significant at all, the G-3 growth is. One explanation is that higher growth is a predictor of higher future interest rates. The $\bar{R}^2$ of 0.61 is somewhat higher than that found by Lee (1993) using annual data, more countries, and less explanatory variables. A Lagrange multiplier to test for (groupwise) heteroskedasticity rejects the null at all standard levels of confidence.

In the case of OECD countries one observes that the interest rate tends to improve the ratings. The explanation for this phenomenon is that these countries are net creditors rather than debtors. Both own growth and the real exchange rate level significantly increase the ratings. Appreciations, on the contrary, depress the rating. Interestingly, the coefficients of both the real exchange rate and appreciations have the same signs (and are significant) in Latin American and OECD countries.

To check for the existence of contagion effects I analyze the residuals of these regressions. Table 2.11 presents the correlation matrix of the credit ratings after controlling for fundamentals in the case of Latin America. Although correlations decrease substantially, 13 out of the 21 pairwise correlations remain significantly positive. Groupwise correlation in turn decreases, but is still significantly different from zero, indicating the presence of contagion.[26]

Table 2.12 presents the correlation matrix of the residuals of OECD countries. It turns out that in this case all 6 pairwise correlations are now not significantly different from zero. All the comovement observed in the credit ratings of these countries (including the negative one) can be explained by the comovement of fundamentals affecting the ratings. Both LR and LM tests show that total correlation is not significantly different from zero.

[26]Using the same explanatory variables for Latin American countries as for OECD countries yields an even more significant rejection of the no-contagion hypothesis. In this case the LR test equals 120.42 while the LM test equals 184.79.

Table 2.11: L.A. Credit Rating Residuals Correlations
After Controlling for Fundamentals

	ARG	BRA	CHL	COL	ECU	MEX	PER
BRA	.186						
CHL	.336	.255					
COL	.085	.188	.480				
ECU	.415	.007	.458	.133			
MEX	.585	.158	.198	−.041	.469		
PER	.371	.219	.267	.141	.027	.365	
VEN	.511	.390	.388	.280	.430	.466	.341

LR test for identity matrix = 74.10 [$\chi^2(28)$]

LM test for identity matrix = 95.59 [$\chi^2(28)$]

Logistic transformation of ratings

95% pairwise correlation critical value = .341

95% critical value for identity matrix = 41.30

Table 2.12: OECD Credit Rating Residuals Correlations
After Controlling for Fundamentals

	ITA	FRA	SPA
FRA	.321		
SPA	.185	.308	
UK	.085	−.108	−.153

LR test for identity matrix = 8.25 [$\chi^2(6)$]

LM test for identity matrix = 8.52 [$\chi^2(6)$]

Logistic transformation of ratings

95% pairwise correlation critical value = .341

95% critical value for identity matrix = 12.59

In sum, there is evidence of comovement of credit ratings of Latin American countries even after controlling for the effect of fundamentals. The same is not true for the case of OECD countries, in which all the comovement is explained by fundamentals. One can therefore conclude that there is evidence of contagion across Latin American countries.

2.4 Explaining Contagion of Illiquid Countries

This section presents a simple model intended to explain the "excess" comovement of creditworthiness of emerging markets. The last section showed that part of the observed correlation can be explained by comovements of market fundamentals, the foreign interest rate being a leading explanatory variable. Yet there is a substantial correlation in some indicators of the market's assessment of countries' repayment prospects after controlling for fundamentals.

The explanation is based on liquidity considerations. The basic intuition is that if countries are illiquid —meaning that if a substantial number of creditors withdraw in the short run then there are not enough resources to pay what was promised and, additionally, future returns are affected negatively— and if people have liquidity needs, then repayment problems in one country may spread to others because people will try to find the required liquidity elsewhere. Conversely, the absence of repayment problems in one country makes it unnecessary to go for liquidity to other countries. Thus, country-specific fundamental innovations —that is, news about country-specific characteristics— may affect other illiquid countries because the likelihood of payments problems in these other countries depends in part on the likelihood of repayments in the first country. Contagion will exist both during periods of distress (that is when people have a liquidity shock) *and* during normal periods if future events of distress are possible (although they may not occur).

The model formalizes a common explanation that traders advance when asked why they withdrew from Latin American countries (and even some NICs) shortly after the Mexican collapse of December, 1994. The claim is that people were rebalancing their portfolios and needed liquidity. Since this liquidity was not in Mexico, they had to sell elsewhere.

In the presence of contracts that promise payments that are not state contingent and that create liquidity, individual returns are affected by the actions of other agents. Liquidity creation has as counterpart the lack of sufficient resources if too many people cash their claims in the short run. Agents who do not need to cash back in the short run may want to do so because other agents are. Thus, some agents who potentially need funds may end up receiving a lower return than promised (possibly zero). Examples of this type of situation are financial intermediation and the fixation of the exchange rate with limited international reserves. Empirically, on the other hand, liquidity creation seems a key part of the contagion problem. There is no evidence of contagion in the case of stock market returns in Latin American countries. Appendix A.1.1 shows that cross-country correlations are not significantly different from zero. When prices adjust to the state of affairs, the interaction of agents' actions, and therefore those of countries, is greatly reduced.

Why do we observe contagion in emerging markets and not in US corporate bonds or OECD countries? There are three reasons under the model advanced here. First, the initial illiquidity can be technologically different in each case. If the specificity of assets is higher in a developing country (that is, they have a relatively unprofitable alternative use), vis-à-vis the case of a corporation for instance, then the interaction problem that agents face is worse. Moreover, a fixed exchange rate regime that risks collapse if there are too much capital outflows increases the (technological) illiquidity of emerging markets' assets. Second, when corporations are in distress, they are protected by bankruptcy laws (e.g., Chapter 11). This greatly reduces the interaction problem, for the assets are liquidated with time and opportunity —minimizing the illiquidity problem— and only then claims are cashed. The lack of bankruptcy laws for countries pushes investors to compete for cashing in their claims, and therefore assets are liquidated more inefficiently. Finally, the illiquidity generated because of the intermediation process can be different in the case of developing countries —for instance, in the form of a higher debt-equity ratio and shorter maturities.[27]

Of course, there are other potential explanations for the problem of contagion. A short list would include bubbles-manias on emerging markets, herd behavior of investors, and signal extraction of cross-country correlated but unobservable characteristics that determine creditworthiness. The first two explanations are usually cited to explain abnormal behavior in financial markets. However, they have the unappealing implication that different countries have to be treated by investors as almost identical assets. They are probably better suited to explain the event of a sudden flow to *one* country.[28] Signal extraction, on the other hand, is exactly the mechanism that the banking literature uses to explain contagion across commercial banks (see section 2.2). In explaining cross country contagion, however, it has the shortcoming of predicting that the excess comovement should be *symmetric.* Finally, a related explanation to the one presented here is given by the effects of specialization of financial intermediation on a group of illiquid assets. If in this case the intermediary creates too much liquidity, and she is called upon to pay what is promised, she will be forced to withdraw from all the assets in which she invested, producing then the observed correlation (which in this case are emerging markets).[29] The problem with this hypothesis is that it is not obvious why such a specialization should arise. In any case, these other explanations should be thought of as complementary rather than mutually exclusive with the one advanced here.

[27]In the case that investors have idiosyncratic liquidity shocks, the existence of contagion could depend on how well the secondary market works. In particular, if it is more convenient to cash a claim than to sell it, liquidity shocks could spread problems among assets that do not have a well functioning secondary market. Thus, one would expect no contagion of US corporate bonds and OECD instruments if they are traded in a properly working secondary market.

[28]Also, neither bubbles nor manias are explained endogenously. In this respect, Garber (1994), p.31, claims that "[...] the business of economists is to find clever market fundamental explanations for events; and our methodology should always require that we search for market fundamental explanations before clutching the 'bubble' last resort."

[29]See Calvo and Reinhart (1996) for further details.

2.4.1 The Model

Time is discrete and there are three periods: 0,1, and 2. There is a continuum of risk neutral investors of size 1 who choose an initial portfolio in period 0, and choose whether to change it in period 1. Investors are all identical and have initial wealth equal to 1. There are three kind of assets:

1. A risk free international asset that yields a gross return $r_f = 1$ per period. It is available in both periods 0 and 1.

2. Countries' assets (emerging markets), indexed by i, that take two periods to mature. They have to be invested in period 0, and promise a return r if money is withdrawn in period 1, and $\hat{R}_i$ (a random variable) if withdrawn in period 2. The amount withdrawn in period 1 affects negatively $\hat{R}$. Countries are illiquid: they may not be able to pay to every investor the yield r if all of them withdraw at the same time. In that case we assume that the country pays only to some investors the promised return r.[30]

3. An investment opportunity that appears in period 1 with probability p. The opportunity has a maximum invested size equal to $I < 1$ per person and yields a known return $\kappa > R$ in period 2 (when it appears).[31]

The most obvious interpretation of the illiquidity is that there is financial intermediation and a rigid technology of production in terms of maturities.[32] While the investment process may take some periods to yield profitable results, intermediaries may offer contracts that promise to pay relative higher yields in the short run and lower ones in the long run. However, this interpretation is not unique. Another interesting and complementary interpretation is that, under a fixed exchange regime,

[30]Because of risk-neutrality from the part of investors the assumption of how the intermediary pays when it has insufficient resources is irrelevant as long as she pays all what she has.

[31]This opportunity could be thought of as a change in the world interest rate. The assumption of fixed size per-person is done for simplicity. This avoids a *commons problem* of people competing to get the investment opportunity which complicates the algebra unnecessarily. If κ were a smooth function of I, one needs $\kappa'(I)$ to be sufficiently negative for the existence of contagion. Because the three assets are real investment projects I do not consider short sales.

[32]For example, as in Diamond and Dybvig (1983).

capital outflows may prompt a devaluation if the level of international reserves is sufficiently low. In turn, exchange rate movements may produce uneven returns for investors. People withdrawing first will have access to a "better" exchange rate. The devaluation itself, on the other hand, may affect the returns in period 2. Withdrawals may also affect future returns directly if they are associated with undoing or stopping projects that contribute to external economies. One particular example is given by taxes that have to finance a fixed level of expenditures by the local government. Tax rates for period 2 will have to increase if more people withdraw in period 1, decreasing net period 2 returns.

For concreteness I follow the first interpretation and assume that countries have investment opportunities that need two periods to mature. In two periods they yield a known gross return R. If projects are interrupted in period 1 they yield a random return $\tilde{q}_i$, known only in period 1. It is public knowledge that q_i has c.d.f. $G_i(q_i)$, associated density $g_i(q_i)$, and support in $(0, 1)$. Financial intermediaries promise a return $r \geq 1$ to those investors who request the money in period 1. To pay this money, however, they need to interrupt part of the projects. Given the realization of $\tilde{q}$, if a fraction x of the projects are interrupted in one country, then the return in period 2 is given by

$$\hat{R} = R\frac{\left(1 - \frac{xr}{q}\right)}{(1 - x)}, \tag{2.1}$$

which is the budget constraint that the intermediary has to satisfy. Because $0 < q < 1 \leq r$, $\hat{R}$ is strictly decreasing in x. Of course, if x is high enough (or, given x, q low enough) so that $\hat{R} < r$, agents will cash in all their claims in period 1 (independently of the amount of money they may need) and a collapse will develop.[33]

[33] I assume the contracts presented here as given. Chapter 3 studies issues regarding the degree of optimal intermediation. In any case, a set-up that justifies intermediation follows from assuming idiosyncratic liquidity needs. If agents are ex-ante identical but a fixed proportion θ has liquidity shock in period 1, it is still possible to generate contagion. One example is given by the following utility functions:

$$\begin{array}{ll} V(C_1) + \beta U(C_2) & \text{for an early consumer} \\ U(C_2) & \text{for a late consumer,} \end{array}$$

where

$$V(C_1) = \begin{cases} 0 & \text{if } C_1 < \hat{C} \\ V & \text{otherwise} \end{cases}$$

Given the assumption that the country still pays r, but has resources equal to q, only a proportion q/r will receive the money.[34]

The set-up presented so far has both country specific innovations (the q_i 's) and well defined collapse or distress situations (when $\hat{R}_i < r$) in which the country is unable to pay its obligations. Thus, one can define contagion as changes in the probability of a country collapse when there is news about country-specific characteristics of other countries. In what follows I investigate how this simple model generates contagion. I also ask whether contagion happens only when the investment opportunity arises (the analog of an international interest rate shock) and whether contagion can be asymmetric.

2.4.2 One Country

Although for the purpose of studying contagion the analysis of one country alone is not sufficient, it is a useful initial step because it helps to establish a first important result, namely that in equilibrium, investors will be always exposed to the possibility of collapses. It is also useful in determining sufficient conditions for the existence of an equilibrium.

In this case, the period 0 investors' problem is to choose a portfolio with weight $a_0 = 1 - a_A$ in the risk-free asset and weight a_A in the (unique) country asset, trying to maximize expected utility, which in turn takes into account the probability of a future collapse. All investors are small and take $\hat{R}$ as given. As usual, in order to analyze this problem one needs to analyze first the rules of withdrawal that will be followed in period 1.

Given the portfolio chosen in period 0 and the realization of q, if the investment

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with $0 < \hat{C} < 1$ and $0 < V \ll \infty$ and where $U'(C_2) > 0$, $U''(C_2) < 0$, and $\beta < 1$.

With idiosyncratic shocks, however, one needs to assume the lack of a well-functioning secondary market for country specific securities and the impossibility to pledge future income from these countries as collateral for present borrowing. In the present case the key assumption is the existence of intermediation.

[34]There always exists a collapse if everybody runs against the country. I disregard this as an equilibrium because along the equilibrium path agents' beliefs have to be correct. If with certainty the equilibrium was collapse, nobody would invest in the first place —the return would be $q < 1$ with probability 1— and therefore there would not be a collapse.

opportunity arises in period 1, agents have to decide whether and how to finance the new investment I. The period 1 investors' problem is:

$$\begin{aligned}\max_{\{w,x,y,z\}} \; & W_2 = (1-y)a_0 + (1-x)a_A\hat{R} + z\kappa + w \\ \text{s.t.} \; & 0 \leq x, y, w \leq 1 \\ & 0 \leq z \leq I \\ & w + z - (ya_0 + xa_Ar) \leq 0,\end{aligned}$$

where $\hat{R}$ is given, W_2 is period 2 wealth, x and y are the proportions of the country and risk-free assets that are liquidated in period 1 respectively, and w and z are the resources invested in the risk-free asset and the investment opportunity in period 1. The Kuhn-Tucker first order conditions of this problem are:

$$\begin{aligned}\mu_{0y} - \mu_{1y} + (\mu - 1)a_0 &= 0 \\ \mu_{0x} - \mu_{1x} + (\mu r - \hat{R})a_0 &= 0 \\ \kappa + \mu_{0z} - \mu_{Iz} - \mu &= 0 \\ 1 + \mu_{0w} - \mu_{1w} - \mu &= 0\end{aligned} \tag{2.2}$$

plus the 9 complementary slackness conditions given by the restrictions. Here the μ's are (non-negative) Lagrange multipliers associated to each restriction. When $r \leq \hat{R}$ the solutions to this problem are given by

$$\{w, x, y, z\} = \begin{cases} \left\{0, \frac{I-a_0}{a_Ar}, 1, I\right\} & \text{if } a_0 \leq I, \text{ and} \\ \left\{y'a_0 - I, 0, y' \in (\frac{I}{a_0}, 1), I\right\} & \text{otherwise.}\end{cases} \tag{2.3}$$

When $\hat{R} < r$, on the other hand, the solutions are given by

$$\begin{aligned}&\{w, x, y, z\} = \\ &\left\{\max\langle I - y'a_0 - a_Aq, 0\rangle, 1, y' \in \left(\max\left\langle\tfrac{I-a_Aq}{a_0}, 0\right\rangle, 1\right), \min\langle a_0 + qa_A, I\rangle\right\}.\end{aligned} \tag{2.4}$$

The final equilibrium is determined simultaneously by this set of solutions and equation (2.1).[35]

[35]See footnote 34. Notice that in the case in which there is no intermediation (that is, if $r = q$),

The intuition for this set of solutions is simple. Because $1 < R < \kappa$, it is always the case that agents take advantage of the investment opportunity. There are two sources to finance it: the risk free asset and the country asset. Their cost, in terms of foregone future consumption are 1 and $\hat{R}/r$, respectively. In a no-collapse equilibrium, that is if $1 \leq \hat{R}/r$, the risk free asset is first used to finance I. If it is not sufficient, the remaining $I - a_0$ is then financed by liquidating the country asset. In particular, agents cash a proportion $x = (I - a_0) / (a_A r)$ of their initial holdings. In case of collapse, that is if $\hat{R}/r < 1$, the country is first withdrawn completely (that is $x = 1$) and the composition of financing becomes irrelevant; there is only one source with alternative cost equal to 1.

The fact that agents always finance the investment opportunity when it appears does not translate directly into withdrawals for one potential solution is that the risk free asset —chosen in period 0— suffices to finance the new project ($I \leq a_0$ and $x = 0$). In this case, independently of the realization of q, collapses would not exist. This equilibrium, however, is ruled out by the following result.

Proposition 1 *Any equilibrium solution to the one-country problem involves $a_0 < I$. Equivalently, the probability of a country collapse is always positive.*

In order to prove the result, assume otherwise. Then, using equation (2.3), one has $x = 0$, and therefore, with probability 1, $\hat{R} = R > r$. But then the initial a_A is smaller than the optimal one because regardless of whether the investment opportunity arises, the country asset (absolutely) dominates the risk-free asset. Regardless of whether the opportunity arises the country returns R, while the risk free asset returns 1. This result is independent of whether agents are risk-neutral.

The probability of collapse is positive because, if the investment opportunity arises (an event with probability p), then from (2.3) and (2.4), and the fact that $a_0 < I$ one has $0 < (I - a_0) / r a_A \leq x$. Given this lower bound for x there exists a unique cut-off

there is a range of values of q in which the country is not withdrawn at all ($x = 0$) even if $a_0 < I$. Specifically, this range is defined by the values of q that make $R/q > \kappa$. Moreover, without intermediation there would never be collapses and the interaction problem disappears.

value q^*, such that for $q < q^*$ one has $\hat{R}\ /r < 1$ and the existence of a collapse. The exact cut-off is given by

$$q^* = \frac{R(I - a_0)}{a_A(R - r) + (I - a_0)}, \tag{2.5}$$

which is increasing in R, and decreasing in a_A and I. The probability of collapse is given by $pG\left(q^*\right)$.

Knowing the withdrawal rules of period 1 one can now solve for the portfolio decision of period 0. Because agents are risk-neutral, the expected return from each and every asset they hold has to equalize. Thus, in a no-corner solution equilibrium agents have to be indifferent between holding the country or the risk free asset, taking into account the possible appearance of the investment opportunity in period 1. In the case of a corner solution, only the country is part of the portfolio and the expected return from the country is the highest. Intuitively, the existence of an interior solution requires that the country is not *too good* in comparison to the investment opportunity (so that $0 < a_0$). Existence of equilibrium, on the other hand, is guaranteed if the density of q is well behaved.

Proposition 2 *If $G(.)$ is a smooth and strictly increasing function of q, then there always exist an equilibrium for the period 0 one-country problem. Moreover, if*

$$\frac{pI(\kappa - 1) + 1 - (1 - p)R}{p} > \begin{array}{l} E\left[q \setminus q < I\right] \kappa G(I) + \\ \left\{I(\kappa - 1) + E\left[q \setminus I \leq q < q'\right]\right\}\left\{G(q') - G(I)\right\} + \\ E\left[I\kappa + R - \frac{IR}{q} \setminus q' \leq q\right]\left\{1 - G(q')\right\} \end{array}$$

with $q' = RI\left(R - r + I\right)$, then an interior solution (that is, with $a_0 > 0$) exists.

In order to show the result let a_0^i denote the optimal portfolio allocation for agent i, and a_0^{-i} the portfolio of the rest of agents (not necessarily the optimal one). A symmetric equilibrium will be given by an allocation such that $a_0^i = a_0^{-i}$. Because of risk-neutrality and the small investor assumption, in a no-corner solution equilibrium agents have to be indifferent between choosing the two portfolios $a_0^i = 1$ and $a_0^i = 0$. Given a_0^{-i}, the return of the portfolio $a_0^i = 1$ is given by:

$$\begin{cases} 1 & \text{with prob. } 1-p \text{ and} \\ 1+I(\kappa-1) & \text{with prob. } p. \end{cases}$$

If the opportunity does not appear the portfolio yields 1, and if it appears, the agent invests I with yield κ. The return of the portfolio $a_0^i = 0$, on the other hand, is given by:

$$\begin{cases} R & \text{with prob. } 1-p \text{ and} \\ \tilde{R} & \text{with prob. } p, \end{cases}$$

where

$$\tilde{R} = \begin{cases} q\kappa & \text{if } q < q^* \\ I\kappa + \left(1 - \frac{I}{r}\right)\hat{R} & \text{if } q \geq q^* \end{cases} \quad \text{if } q^* \leq I \text{ or}$$

$$\tilde{R} = \begin{cases} q\kappa & \text{if } q < I \\ I\kappa + (q - I) & \text{if } I < q \leq q^* \\ I\kappa + \left(1 - \frac{I}{r}\right)\hat{R} & \text{if } q \geq q^* \end{cases} \quad \text{if } q^* > I,$$

with

$$\hat{R} = \frac{(1-a_0^{-i})rR}{(r-I) - a_0^{-i}(r-1)}\left(1 - \frac{I - a_0^{-i}}{(1-a_0^{-i})q}\right),$$

and q^* as defined in (2.5). If the opportunity does not arise the return is R; if it arises then the return is $\tilde{R}$ which is a function of both the initial portfolio chosen by the other agents and the realization of $\tilde{q}$. An interior equilibrium is characterized by an a_0^{-i} that equalizes the expected return of the two portfolios. The corner solution, on the other hand, requires the return of the $a_0^i = 1$ portfolio to be higher than that of the $a_0^i = 0$ portfolio, taking $a_0^{-i} = 1$ as given.

Figure 2-3 depicts the returns of the two portfolios for a given realization of q as a function of a_0^{-i}. The expected return of the portfolio $a_0^i = 1$ is independent of a_0^{-i} and represented by the horizontal schedule WW. The expected return of the portfolio $a_0^i = 0$, represented by VV, is strictly increasing in a_0^{-i}. When $a_0^{-i} = I$ the return of this portfolio is strictly higher than the portfolio $a_0^i = 0$.[36] Moreover, if $G(.)$ is

[36]In this case $q^* = 0$ and the expected return for the portfolio with $a_0^i = 1$ is equal to

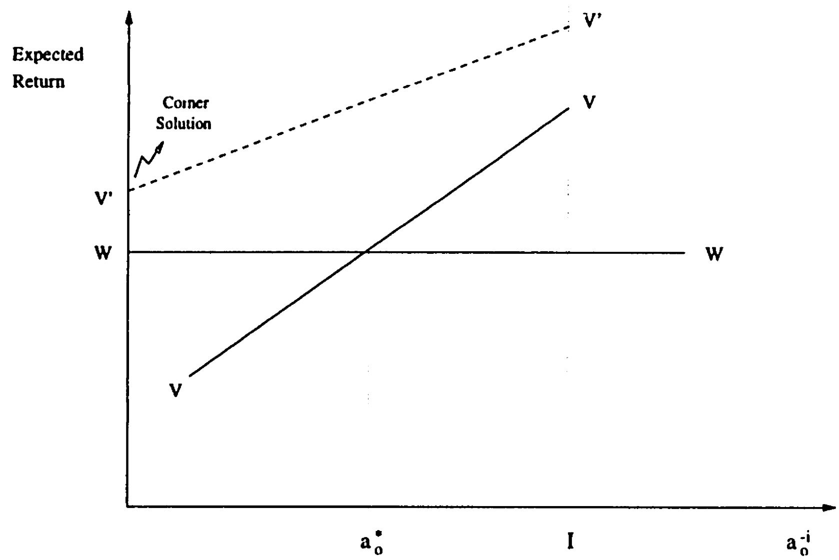

Figure 2-3: Portfolios and Expected Returns

smooth and strictly increasing (that is, if $g(q) > 0$ everywhere and there is no mass concentrated in any q), then VV is continuous and an equilibrium always exists. If the schedule VV crosses WW then there is an interior solution (denoted by a_0^* in figure 2-3). Otherwise, the solution is given by the corner $a_0 = 1$ (in this case the return schedule is depicted by the dashed line V'V'). Finally, an interior solution will exist as long as the portfolio $a_0^i = 0$ has higher expected return than the portfolio $a_0^i = 1$, taking $a_0^{-i} = 0$ as given. This condition is precisely what is stated in the second part of proposition 2.

2.4.3 Two Countries

For the case of two countries I shall include the following assumptions:

- $\tilde{q}_i$ has c.d.f. $G_i(\tilde{q}_i)$ and associated density $g_i(\tilde{q}_i)$ for $i = A, B$. Ex-ante, $G_A = G_B$.
- $\tilde{q}_A$ and $\tilde{q}_B$ are independent.

$p(I\kappa + 1 - I/r) + (1 - p)R$, while the expected return of the portfolio with $a_0^i = 0$ is given by $1 + pI(\kappa - 1)$.

- Both countries offer the same short term return r and have the same period 2 physical return R.

In this case, the period 0 investors' problem is to choose a portfolio with weights a_A in country A, a_B in country B, and the rest ($a_0 \equiv 1 - a_A - a_B$) in the risk-free asset. The investors' period 1 problem is now:

$$\begin{aligned}
\max_{\{w, x_A, x_B y, z\}} \quad & W_2 = (1-y)a_0 + (1-x_A)a_A\hat{R}_A + (1-x_B)a_B\hat{R}_B + z\kappa + w \\
\text{s.t.} \quad & 0 \le x_A, x_B, y, w \le 1 \\
& 0 \le z \le I \\
& w + z - (ya_0 + x_A a_A r + x_{BA} a_B r) \le 0,
\end{aligned}$$

where x_A and x_B are the proportions to be withdrawn from countries A and B respectively. The FOCs of this problem are the same as those in (2.2) in addition to the FOC for x_B

$$\mu_{0x_B} - \mu_{1x_B} + (\mu r - \hat{R}_B)a_0 = 0 \tag{2.6}$$

and the 11 complementary slackness conditions corresponding to the restrictions. Again, the μ's are positive Lagrange multipliers. The specific solution will depend on the ordering of withdrawal followed by agents.

The results of the last section also hold for the two country case. In equilibrium, the risk-free asset cannot be sufficient to finance the investment opportunity, when it appears agents always try to finance it, and the probability of collapse in both countries is always positive. However, this does not directly translate into contagion. Country-specific news (for example a worse realization of q_i or another G_i distribution) will change the probability of collapse of the other country depending on the decision rule that agents adopt when they need liquidity. The first issue to resolve then is how investors decide to withdraw in period 1 when there is no collapse in either country. Knowing how agents withdraw will give cutoffs for q_1 and q_2 that define collapses.

Contingent Ordering of Countries

In general, rules of ordering could depend on anything.[37] One possibility, therefore, is that the realizations of q_1 and q_2 themselves act as "coordinators." This subsection studies such a case. More specifically, I concentrate on a symmetric Nash equilibrium that both gives contagion and has straightforward implications for the period 0 portfolio problem if countries are ex-ante identical.

I assume that the rule of withdrawal is one in which agents choose to cash in percentages x_A and x_B from each country such that the period 2 returns $\hat{R}_A$ and $\hat{R}_B$ are equalized. This is indeed a Nash equilibrium because the costs of raising funds from each country $(\hat{R}_i/r)$ are in fact equalized along the equilibrium path so any mixture is equally optimal.[38] Collapses in both countries happen together, when $\hat{R}_A = \hat{R}_B < r$. Using equation (2.1), $\hat{R}_A = \hat{R}_B$ translates into the following withdrawals from country A, x_A, as a function of withdrawals from B, x_B:

$$x_A = \frac{q_A q_B x_B - q_A r x_B}{q_A q_B + q_B r x_B - q_A r x_B - q_B r}. \tag{2.7}$$

This function is increasing in x_B, equal to x_B when $q_A = q_B$ or $x_B = 1$, and strictly concave (convex) when $q_A > (<)\ q_B$.

As in the case of 1 country, because $\kappa > R/r$, the investment opportunity is always financed when it appears. In terms of the period 1 problem, one has $z = \min \langle a_0 + a_A q_A + a_B q_B, I \rangle$. If there is no collapse, the opportunity is financed first with the risk-free asset (that is $y = 1$ and $w = 0$), and then by withdrawing from countries. Given a_A and a_B, this constraint gives another relationship between x_A and x_B, namely

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[37]The potentially simplest rule that agents can follow is the existence of a fixed and known ordering of countries to be withdrawn. This rule is indeed a Nash equilibrium in period 1. However, it has two important shortcomings. On one hand, countries are no longer identical (which makes it difficult to assume the same level of intermediation in the two countries). On the other hand, this rule oddly predicts that investment should occur in only one country if the two countries have identical distribution functions for q.

[38]Other Nash equilibria are withdraw first from low (high) q country. These other equilibria have two counteracting effects in terms of contagion. Conditional on a determined ordering there is contagion from the first country to be withdrawn to the second country. The change of ordering, on the other hand, produces exactly the opposite effect.

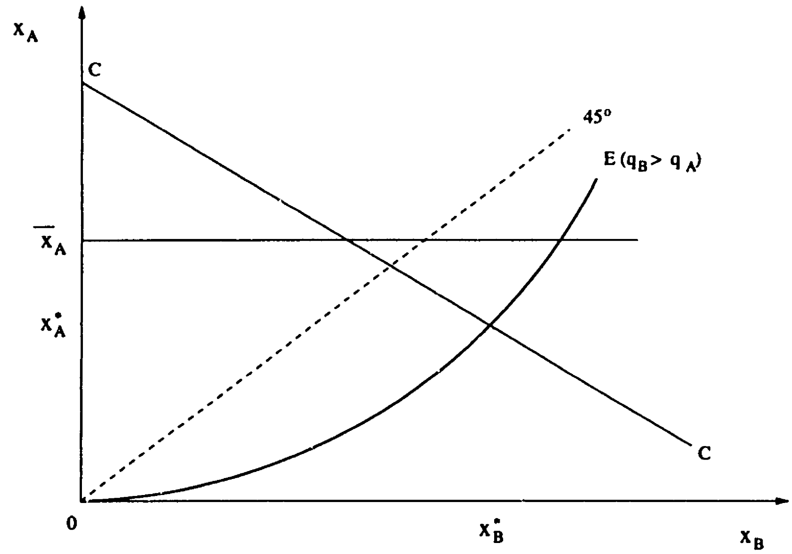

Figure 2-4: Contingent Ordering with No-Collapse Equilibrium

$$x_A a_A r + x_B a_B r = I - (1 - a_A - a_B)\,. \tag{2.8}$$

Figure 2-4 shows the schedules (2.7) and (2.8) for the case in which $q_A < q_B$. The schedule CC represents the budget constraint (2.8), while OE represents the equilibrium condition (2.7). The point (x_A^*, x_B^*) is an equilibrium (and therefore part of the period 1 problem solution) if it does not generate a collapse. Because a no-collapse equilibrium requires that $\hat{R}_A = \hat{R}_B > r$, and given q_A and a_A and the fact that $\hat{R}$ is strictly decreasing in x_A, there exist a cut-off value $\overline{x}_A$, such that for $x_A^* < \overline{x}_A$, the point (x_A^*, x_B^*) is indeed an equilibrium. The exact cut-off is given by

$$\overline{x}_A = \frac{q_A (R - r)}{r (R - q_A)}, \tag{2.9}$$

which is the value of x_A that makes $\hat{R}_A = r$. It is increasing in q_A and less than 1. In figure 2 this cut-off is the horizontal line at $\overline{x}_A$, so the point (x_A^*, x_B^*) is in fact a no-collapse equilibrium.

Figure 2-5 presents the case in which there is collapse, namely when $\bar{x}_A < x_A^*$. In this case q_A and q_B are too low to sustain withdrawals and if the investment

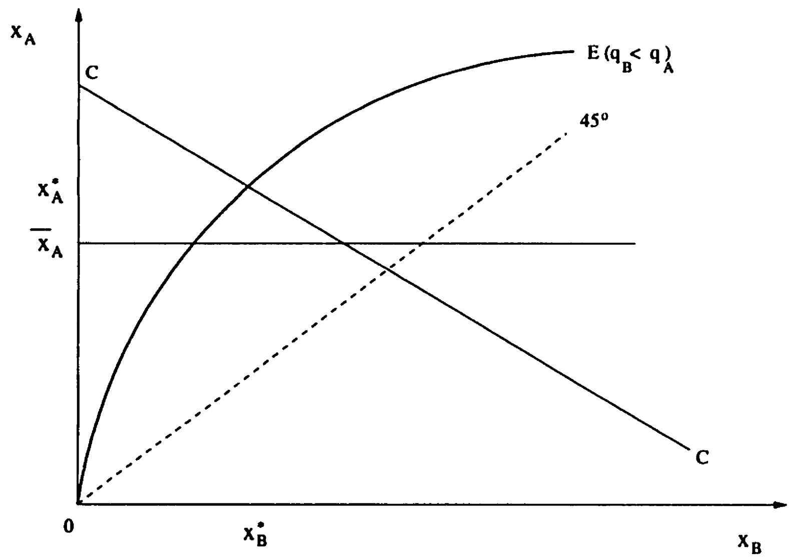

Figure 2-5: Contingent Ordering with Collapse Equilibrium

opportunity arises, neither country is able to pay the promised return r. Although the figure depicts the case in which $q_B < q_A$, this condition is not related to the existence of a collapse. The solution of the period 1 problem in this case is given by $x_A = x_B = 1$ (and the corresponding w, y, and z).

The effects of a higher realization of q_A (given q_B) are both to move the schedule $\overline{x}_A$ upward, and to move the OE schedule counter-clockwise, making it more concave (or less convex). The schedule CC does not change. This effects are shown in figure 2-6, and have opposite effects in terms of triggering (or avoiding) a collapse. However, because collapses in both countries happen together, one can show that the effect of the movement in $\overline{x}_A$ dominates: a higher q_A makes more unlikely a collapse in country A. In fact, an analogous figure exists for country B and in that case a higher q_A only moves the OE schedule clockwise, making a collapse in both A and B less likely. Given q_B, one can therefore define a cut-off q_A^* such that for $q_A < q_A^*$ a collapse in both countries develops. Formally, q_A^* is given by the q_A that solves the equation

$$\frac{I - a_0}{a_B r (R - r)} - \frac{a_A q_A}{a_B (R - q_A)} = \frac{q_B}{r (R - q_B)}, \tag{2.10}$$

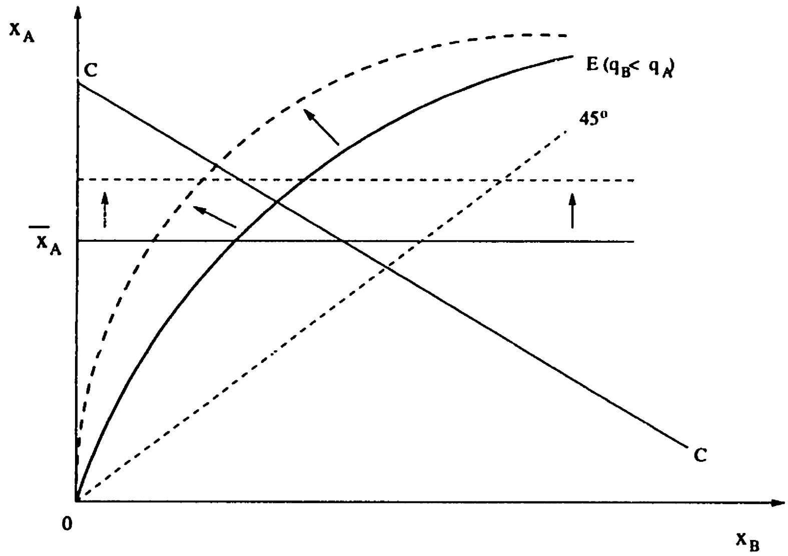

Figure 2-6: Effects of a Higher Realization of q_A

which results from solving (2.7) and (2.8) for x_B and using the value $\overline{x}_A$ for x_A^*. The probability of collapse in country A (and country B, given the symmetry) is then given by $pG_A(q_A^*)$. With this probability one can easily prove that there is contagion.

Proposition 3 *Provided that the rule of withdrawal keeps $\hat{R}_A = \hat{R}_B$, the probability of collapse of country A is decreasing in q_B. Equivalently, there is contagion between countries A and B.*

To show the result it is sufficient to show that q_A^* is decreasing in q_B. Graphically, this happens because a lower q_B moves only the OE schedule counter-clockwise (making it more concave). Then the q_A that makes $x_A^* = \overline{x}_A$ has to be higher. Formally, differentiate implicitly equation (2.10) to get

$$\frac{dq_A^*}{dq_B} = -\frac{a_B (R - q_A)^2}{a_A r (R - q_B)^2}, \tag{2.11}$$

which is negative. Contagion occurs because the probability of collapse in country A increases with bad news about country B (which are country specific).

Interestingly enough, contagion has an asymmetry. Better (higher) realizations of q_B affect negatively q_A^* at a decreasing rate. To show this differentiate (2.11) with respect to q_B to get

$$\frac{d^2 q_A^*}{dq_B^2} = -\frac{2a_B (R - q_A)^2}{a_A r (R - q_B)^3}, \tag{2.12}$$

which is always negative. The intuition for this result is that a high enough q_B may be able to finance all the new investment, making the realization of q_A unimportant in defining collapses.

The investors' problem in period 0, given the decision rule of equal returns, is very simple when the distribution functions G_A and G_B are identical. Because in a no collapse equilibrium both assets yield the same returns (r and $\hat{R}$) and during collapses both returns are draw from the same distribution if $a_A = a_B$, the initial portfolio with $a_A = a_B$ is indeed an equilibrium. For the case in which G_A and G_B differ, the solution has a portfolio with different weights. The solution can be interior (that is, with $a_A, a_B > 0$) because in case of a collapse the ranges from which q_A and q_B are drawn are different. In particular, if the distribution of G_A is *better* than G_B, then conditional on a collapse, q_B is drawn from a support that includes the support of q_A plus a set of higher values.[39]

Although this is not formally in the model, it is possible to get contagion even before the investment opportunity arises —that is contagion may occur at times in which an exogenous portfolio rebalancing is only a future possibility. If there is news about a change in the distribution G_B (say it improves with the new one first degree stochastically dominating the old one), the probability of collapse in country A changes (in this case declines). Formally, q_A^* is a random variable as of period 0 because it is a function of q_B. Changes in distribution of q_B then affect the distribution of q_A^*, and with this the probability of $q_A < q_A^*$.

Finally, it is useful to recapitulate about the question of why contagion may happen in emerging markets only. If the risk-free asset is thought of being investment

[39]Starting from $a_A > a_B$ the effect can be understood as follows. Given q_B the required withdrawal x_A is smaller the higher a_A. This translates into a lower q_A^*, which means that in case of collapse the realization of q_A has to have been *rather low* in comparison to q_B, which in turn, can be higher and a collapse exist anyway.

in the developed world (say bonds), then the interpretation is that this investment has no major problem of illiquidity. It either has a q whose realizations are not very different from the promised returns, or returns are contingent. In any event, what happens with other assets is unimportant in terms of how well this investment does. A second interpretation is that developed countries also have illiquid assets, but the illiquidity is "smaller." This can make the relative cost of withdrawing from these assets higher than the LDC assets.' An interesting case is when R in the developed world is smaller than in emerging markets, but R/r is higher. In that case emerging markets could be withdrawn before illiquid assets in developed countries, even if the latter were able to finance the investment opportunity without problems.

Random Ordering of Countries: Correlated Equilibrium

In this subsection I consider the case in which there exists a "coordinating" variable independent of the q's, say λ, that defines which country will be withdrawn first. This variable can be thought of as measuring which country has more political turmoil in period 1 —for example, the upswing of a *guerilla.* The ordering then is known only in period 1, but has a known distribution in period 0. This mechanism yields both contagion and, contrary to the result of the previous subsection, the possibility of collapses in one country while the other is able to pay the promised return r. In game theoretic jargon this is a "correlated equilibrium."[40]

For concreteness, I assume that λ takes two letters: A or B with probability π and $1 - \pi$ respectively ($\lambda = A$ meaning withdraw first from country A). Of course, ex-ante symmetry imposes $\pi = 1/2$. In period 1, once λ is known and the investment opportunity arises, agents decide whether and from where to withdraw. As before, since the return of the opportunity dominates both countries' assets, it is the case that agents always try to finance it. Formally, the solution of the investors' period 1 problem includes $z = \min \langle a_0 + a_A q_A + a_B q_B, I \rangle$. Also, if there is no collapse in either country the risk free investment is first (and totally) used to finance the investment

[40]See Fudenberg and Tirole (1991), pp. 53–59.

opportunity ($y = 1$).

Financing the investment first from country λ (after the risk-free asset has been used) is indeed an equilibrium. There are two cases: (i) If what country λ has is enough to cover $I - a_0$ without a collapse, then $\hat{R}_\lambda < \hat{R}_{-\lambda} = R$ (where $-\lambda$ denotes the other country). Hence, it is optimal for every agent to withdraw first from λ. (ii) If country λ collapses after trying to cover $I - a_0$, then it is optimal to withdraw any investment in this country.

Because country λ (together with the risk-free asset) has to finance the entire investment opportunity in order not to collapse, one can define a cut-off value q^*_λ such that if $q_\lambda < q^*_\lambda$ a collapse in λ occurs. The exact cut-off is given by

$$q^*_\lambda = \frac{R\,(I - a_0)}{a_\lambda(R - r) + (I - a_0)}. \tag{2.13}$$

The probability of collapse in country λ is then given by $pG(q^*_\lambda)$. Once the ordering of countries is known there is no contagion from country λ to country $-\lambda$; the probability of collapse is independent of the realization of $q_{-\lambda}$. Country $-\lambda$, however, suffers from contagion from country λ.

Proposition 4 *Provided that the rule of withdrawal is "withdraw first from country λ," the probability of collapse of country $-\lambda$ is decreasing in q_λ. Equivalently, there is contagion from country λ to country $-\lambda$.*

In order to prove the result, notice first that collapses in $-\lambda$ happen only after λ has collapsed. Moreover, the funds required from $-\lambda$ are given by $I - a_0 - a_\lambda q_\lambda$ under the assumption that people getting more than what they need can lend to those who do not get anything from the collapsed country.[41] Thus, one can define another cut-off value $q^*_{-\lambda}$ such that for $q_{-\lambda} < q^*_{-\lambda}$ there is collapse in country $-\lambda$. The exact value is given by

$$q^*_{-\lambda} = \frac{R\,(I - a_0 - a_\lambda q_\lambda)}{a_{-\lambda}(R - r) + (I - a_0 - a_\lambda q_\lambda)}, \tag{2.14}$$

[41] This is equivalent to the case in which the intermediary gives a return q_λ to every investor.

which is decreasing in q_λ. The probability of a collapse in $-\lambda$ is consequently $pG_\lambda(q_\lambda^*)G_{-\lambda}(q_{-\lambda}^*)$, which is decreasing in q_λ. The intuition is simple: if country λ is more liquid it is less likely that the investors will need to withdraw funds from the other country, meaning that the probability of collapse in this other country declines.

The final solution of the period 1 problem depends on the realizations of λ, q_A, and q_B. The initial period 0 portfolio problem will have an equilibrium depending on the parameters of the model. Of course, if $G_A = G_B$, and $\pi = 0.5$ a symmetric equilibrium exists (that is $a_A = a_B$). More generally, when G_A and G_B differ, π will have to balance the expected returns from both countries for an equilibrium to exist.[42]

Contagion also exists before it is known which country will be withdrawn first. This follows the same logic as before: A better distribution of q_B both reduces the likelihood of a collapse in country B (regardless of which country is withdrawn first) and reduces the likelihood of collapse in country A if this country happens to be withdrawn second.

Finally, the model can also generate asymmetric contagion. Worse news in country B always affects negatively country A, because the expected amount to be withdrawn from this country strictly increases with a lower q_B. Good news about country B does not have this property: it may pass a threshold in which if country B is withdrawn first then there cannot be a collapse in country A. In that case further good news in country B only affects this country.

2.5 Concluding Remarks

This chapter has shown that fundamentals are unable to explain all the observed comovement of creditworthiness in a group of Latin American countries. In particular, both the cross-country correlation of secondary market debt prices and country credit ratings is significantly positive. More importantly, the correlation is significant after

[42]With risk-averse agents the role of π in generating an equilibrium is less crucial for agents would naturally pursue a more diversified portfolio.

controlling the effect of fundamental determinants of creditworthiness and capital flows. As long as creditworthiness is an important determinant of capital flows, this puzzle of contagion also translates to cross-country correlation of capital movements.

Using debt prices of US corporations and credit ratings of some OECD countries, this chapter has also shown that contagion is not a common phenomenon. In these cases the observed comovement is completely explained by the behavior of fundamentals. It has also shown that the observed contagion in Latin American countries cannot be explained by "big news" events, such as the announcement of Brady agreements and negotiations, the Brazilian moratorium, or the Citibank announcement of 1987. Finally, it has provided some evidence that contagion is asymmetric, being stronger for negative innovations in creditworthiness.

In an attempt to explain this puzzle I have presented a simple model of capital flows in which the liquidity existing in an individual country —a country-specific characteristic— affects the probability of repayment of other countries. Thus, what is apparently a country-specific fundamental (that can be completely uncorrelated with fundamentals of other countries) becomes a fundamental variable of other countries. The intuition is simple: If agents want to change their portfolios, they will cash their claims asking for liquidity, and if they do not find this liquidity in one country they will seek for it in a second country. Thus, the illiquidity of the first country influences the size of the withdrawals from the second country.

The model has formally shown that in the presence of contracts that promise certain return, e.g., because of financial intermediation, the illiquidity of a country will affect the creditworthiness of other countries. In particular, under two alternative equilibrium definitions I have shown that the probability of repayment of one country is negatively affected by the degree of illiquidity of other countries. Moreover, the model has shown that this effect is asymmetric, being stronger on the side of negative innovations of creditworthiness. Finally, I discussed that the existence of contagion does not require actual changes in portfolio (or actual liquidity needs). The possibility of these changes alone is enough to make the apparent country-specific fundamentals matter for other countries.

The existence of contagion effects gives further value to prudential regulation and supervision from the part of International Financial Institutions (IFI's). Because there are spillovers effects from problems in one country to other countries, there are in fact externalities in countries' actions. An incorrect domestic policy not only affects that country but also other countries. By taking into consideration these externalities, the IFI's effort is more valuable than country-specific supervision.

There are important implications from the model presented above regarding regulation and responses from the perspective of IFI's. If liquidity problems indeed play a key role in generating contagion, then intermediation ought to be closely monitored. The desired liquidity provision from the point of view of one country may be excessive from the point of view of other countries.[43] The Mexican crisis of 1994 is a good example in this regard. Intermediation in the form of foreign denominated and short-term maturity instruments (e.g., Cetes) made Mexico excessively vulnerable to potential interest rate shocks and devaluations.[44] The model offers a simple recommendation in terms of the IFI's optimal response in case of a country-specific crisis: IFI's should provide the required liquidity in the short run in order to avoid the contagion (and crisis) effects. This response avoids the liquidation of profitable projects and further effects in other countries. Interestingly, the US-IMF policy for the Mexican crisis was exactly to provide short run liquidity. Of course, this recommendation does not take into account moral hazard issues. If countries and investors know that liquidity will be provided, the initial excess intermediation can be exacerbated. This makes prudential regulation of intermediation even more valuable.

[43]Chapter 3 analyzes the divergence regarding the optimal level of intermediation between the private sector and the government.

[44]Excess intermediation should not be confused with financial deepening. As Sachs et al. (1996) show, what matters is the change of intermediation per unit of time (e.g., the change of the ratio of claims on the private sector to GDP), not the size of the financial sector.

Chapter 3

Balance of Payment Crises and Capital Flows: The Role of Liquidity

3.1 Introduction

The Mexican external crisis of December 1994 brought into question our basic understanding of this type of events. The collapse of the Peso was prompted by an initial devaluation and was characterized by a severe run against the foreign reserves caused by a sudden outflow of capital. The immediate preoccupation of the Mexican government (and several policy makers in the US) was to solve the very short run problem of rolling over the debt and avoiding the major step of announcing their default. The run against Mexican assets gave the impression that there was a strong component of a liquidity crisis involved which is more similar to the models of the Bank Run literature than to the traditional models of balance of payment crises.[1]

Other balance of payment crises, in particular the severe ones, such as in Chile (1982), Finland (1992) and Mexico (1982), share with Mexico (1994) the above phenomenon as well as three other interesting features. First, they all experienced a

[1]See, e.g., Sachs (1995).

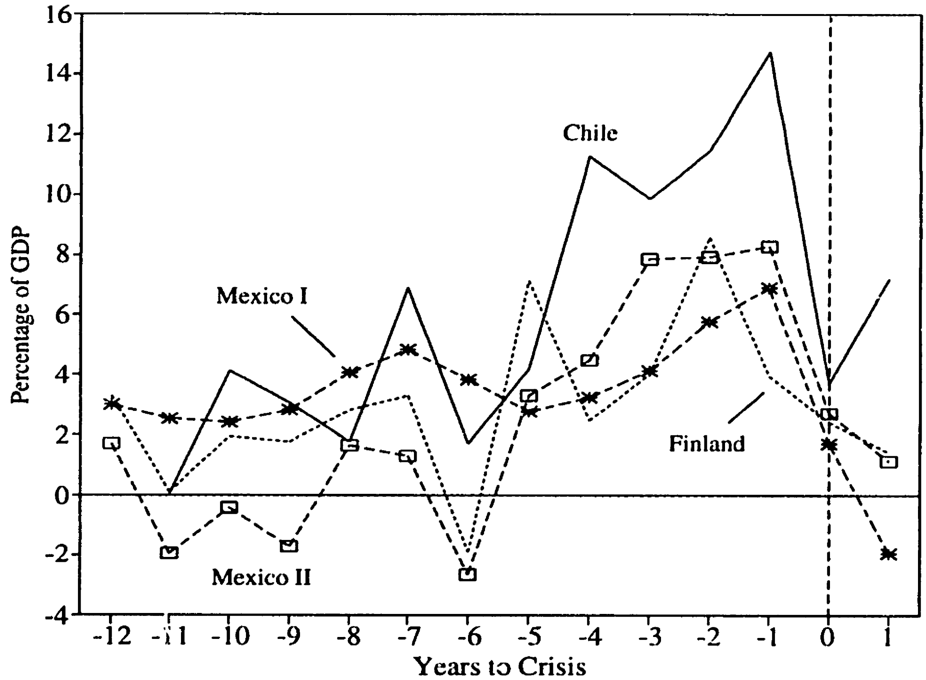

Figure 3-1: Capital Inflows in Mexico, Chile and Finland

capital inflow surge in the years preceding the crises. Second, this capital inflow was intermediated, at least in part, by the domestic financial sector which, in addition, increased its proportion of short term liabilities. Finally, the external collapses were accompanied by severe banking crises.[2]

The capital cycles of surges and sudden outflows have been documented extensively in the literature[3] and have been a major issue of concern to policy makers who are caught in the dilemma of introducing capital controls.[4] In their analysis of the Mexican crisis, Sachs, Tornell and Velasco (1995) argue that the volatility of capital flows (and the inadequate response of Mexican authorities) played a major role in the crisis. Figure 3-1 shows the capital inflows in the years preceding the crises for the countries cited above.

The composition of capital inflows is also interesting. Table 3.1 presents the figures for the countries in the study of Schadler et al. (1993) which focuses on capital inflow surges. The main conclusion from this table is that Foreign Direct Investment is not

[2]For a description of these 4 crises see Dornbusch, Goldfajn and Valdés (1995).
[3]See Calvo et al. (1993) and Schandler et al. (1993).
[4]See IMF(1995).

Table 3.1: Composition of Some Capital Inflow Surges
First Year of Surge minus Previous Year, US$ mill.

	Years of Surge	Direct Invest.	Port. Invest.	Other Long/T.	Other Short/T	Total
Chile	1990–93	-697	272	2053	212	1840
Egypt	1991–92	-531	6	7758	-900	6333
Mexico	1989–93	774	177	6411	-1757	5605
Spain	1987–91	752	2571	7601	4946	15870
Thailand	1988–92	899	184	–341	2035	2777

Source: IFS.

Note: The countries are those studied in Schadler et al. (1993). Colombia was left out because of lack of intermediation data.

the driving force. Other capital —which is more associated with intermediation— explains the bulk of the inflows. This includes bonds, direct borrowing, and other short and long run fixed income instruments.

Less emphasized is the fact that capital inflows are usually accompanied by increased intermediation and, sometimes, shortening of maturities. The idea that higher capital inflows are related to increasing intermediation is a phenomenon that has a strong counterpart in the real world. For instance, if we analyze the episodes of capital inflow surges studied in Schadler, et al. (1993), there is evidence that financial intermediation increased significantly during the time of the surges. Figure 3-2 presents real claims of the financial sector on the private sector during these episodes (Chile, Egypt, Mexico, Spain, and Thailand). The surge starts in quarter 0. It is clear from the figure that in all five countries financial intermediation increased during the surges.

Less attention is given to the fact that when capital flows are abruptly reversed, often a banking crisis emerges as an additional strain. In all the four cases highlighted above, banking crisis was indeed an important consideration to policy makers. In fact, the study by Kaminsky and Reinhart (1995) concludes that there is a strong

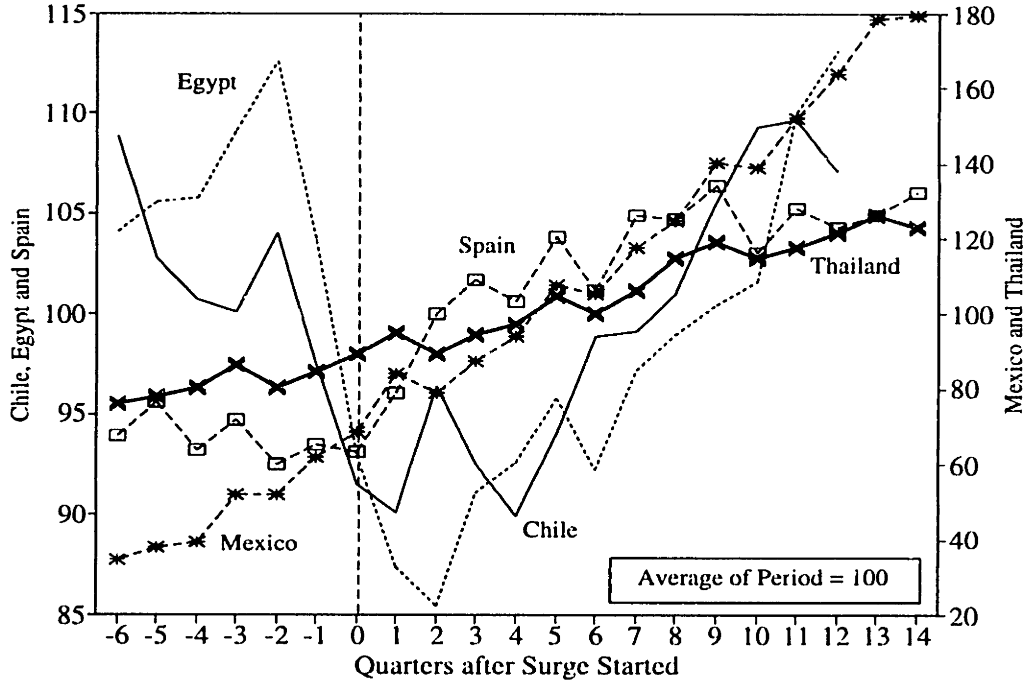

Figure 3-2: Real Financial Claims on the Private Sector

link between banking and balance of payment crises for a large number of episodes.[5]

It is difficult to explain major external crises in a context where all agents — investors, intermediaries and policy makers— are rational given the magnitude of the currency crises and the relatively small size of the underlying shocks (internal or external). Usually, it is assumed that policy makers are following an inconsistent policy. Surprisingly, it is easier to explain major crises in association with the observed capital swings and banking crises. The latter provides the magnification and propagation effects needed for a complete explanation.

The traditional theoretical framework on balance of payment crises is based on the large literature on speculative attacks that followed the seminal article by Krugman (1979). The key starting point of this literature is that the government follows an inconsistent policy combined with a fixed exchange rate regime, which would eventually have to collapse. The major contribution, then, is to use rational investors to define exactly when and how the collapse occurs.[6]

[5]Their goal is more ambitious. They aim to establish a causal link between the *twin crises*. See also the papers on banking crises in Latin America by Gavin and Hausman (1995) and Rojas-Suarez and Weisbord (1995).

[6]See, e.g., Agénor et al. (1992), Dornbusch (1987) and Flood and Garber (1984).

The main candidate for government inconsistency is its fiscal policy. The Mexican, Finish and Chilean experiences, however, do not support this contention (although it is a good explanation in several other cases). The normal measures of fiscal budget indicated that Mexico was running budget surpluses up to the year of the crisis.[7] Equivalently, credit creation by the central bank was relatively stable up to 1994 .

This essay departs from the Krugman tradition and does not assume an inconsistency in policy making.[8] The crises arise as a result of an internal or external shock that is amplified and propagated to the rest of the economy by liquidity creating financial intermediaries who generate more than proportional capital flows. The model is able to replicate the observed cycles in capital flows: large inflows, crises and abrupt outflows. This is done in a context where both investors and financial intermediaries are fully rational and anticipate the possibility of crisis.

The chapter focuses on the interaction between liquidity, capital flows and exchange rate collapses. Liquidity considerations arise only in a world where there are intermediaries transforming maturities, offering liquid assets to their customers and, implicitly, allowing the possibility of runs on their assets. Thus, the introduction of intermediaries in the model is a synonym for liquidity creation and all its side effects.

The model below highlights the fact that there is an asymmetry between the time needed for investment to mature and the timing of investors. The latter are short sighted by necessity. They may need the money in the short run for their consumption or want to have liquid assets in order to have the flexibility to invest in other places in the short run. The intermediaries offer these assets to investors in order to attract them. On the other side they invest in production which needs time to mature (early interruptions are not profitable). In other words, they transform their illiquid assets into liquid ones in order to attract capital. It is precisely this transformation that brings more capital to the economy but it is also the one that introduces the possibility of runs. Ex-post, the good outcome is the one in which the intermediary offers liquid

[7]As of September of 1994 the fiscal budget surplus-GDP ratio figures are as follows: 1.6% in 1992, 1.0% in 1993, and -0.5% in 1994.

[8]Although an inconsistent policy is completely compatible with the model and would reinforce our results.

assets, there are no runs and (more) investment is realized. However, the possibility of runs and massive disruption does exist.

Intermediation, therefore, produces two main effects. On one hand, it can increase the capital inflows to the economy. By allowing more flexibility, offering more liquid assets, intermediaries improve the attractiveness of the economy in the eyes of the foreign investors. On the other hand, they may generate runs and large capital outflows, amplifying initial shocks that otherwise would not have generated crises.

Intermediation, together with its creation of liquid assets, *allows* for the possibility of runs and crises but it does not generate crises by itself. Throughout the chapter, we analyze two types of shocks: productivity and international interest rates. For each type of shock, there will be a cutoff point that determines a region where runs against the intermediary are the equilibrium outcome. This region is determined by the foreign investors, who decide whether to accelerate the timing of their withdrawals. With this region defined we can explicitly determine the probability of crises. In this sense we depart from the standard "bank run" literature in which the outcome of the models are multiple self-fulfilling equilibria whose likelihood is not determined endogenously.

The interaction between exchange rate collapses and runs against the intermediaries is especially interesting. The effects work in both directions. The existence of runs against the intermediaries generates a sudden demand for reserves that may force a devaluation of the currency, independently of the fiscal policy followed by the government. On the other hand, an expected devaluation of the currency will change the return profile of the investment, increasing the benefits of early withdrawals, and, therefore, increasing the chances of a collapse.

This chapter is organized as follows. In section 3.2 we set up the simplest possible model with its basic components: foreign investors, intermediaries, technology and the central bank. As a useful benchmark, we initially solve the model for the capital flow pattern that would exist in the absence of intermediation. Then, we introduce intermediation, solve for the optimal early withdrawal policy, and identify the endogenous probability of runs. We show that this probability is strictly positive and does not decrease when intermediaries offer more liquidity. In section 3.2.2, we verify that runs effectively increase the capital outflows and in section 3.2.2 we propose that, under certain conditions, capital inflows may actually increase with intermediation. In section 3.3 we give a closed-form solution of the model using a Constant Relative Risk Aversion (CRRA) utility function and a Bernoulli distribution of the shocks. In several simulations, we show that capital inflows effectively increase with intermediation and we look at some comparative statics.

The relationship between runs on intermediaries and exchange rate collapses is explored in section 3.4. First, we verify that runs increase the probability of an exchange rate collapse. Then, we show that the possibility of a devaluation increases the region where runs against intermediaries are the unique equilibria. Finally, we analyze the interactions of two intermediaries with imperfectly correlated investment pools, showing that runs against an otherwise liquid intermediary can occur if there is a run against the other intermediary. This effect increases both the size and probability of the collapse.

Once the main contributions of the chapter are completed, we explore an extension. In section 3.5 we demonstrate how all the effects can still go through when the nature of the initial shock is changed. We explore the interesting case where the impulse is the international interest rate. Finally, section 3.6 concludes.

3.2 The Basic Model

International Investors are risk averse agents that maximize their expected utility of wealth, choosing their optimal portfolio allocation between a safe international asset and a risky foreign technology (*home* from the perspective of the receiving country).[9] They solve

$$Max_a E[U[\tilde{W}]] \tag{3.1}$$

[9] Here we do not need a riskless international technology but only a safer one.

s.t.

$$\tilde{W} = W_0(a\tilde{r} + (1-a)r^*), \tag{3.2}$$

where W_0 is the initial endowment, henceforth set equal to 1. r^* and $\tilde{r}$ are the gross returns on the safe international asset and the risky asset abroad, respectively.

Investors may have liquidity needs. They have a random probability of requiring the money. At time zero each investor does not know if he will need the money in the next period. We assume that the discount rate equals to 1.

Time is discrete and there are three periods. As in Diamond and Dybvig (1983), investors are divided between two types:

There is a proportion θ of the population that needs the money in period one. Their utility function is $U[W_1]$, where W_1 is wealth in period 1. These are the investors that will always interrupt the investment in period one.

They are in proportion $1-\theta$ and their utility function is $U[W_2]$, where W_2 is wealth in period 2. These investors have the option to maintain their resources invested in the technology but may choose to withdraw in period 1 if this is more profitable.

Although each investor does not know what his type is in period 0, we will assume that the proportion of the population θ that have liquidity needs is fixed and known.[10]

The return on the investment abroad is ultimately tied to a constant returns to scale technology. It is relatively irreversible, requiring some time to generate profits. The gross return on a unit invested in this technology is given by:

$$\text{Return} = \begin{cases} \tilde{R} & \text{if } t = 2 \\ q & \text{if } t = 1. \end{cases} \tag{3.3}$$

Here we assume that $q < r^*$. This captures the fact that investment is irreversible or illiquid. Illiquidity is defined as the cost to liquidate an asset in the short run. This

[10] We normalize the total number of investors to be 1. In a previous version, we relaxed this assumption and analyze the model when there is uncertainty with respect to the proportion of early consumers.

cost is the difference between the return on the short run and the return per period of the technology in the long run. The technology generates $\tilde{R}$ if it is not interrupted in period 1. This return has a publicly known distribution $\mathcal{G}(\tilde{R})$. We assume its support has a lower bound $\underline{R} = q$.

The investors do not need to invest directly in the technology. They can use the services of the intermediaries, that compete à la Bertrand. The intermediaries role is to transform the illiquid technology into liquid assets, providing liquidity to potentially illiquid investors. Their liabilities may be composed of demand deposits (as in the case of the banks), other fixed income assets (investment banks or governments) or simple quotas (as in mutual funds). Here we will simply assume that they offer the following contract to the investors:

$$\tilde{r} = \begin{cases} \tilde{r}_2 & \text{in } t = 2 \\ r_1 & \text{in } t = 1. \end{cases} \tag{3.4}$$

The transformation of liquidity is done by investing the proceeds in the technology and offering the foreign investors a contract that pays a rate of return $r_1 \geq q$ in period 1. In this way, the intermediary will be effectively reducing the liquidity costs to the investors, which in case of necessity will obtain a better rate. Of course, this contract is feasible because the intermediaries, constrained by the technology, will pay a rate $r_2 \leq R$ in the second period. This reduction of the spread increases utility for sufficiently risk averse consumers.[11]

The link between the rates in different periods is given by the resource constraint of the economy:[12]

$$\frac{r_1\theta}{q} + \frac{r_2(1-\theta)}{\tilde{R}} = 1, \tag{3.5}$$

[11]The model does not change in any substantial way if we allow the intermediaries to directly invest a portion of their portfolios in the international safe asset.

[12]Initial wealth is one because individual endowments and the number of investors were both normalized to one.

so that the return promised in period two is given by:

$$\tilde{r}_2 = \frac{\tilde{R}(1 - \frac{r_1 \theta}{q})}{1 - \theta}. \tag{3.6}$$

It is immediately apparent from (3.6) that $r_1 \geq q$ implies $r_2 \leq R$.

The intermediaries compete à la Bertrand, offering investors better rates in order to attract capital and maximize profits. They end up with zero profits and offering a contract with interest rates that maximize investors utility.

The return in equation (3.6) is feasible if only early consumers withdraw in period one. However, the intermediary cannot distinguish between types and will have to honor the withdrawals of every investor. The return that it will effectively be able to offer will be:

$$\tilde{r}_2 = \max\left\{\frac{\tilde{R}(1 - \frac{r_1 f_1}{q})}{1 - \theta}, 0\right\}, \tag{3.7}$$

where f_1 is the proportion of withdrawals in period 1 which cannot generate an outflow greater than what the technology is able to produce:

$$r_1 f_1 \leq q. \tag{3.8}$$

The transformation of liquidity makes the intermediary vulnerable to runs. There is always the possibility that the expectation of a high number of withdrawals in period 1 (e.g. higher than the proportion of early consumers θ) will drain the resources available to continue investing in the technology and the return promised to investors in period 2 may turn unprofitable. All the late consumers will have an incentive to withdraw early. This may generate a self-fulfilling run on the intermediary. Moreover, if the return promised in period one ends up being higher than the realized r_2 (under a normal proportion of withdrawals θ), it will be optimal for everybody to withdraw in period one, and the run is the unique equilibrium outcome. In order to formally analyze the possibility of runs, the behavior of the intermediary under a run must be precisely defined.

We assume that in the case of a run the intermediary will distribute all its assets equally among the investors.[13] Since the bank will have to interrupt all its investment in the technology to pay for the withdrawals, every investor will get q. Thus, the final return profile is:

$$\tilde{r} = \begin{cases} q & \text{in the case of run} \\ r_1 & \text{in t=1 if there is } \textit{no} \text{ run} \\ \tilde{r_2} & \text{" t=2 \quad ".} \end{cases}$$

The Central Bank fixes the nominal exchange rate $e = \bar{e}$. In order to clearly depart from the exchange rate collapse literature, we will assume that the government is *not* following an inconsistent policy: the treasury has a balanced budget and the central bank is not increasing domestic credit.

Also, we will *initially* assume that the authority has enough reserves to maintain the exchange rate fixed even in the event of capital outflows resulting from a liquidity crisis. [14] Therefore, in this section, the returns to foreign investment can be thought of as denominated in the international currency (in order to simplify notation we will normalize the nominal exchange rate to be 1). The more interesting case where reserves are not sufficient to overcome a liquidity crisis is analyzed in section 3.4.

Investment is carried out in period 0, the returns are known only in period 1, and realized in period 2. The timing of the model is given below where it is clear that all uncertainty is resolved in period 1:[15]

[13]This can also be done as a "first come first serve basis", where the last investors in line do not get anything, as in Diamond and Dybvig(1983). A version of the model with this assumption can be obtained directly from the authors.

[14]Formally, the Central Bank has net reserves Rx, after subtracting the current account X, such that: $Rx = RX - X > qa^*$, where qa^* is the maximum outflow in period 1.

[15]We assume that there is no side-trading in the form of early consumers selling their "shares" of the intermediary to late consumers. In the model this is equivalent to assuming that the risk-free investment is not sufficient to finance these transactions. In the actual world we do not observe much of these transactions. A lack of an institutional arrangement and adverse selection considerations may explain this phenomenon.

$$
\begin{array}{ll}
t=0 & \begin{cases} \text{Banks specify } r_1 \text{ and } r_2, \\ \text{Investors decide } a. \end{cases} \\
t=1 & \begin{cases} \text{Investors learn their type,} \\ \tilde{R} \text{ is realized,} \\ \text{Withdrawal decision made: possibility of runs,} \\ \text{Central bank sustains or fails to sustain } \bar{e}. \end{cases} \\
t=2 & \text{Patient investors get } r_2 \text{ if there was no run.}
\end{array}
$$

3.2.1 Absence of Intermediation

In the absence of intermediation the foreign investors still have the option to invest directly in the technology. The returns are given by the technology in (3.3) and the return on the safe asset r^*.

Since the proportion of early consumers is fixed at θ, each investor knows the probability that he will need to withdraw in period 1. The maximization problem is

$$
Max_a E[U[\tilde{W}]] = \theta U(aq + (1-a)r^*) + (1-\theta)\int_q^{\bar{R}} U(aR + (1-a)r^*)d\mathcal{G}(\tilde{R}), \quad (3.9)
$$

where a is the amount (and proportion) of initial wealth invested in the technology.

Each investor has to worry only about his idiosyncratic shock (being a late or early consumer) and the macroeconomic shock $\tilde{R}$. There is no need to worry about the possibility of exchange rate crises (which will generally affect the returns in the international currency) because we assume that the central bank has enough reserves Rx to sell to all the early consumers, and, therefore, is able to sustain the fixed parity. Neither, is there the possibility of runs against domestic assets. There are no intermediaries to link the returns of the investors (here $\tilde{R}$ and q do not depend on the behavior of the other investors), hence, the self-fulfilling run cannot exist.

The maximization in (3.9) implies an optimal amount invested in the country given by:

$$a^*_{ni} = a^*_{ni}(q, \tilde{R}, \theta, r^*), \tag{3.10}$$

where the subscript ni stands for no intermediary. The flow of capital, in turn, will be given by:

$$\begin{aligned} t = 0 &\quad a^*_{ni} \\ t = 1 &\quad -\theta q a^*_{ni} \\ t = 2 &\quad -(1-\theta) R a^*_{ni}. \end{aligned}$$

3.2.2 Intermediation

Including the possibility of investment through intermediaries introduces two interesting features. First, the intermediary may offer a different return profile to the foreign investor which may change his investment decisions. It will be particularly interesting when this new pattern increases the capital inflows to the country. Second, with intermediaries there is always the possibility of runs on their assets, provided they are transforming illiquid assets into liquid ones. This possibility has to be taken into consideration by the investor when choosing his portfolio allocation, since it affects the returns, as shown in (3.7).

Higher Probability of Runs

In order to precisely define the investors' problem, we need to solve backwards and first obtain the probability of runs. The runs are defined when all the investors withdraw in period 1. Since early consumers are those who always withdraw in period 1, the runs will be determined only by late consumers, who may decide to withdraw early. These will choose to withdraw only if the payoff of waiting is lower than the payoff to immediate withdrawal. In terms of the model, the late consumers will accelerate their withdrawals if

$$r_1 r^* \geq r_2,$$

which implies that there will be a cutoff in the realization of $\tilde{R}$, say $\hat{R}$, such that for values smaller than $\hat{R}$ a run is the unique equilibrium. The cutoff is determined by:

$$r_1 = \frac{R(1 - \frac{r_1\theta}{q})}{1-\theta} \rightarrow$$

$$\hat{R} = \frac{r_1(1-\theta)}{(1 - \frac{r_1\theta}{q})}, \tag{3.11}$$

where we have normalized $r^* = 1$.

The probability of a run will be given by $\mathcal{G}(\hat{R})$. [16]

Proposition 5 *The probability of runs with intermediation is strictly positive. Also, this probability is non-decreasing in the level of liquidity that is provided.*[17]

The first part of the proposition is a straightforward consequence of the fact that intermediaries create liquidity which, using equation (3.11) implies that $\hat{R} > q = \underline{R}$, and therefore $\mathcal{G}(\hat{R}) > 0$. The second part is obtained by differentiating (3.11) with respect to r_1 and using the definition of liquidity provision by intermediaries ($r_1 > q$) we conclude that $\frac{\partial \hat{R}}{\partial r_1} > 0$. Given that $\mathcal{G}'(\hat{R}) \geq 0$ we establish that the probability of runs cannot decrease (and will most likely increase) with a higher r_1.

In summary, for every $R \leq \hat{R}$ the only possible equilibrium is a run. The probability of the equilibrium being a run does not decrease when the intermediary increases r_1, increasing the cutoff $\hat{R}$.

In addition to the equilibria described above, there is always the possibility of a self-fulfilling run independent of the realization of $\tilde{R}$.[18] If all the rest of the investors withdraw it is optimal for a specific investor to withdraw because the return in period 2 depends on the amount withdrawn in period 1 (see equation 3.8). There are two problems with this type of equilibrium. First, as in any sunspot equilibrium, there is not an endogenous probability of the occurrence of this event. A coordinating event is required and this has to be exogenously defined. Second, there are problems

[16] As explained below, we do not consider self-fulfilling runs here.

[17] Liquidity provision was defined as setting $r_1 > q$. More liquidity is increasing r_1, making it closer to $\sqrt{R}$, which is the one-period-equivalent return of the technology.

[18] Provided $r_1 > q$, which is exactly the case when intermediaries create liquidity.

involved in defining rigorously the equilibrium concept because along the equilibrium path beliefs have to be correct.[19] This means that without an exogenous coordinating event —which makes agents act in a particular way so that the initial beliefs turn out to be correct— the expected probability of a self-fulfilling run has to be zero (if it does not occur) or one (if it occurs). However, if this probability were one, agents would never invest in the first place since runs generate a return lower than the safe return r^*. Thus, without a coordinating event the sunspot equilibrium has to have probability zero and the probability of a run will continue to be given by $\mathcal{G}(\hat{R})$.

Investors' Problem, Runs and Capital Outflows

When agents invest through intermediaries, each foreign investor takes into account the probability of a run, $\mathcal{G}(\hat{R})$, and the return q in this event. He now solves:

$$\begin{aligned} &Max_a E[U[\tilde{W}]] = \\ &\qquad (1-\mathcal{G}(\hat{R}))[\theta U(ar_1 + (1-a)) + (1-\theta)\int_{\hat{R}}^{\bar{R}} U(a\tilde{r}_2 + (1-a))d\mathcal{G}(\tilde{R})] \\ &\qquad + \mathcal{G}(\hat{R})U(aq + (1-a)), \end{aligned} \tag{3.12}$$

which gives an optimal investment policy with an intermediary:

$$a_i^* = a_i^*(r_1, q, \theta, \Omega), \tag{3.13}$$

[19]See, e.g., Postlewaite and Vives (1987) for more on the problems involved in specifying this as an equilibrium. See Fudenberg and Tirole (1991), pp. 99-100, for some problems that the requirement of correct beliefs along the equilibrium path may cause.

where Ω includes all the parameters in the distribution. The flow of capital in this case will be given by:

$$t = 0 \quad a_i^*$$

$$t = 1 \quad \begin{cases} -\theta r_1 a_i^* & \text{with probability } (1 - \mathcal{G}(\hat{R})) \\ -q a_i^* & \text{with probability } \mathcal{G}(\hat{R}) \end{cases}$$

$$t = 2 \quad \begin{cases} -(1-\theta)\tilde{r_2} a_i^* & \text{with probability } (1 - \mathcal{G}(\hat{R})) \\ 0 & \text{with probability } \mathcal{G}(\hat{R}) \end{cases}$$

Proposition 6 *There are proportionally more capital outflows in period 1 with intermediation and, particularly, in the event of runs, i.e.,* $\theta q < \theta r_1 < q$.

The second inequality says that capital outflow in period one is higher with runs. This comes from the fact that the intermediary cannot contract to pay to investors in t=1 more than the technology allows (i.e., $r_1\theta < q$; see equation (3.8)). The first inequality is a straightforward consequence of the fact that intermediaries create liquidity $r_1 > q$.

The increased capital outflows means that with a run against the intermediaries there will be a higher demand on the central banks foreign reserves. We assumed in this section that the central bank has enough reserves, after paying net imports payments, to pay for the capital outflows (i.e., $Rx \geq \theta r_1 a_i^*$).

Intermediaries Competition and Capital Inflows

The intermediaries, knowing the investors' function $a_i^* = a_i^*(r_1, \tilde{R}, \theta, \Omega)$, will choose the rate r_1 to attract more investment and maximize profits. Bertrand competition among intermediaries will lead to zero profits and an r_1 that maximizes investors utility:

$$Max_{r_1} E[U[\tilde{W}]] =$$
$$(1 - \mathcal{G}(\hat{R}))[\theta U(a_i^* r_1 + (1 - a_i^*)) + (1 - \theta) \int_{\hat{R}}^{\bar{R}} U(a_i^* \tilde{r}_2 + (1 - a_i^*)) d\mathcal{G}(\tilde{R})]$$

$$+\mathcal{G}(\hat{R})U(a_i^* q + (1 - a_i^*)) \tag{3.14}$$

subject to equation (3.13).

This gives us an equilibrium r_1:

$$r_1^* = r_1^*(q, \Omega, \theta). \tag{3.15}$$

Plugging this equilibrium r_1^* back in the investment function (3.13) we get the equilibrium capital inflows with intermediaries.

Proposition 7 *There exist utility functions and distribution functions such that capital inflows in period 0 increase with intermediation.*

In the next section we work out a closed-form solution where $a_{ni}^* \leq a_i^*$ (constant relative risk aversion utility function and Bernoulli distribution). Even though investors rationally expect crises in bad states of nature, the benefits from the liquidity provision by intermediaries will more than compensate that effect and will induce them to invest a higher proportion of their portfolio in the economy.

3.3 A Closed-Form Solution: CRRA Utility and Bernoulli Distribution

In order to solve this problem explicitly we will assume a specific distribution for $\mathcal{G}(h$. In particular we assume:

$$\tilde{R} = \begin{cases} \bar{R} & \text{with probability} \quad \alpha \\ q & \quad \text{"} \quad\quad 1 - \alpha \end{cases}$$

We also assume a constant relative risk aversion utility function (CRRA).

The maximization for the case where $\hat{R} < \bar{R}$ becomes:

$$Max_{a_i, r_1} \quad (1 - \alpha)\frac{(aq + 1 - a)^{1-\gamma}}{1 - \gamma} +$$

$$\alpha[\theta\frac{(ar_1+1-a)^{1-\gamma}}{1-\gamma}+(1-\theta)\frac{(a\frac{\bar{R}(1-\frac{r_1\theta}{q})}{(1-\theta)}+1-a)^{1-\gamma}}{1-\gamma}],$$

where γ is the coefficient of risk-aversion.

The FOCs for this case are given by:

$$\frac{(r_1-1)\theta\alpha}{(a(r_1-1)+1)^{\gamma}}-\frac{(1-\alpha)(1-q)}{(1-a+aq)^{\gamma}}+\frac{\alpha(1-\theta)(r_2^H-1)}{(1-a-ar_2^H)^{\gamma}}=0 \tag{3.16}$$

and

$$\frac{\theta\alpha a}{(a(r_1-1)+1)^{\gamma}}+\frac{\alpha(1-\theta)a\frac{\bar{R}\theta}{q}}{(1-a-ar_2^H)^{\gamma}}=0, \tag{3.17}$$

where r_2^H is given by equation (3.6) applied to $\bar{R}$.

In order to find a_i^* and r_1^* explicitly we solve equation (3.16) for a (simplifying terms using equation (3.17)), solve equation (3.17) for a, and equate. The final solutions are given by:

$$a_i^*=\frac{\Phi_2\left\{\theta\overline{R}\Phi_1+q(1-\theta)\right\}-\Phi_1\left\{\theta\overline{R}+q(1-\theta)\right\}}{(1-q)\Phi_2\left\{\theta\overline{R}\Phi_1+q(1-\theta)\right\}-\Phi_1\left\{(\theta-q)\overline{R}+q(1-\theta)\right\}} \tag{3.18}$$

and

$$r_1^*=\frac{q\left[\Phi_1\left\{\overline{R}-(1-\theta)\right\}+(1-\theta)\right]}{\theta\overline{R}\Phi_1+q(1-\theta)}+\left\{q(1-\Phi_1)(1-\theta)\right\}\times \tag{3.19}$$

$$\frac{(1-q)\Phi_2\left\{\theta\overline{R}\Phi_1+q(1-\theta)\right\}-\Phi_1\left\{(\theta-q)\overline{R}+q(1-\theta)\right\}}{\left\{\theta\overline{R}\Phi_1+q(1-\theta)\right\}(1-\Phi_2)\left\{\theta\overline{R}\Phi_1+q(1-\theta)\right\}},$$

where

$$\Phi_1\equiv\left(\frac{q}{\overline{R}}\right)^{\frac{1}{\gamma}}$$

and

$$\Phi_2\equiv\left(\frac{\alpha\left\{\overline{R}(q-\theta)-q(1-\theta)\right\}}{\overline{R}(1-\alpha)(1-q)}\right)^{\frac{1}{\gamma}}.$$

Note that for the problem to be well defined we need to restrict the parameter values such that $\overline{R}(q-\theta)-q(1-\theta)\geq 0$.

For the case of no intermediation, the optimal investment level a_{ni}^{*} is given by:

$$a_{ni}^{*}=\frac{1-\Phi_3}{1-q+\Phi_3\left(\overline{R}-1\right)}, \tag{3.20}$$

where

$$\Phi_3\equiv\left(\frac{(1-q)\left\{\theta+(1-\theta)(1-\alpha)\right\}}{(1-\theta)\,\alpha\left(\overline{R}-1\right)}\right)^{\frac{1}{\gamma}}.$$

Although it is possible to compute partial derivatives from the closed-form solutions, for simplicity we present here some simulations using a concrete numerical example. Figure 3-3 presents the optimal capital inflows with and without intermediaries, and the optimal liquidity provision for different parameter values. The baseline case has the following parameter values: $\bar{R}=1.7$, $q=0.8$, $\alpha=0.6$, $\theta=0.2$, $\gamma=2$. These parameters imply the following results: $a_i^{*}=0.942$, $r_1^{*}=1.054$, and $a_{ni}^{*}=0.753$. That is, intermediation results in liquidity provision —even in excess of the risk-free rate—, an increase in capital inflows, and an increase in the probability of collapse —which changes from zero to $1-\alpha$.

Figure 3-3 shows that for parameter values where the intermediaries provide liquidity, that is $r_1^{*}>q=.8$, capital inflows under intermediation are systematically higher. In principle, there are two opposite effects determining the amount of investment when there is intermediation. On one hand, by providing liquidity, intermediaries make investment in the country more attractive to potentially illiquid investors. On the other hand, the provision of liquidity by intermediaries allows for the possibility of runs and makes rational investors more cautious with regard to investing in the country.[20]

In the example shown here, the liquidity effect dominates the risk of been forced to early withdraw (in the case of a run) and we observe larger capital inflows when intermediaries provide liquidity. Notice that in all the graphs, when there is no

[20]In general, there is a third effect. By changing the wealth of investors, intermediation can potentially change investors' risk-aversion and, consequently, the amount invested. In our example we have left out this effect by fixing the relative risk-aversion.

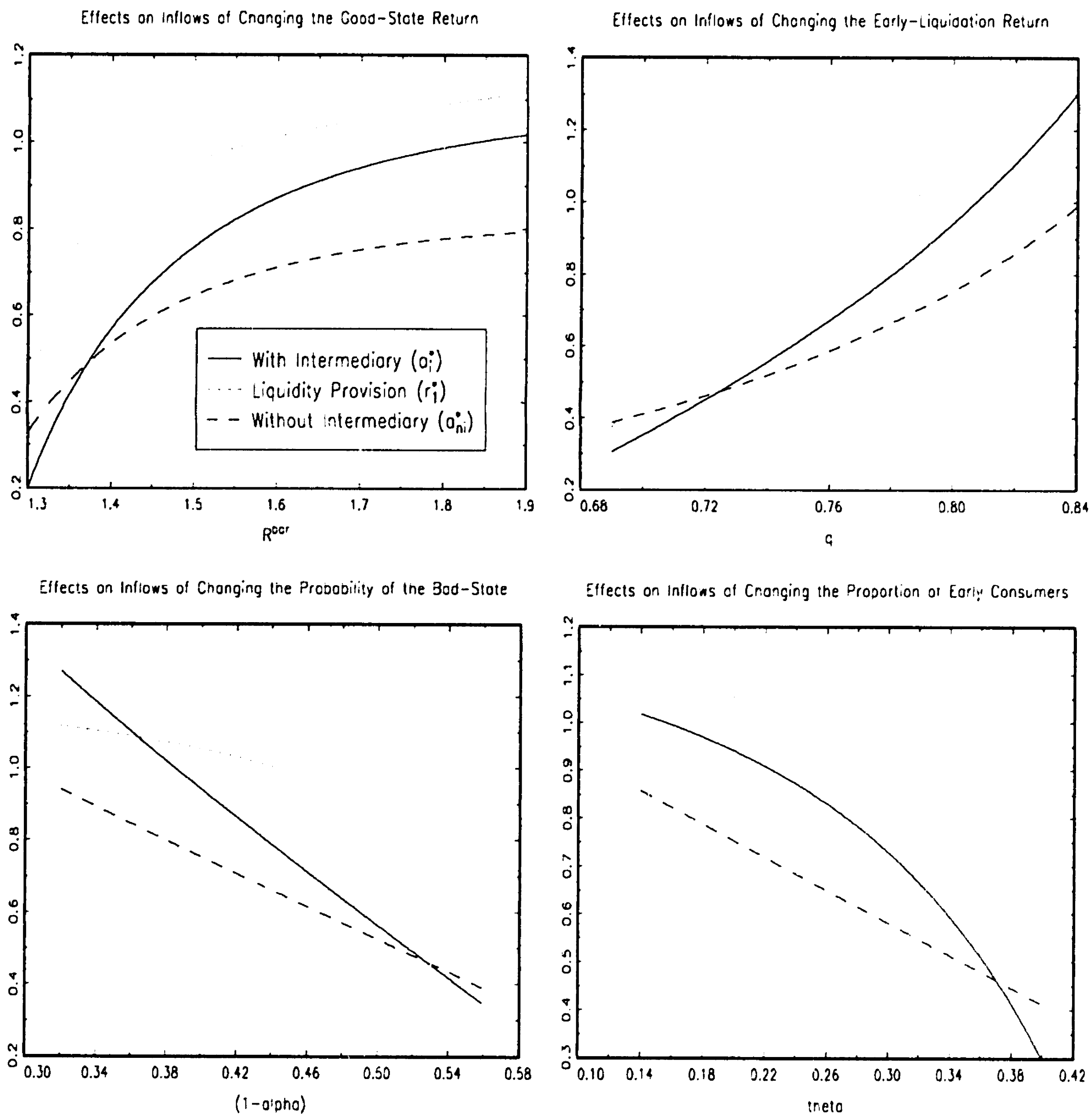

Figure 3-3: Capital Inflows Simulations

liquidity creation ($r_1 = q = 0.8$) the amount of inflows with intermediaries is the same as without intermediation, i.e., $a_i^* = a_{ni}^*$. At these points the return and probability of the different states that the investor faces are identical, regardless of the presence of intermediation. Interestingly, for parameters values at which the intermediaries (optimally) offer illiquid contracts, i.e., $r_1^* < q = .8$, there are fewer capital inflows.

Figure 3-3 allows us to analyze some of the comparative statics involved in the problem.

As expected, a higher good-state return, $\bar{R}$ increases the inflows both with and without intermediation. More important, however, is the fact that both the difference between the two inflows and the provision of liquidity increase. For a given q, a higher good-state return increases the spread of the returns and makes liquidity creation and intermediation more valuable.

A higher liquidation return q also increases capital inflows. The difference between the two inflows expands too. As q rises, the cost for each individual investor in the case of a run on the intermediaries decreases. This makes investment with the intermediaries more attractive.

A higher probability of a lower return (that is a higher $1-\alpha$) has opposite effects. Inflows with and without intermediation fall, but the former drops more because of a higher probability of runs on the intermediary. Finally, if a higher proportion of Early-Consumer type of investors (that is a higher θ) is expected, there are less inflows and intermediation in equilibrium. The extra inflows generated by intermediation drops for higher values of θ because the existence of a higher proportion of withdrawals in period 1 makes intermediaries provide less liquidity (in other words, the existence of a large proportion of short term capital inflows makes less attractive the marginal investment through the intermediaries).

3.4 Exchange Rate Collapses

The model presented so far has analyzed the effect of financial intermediation on both capital inflows and outflows. This section, introduces an upper bound to the stock of foreign exchange reserves available to the central bank, in order to investigate the interactions between runs against intermediaries and balance of payments collapses in economies with a fixed exchange rate.

The introduction of an upper bound to the stock of reserves in our previous model both amplifies and propagates the runs against the intermediaries. First, there is the effect of runs on the sustainability of the exchange rate. Relaxing our previous assumption of sufficiently high level of reserves, runs can generate abnormal capital outflows that may force a devaluation. This will be the case if the Central Bank is not able to finance the sudden outflow, in the short run, borrowing immediately against future reserves.[21] Thus, outflows generated by runs against intermediaries —even against a small number— will put pressure on the exchange rate and will propagate the effects of a negative shock to the rest of the economy. Second, given that forced devaluations are now possible and that portfolio returns depend on them. investors have to recalculate their optimal allocation and the optimal time to withdraw. The anticipation of a devaluation produces strong incentives for a run against the Central Bank. As in the case of intermediaries offering bank-type deposits, the position in the line of the central bank matters because a devaluation produces a capital loss to those at the end of the line. Therefore, even if the investors' portfolios include "liquid" intermediaries or direct investment, these agents may have incentives for early liquidation because the returns measured in the international currency are affected by the eventual devaluation. Typically, there will be runs in more states of nature. This is the amplification effect that exchange collapses have on intermediaries' crises.

There is an alternative link between intermediation and Balance of Payments. If intermediaries have a fiscal-backed deposit insurance system, runs against intermediaries will produce an extra burden on the fiscal sector. This extra burden, in turn, will both bring forward a Balance of Payments crises and make it more likely. This link is investigated in Calvo (1995).

[21] This is the typical assumption in the Balance of Payments Collapse literature. This will typically be the case if the required future fiscal policy is not credible or if there is risk of strategic repudiation. In this model, the assumption implies that there are no immediate public compensatory flows of capital.

In what follows below we will concentrate on the direct amplification and propagation effects between exchange collapses and intermediaries that were described above. The effect of runs against the intermediaries on the sustainability of the exchange rate is investigated first in section 3.4.2. Then, the feedback of exchange collapses on runs are analyzed in sections 3.4.3 and 3.4.4.

3.4.1 The Economy Under Fixed Exchange Rate

Before introducing the possibility of devaluations, we need to be more specific with respect to the units in which the projects and the final returns to the investor are measured. The projects are investment opportunities in the non-tradable goods sector, with returns measured and paid in the local currency. Therefore, a devaluation of the currency reduces the return on the foreign investment.

The devaluations in period 1 are possible because we assume the Central Bank faces the following restriction:

$$\theta r_1 a^* \leq Rx \leq qa^*.$$

There are enough reserves to sustain the fixed parity in the event of normal capital outflows but not in the case of crisis in the intermediaries.

There are N intermediaries that compete à la Bertrand, each one with a pool of projects which gives an aggregate return $\tilde{R}_i$. We assume that these returns are not perfectly correlated, and, for simplicity, that have the same c.d.f. $\mathcal{G}(.)$.[22]

The rest of the economy is represented by a sequence of current account deficits X_t which are exogenous to the model. We assume the current account surplus in period 2 is high enough to finance the highest possible capital outflow in period 2, which, in turn, is given by the maximum possible realization of $\tilde{R}$.[23]

[22]One intermediary would dominate the existence of many intermediaries if administration costs and sector-specific knowledge were not important. We assume here that they are important, meaning that more than one intermediary is optimal. At the same time, these costs make full diversification suboptimal.

[23]This assumption precludes exotic cases in which future returns and capital repatriation are so high, that there is a Balance of Payments crisis in period 2.

There are two key assumptions about central bank behavior. First, under a fixed exchange rate regime, it will try to maintain the exchange rate fixed whenever it is possible. In period one, the authority would like to keep the exchange rate fixed at the level it started in period 0.[24] In the event of a devaluation in period 1, given the assumption of a current account surplus in period 2, the Central Bank will fix the exchange rate at the new level. Second, we assume that the central bank follows the following rule-of-thumb in the case of being forced to devalue. As long as the amount of net reserves Rx (reserves RX net of current account deficit) is bigger than the demand for reserves (or capital outflows) the exchange rate is kept fixed. If the demand for reserves is higher than the net reserve stock, reserves are exchanged at the fixed exchange rate until they hit a predetermined-specified level $Rx_{\min}$. At that level the remaining reserves are publicly auctioned so as to clear the market.

With these assumptions, for a given stock of net reserves in period 1, $Rx = RX - X$, and a given demand for reserves in period 1, F/e, where F is capital outflows measured in local currency, the exchange rates will take the following values at the end of each period:

$$
\begin{aligned}
e_0 &= 1 \\
e_1 &= \begin{cases} 1 & \text{if } F \leq Rx \\ 1 + \frac{F - Rx}{Rx_{\min}} & \text{otherwise} \end{cases} \\
e_2 &= e_1.
\end{aligned}
$$

In period one, if there are not enough reserves, the exchange rate will increase so that the demand for reserves will match the remaining supply.

Investors, in turn, will face the following exchange rates in period 1:

$$
e_1 = \begin{cases} 1 & & \text{if } F \leq Rx \\ 1 & \text{with prob. } \alpha & \text{if } F > Rx \\ 1 + \frac{F - Rx}{Rx_{\min}} & \text{with prob. } 1 - \alpha & \text{if } F > Rx, \end{cases}
$$

[24]Normalized to be equal to 1.

where $\alpha = (Rx - Rx_{\text{min}})/F$. Of course, the smaller Rx_{min}, the higher the devaluation.

3.4.2 The Effect of Intermediation Runs on the Exchange Rate

A run against a financial intermediary has a simple direct effect on the exchange rate determination. Given an amount of reserves and a current account deficit level, these runs increase both the probability of a Balance of Payments crisis, and, if there is a collapse, the size of the devaluation. The non-linearities produced by the intermediation process make small real shocks in project returns translate into Balance of Payment crises.

In terms of the model, and in the simple case of one intermediary, outflows of capital increase by $\Delta = a_i^*(q - \theta r_1)$ when there is a run, where $a^*\theta r_1$ is the "normal" capital outflow. If we assume that there is no Balance of Payment crisis under the "normal" capital outflow, the extra outflow translates into a Balance of Payment crisis if $\Delta > Rx - a^*\theta r_1 > 0$, That is, if the Central Bank does not have enough reserves to sustain the extra capital outflow that results from the run on the intermediary. Moreover, if there is a devaluation, the new exchange rate level will be given by $1 + (a_i^* q - Rx)/Rx_{\text{min}}$.

Given our assumption that under a "normal" capital outflow there is no exchange collapse, we can extract the probability of collapses from the likelihood of runs against the intermediaries. If we denote by R^c the early withdrawal policy cutoff for $\tilde{R}$, the probability of a crisis will be simply given by $\mathcal{G}(R^c)$.[25]

Proposition 8 *Under a fixed exchange rate regime, the probability of devaluation increases when there is intermediation and the risk of runs.*

Under our assumptions, where we normalized the probability of exchange rate collapse to zero if there are no runs against the intermediary, the proposition will be

[25] As shown below, in section (3.4.3) it is not always the case that this is the same cutoff as before, $\hat{R}$.

true when $\mathcal{G}(R^c) > 0$. Following the same reasoning as in proposition 1, this proves to be indeed correct.

3.4.3 The Effect of Exchange Collapses on Runs: 1 Intermediary

In this section we will show that an expected devaluation will increase the probability of a run against the intermediary (holding constant the feedback from runs on intermediaries to devaluations, shown to exist in the previous section).

Investors who are able to keep the investment until period 2 will evaluate whether it is convenient to withdraw in period 1. As in the simple model, there will be a cutoff R^c, such that if the project return is higher than R^c it is optimal not to withdraw. The cutoff level in this case will depend on the reserve level of the central bank, the current account deficit, and the reserve level at which the authority auctions the remaining reserves.[26] In particular, given the amount invested in period 0, a_i^*, the cutoff which defines optimal early withdrawal is uniquely defined by:

$$R^c = \begin{cases} \hat{R} & \text{if } a^* r_1 \theta \leq Rx \\ R' & \text{otherwise,} \end{cases}$$

where $\hat{R} = r_1 (1-\theta) / \left(1 - \frac{r_1 \theta}{q}\right)$ is our previous cutoff. If reserves are not enough to finance "normal outflows", we can show that the expected devaluation changes the cutoff to R', which is defined by the implicit equation:

$$\begin{aligned} U\left[\tfrac{a^* \tilde{r}_2}{e_2} + 1 - a^*\right] &= \\ \alpha U\left[a^* r_1 + 1 - a^*\right] + (1-\alpha)\, U\left[\tfrac{a^* r_1}{e_2} + 1 - a^*\right], \end{aligned} \tag{3.21}$$

where $\tilde{r}_2 = R' \left(1 - \frac{r_1 \theta}{q}\right) / (1-\theta)$, and where α is as defined above, with $F = a^* r_1 \theta$.

If $a^* r_1 \theta \leq Rx$, then there is no devaluation if late consumers do not run and the returns are the same as in the simple model. If $a^* r_1 \theta > Rx$, then there is

[26] If we allow for a sunspot equilibrium it is possible to have a full collapse of the intermediary independently of the amount of reserves.

devaluation with probability 1, and there exist a unique R' such that late consumers are indifferent between early and late withdrawal, taking into account the effect of a devaluation (with $F = a^{\star}r_1\theta$). R' exists and is unique because, given F the RHS of equation (3.21) is constant and the LHS is monotonic and continuous in R' (assuming a well behaved utility function: continuous, with $U'(.) > 0$ and $U''(.) < 0$).

It is worth noticing that the cutoff $\hat{R}$ is the same as before, in the case in which there were sufficient reserves to finance any capital outflow. The main result, however, is summarized in the following proposition.

Proposition 9 *If devaluations are expected, runs against the intermediary are more likely.*

Proving this proposition amounts to showing that $\mathcal{G}(\hat{R}) < \mathcal{G}(R')$, or, equivalently,

$$\frac{r_1 (1-\theta)}{1 - \frac{r_1\theta}{q}} < R'.$$

The inequality can be verified by noticing that if $a^{\star}r_1\theta > Rx$, then $1 < e_2$, regardless of the existence of a run against the intermediary. Therefore, the LHS of equation (3.21), which is equal to a convex combination of two terms, has to be bigger than $U\left[a^{\star}r_1/e_2 + 1 - a^{\star}\right]$, the smallest of the two terms of the combination. Comparing the arguments of the two functions and using the fact that $U'(.) > 0$, yields the result.

Given this proposition and the previous one in section 3.4.2, runs against intermediaries and exchange rate collapses have a reinforcing effect on each other. This will be investigated in the next section where we do not keep the probability of devaluation constant.

3.4.4 Early Withdrawal Decision: 2 Intermediaries

An interesting interaction between a fixed exchange rate regime and the intermediation process occurs when there is more than one intermediary. In this case, we can show the total effect of having intermediation on both exchange rate crises and the probability of runs, taking into account their mutual feedback (shown to exist in the last two sections).

Potentially, the return on the investment in all intermediaries matters for the decision of early withdrawal from a particular intermediary. The return of other intermediaries matters because the exchange rate affects the final return and the size of an eventual devaluation is a function of the total amount withdrawn in period 1. In general, the early withdrawal solution will be characterized by multiple Nash-equilibria.

Restricting our attention to symmetric solutions in the case of two intermediaries (indexed by i and j) we now characterize the Nash-equilibrium strategies. Depending on the amount of reserves in period 1, three different cases can be isolated. In the first one the amount of reserves in period 1 is sufficient to cover the outflows generated by the runs against one or both intermediaries in addition to the "normal" capital outflow (that is the non-run outflow). In this case the decision rule is the same as in the simple case: withdraw in period 1 if and only if $\tilde{R} < \acute{R}$, with $\acute{R}$ defined as above (notice that the strategy in this case is independent of the return of the other intermediary).

In the second case, where reserves are enough to cover the "normal" outflow of capital, but not sufficient to additionally finance the outflow of a run in one intermediary, the equilibrium strategies can depend on the portfolio returns of *both* intermediaries. In particular, assuming that $2a^{*}r_1\theta \leq Rx < a^{*}q + a^{*}r_1\theta$, and that Rx_{min} is sufficiently high (but less that Rx), the optimal strategies are characterized as follows:[27]

There are two cutoff values for $\tilde{R}_i$, R^c_H and R^c_L, such that for $\tilde{R}_i < R^c_L$ early withdrawal is optimal, and for $R^c_H \leq \tilde{R}_i$ late withdrawal is optimal, regardless of $\tilde{R}_j$. For $R^c_L \leq \tilde{R}_i < R^c_H$, the withdrawal decision depends on the realization of the return of the other intermediary $\tilde{R}_j$. If $\tilde{R}_j < R^c_L$, then early withdrawal is optimal, and if $R^c_H \leq \tilde{R}_j$ late withdrawal is optimal. If both returns are between the two cutoff values there exist three Nash-equilibria: two pure strategy equilibria (both investors withdraw or

[27]If Rx_{min} is not high enough, it is not possible to insure that R' is increasing in F, and the proposed solution does not need to hold. To show that R' is increasing in F totally differentiate equation (3.21).

both choose to wait) and a mixed strategy one (early withdrawal with probability λ_i, which in turn depends on the realization of the returns). Moreover, given a^*—the amount invested through *each* intermediary— the cutoff R^c_H is determined by the implicit equation (3.21), with $F = a^*q + a^*r_1\theta$.

Given the central bank policy, the lower bound cutoff R^c_L is given by $\hat{R}$. Returns below $\hat{R}$ will trigger early withdrawal regardless of the exchange rate, and therefore regardless of $\tilde{R}_j$. This is so because a devaluation will never turn (relatively) less attractive an early withdrawal (given the possibility of getting $e = 1$). The upper bound R^c_H defines the region where higher returns will induce late withdrawal even if there is a devaluation. This cutoff is defined at the highest level of the exchange rate in the absence of a run against i, which occurs when there is a run against j. Given that particular exchange rate level, the assumptions about $Rx_{\min}$, and a well behaved utility function, it is always possible to find an R' that solves equation (3.21). Let R^c_H be equal to this R'. Since the LHS is increasing in R' returns higher that R^c_H make late withdrawal strictly preferred. When $R^c_L \leq \tilde{R}_i < R^c_H$, early withdrawal is optimal if and only if there is a devaluation and hence the importance of the realization of $\tilde{R}j$.

In the third case, where reserves are not enough even to cover the "normal" outflow (so that a devaluation occurs with probability 1), the equilibrium strategies will also depend on the returns of both intermediaries because runs will affect the size of the devaluation . In this case we have $Rx < 2a^*r_1\theta$ and again there are two cutoff values for $\tilde{R}_i$, R^c_H and R^c_L, which determine the optimal withdrawal policy. If $Rx_{\min}$ is sufficiently high, these cutoffs are determined by the implicit equation (3.21), with $F = a^*q + a^*r_1\theta$ and $F = 2a^*r_1\theta$, respectively. For $\tilde{R}_i < R^c_L$ and $R^c_H \leq \tilde{R}_i$ early and late withdrawal are optimal respectively, regardless of $\tilde{R}_j$. For $R^c_L \leq \tilde{R}_i < R^c_H$, the optimal strategy depends on $\tilde{R}_j$ as in the second case.

Proposition 10 *With an eventual unsustainable fixed exchange rate and two or more intermediaries, both the probability of runs against intermediaries and the probability of a Balance of Payments crisis increase* (vis-à-vis *the case of a sustainable fixed exchange rate or one intermediary).*

Following similar steps as in the case of one intermediary it is straightforward to show that $\hat{R} \leq R_L^c < R_H^c$, which gives the result.[28]

3.5 International Interest Rates

There is a lively debate in the literature about the role of external factors in determining capital flows to (or from) LDCs. There is some evidence that movements in the international interest rate are an important determinant of the *direction* of capital flows to (or from) LDCs.[29] However, it is fairly difficult to justify how rather modest changes in the US interest rates can determine the *magnitude* of these impressive capital inflow and outflow surges. This is certainly the case of a crisis, when the magnitudes of the capital outflows are much larger than the ones predicted by fundamentals.

The structure developed in the previous sections is suitable to show how relatively small shocks may generate large swings in capital flows and, in the case of insufficient reserves, even an exchange rate crisis. Although the focus up to this point has been the role of internal (or country specific) factor shocks, exemplified by productivity shocks, it is straightforward to extend the model in order to include external factors as the initial impulse.

An initial increase of US interest rates, for example, may prompt more than the normal withdrawals if late consumers have the incentive to withdraw early to take advantage of better opportunities abroad. If this is reinforced by the contract offered by intermediaries, basically offering liquidity and reducing the cost of withdrawal at short notice, the incentive is even higher and a surge of capital outflows may occur. Capital inflows can also be explained if the intermediation process becomes endogenous. For instance, a small inflow prompted initially by a drop in the international interest rate can produce a surge if there are thick market externalities in the process of intermediation, which, in turn facilitate the liquidity provision process.

[28] Again, we need to assume here that $Rx_{\min}$ is high enough so that R' is increasing in F.
[29] See, e.g., Calvo, Leiderman and Reinhart (1993).

Using the same methodology as in the case of internal factors, there will a cutoff $\hat{r^*}$, such that for second-period interest rates higher than $\hat{r^*}$ all late consumers will have an incentive to withdraw early. [30][31] The probability of crises will be given by $\mathcal{G}(\hat{r^*})$ which will be strictly positive and non decreasing in r_1. The runs against the intermediaries will generate a larger outflow and, in the absence of enough international reserves, this may trigger a devaluation. The more liquidity creation by intermediaries, the smaller will be the cutoff and, therefore, higher realizations of the international interest rate will be able to generate a run.

An important consideration is that because it is an external shock, the international interest rate simultaneously affects all intermediaries (and countries) and, hence, could help explain the generalized effect that movements in the US interest rate produce in capital flows across countries. Moreover, if this was the source of instability, cross-country insurance schemes would not work.

3.6 Conclusion

Exchange rate crisis sometimes occur in a disproportional manner. The resulting capital flows and price movements happen with a force above and beyond any observable initial impulse, generated by an external or internal event. In addition, some crises seem to have a strong component of a *run* on liquid assets, where a large proportion of the investors (if not all of them) try to cash in their investments ahead of the rest and transfer them abroad. The magnitude and size of the devaluation that follows suggest that this behavior is important and that it is worthwhile to attempt to introduce them into our standard exchange rate collapse models.

In this chapter we have stressed the role of *run behavior* on exchange rate crises and capital flows. We have showed that intermediaries, by offering assets that pay a better return in the case of early withdrawal, allow the possibility of runs and

[30]See Hellwig (1994) for a similar model based on the Diamond and Dybvig approach to analyze the interest rate risk. The focus of that paper is quite different from this one; it aims to analyze the optimality of deposit contracts when the interest rate is stochastic.

[31]The cutoff in this case is $\hat{r^*} = \frac{R(1-\frac{r_1\theta}{q})}{r_1(1-\theta)}$

magnify the outflows of capital (in particular, in bad states of nature) relative to the no intermediation case.

Also, we have showed that if credit is funneled through liquidity creating intermediaries, internal or external adverse shocks may generate runs and large exchange rate devaluations that otherwise would not have occurred. The devaluation, then, propagates the shocks to the rest of the economy. Therefore, it is the fragile financial situation of the intermediaries that allows the propagation and amplification of a given initial shock and produces strong capital movements and exchange rate overreaction.

Interestingly, we find the effect working in the other direction, as well. The expectation of an exchange rate collapse exacerbates the financial fragility of the intermediaries by reducing the return of the investments in the event of runs, measured in foreign currency units. Therefore, the mutual interaction between financial fragility and exchange collapses can multiply and amplify an initial adverse shock and resemble the magnitude of the crises that are sometimes observed in reality.

The financial fragility of intermediaries raises two valid questions. First, is there a competitive structure that generates this fragile situation? In the model of the paper, the existence of relatively illiquid investments and investors that have strong liquidity needs, combined with Bertrand competition between intermediaries, produces a situation where the main role of the intermediaries is to create liquidity. The financial fragility situation is embedded in this role.

Second, with rational investors, does the financial fragility still allow us to reproduce the observed surges in capital flows that precede the crisis? [32] Under reasonable assumptions about the utility function and the distribution function of the shocks, we were able to simulate several cases where capital inflow *increases* with intermediation, even though rational investors anticipate the possibility of runs. The liquidity provision services provided by intermediaries more than compensate for the risk of runs.

The assumption about competition among intermediaries means that the liquidity provided in equilibrium is the optimal one from the investors' point of view. However,

[32] See the graph and description in the introduction.

the optimal level of intermediation from the recipient country's point of view —which takes into account the trade-off between the size of capital inflows and the probability of crisis— is not necessarily the same. If a country prefers to have a low crisis risk rather than larger capital inflows, capital movement controls, Tobin taxes, and intermediation controls might be desirable. The experience of Chile during the last two years provides a good example of such policies (see, e.g., Corbo and Hernandez, 1995).

The focus on the financial fragility of liquidity creating intermediaries may help explain the different nature of some exchange rate collapses. In Latin America or other recently stabilized countries, where intermediaries are still readily available to offer liquid assets (as a consequence of the previous inflationary environment), external crises take the full proportion, with *a bank run* phenomenon as a major part of the collapses. In other countries, with less creation of liquid assets, exchange rate crises are costly events, but do not reproduce the *bank run* effects.

Chapter 4

The Aftermath of Appreciations

4.1 Introduction

One of the leading explanations behind almost all exchange rate crises is that the real exchange rate was previously overvalued. This would explain the market speculation against the currencies and the subsequent real devaluation. Although economists do not agree on the concept of overvaluation (sometimes called misalignment or just appreciation) or on its empirical counterpart, the magnitude of two recent crises reintroduced the discussion. In 1992, the exchange rate crises in Italy, Spain, and the United Kingdom affected the perceived sustainability of the European Monetary System and cast doubts about the success of the future European Union. In 1994, the magnitude of the Mexican exchange rate crisis and its implications for global financial instability obliged the US treasury and the IMF to mobilize a rescue package.

There is a vast literature on whether exchange rate overvaluation was the main cause behind each of these crises. There has also been some effort in identifying common factors to exchange rate crises and major devaluations. [1] However, the sample of countries chosen in these studies is not adequate to answer some important questions. For example, the question *what is the probability that a currency which has*

[1] See Dornbusch, Goldfajn and Valdés (1995); Eichengreen, Rose, and Wyplosz (1994) and (1995); and Edwards (1989) for some recent attempts to characterize exchange rate crises and devaluations. All these studies find that the RER is overvalued during the period previous to devaluations.

appreciated by 25% in real terms will face a crisis or need a large devaluation? cannot be answered with a sample of devaluations or crises only.[2] This sample selection bias does not exist in studies that test Purchasing Power Parity (PPP) but their focus is on whether the real exchange rate will eventually revert to its mean and not on how this reversion occurs. Surprisingly, little attention has been given to the likelihood of crises or devaluations in appreciation episodes. More generally there are, to our knowledge, no studies that focus on characterizing appreciations.

The importance of describing appreciations and the likelihood of devaluation is easier to understand as a practical matter. Several countries have used the exchange rate as an instrument to stabilize inflation and coordinate expectations around an easy focus point. In several cases, the credibility of the policymaker seems to depend largely on her ability to maintain the exchange rate peg. There are several current examples. In the context of developing countries Argentina and Brazil are interesting cases. Argentina's economic policy and credibility depend largely on its ability to sustain the peg. After four years of higher inflation at home than abroad in a fixed exchange regime, the Argentinean Peso appreciated considerably in real terms. Even if one takes for granted that in the medium or long run the Argentinean Peso will revert to its PPP value, the question of how this reversion will occur is still relevant. A nominal devaluation would probably undermine the credibility of the government's economic policy and induce capital outflows *à la* Mexico. Thus, for Argentinean policymakers (and public) and international investors the question of how likely it is to have a *smooth landing* (avoiding a large devaluation), given how appreciated their currency is, becomes extremely important. The same is true in the case of Brazil.

From a theoretical perspective there are several reasons why it is important to understand the dynamics of appreciations, and especially how they are corrected. In fact, several models assume (and some derive) real costs of a nominal exchange rate devaluation. For example, in building a model to discuss whether currency

[2]Klein and Marion (1994) study the duration of peg regimes in Latin America avoiding this sample selection problem. However, they do not address the questions we try to answer here. Interestingly, they conclude that the level of the RER is the main determinant of the duration of pegs.

crises are self-fulfilling, Krugman (1996) assumes that there are real costs in terms of reputation when the authority decides to devalue. The literature on exchange-rate based stabilizations, on the other hand, has stressed the importance of imperfect credibility as an explanation for the consumption boom and real appreciation that usually accompany such stabilizations. Credibility, in that literature, is defined as the likelihood of the abandonment of the peg.[3] Knowing whether it is possible to correct an overvaluation without a (large) nominal devaluation is a key step in evaluating the plausibility of the imperfect credibility explanation. Finally, the analysis of how likely is an appreciation episode to end through inflation differentials rather than nominal exchange rate movements sheds light to the question of how rigid nominal prices are and how persistent inflation is.

This essay empirically analyzes a broad range of real exchange rate appreciation cases. For that purpose, we define appreciations as PPP departures in the short and medium run. The cases are identified after compiling a large sample of monthly multilateral real exchange rates from 1960 to 1994. The objective is twofold. First, the chapter studies the dynamics of appreciations, avoiding the sample selection of analyzing exclusively the crisis (or devaluation) cases. In particular, we analyze the number of appreciation cases that exist under different definitions, their duration, temporal distribution and exchange rate arrangement characteristics. The main conclusions are as follows: First, the most striking result is the large asymmetry between the duration of the appreciation build-up and the return-to-normality phases. Second, we present evidence that fixed arrangements are more likely to suffer appreciations. Third, we show that appreciation episodes happen more often during the last part of our sample period (1980–94). Finally, we also show that episodes are notably shorter when fundamentals are considered.

The second objective of the chapter is to analyze the mechanism by which the overvaluations are corrected. In particular, we study what proportion of the reversions occurs through nominal devaluations rather than through nominal price adjustments

[3]See Rebelo and Végh (1995) for an evaluation of competing explanations of the stylized facts of exchange rate-based stabilizations.

(or cumulative inflation differentials). We calculate the probability of successful appreciations for various degrees of appreciation.[4] Figure 4-1 shows a typical result. Note that there are no successful cases when an appreciation reaches 35% or more.

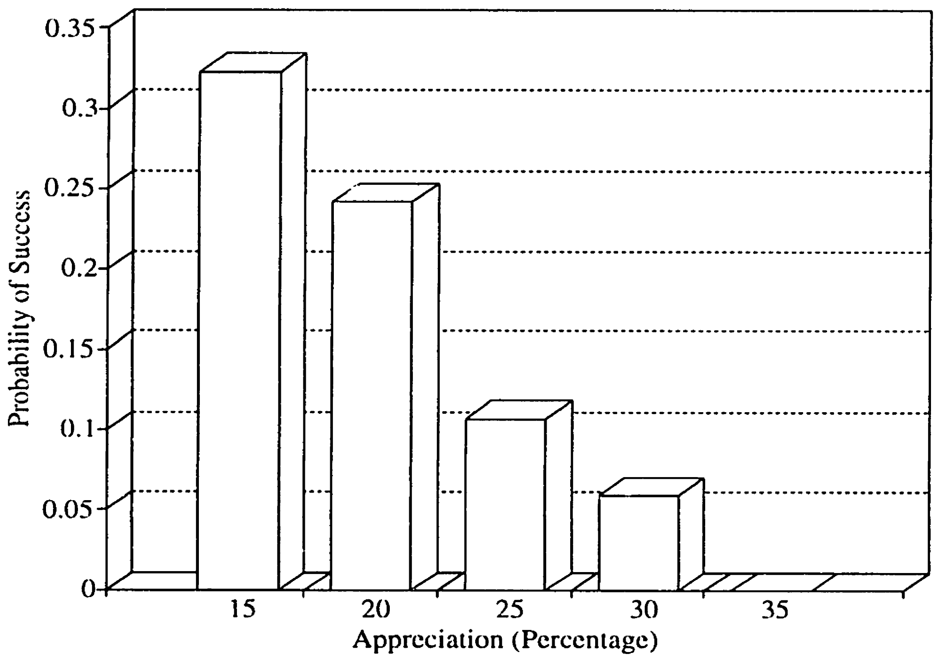

Figure 4-1: Probability of Successful Appreciation

The chapter is organized as follows. Section 4.2 sets the theoretical framework that defines real exchange rates and overvaluation episodes. Section 4.3 characterizes appreciation episodes across time and exchange rate regimes. Section 4.4 decomposes the return-to-equilibrium real depreciation into the fraction of the adjustment that takes place through nominal exchange rates and inflation differentials, respectively. This section also calculates the probability of successful adjustment. Section 4.5 concentrates on the dynamics of appreciation episodes and calculates transition matrices. Finally, section 4.6 concludes.

[4]We formally define the term successful appreciation in section 4.4. For now, we mean appreciations that end without large nominal devaluations.

4.2 Methodology and Data

In order to analyze and interpret movements of the real exchange rate (RER) as an appreciation episode one needs to define an equilibrium concept and the dynamics out of steady state. This is not an easy task. In fact, we speculate that one of the main reasons that prevented previous attempts to characterize overvaluations is the lack of a consensus around a sound empirical counterpart to any definition of the equilibrium RER. The RER between two countries is defined as the relative cost of a common basket of goods measured in terms of a common numeraire: P_1/P_2, where P_i is the price of the basket in country i.

The equilibrium concept we use is *Purchasing Power Parity - PPP*, probably the simplest and most powerful theory of real exchange determination.[5] It is based on the *Law of One Price* which states that, abstracting from tariffs and transportation costs, free trade in goods should ensure identical prices of these goods across countries. This implies that the same basket of goods in two different countries must have the same price, or $P_1/P_2 = 1$.

This essay denotes by **overvaluation** or **appreciation** the episodes of PPP departures in the short or medium run.[6] The correction of PPP deviations (or overvalued RER) can be thought to occur through the following channel. An overvalued currency generates unsustainable current account deficits through the loss of competitiveness. The latter also leads to possible recession and losses of reserves. All of these effects will work to adjust domestic prices expressed in foreign currency to international levels.[7]

In the definition of RER we can theoretically disaggregate the price levels in three categories: Price of exports (P_x), price of imports (P_m) and price of nontraded goods

[5] See Dornbusch (1987) for an historical perspective.

[6] We ignore undervalued episodes. The emphasis on overvaluations in the literature and policy discussions is probably because prices and wages are flexible upwards. Presumably, undervaluations are less costly to reverse.

[7] A fundamental issue for the interpretation of our paper is whether the RER is a trend-stationary stochastic process —that is if it tends to revert towards its mean. Recent studies have shown that this is indeed the case. See Froot and Rogoff (1995), Isard (1995) and Breuer (1994).

(P_n).[8] The RER is then defined as follows:

$$E \equiv \frac{P_m^{\alpha} P_x^{\beta} P_n^{\gamma}}{P_m^{*\alpha'} P_x^{*\beta'} P_n^{*\gamma'}}. \tag{4.1}$$

Taking logs and rearranging we have:

$$e = \{\alpha(p_m - p_m^*) + \beta(p_x - p_x^*)\} + \{\gamma(p_n - p_n^*)\} + \{(\alpha - \alpha')p_m^* + (\beta - \beta')p_x^* + (\gamma - \gamma')p_n^*\},$$

or equivalently,

$$\begin{aligned} e = \; & \text{Departures from Law of One Price} + \text{Relative price of nontradables} + \\ & \text{Terms of Trade effect.} \end{aligned}$$

The idea is that when the law of one price holds, ceteris paribus, there will be no pressure on relative prices (current account deficits will be optimal, wages and prices in equilibrium). This amounts to:

$$P_x = P_x^* \quad \text{and} \quad P_m = P_m^*.$$

We can abstract from the *direct* Terms of Trade effect if we assume that the weights are not so different between the baskets. If $\alpha - \alpha' = 0$, $\beta - \beta' = 0$ and $\gamma - \gamma' = 0$, then we have:

$$e = \{\alpha(p_m - p_m^*) + \beta(p_x - p_x^*)\} + \{\gamma(p_n - p_n^*)\}, \tag{4.2}$$

where we remain with only two components, namely departures from the law of one price and nontradables price differences.

If we assume that differences in nontradable prices do not exert reverting pressures (as in the case of haircuts), then only differences in tradable prices should be considered in the overvaluation measure. Therefore, one needs to disentangle the two

[8]Here the subscript m (or x) represents the import (export) good in the home country which is, also, the export (import) good of the rest of the world.

components of the RER above. One approach is to assume that equilibrium movements in the term $\gamma(p_n - p_n^*)$ of equation (4.2) occur slowly and that time trends will capture these movements.[9] A second approach is to control for the effects of fundamentals by regressing the RER on several variables that are related to nontradable prices but not to departures from the law of one price.[10]

We follow both approaches in the essay. We first follow the approach of regressing the RER on time trends, without taking into account fundamentals. Besides being a simple procedure, this would be the optimal approach if the price index had a small proportion of nontraded goods, and their prices change smoothly.[11] For each country we calculate

$$E^{pr} = \alpha + T'\beta, \tag{4.3}$$

where E^{pr} is the predicted value from the regression of the log of the RER on two time trends (linear and square) denoted by T.

Using the predicted value as our equilibrium real exchange rate, the departures from equilibrium are calculated as follows (normalizing the series to 100 when the RER is in equilibrium):

$$E^* = 100 + 100 \times \frac{E - E^{pr}}{E^{pr}}, \tag{4.4}$$

where E is the original series.

[9] An example of these movements is the Balassa-Samuelson effect. When there is a productivity growth differential between the traded and nontraded goods sectors *and* this differential is not homogeneous across countries, then the (cross country) relative prices of nontraded goods, and therefore, the RER, will change over time.

[10] One could argue that some of the fundamentals chosen may also be related to the departures from the law of one price. In this case, this second approach will tend to underestimate the extent of overvaluation. Since the first approach does not control for fundamentals and may overestimate the extent of overvaluation, one can interpret the resulting two series as defining the boundaries of the true overvaluation episode.

[11] Since the RER is trend-stationary this is a perfectly valid procedure.

4.2.1 Controlling for Fundamentals

We also follow the second approach. Here we assume that nontraded prices do change with movements in fundamentals. Thus, we want to clean RER movements from changes in the term $\gamma(p_n - p_n^*)$ of equation (4.2).

Operationally, we calculate for each country:

$$E^{pr} = \alpha + T'\beta + X'\gamma, \tag{4.5}$$

where X is the set of fundamentals.

The fundamentals we use to isolate the RER movements from movements of non-traded good prices are the following:

Terms of Trade (TOT) TOT shocks affect the relative price of nontradables in small open economies.[12] If there is a positive permanent shock, the demand for nontradables will increase with the increase in permanent income. In equilibrium, the relative price of nontradables will rise and we should observe a real appreciation.

If the shock is temporary, and therefore the effect on permanent national income is small, the demand for nontradables will not increase and the relative price of nontradables will not react, provided the supply is unchanged. This will be the case whenever there is a fixed cost to move resources out of the tradable sector and decrease the supply in the short run. Otherwise, even temporary TOT shocks can have an effect on the RER. Here we assume that TOT affect the equilibrium RER through supply effects only in the long and medium run. Then, the optimal procedure is to net out the effect of TOT and smooth the resultant predicted values. In this way long run trends will be captured and very short effects smoothed.

In the case of large countries there is an endogeneity problem because the TOT are defined simultaneously to the relative price of nontraded goods.

[12] See Edwards (1989).

Government Spending An expansion in government spending will appreciate the RER if it increases the overall demand for nontradables. This will be the case if the government propensity to consume nontradables is larger than the private sector's. When the propensities are the same and an increase in expenditures is financed by debt the effect depends on how permanent is the shock and how forward looking are consumers. As a general rule, the effect on nontradable prices increases the more temporary the government shocks are (when the shocks are temporary the private sector will not decrease consumption proportionally) and the less forward looking consumers are (Ricardian equivalence will not hold). We measure government spending as the ratio of government expenditures to GDP.

Openness Openness reflects how connected the economy is to the rest of the world and stands here for trade liberalization. It is proxied here by the ratio of exports plus imports to GDP.

A trade liberalization generates an equilibrium RER depreciation from a labor market general equilibrium perspective. The decrease in tariffs generates the necessity of a crowding-in to restore full emplyment. This, in turn, requires a reduction in the price of nontradables.[13]

Some transitory shocks to the fundamentals we consider have no effect on equilibrium RER's.[14] In this case, because the regression in equation (4.3) will capture the long run relationship between the RER and fundamentals, short run movements in the latter may generate *false* short term movements in our "equilibrium" estimate. These movements, however, will be unrelated to movements in the actual RER. In order to minimize this effect, we smooth the predicted RER's with a 12-month centered moving average.

[13]See Dornbusch (1974).

[14]An example is given by a transitory positive shock to the terms of trade.

4.2.2 Episode Definition and Phases

Figure 4-2 presents an example of an appreciation episode. We define the start of an appreciation case as the time when the difference between the actual RER and our estimate of "equilibrium" RER (the predicted value from equations (4.3) or (4.5)) is equal or higher than a certain threshold (e.g., 15% or 25%). The appreciation ends when this difference hits a second threshold associated with the existence of no appreciation. We define this second threshold as 5%. In order to control for data blips, an episode has to be sustained for more than 2 consecutive months to classify as such.

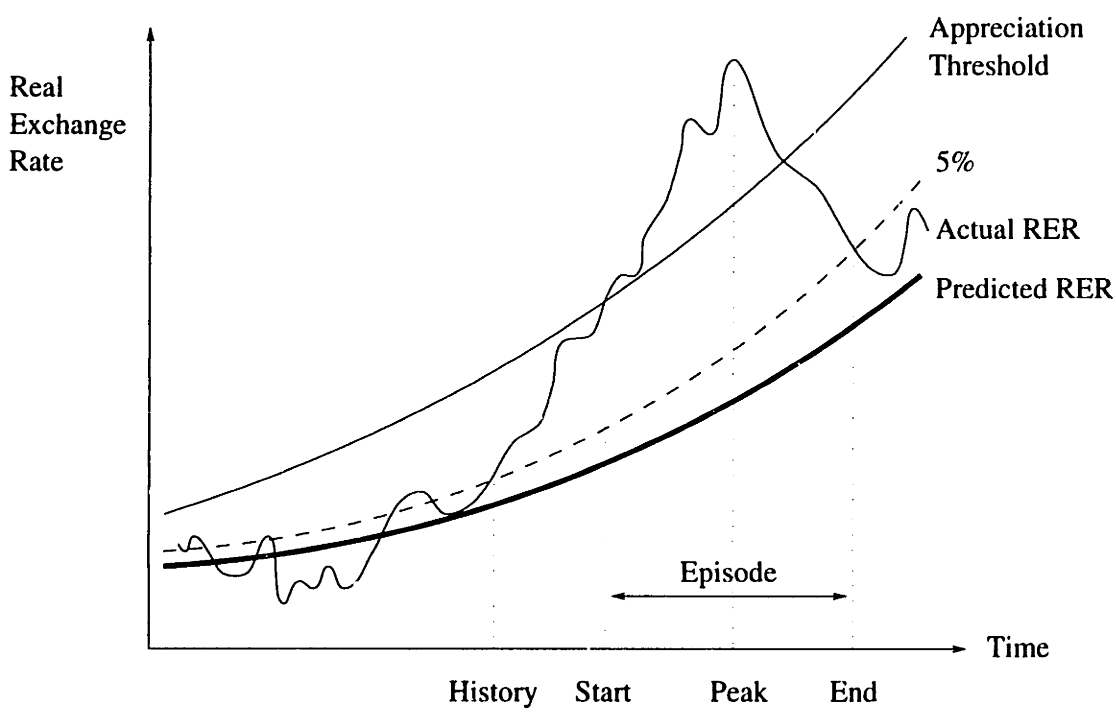

Figure 4-2: Appreciation Episode Definition and Phases

We define four notable points: (i) *Start*, when the appreciation hits the threshold, (ii) *End*, when the appreciation disappears —i.e., the RER hits the 5% benchmark, (iii) *Peak*, when the appreciation is the highest, and (iv) *History*, when the appreciation first reached 5%. An appreciation episode is then defined as the Start-End period.

There are also two phases: History-Peak, representing the build-up problem and Peak-End, representing the return to a "normal" level.[15]

4.2.3 Data Description

The initial sample is given by monthly data of 93 countries during the period 1960–1994 (39,060 observations). Because of missing values the actual sample size of RER is equivalent to 86.1% of the potential sample (when we include fundamentals the actual sample size falls to 73.6% of the potential sample size). The initial sample is composed of countries in the Summers and Heston database with more than 1 million people in 1985, with monthly price data from the International Financial Statistics (IFS), and with origin-destination trade data from the United Nations' *Yearbook of Trade Statistics.* The list of countries is presented in appendix B.3.

We construct the multilateral RER for each country as a trade-weighted average of bilateral RER's with those trading partners encompassing 4% or more of trade (in either exports or imports). The weights are fixed and represent the trade flows of 1985, or the closest year for which data is available. They are presented in appendix B.4.[16]

In order to minimize the effect of movements in nontradables prices, we construct our empirical measure of RER using WPI when possible. Consumer price indices may contain a large proportion of nontraded final goods in their index that have little effect on competitiveness. It is not surprising, then, that it is easier to reject the random walk hypothesis when WPI are used in PPP tests. When countries do not have a reliable WPI series we use CPI. This is the case with some developing

[15]The phases add-up to more than an episode because the latter does not include the build-up to the appreciation threshold. In characterizing episodes, we are interested in what happens conditionally on being appreciated, not just in general.

[16]We checked for data errors in the original data using graphic methods. The price series of El Salvador for 1977 was geometrically interpolated from December 1976 and January 1978 because it shows a break in 1978 (the IFS flags the series as having a break and it shows deflation of 21% in 1 month). Missing values of price data of Ghana (Apr.'81–Jan.'82), Iran (Jul.'86–Mar.'89), and Kuwait (Jan.'84–Dec.'84) were also interpolated.

countries (see appendix B.3 for a complete list). Since these countries tend to have also a higher inflation than the average, we are confident that even these cases have a mean-reversion process.

One caveat regarding our RER construction is that some WPI's may have a large component of an imported intermediate good that is not produced at home. This implies that for some countries the WPI may not be a good proxy for their price level and competitiveness. Although we do not control for these cases and, therefore, we may not detect some appreciation cases, this should not bias our results regarding how the RER returns to equilibrium.

In order to analyze the role of the nominal exchange rate and inflation differentials in the return-to-normal phase of the RER one needs a nominal exchange rate index for each month and country. We construct this index using the exchange arrangement description of the IMF annual report *Exchange Arrangements and Exchange Restrictions.* The report presents for each country a summary of the exchange arrangement status as of December of each year and a chronology of changes during that same year. We use this information to construct a monthly exchange arrangements database describing the principal features of the arrangements. Appendix B.2 presents a description of the coding and summary statistics describing the arrangements. With this data on hand we construct a nominal index for each month and country. When the arrangement is a peg we use the respective nominal exchange rate; when the arrangement is an unknown basket we usually use the nominal exchange rate with respect to SDR (in some cases we use the last peg); when the arrangement is floating we use the currency used in the last peg that was in place.[17]

The data for the construction of fundamentals has annual frequency and the sources are the following: Terms of Trade are from the World Bank Tables completed with unit import and export prices from the IFS for 1960–64 and 1993–94. Openness (the ratio of exports plus imports to GDP) and government spending (as

[17]We classify target zones with a width less than 7% as pegs. We classify crawling pegs, managed floating, and periodic adjustable pegs as flexible arrangements and use the underlying nominal exchange rate for our index.

percentage of GDP) are from the Summers and Heston database, completed with the World Bank's *Development Report* data for 1993–94 when possible.

4.3 Characterizing Appreciations

This section presents several features of the episodes in our sample. In particular, we analyze the number of appreciation cases that exist under different definitions, their duration, temporal distribution and exchange rate characteristics. The main conclusions can be summarized as follows: First, the most striking result is the large asymmetry between the duration of the appreciation build-up and the return-to-normality phases. Second, we present evidence that fixed arrangements are more likely to suffer appreciations. Third, we show that appreciation episodes happen more often during the last part of our sample period (1980-94). Finally, we also show that episodes are notably shorter when fundamentals are considered.

4.3.1 Number of Appreciations

The number of appreciations episodes that exist in our sample depends on both the cutoff that defines appreciations (the threshold that defines the start date in figure 4-2) and the method we use in defining the "equilibrium" RER (the RER^{pr} in equations (4.3) or (4.5)). Table 4.1 presents these results.

Table 4.1: Number of Appreciation Episodes

Apprec. Cutoff	RER Estimate	
(percentage)	Trends Only	Fundamentals
15	173	158
20	111	91
25	71	56
30	52	34
35	36	20

As expected, the number of episodes declines with the appreciation cutoff (for example, there are only 36 and 20 cases that had an appreciation larger than 35%). Also, there are less cases when we take into consideration the effect of fundamentals in the equilibrium RER estimation. The methodology disregards some appreciations episodes that were previously detected because their actual RER movements are now considered equilibrium changes (given the movement of fundamentals).[18]

4.3.2 Duration

The average duration of appreciations depends on both the threshold that defines appreciations and whether fundamentals are considered. Moreover, duration is very different between the History-Peak and Peak-End phases. In what follows we will focus on 4 benchmark cases: appreciation thresholds of 15% and 25%, with and without controlling for fundamentals. Table 4.2 presents the statistics of average duration in months, including incomplete cases.

Table 4.2: Average Duration of Appreciations (Months)

	Entire Episode	History-Peak	Peak-End
Trends - 15%	22.2	19.5	11.1
Trends - 25%	22.8	26.8	11.1
Fundam. - 15%	11.2	10.2	6.8
Fundam. - 25%	8.5	12.3	4.6

The average duration of appreciations using only time trends to estimate the equilibrium is about 2 years. Using fundamentals, the average duration drops by approximately 1 year. This pattern of shorter duration when one takes into account fundamentals also holds in the History-Peak and Peak-End phases. Interestingly, the average duration of the Peak-End phase is approximately one half of the duration

[18]We also get some new episodes because of movements in fundamentals. We smoothed the predicted RER in order to minimize the number of "false" appreciation cases —the ones driven by excess movement of our equilibrium values. See section 4.2.1.

of the History-End period. Of course, behind this difference is the sudden return to equilibrium produced by nominal devaluations.

We also present the frequency histograms of duration of our benchmark cases. Figures 4-3 and 4-4 present the cases of entire episodes given an appreciation threshold of 15%, with and without considering fundamentals. Figures 4-5 and 4-6, on the other hand, present the histogram of the History-Peak and Peak-End phases duration with the same threshold. Figures B-1 to B-4 in appendix B.1 present the cases for an appreciation threshold of 25%. The same conclusions hold. Duration is highly asymmetric between the build-up and the come-back phases. The higher duration of the History-Peak phase spreads over all categories of duration lasting more than 4 months. This last conclusion is independent of the threshold and whether fundamentals are considered. Also, including fundamentals reduces the duration of the episodes (not only the average duration).

A final question regarding duration is what happens with incomplete cases, that is, cases that remained being an episode when the data of the respective country ended. If these cases had significantly longer durations than the complete episodes, there would be evidence that they are of a different nature, namely equilibrium appreciations (not picked-up by trends and fundamentals) that only in the long run would disappear. Table 4.3 shows the average duration (and number of episodes) of such cases. The main conclusion is that these durations are almost always *smaller* than the durations of complete cases.

Table 4.3: Average Duration of Incomplete Appreciations

	Episodes (number)	History-Peak	Peak-Incomplete
Trends - 15%	15.1 (16)	16.6	7.8
Trends - 25%	11.4 (5)	20.4	6.8
Fundam. - 15%	7.4 (8)	11.6	2.3
Fundam. - 25%	9.0 (3)	17.7	1.7

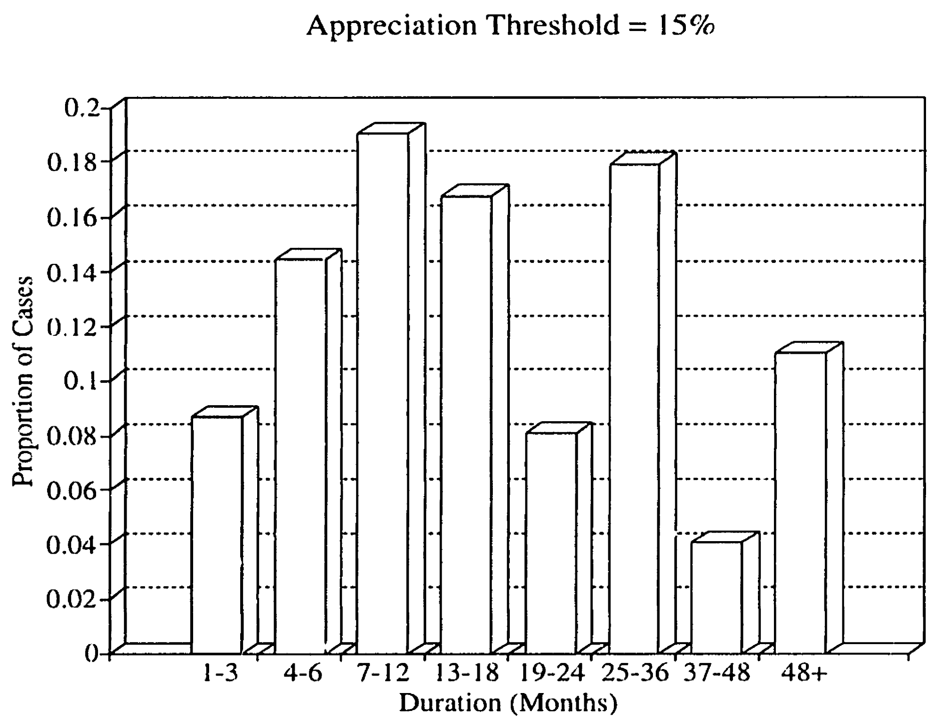

Figure 4-3: Histogram of Duration - Trends Only

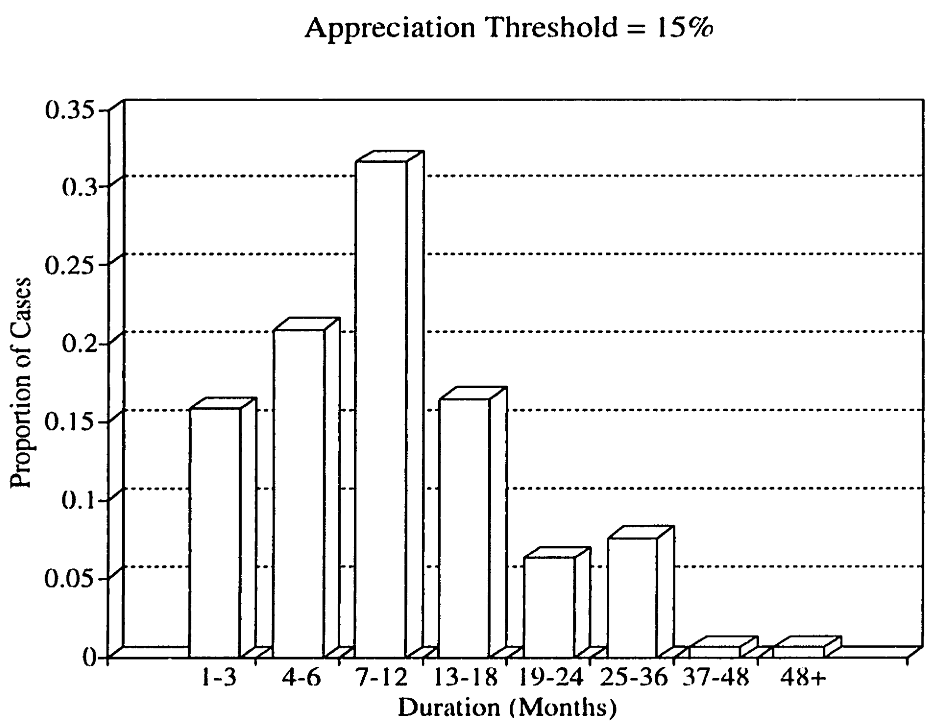

Figure 4-4: Histogram of Duration - Fundamentals

Appreciation Threshold = 15%

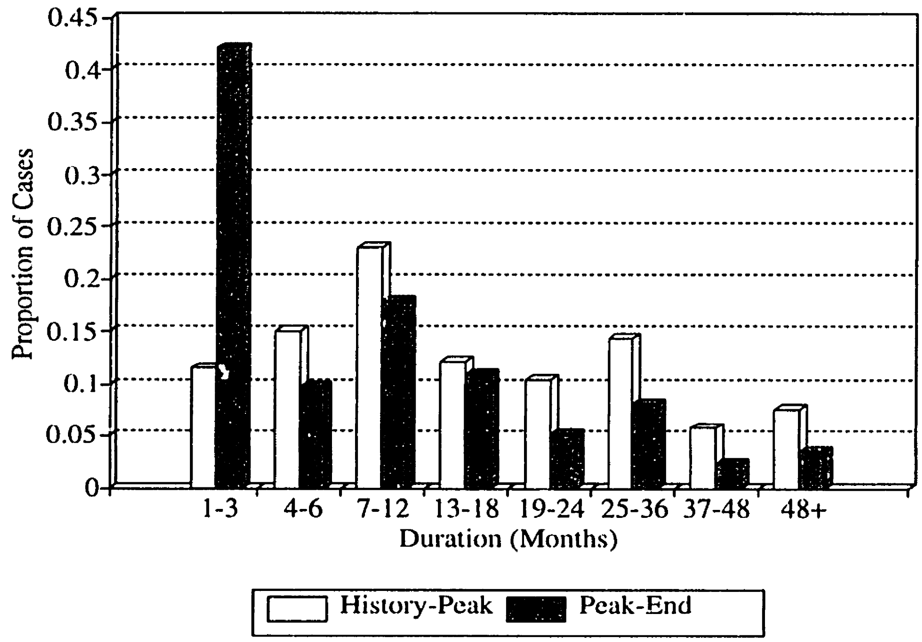

Figure 4-5: Phases Duration - Trends Only

Appreciation Threshold = 15%

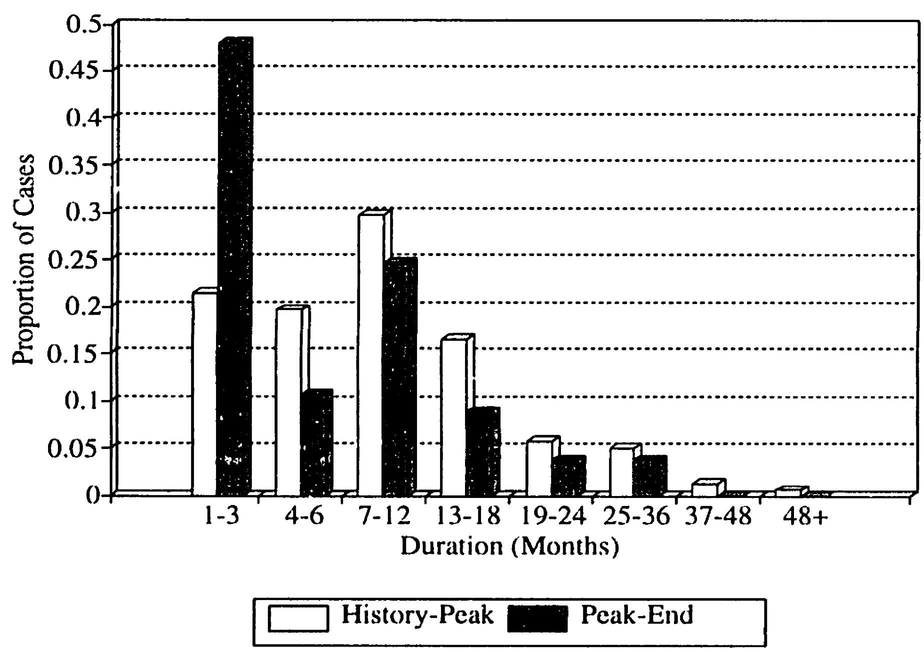

Figure 4-6: Phases Duration - Fundamentals

4.3.3 Temporal Distribution

Several structural changes in the world economy may have affected the temporal distribution of appreciation episodes. Among other factors, changes in inflation levels, capital mobility, and exchange arrangements may have produced bunching of cases during some periods.[19] The presumption is that the first two have raised the likelihood of appreciations during the second part of our sample, while the movement towards more flexible exchange regimes may have decreased it.

Because our panel data is unbalanced —some countries have more observations than others— the simple time path of number of cases is a misleading indicator of the temporal distribution of cases. Instead, we present the ratio of episodes to total countries in the sample with data grouped every 5 years. Cases are dated using the date of Start.[20] The results for the benchmark cases with an appreciation threshold of 15% is presented in figures 4-7 and 4-8. The cases with a threshold of 25% are presented in figures B-5 and B-6 in appendix B.1.

The graphs show that towards the second part of our sample the number of cases clearly increases. In fact, during the period 1980–94 there are at least twice as much cases as during 1960–75 (controlling for the number of potential episodes). The cases with RER's after controlling for fundamentals show an even more clear upward trend. Interestingly, when only trends are considered, there is a notorious bunching of episodes around 1980–85.

4.3.4 Exchange Arrangements

The overall trend of exchange arrangements is towards more flexible systems, although some countries have changed their systems back to fixed regimes. Appendix B.2 describes our characterization of exchange arrangements and presents summary statistics for our sample period.[21]

[19]See appendix B.2 for a description of exchange arrangements during our sample period.

[20]Notice that this ratio is not immune to composition effects. An example is given by developed countries having more data, and being less likely to suffer appreciations.

[21]Using a panel of annual data, Ghosh et al. (1995) study the impact of exchange arrangements on inflation and growth. They conclude that fixed regimes have less inflation and that the arrangement

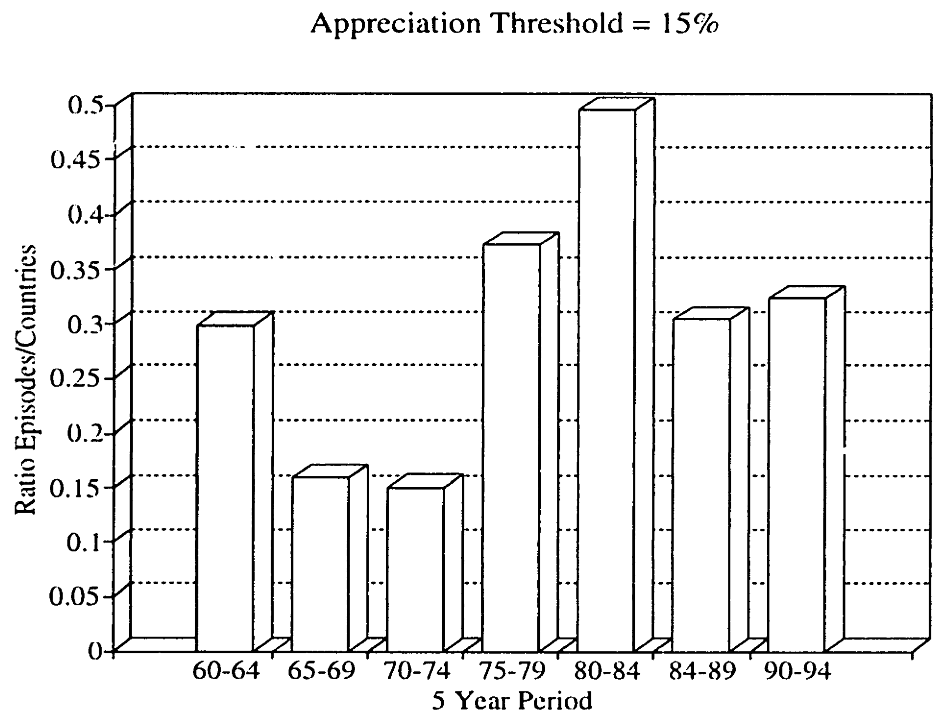

Figure 4-7: Temporal Distribution - Trends Only

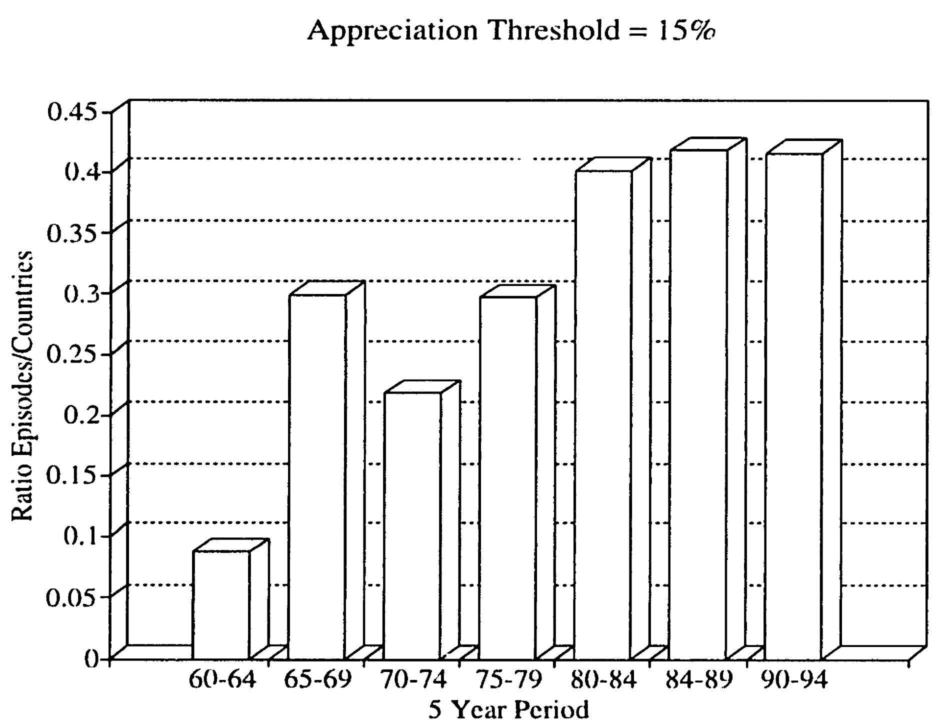

Figure 4-8: Temporal Distribution - Fundamentals

In order to evaluate whether appreciation episodes happen more often under specific exchange rate arrangements we compare the proportion of each type of arrangement during the episodes (more specifically during the History-Peak and Peak-end phases) with the proportion of each type observed in the total population.[22] Because of the trends issues discussed above, a total average would be misleading for the number of appreciations has increased over time and fixed exchange rate arrangements have declined. In order to control for this problem we compare the proportion of each type of arrangement of episodes grouped every 5 years with the population proportion during those same 5 years. We then calculate a weighted average of this indicator using the actual number of episodes that occurred during those same 5 years. The date of the episodes is assigned according to the Start date. Table 4.4 presents these results.

The results show that, as expected, fixed regimes are more likely to suffer appreciations. This effect is higher when larger appreciations are considered. Flexible regimes are less likely to suffer appreciations. These regimes include crawling pegs, adjustable bands, adjustable pegs to baskets, and managed floating. In terms of dual and multiple exchange rates, the results show that during appreciations episodes, countries have these arrangements at least twice as many as in normal times. This could be interpreted as implying that dual-multiple regimes have a higher probability of appreciating. However, in this case the reverse causality also exists. When an episode starts countries are more likely to put in place dual markets in order to improve the competitiveness of certain sectors.[23]

There are clear asymmetries in the exchange arrangements prevailing during the History-Peak and Peak-End phases. In particular, the proportion of fixed exchange rate arrangements is notably larger during the History-Peak period. The contrary happens with flexible and floating arrangements. This fact gives support to the

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is unrelated to growth.

[22]In cases in which episodes have more than one arrangement we calculate the episode's proportion of each arrangement according to the number of months each arrangement was in place.

[23]This effect also means that, in these cases, the nominal exchange rate used to calculate the real exchange rate loses its relevance.

Table 4.4: Exchange Arrangements of Appreciations
Proportion of Each Arrangement

		Trends 15%	Trends 25%	Fundam. 15%	Fundam. 25%
History-Peak Phase	Fixed	68.9	79.3	74.1	74.4
	Flexible	24.5	17.9	21.6	22.1
	Floating	6.6	2.8	4.4	3.4
	Dual-Mult.	32.3	40.1	37.0	54.8
Peak-End Phase	Fixed	63.1	71.9	68.6	65.7
	Flexible	29.2	24.4	25.0	26.9
	Floating	7.7	3.6	6.3	7.4
	Dual-Mult.	35.8	48.2	36.2	50.9
Total Population	Fixed	62.0	60.8	61.5	59.7
	Flexible	31.3	32.4	31.9	33.3
	Floating	6.7	6.8	6.7	7.0
	Dual-Mult	16.9	17.1	17.5	17.5

Average calculated every 5 years and weighted by the number of episodes every 5 years.
Number represents percentage of time of each arrangement.

notion that the return-to-equilibrium is more easily accomplished by flexible exchange regimes. These results hold independently of appreciation thresholds and whether fundamentals are included. Dual systems do not appear more likely during either phase.

4.4 Nominal Exchange Rate-Inflation Decomposition

One of the basic questions in this chapter is whether there are appreciation episodes that do not end in exchange rate collapses or large devaluations. More specifically, one can ask how do appreciation episodes end: Is the inflation differential —prompted by the loss of competitiveness— enough to return to the equilibrium RER? How much of the total work is done by the nominal exchange rate? In order to answer these questions we constructed a monthly nominal exchange rate index for each country. This index follows the movements of the pegs that a country may have, including changes in the currency to which the peg is established. In cases in which unknown baskets of currencies are the nominal target we use the nominal exchange rate with respect the SDR. In cases of flexible and floating regimes we use the price of the currency last used as a peg.

In order to decompose the real depreciation that occurs during the return to the equilibrium we calculate the total depreciation of the actual RER during the Peak-End phase, and the total nominal actual depreciation during that same period. *Successful* appreciations can then be defined as episodes that require less than a certain threshold in order to return to the equilibrium.[24] Letting Δ denote percentage change we have the identity:

$$\Delta E = \Delta \mathrm{Nom} + \Delta \left(P - P^{*} \right)$$

where Nom is the nominal exchange rate index and P and P^{*} the price indices. We can then calculate

$$S = 1 - \frac{\Delta \mathrm{Nom}}{\Delta \mathrm{E}}$$

as our successful index.

4.4.1 Detrended RER

Successful Index Distribution

A first issue to analyze is the distribution of our successful indicator S. Knowing this distribution will allow us to measure how sensitive the definition of successful is to the threshold for S. In particular, if very few cases are partially successful, the

[24] There is an important issue regarding appreciation cases that happen after a "structural" break in the equilibrium RER. Our methodology does not allow for such changes, so we count this break as an episode (that has an end). The key is that if this is the case, then the RER during the whole episode is not under any pressure and nominal devaluations should not occur. This biases our results towards observing successful cases.

threshold one chooses is not crucial.

Figures 4-9 and 4-10 present the histograms of the S indicator for our two benchmark cases using the first methodology (trends as the equilibrium concept). We observe a large mass of cases that are not successful at all —the nominal devaluation does more than all the work.[25] There is also some mass in totally successful cases —the inflation differential does all the work. There are few cases in which the appreciation was partially successful.

Finally, comparing figures 4-9 and 4-10, we observe that when larger appreciations are considered, there is less probability of success (for any S). There is less mass on or close to $S = 1$ in figure 4-10, where the threshold is 25%.

Searching For a Critical Cutoff

Knowing the distribution of S we can now search for the critical level of appreciation: the level at which a successful episode is very unlikely to happen. We define (arbitrarily) a successful appreciation when the nominal exchange rate does less than half of the work ($S > 0.5$). Since the mass of partially successful cases is small our conclusions do not critically depend on the successful definition. Figure 4-11 shows the probability of success for different appreciation levels. Here each episode is considered as one case, regardless of its duration. (In section 4.5 we explore in more detail the link between degree of appreciation, time, and the probability of success).

When appreciations of 25% or more are considered only 10% of the cases are successful —that is they devalue less than 50% of the observed real depreciation between Peak and End. This probability clearly decreases with the appreciation level. The conclusion is that for large appreciations, say 25% or more, it is unlikely to undo an appreciation without a devaluation; sooner or later a nominal exchange rate correction is required.

[25]Inflation differentials may have a negative contribution to the return. In this cases, nominal devaluations do *more* than all the work.

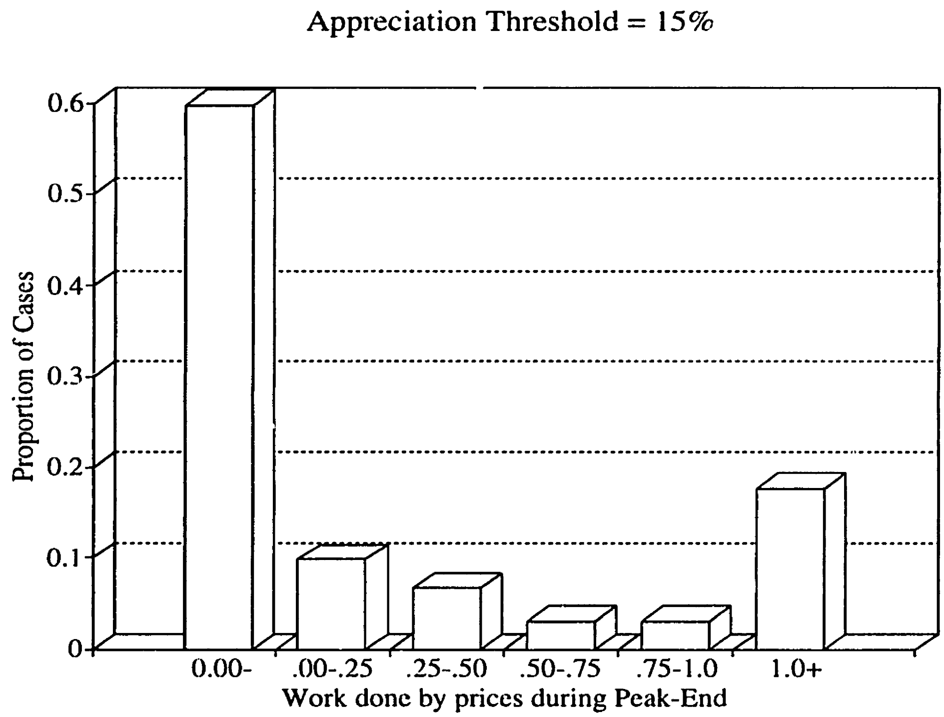

Figure 4-9: Histogram of Success - Trends Only (15%)

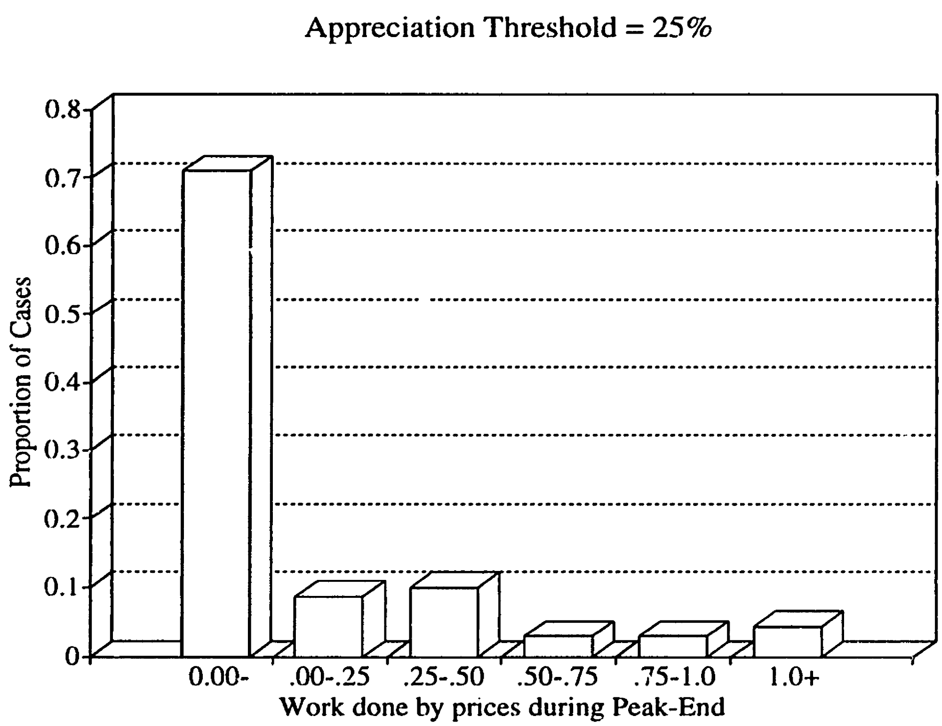

Figure 4-10: Histogram of Success - Trends Only (25%)

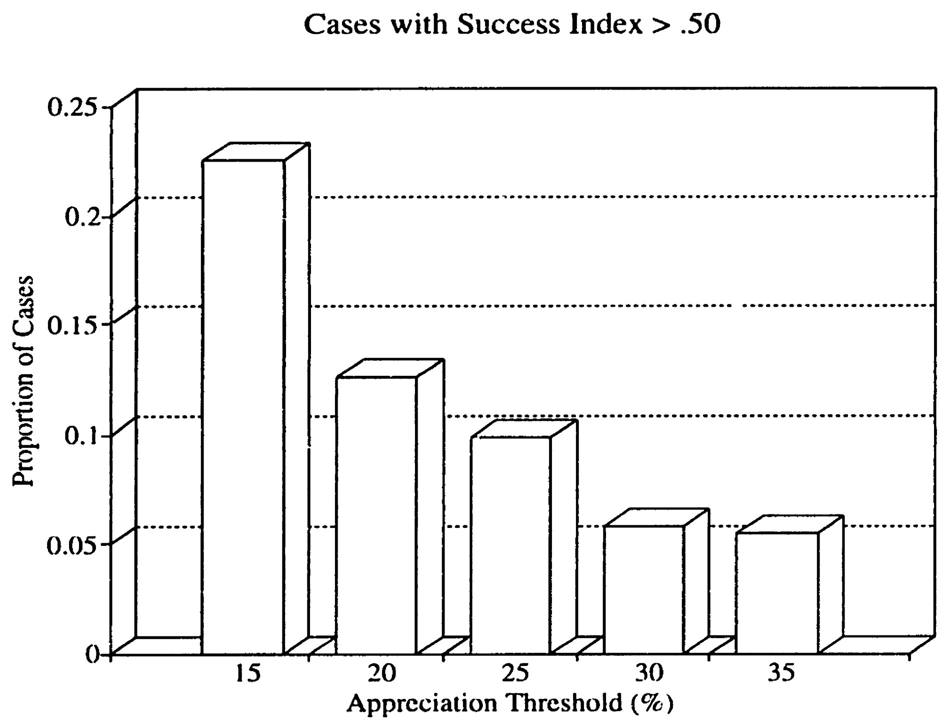

Figure 4-11: Probability of Successful Appreciation - Trends Only

Successful Episodes: Description

This subsection describes the appreciation episodes in which the nominal devaluation caused less than half of the total real depreciation, so they can be considered as relatively successful cases. The initial sample includes appreciations of 25% or more, with respect to the trend RER.

The list shows that these countries are not typical appreciation cases; if one considers medium and large size countries the probability of success is even smaller. Notably, almost all have fixed exchange arrangements. This does not mean that fixed arrangements should be kept in place, for the probability of success of these arrangements is small. The key policy recommendation is to avoid the appreciation in the first place (or at least weight its benefits with the high probability of future devaluation).

Finally, notice that a couple of successful episodes do not suffer an actual real appreciation during the build-up period or an actual real depreciation during the return-to-normality phase. Trends in the RER make these cases to be identified as

Table 4.5: Successful Appreciation Episodes

Country	Start-Date	Duration (months)	Actual Build-up	Actual Deprec.	Fixed X-Arr	Estimated Build-up
Paraguay	Oct.'77	5	22.6	32.3	1.0	25.1
Nepal	Oct.'72	2	22.1	36.5	1.0	27.0
Sri Lanka	Aug.'70	86	-9.7	196.0	0.7	37.3
Sri Lanka	Feb.'94	9	14.0	5.4	0.0	25.1
Burundi	Feb.'85	16	23.4	40.9	1.0	27.5
Ethiopia	Aug.'84	22	35.0	55.1	1.0	37.7
Nigeria	Jan.'60	45	–	-4.1	1.0	34.1

Success if $S > 0.50$ – Appreciation Threshold = 25%

appreciations under our definition.

4.4.2 RER and Fundamentals

If one repeats the exercise of the last section using the predicted RER calculated with fundamentals none of the conclusions change. Moreover, the conclusion regarding how difficult it is to undo appreciations without nominal devaluations is stronger: there are no experiences of successful episodes if appreciations of 35% or more are considered. Figures 4-12 to 4-13 show these results.

4.4.3 Conditional Probabilities

This subsection reports probabilities of successful appreciations conditional on different characteristics. Table 4.6 presents the results. First, during the second period of the sample, 1980–1994, the probability of successful appreciations is substantially lower than in the first period. Second, there is no apparent pattern relating successful appreciations with the duration of the episodes. Third, as expected, flexible and floating regimes are less prone to return to equilibrium through price changes.

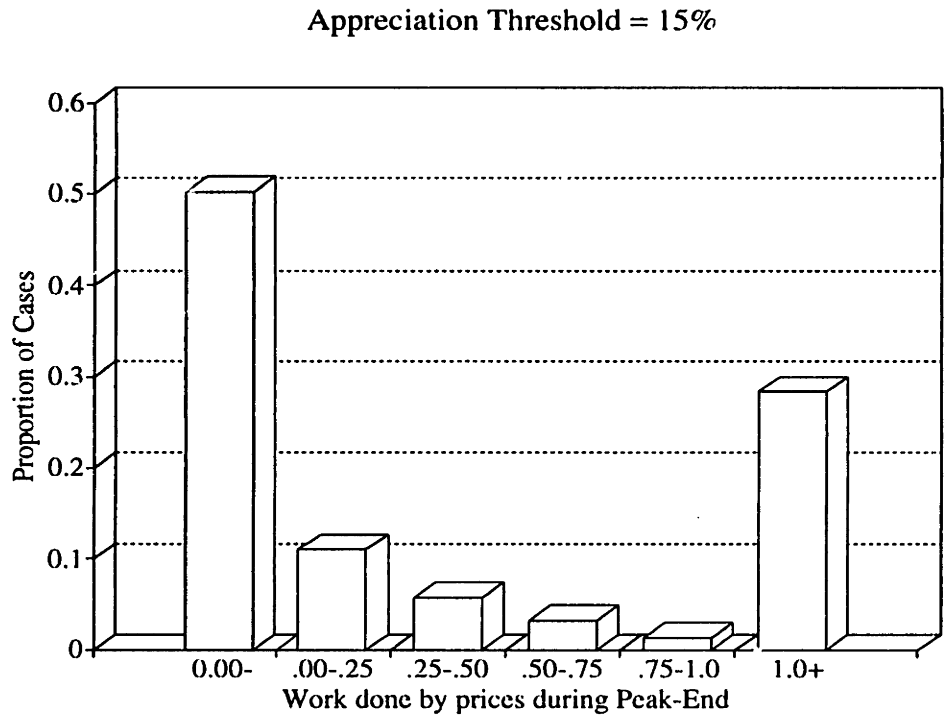

Figure 4-12: Histogram of Success - Fundamentals (15%)

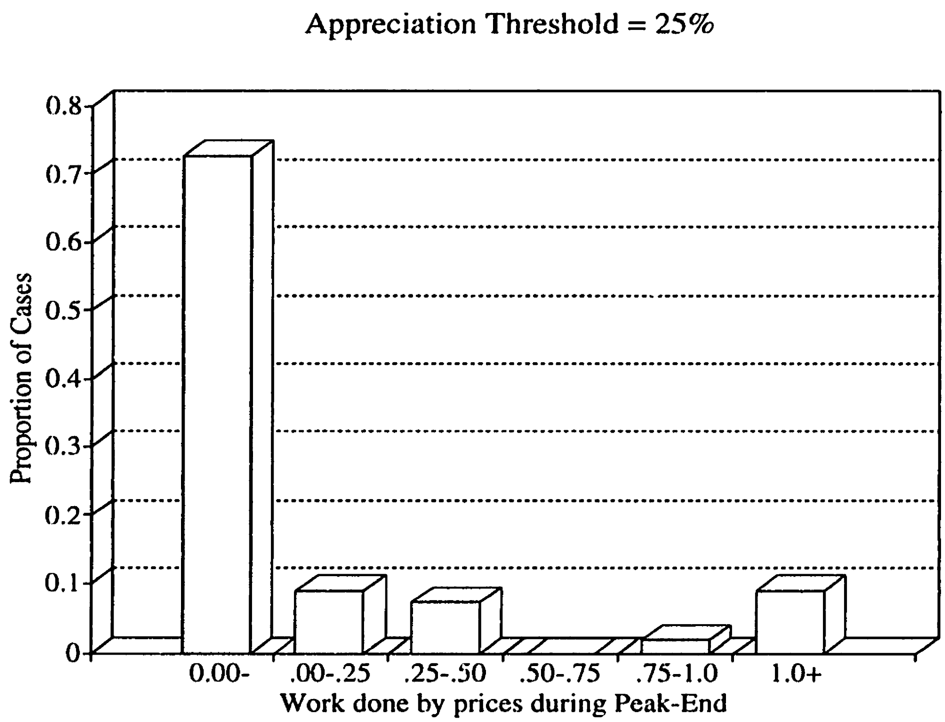

Figure 4-13: Histogram of Success - Fundamentals (25%)

Table 4.6: Probability of Success - Different Sampling (Percentage)

Trends Only				
Apprec. Threshold	Total Sample	Float and Flexible	Start after 1980	Long Duration
15	22.5	8.3	14.9	21.5
20	12.6	6.3	10.5	15.7
25	9.9	5.6	6.1	9.6
30	5.8	0.0	2.6	7.9
35	5.6	0.0	3.6	6.9

Fundamentals				
Apprec. Threshold	Total Sample	Float and Flexible	Start after 1980	Long Duration
15	32.3	2.2	16.8	38.0
20	24.2	3.8	13.6	33.3
25	10.7	0.0	5.3	16.0
30	2.9	0.0	3.8	5.6
35	0.0	0.0	0.0	0.0

Long duration = $End - Start > 6$ months.

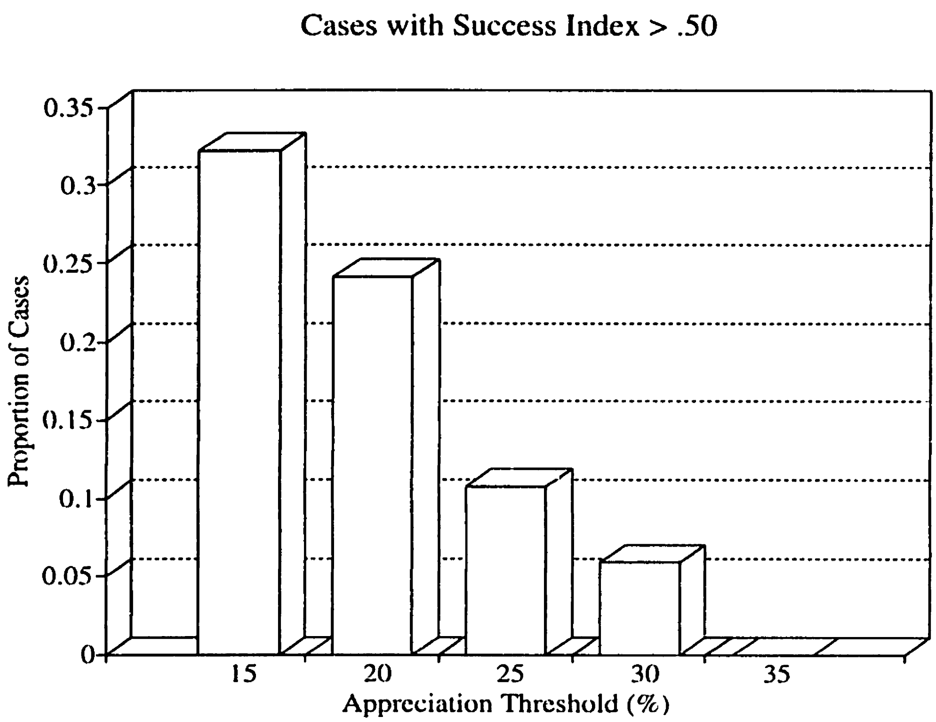

Figure 4-14: Probability of Successful Appreciation - Fundamentals

4.5 Degree of Overvaluation and Transition Matrices

One of the objectives of this study is to identify the probability of RER reversion in a certain period of time, for various levels of appreciation. In particular, we would like to test the assertion that the probability of returning to equilibrium is positively correlated to the degree of appreciation.

We constructed *transition matrices* for our appreciation cases. The matrices show the probability of reaching a specific exchange rate value conditional on a given degree of appreciation. The overall sample is the exchange rate values of the appreciation episodes, defined using the benchmark cutoff of 15%. Therefore, the matrices show the conditional probability of reaching a specific exchange rate value *once a country has surpassed 15% appreciation in the past.*

Table 4.5 presents the results for the case of trend RER. There are two points to highlight from the table. First, there is a high degree of inertia in RER's. All the diagonal terms (shadowed for contrast) show substantially higher probabilities.[26] In part, this is a consequence of the relatively short transition time shown: 6 and 12 months. In fact, the transition table for 24 months (shown in appendix B.1) shows lower inertia, although we still observe higher probabilities along the diagonal.

Second, once high degrees of appreciation are achieved (for instance, 30% in table 4.5), there is a low probability of moving to a slightly lower appreciation degree (in this case 0.05 to reach 20–25%), but a high probability of reversing the whole appreciation (0.24 to reach a value lower than 5%). This result shows that smooth returns are highly improbable in large appreciation cases and get more unlikely as the appreciation deepens.

Figure 4-15 plots the probability of returning to an appreciation of less than 5% for several levels of appreciation. It plots the last column of the transition matrices described above (for 6 and 12 months), but also other transition times as 1, 3, 24 and 48 months. As expected, the longer the period considered, the higher the probability of return. With 48 months, for example, the probability of return ranges from 80 to 96%. This confirms the latest PPP mean-reversion results in the literature.

The more interesting and relevant result is the U-shaped curve obtained for the probability figures. It shows that there is a threshold where increasing the level of appreciation implies a higher probability of return. The reason for the nonlinearity is the existence of a trade-off between *distance* and *pressure* factors. Since each curve in figure 15 is plotted fixing the time period available to return, it is reasonable to expect that small appreciations and, therefore, with shorter distances to cover, have a higher probability of return. This is the *distance* factor and is reflected by the downward slope part of the curves. On the other hand, as the degree of appreciation deepens there are pressures that make the RER return to the equilibrium (as defined above) which will tend to increase the probability of return. Figure 15 shows that the pressures to return start to dominate when the appreciation reaches 20–25%.

The concern with appreciation episodes is not so much whether they will revert

[26]There is a substantial larger mass in the diagonal term of appreciations of equal or higher than 30%. However, there is also more support in this area.

Table 4.7: Transition Matrices of Appreciations - 6 and 12 Months

Detrended RER
Appreciation Threshold = 15%

6 Months Matrix

RER Appreciation in t+6 months

	30+	30-25	25-20	20-15	15-10	10-5	5-
30+	**0.58**	0.07	0.05	0.02	0.02	0.01	0.24
30-25	0.23	**0.29**	0.18	0.07	0.02	0.01	0.19
25-20	0.08	0.22	**0.26**	0.12	0.08	0.03	0.20
20-15	0.02	0.03	0.20	**0.25**	0.20	0.10	0.18
15-10	0.00	0.01	0.04	0.17	**0.27**	0.24	0.26
10-5	0.00	0.01	0.01	0.06	0.16	**0.26**	0.50

12 Months Matrix

RER Appreciation in t+12 months

	30+	30-25	25-20	20-15	15-10	10-5	5-
30+	**0.39**	0.06	0.04	0.03	0.03	0.01	0.44
30-25	0.22	**0.15**	0.11	0.08	0.05	0.02	0.36
25-20	0.10	0.16	**0.19**	0.10	0.07	0.05	0.34
20-15	0.04	0.07	0.14	**0.12**	0.16	0.12	0.36
15-10	0.01	0.01	0.04	0.13	**0.18**	0.18	0.44
10-5	0.01	0.00	0.03	0.03	0.09	**0.10**	0.74

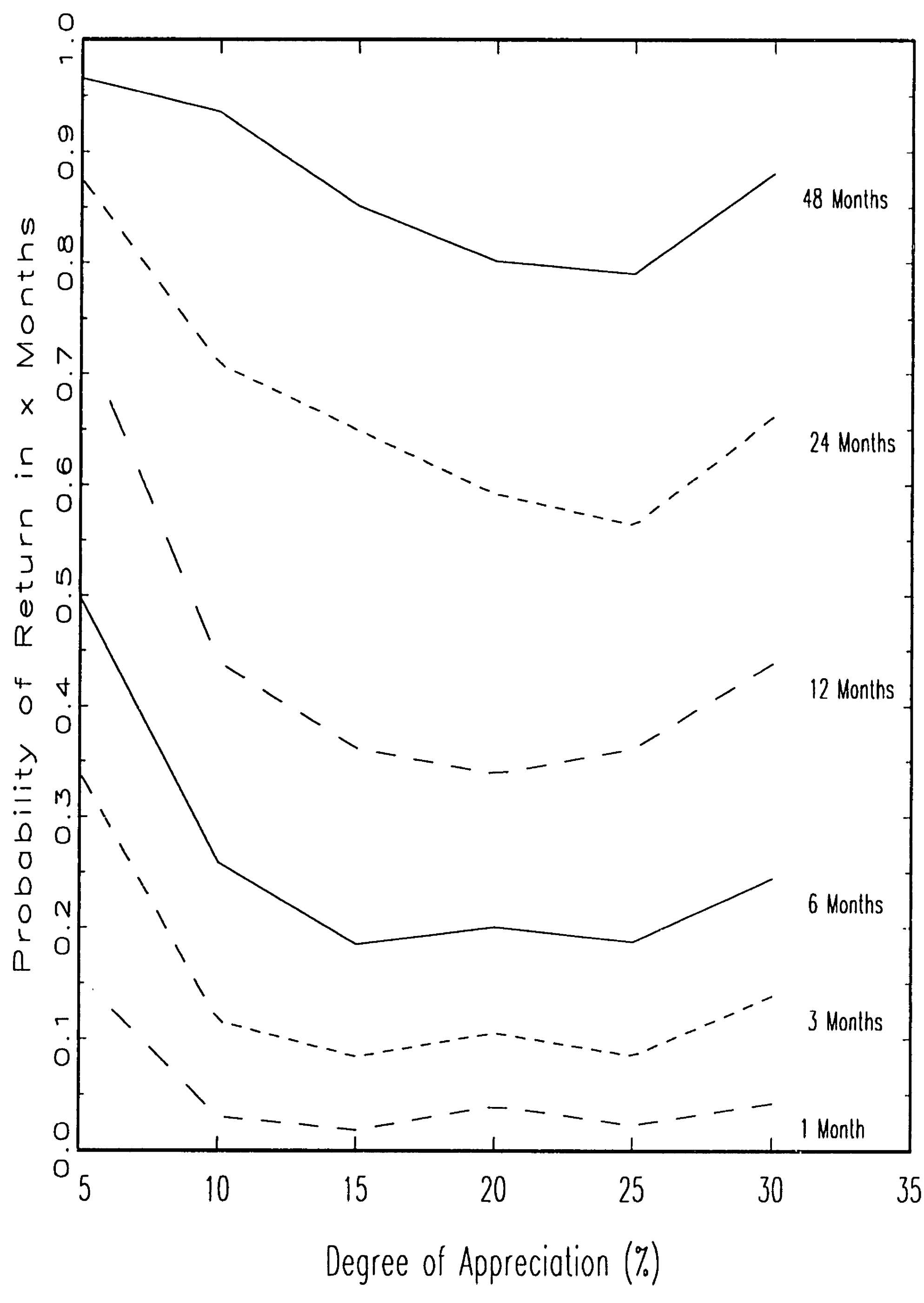

Figure 4-15: Degree of Appreciation and Probability of Return - Trends Only

but rather how this reversion will occur. In particular, the question is whether the reversion will occur through a collapse in the nominal exchange rate as opposed to a smooth reversion. Figure 4-16 plots the probability of a *collapse*, defined as a return with more than 95% of the total real depreciation caused by nominal devaluation, as opposed to inflation differentials ($S \leq 0.05$ in terms of the success index). It is clear that the probability of a collapse is an increasing function of the degree of appreciation.[27] The magnitudes are important also. Taking 24 months as a benchmark, the probability of collapse increases from 0.36 to 0.57 when the degree of appreciation increases from 10% to 30%. Since we are focusing on the probability of collapse and not the broader probability of return, figure 16 in fact isolates the *pressure* from the *distance* effect (the shorter distance implies that the probability of return from a 5% appreciation is high but not that the corresponding probability of collapse is higher). Therefore, figure 4-16 in general does not show U-shaped curves.

We repeat the exercise using the episodes obtained from the second definition of equilibrium RER (controlling for fundamentals). The transition matrices shown in table 4.8 and the probabilities plotted in figures 4-17 and 4-18 are very similar to the ones described above. There are minor differences between figures 4-17 and 4-18 and the corresponding 4-15 and 4-16. First, the U-shaped curves are more pronounced when we control for fundamentals. Also, since the overall duration of the episodes when we control for fundamentals is shorter (see description in the previous section), the 24 month schedule does not have a U-shaped form (the probability of reversal is close to 1 for any degree of appreciation). Figure 4-18 shows an even steeper slope for the probability of collapse as a function of the degree of appreciation (see the 24 and 48 month schedules).

Subsampling We calculated the previous transition matrices and probability of collapse using specific subsamples of our data. First, we divided our sample between 1960–79 and 1980–94. There are no significant differences between the two sub-

[27] Here each month of an episode corresponds to an observation. Before, in subsection 4.4.1, each episode was an observation.

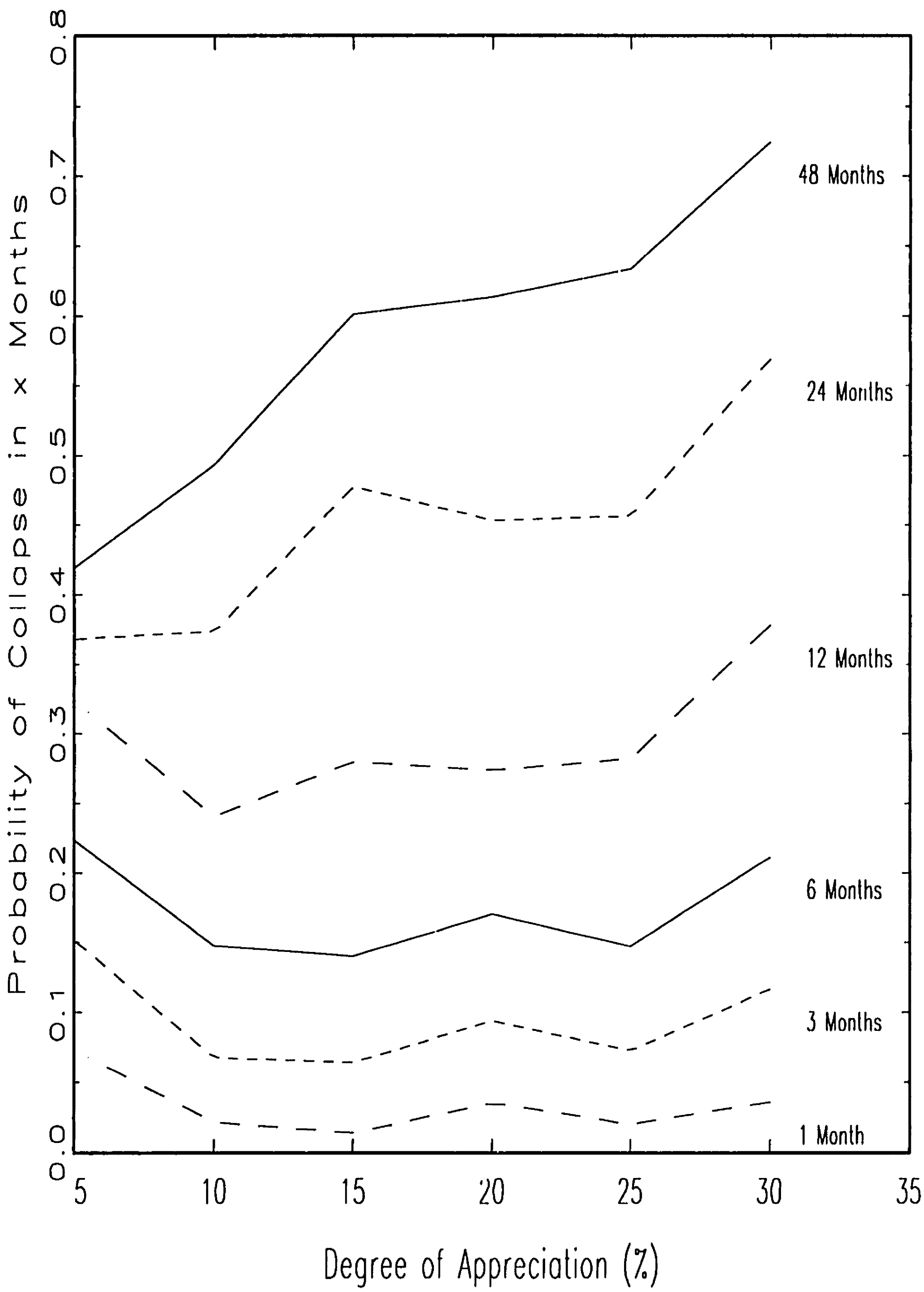

Figure 4-16: Degree of Appreciation and Probability of Collapse - Trends Only

Table 4.8: Transition Matrices of Appreciations - 6 and 12 Months

RER After Fundamentals
Appreciation Threshold = 15%

6 Months Matrix

RER Appreciation in t+6 months

	30+	30-25	25-20	20-15	15-10	10-5	5-
30+	0.26	0.04	0.05	0.03	0.03	0.00	0.60
30-25	0.10	0.06	0.07	0.07	0.13	0.03	0.54
25-20	0.13	0.08	0.07	0.12	0.12	0.10	0.40
20-15	0.05	0.04	0.09	0.14	0.18	0.15	0.34
15-10	0.01	0.01	0.02	0.07	0.24	0.23	0.42
10-5	0.00	0.00	0.01	0.03	0.10	0.21	0.65

12 Months Matrix

RER Appreciation in t+12 months

	30+	30-25	25-20	20-15	15-10	10-5	5-
30+	0.08	0.04	0.04	0.02	0.03	0.01	0.80
30-25	0.06	0.00	0.00	0.03	0.04	0.03	0.84
25-20	0.04	0.01	0.02	0.06	0.07	0.06	0.73
20-15	0.03	0.01	0.04	0.05	0.13	0.12	0.63
15-10	0.02	0.01	0.02	0.03	0.11	0.16	0.66
10-5	0.02	0.01	0.01	0.03	0.01	0.03	0.90

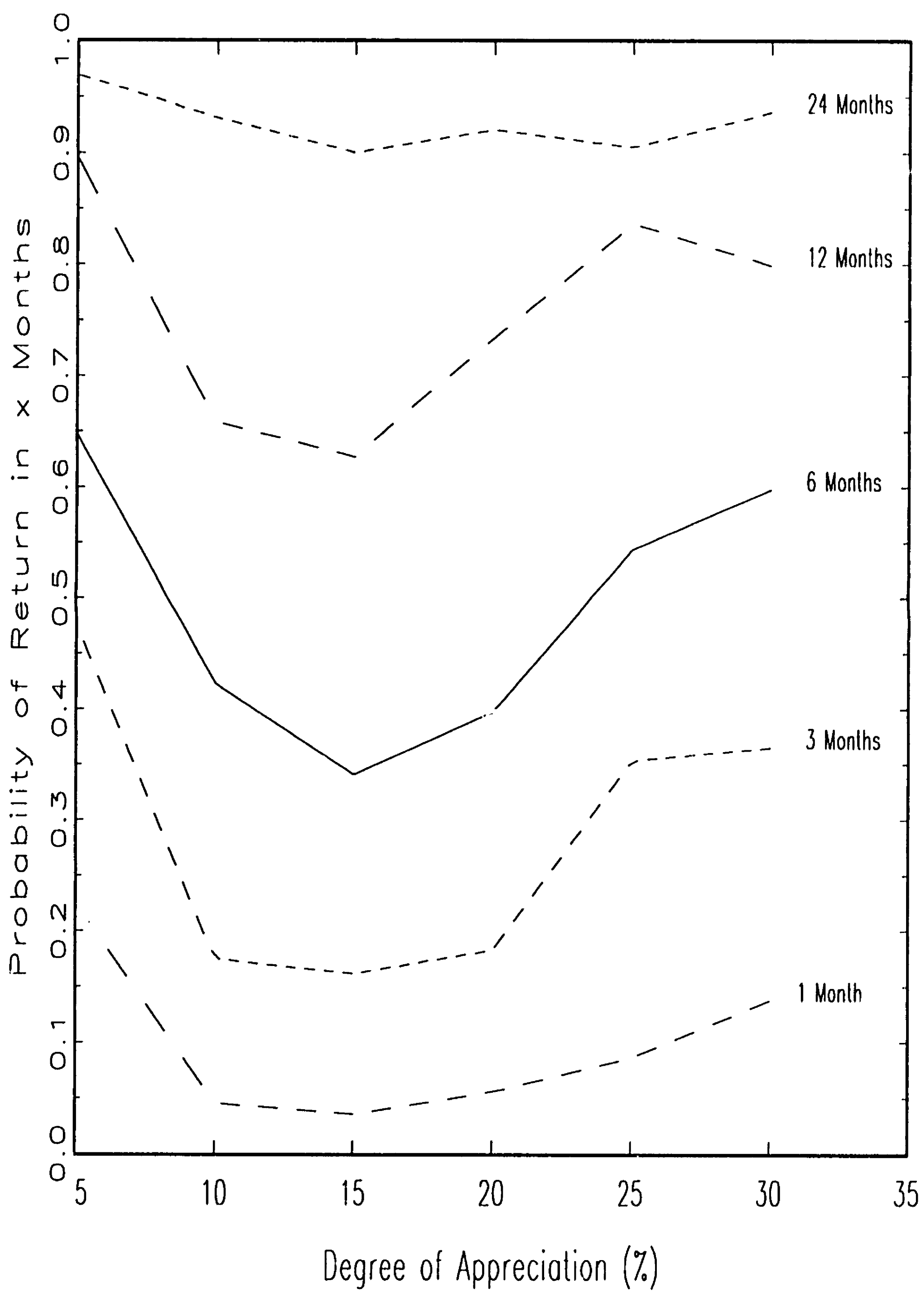

Figure 4-17: Degree of Appreciation and Probability of Return - Fundamentals

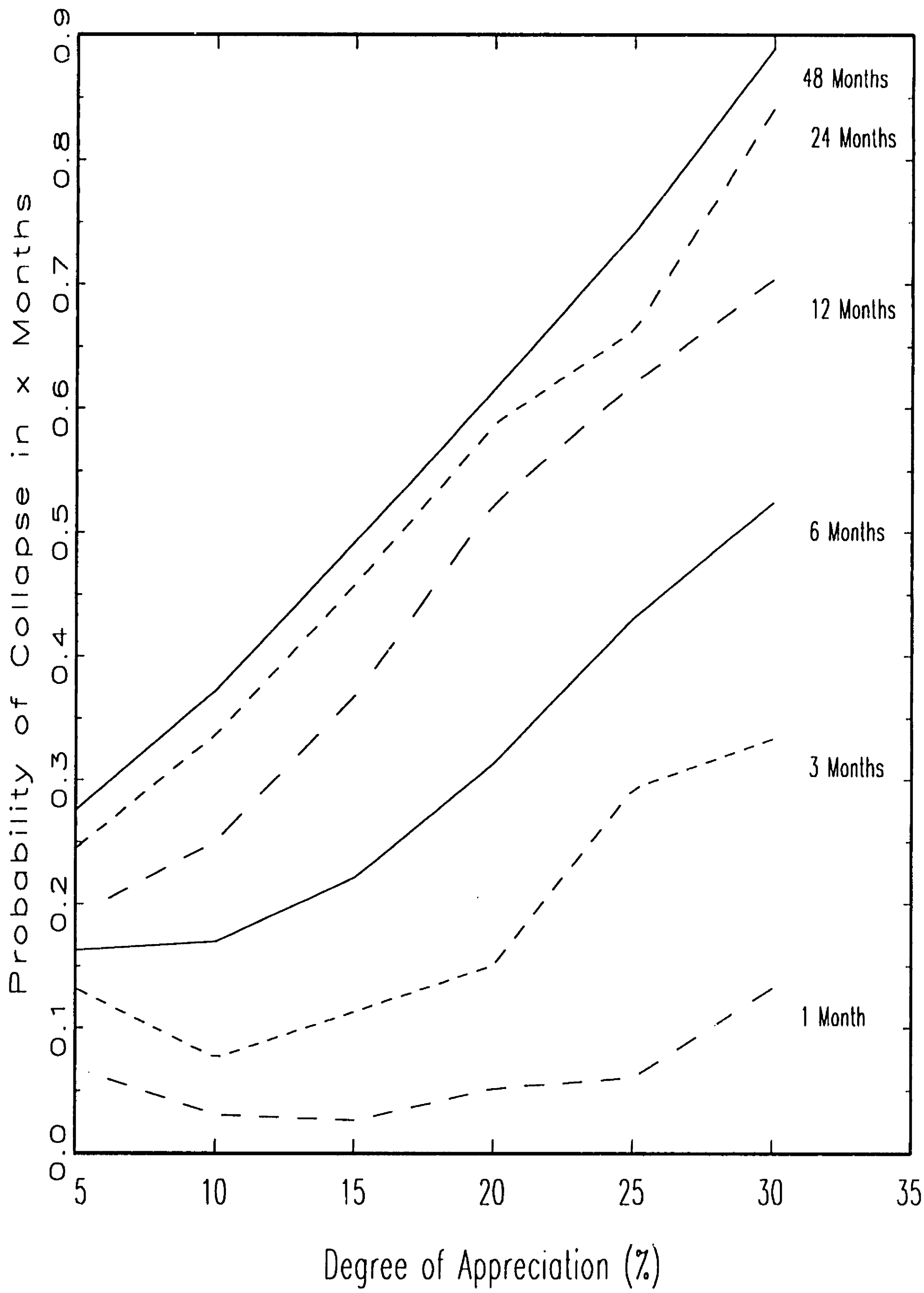

Figure 4-18: Degree of Appreciation and Probability of Collapse - Fundamentals

periods. Second, we divided our sample between fixed and flexible regimes (the latter including a few cases of floating regimes). As expected, most of the results are driven by fixed exchange regime episodes. Flexible regime overvaluation episodes do not reproduce the steep upward sloping feature for the probability of collapse (as in figure 4-16).

4.6 Conclusions

After the European and Mexican exchange rate crises during the fist half of the 90's, several studies have advanced the hypothesis that the level of the real exchange rate is important in explaining future devaluations and collapses.[28] This essay calculates the probability of devaluation for various levels of real exchange rate looking at a sample of 93 countries and tries to identify all the appreciation episodes during the last 35 years (1960–1994).

The results show that it is relatively unlikely to smoothly undo appreciations greater than 25%. In our sample, only 10% of the cases had a devaluation and collapse-free return. This probability falls as we concentrate in even more appreciated cases. There are no successful cases for appreciations larger than 35%.[29]

The chapter also presents transition matrices for the appreciation episodes. They show inertia in the real exchange rate for short periods of time: the RER tends to stay overvalued and at relatively the same level for 3 to 6 months. More importantly, they also show that, in a given period of time, it is much more probable to undo *completely* the appreciation than to return the long-run equilibrium value only partially. This suggests that appreciations end abruptly and do not have a smooth return, at least in very appreciated cases. The transition matrices also focus on the probability of collapse (excluding small and medium nominal devaluations). Taking a 24 month horizon as a benchmark, the probability of collapse increases from 0.36 to 0.57 when the degree of appreciation increases from 10% to 30%.

[28] See references in section 4.1.

[29] The benchmark here is cases chosen with an appreciation threshold of 25% controlling for fundamentals.

As a by-product the chapter also characterizes the appreciation cases. We show that appreciations have a longer duration in the build-up than in the return phase and are more likely to occur in fixed exchange regimes and during the last part of our sample period, in particular in the early 80's.

Appendix A

Further Results and Data used in Chapter 3

A.1 Further Results

A.1.1 Stock Market Correlations

This appendix presents the correlations of monthly returns of stock markets for some Latin American countries. The correlations are calculated using country indices known as the *General Index*, without controlling for the effect of fundamentals. If the *Investable Index* is used instead the conclusions do not change. Interestingly, the pairwise correlations are not significantly from zero in all cases but one (Mexico-Argentina). Moreover, the groupwise correlation is not significantly different from zero: the hypothesis that the correlation matrix is identical to the identity matrix cannot be rejected. Controlling for fundamentals, e.g. an external stock index such as the SP 500, will most likely decrease the correlations even more. One potential explanation for the low correlation is country-specific noise. The test loses power in that case.

Table A.1: Stock Returns Correlation Matrix
December 1990 — December 1994

	ARG	BRA	CHL	COL	MEX
BRA	0.10				
CHL	0.20	0.23			
COL	0.02	0.17	-0.13		
MEX	0.36	0.21	0.27	0.01	
VEN	0.14	-0.05	-0.12	0.18	-0.05
LR test for identity matrix = 21.59 [$\chi^2(15)$]					

Source: International Finance Corporation.

Correlations are of the General Index.

95% pairwise correlation critical value = .290

95% critical value for identity matrix = 25.00

A.1.2 Capital Flows and Credit Ratings

This appendix presents empirical evidence that the markets' risk assesment —proxied here by credit ratings— is indeed an important determinant of capital flows to emerging markets. Because of data availability I only analyze flows to Argentina, Brazil, and Mexico. I use semi-annual data from 1979 to 1994 (that is 31 data points). Flows are measured in US$ millions of 1990 and constructed from quarterly data as the sum of the result of the capital account of the balance of payments and erros and omissions. I also control for the effect of international interest rates using the semi-annual average of the 6-months Libor in US$. Table A.2 presents the estimation using OLS and MLE with AR(1) correction.

Table A.2: Capital Flows and Credit Ratings
(Dependent Variable: Capital Flows)

	ARG	BRA*	MEX*
Constant	693.7	-9988.8	106.3
	(853.8)	(4529)	(5045.4)
Credit Rating	155.2	342.6	253.1
	(29.8)	(130.7)	(132.0)
Libor	-586.7	-326.9	-925.9
	(108.9)	(315.6)	(452.4)
$\bar{R}^2$	.51	.52	.30
D.W. ($\hat{\rho}$ if AR(1))	1.95	.55	.31

(*): MLE with AR(1) correction.
Standard errors in parenthesis.

In all three countries the credit rating coefficient is significant in explaining capital flows. For Brazil, the interest rate coefficient is not significantly different from zero. Considering that the standard deviations of the ratings are 14.9 for Argentina, 11.0 for Brazil, and 14.7 for Mexico, and the one of Libor is 4.1, the predicted variation explained by ratings alone is as important as the one explained by the interest rate in the cases of Argentina and Mexico, and more important in the case of Brazil.

A.1.3 Information Events and Regressions

This appendix describes the "big news" events I consider in subsection 2.3.2 and presents the results of the debt price regressions taking into account these events.

The events and their respective dates are:

1. Brazil moratorium declaration in February of 1987. Negative impact during the period February-April, 1987.

2. Citibank announcement of a "Loan Loss Reserve" for Latin American debt. Negative impact during June-October, 1987.

3. Riots in Venezuela as a result of tough economic measures in February, 1989.

4. Announcement of the Brady Plan in March, 1989.

5. Mexico's agreement "in principle" for a Brady plan of debt reduction. July, 1989.

6. Venezuela's negotiation of a Brady debt reduction plan in 1990. Positive impact during the period March-June, 1990.

7. Brazil's negotiation of a Brady debt reduction plan in 1992. Although announced in August, 1992, the positive spell occurred during the period March-May, 1992.

8. Argentina's negotiation of a Brady deal in 1992. Positive impact during March-June, 1992.

Table A.3: Event Dummies Regressions
(Dependant Variable: First Difference of log of Debt Prices)

	ARG	BRA	CHL	ECU	MEX	PER	VEN
BRA Moratorium	-0.35	—	-0.54	-0.57	-0.12	-0.29	-0.31
	(1.55)	—	(0.54)	(1.59)	(0.76)	(2.74)	(1.05)
Citibank	-0.33	-0.80	-0.46	-0.48	-0.55	-1.01	-0.43
	(0.45)	(0.51)	(0.16)	(0.47)	(0.24)	(0.81)	(0.31)
Riots in VEN	0.14	1.21	-0.54	-0.43	0.88	-0.16	—
	(0.91)	(1.01)	(0.33)	(0.99)	(0.44)	(1.75)	—
Brady Plan	0.02	-1.61	-0.39	0.39	-1.27	-1.80	-0.48
	(0.94)	(1.04)	(0.32)	(0.95)	(0.44)	(1.61)	(0.52)
MEX Agreement	2.00	1.87	-0.11	0.53	—	0.18	0.88
	(1.14)	(1.09)	(0.36)	(1.04)	—	(1.76)	(0.56)
VEN Negotiation	-0.07	-0.14	0.17	-0.37	-0.19	-0.11	—
	(0.52)	(0.61)	(0.18)	(0.54)	(0.25)	(1.02)	—
BRA Negotiation	-0.32	—	0.12	1.99	0.36	3.53	0.44
	(0.52)	—	(0.39)	(1.21)	(0.55)	(2.01)	(0.62)
ARG Negotiation	—	-0.55	0.01	-2.03	-0.34	-2.57	0.00
	—	(0.64)	(0.04)	(1.35)	(0.60)	(2.24)	(0.70)
R^2	0.36	0.19	0.20	0.25	0.25	0.18	0.33
D.W. ($\hat{\rho}$)	2.03	1.97	1.90	1.78	1.85	1.83	(0.25)

See text for explanations. Standard errors in parenthesis.
Estimation controlling for fundamentals. All coeficients $\div 10$.

A.1.4 Positive and Negative Contagion Regressions

This appendix presents the results of pairwise regressions of debt price change residuals (after fundamentals) using an interactive dummy variable for positive residuals.

Table A.4: Positive-Negative Contagion Regressions
(Dependent Variable: Return after Fundamentals)

	Const.	$\hat{p}_i$	$\hat{p}_i \times 1_{[\hat{p}_i>0]}$	$\bar{R}^2$	D.W.
BRA-ARG	0.18	0.75	5.79	.11	1.86
	(0.13)	(2.02)	(3.32)		
CHL-ARG	0.06	0.33	1.92	.15	1.77
	(0.04)	(0.62)	(1.02)		
ECU-ARG	0.02	0.04	0.57	.11	2.02
	(0.01)	(0.19)	(0.31)		
MEX-ARG	0.01	0.12	0.19	.19	1.84
	(0.01)	(0.09)	(0.14)		
PER-ARG	-0.00	0.80	-0.04	.17	1.91
	(0.02)	(0.31)	(0.51)		
VEN-ARG	0.01	0.15	0.28	.22	1.76
	(0.01)	(0.10)	(0.15)		
CHL-BRA	-0.00	0.17	-0.13	.10	1.98
	(0.00)	(0.06)	(0.09)		
ECU-BRA	0.02	0.07	0.46	.13	1.97
	(0.01)	(0.17)	(0.25)		
MEX-BRA	-0.00	0.25	-0.00	.30	2.16
	(0.01)	(0.07)	(0.11)		

continued on next page

Positive-Negative Contagion Regressions (continued)
(Dependent Variable: Return after Fundamentals)

	Const.	$\hat{p}_i$	$\hat{p}_i \times 1_{[\hat{p}_i>0]}$	$\bar{R}^2$	D.W.
PER-BRA	0.03	-0.20	1.01	.08	1.80
	(0.02)	(0.29)	(0.44)		
VEN-BRA	-0.00	0.34	-0.12	.24	2.02
	(0.01)	(0.09)	(0.14)		
ECU-CHL	-0.00	0.92	-0.20	.07	2.08
	(0.01)	(0.48)	(0.77)		
MEX-CHL	-0.00	0.85	-0.46	.19	1.91
	(0.00)	(0.21)	(0.34)		
PER-CHL	0.00	0.96	0.52	.04	1.84
	(0.02)	(0.81)	(1.32)		
VEN-CHL	-0.00	1.04	-0.13	.30	1.71
	(0.01)	(0.24)	(0.39)		
MEX-ECU	0.01	0.06	0.17	.09	2.01
	(0.01)	(0.09)	(0.15)		
PER-ECU	-0.01	0.62	-0.14	.09	1.74
	(0.02)	(0.31)	(0.52)		
VEN-ECU	0.00	0.19	0.03	.11	2.07
	(0.01)	(0.10)	(0.18)		
PER-MEX	0.00	0.67	0.16	.03	1.76
	(0.02)	(0.63)	(1.07)		
VEN-MEX	-0.00	0.91	-0.00	.54	2.16
	(0.01)	(0.15)	(0.26)		
VEN-PER	-0.00	0.13	-0.04	.05	1.94
	(0.01)	(0.06)	(0.10)		

First country is dependent. Second is i.

OLS estimation. Standard errors in parenthesis.

A.1.5 US Corporate Bonds Regressions

This appendix presents the results of the regressions of US corporate bond prices as a function of US Government bond prices.

Table A.5: US Corporate Bonds Regressions
(Dependent Variable: First Difference of log of Bond Price)

	Exxon Co.	Gen. Motors	Int. Bus. Mach.	Phillip Morris
Constant	0.00	–0.00	–0.00	0.00
	(0.03)	(0.00)	(0.00)	(0.00)
T. Bonds	0.68	1.08	0.40	0.80
	(0.04)	(0.08)	(0.04)	(0.04)
R^2	.70	.66	.49	.81
D.W.	2.62	2.40	2.58	2.54

Standard errors in parenthesis. T. bonds in first differences of logs.

A.1.6 Credit Ratings Correlations (First Differences)

This section presents the correlations of the logistic transformation of credit ratings in first differences for the purpose of comparison with the correlations of debt prices, which are also in first differences. Almost all of the pairwise correlations are significantly different from zero, and, more importantly, the groupwise correlation is significantly positive. Although the sample size is very different, the magnitude of the correlations is comparable to those of debt prices.

Table A.6: Credit Rating Correlations - First Differences
Latin America — September 1979–September 1994

	ARG	BRA	CHL	COL	ECU	MEX	PER
BRA	.252						
CHL	.501	.610					
COL	.329	.352	.485				
ECU	.694	.489	.651	.403			
MEX	.544	.022	.458	.160	.667		
PER	.346	.139	.480	.571	.495	.384	
VEN	.445	.650	.772	.445	.642	.399	.403
LR test for identity matrix = 155.99 [$\chi^2(28)$]							

First difference of logistic transformation of ratings
95% pairwise correlation critical value = .341
95% critical value for identity matrix = 41.30

A.2 Data

A.2.1 Data Sources and Definitions

This appendix describes data sources and definitions.

Secondary Market Debt Prices: Monthly bid and ask average price. For April 1986, November 1986 and January 1987 I use the prior month price. Emerging Markets Data, Salomon Brothers.

Country Credit Ratings: *Institutional Investor* magazine.

US Corporate Bonds Prices: Standard and Poor's Bond Guide. Debentures maturing in 2001 ($\pm$ 3 years). The same bond is tracked throughout the period of analysis. All bonds are debentures.

Libor: 6 months London Inter-bank Interest Rate in US$. IFS.

Long Run Interest Rate: 10 years government bonds. IFS.

Treasury Bond Prices: Bond maturing in 2001. Moody's Bond Guide.

Debt: Total external debt in US$ millions. Semi-annual data extrapolated from December of each year observation. World Tables and JP Morgan Emerging Markets Economic Outlook.

Exports: Last 12 months of total exports in US$ millions and monthly seasonal adjusted. IFS.

Imports: Last 12 months of total imports in US$ millions. IFS.

Terms of Trade: Exports price index $\div$ Imports price index. Constructed as described below.

Real Exchange Rates (RER): Non-Food trade weighted relative WPI. JP Morgan Database.

Appreciation Rate: Change in RER during the last 6 months.

Reserves: Current total reserves in US$ millions, seasonal adjusted. IFS.

Inflation: Seasonal adjusted monthly inflation and 12 months change in CPI. IFS.

GDP: GDP in US$. Semi-annual data extrapolated from yearly figures. Last two years completed with real GDP growth in local currency. World Tables and JP Morgan Emerging Markets Economic Outlook.

Growth: GDP growth rate in local currency. Semi-annual data extrapolated from yearly figures when quarterly data is not available. IFS and JP Morgan Emerging Markets Economic Outlook.

G-3 Growth: Weighted average of GDP growth in local currency of the US, Japan and Germany (weights 0.4, 0.3 and 0.3 respectively).

A.2.2 Terms of Trade

Terms of trade are constructed as the ratio of an export and an import price index. These indexes, in turn, were constructed as weighted averages of commodity prices and price indexes. The weights were found by regressing the World Bank export and import price index on a relevant set of prices for each country using annual data from 1970 to 1992. The set of relevant prices is defined by the main exports and imports reported in the ELAC's Statistical Yearbook. Restricted OLS were estimated — coefficients add up to 1. Some prices (e.g. machinery or finished goods) were chosen depending on the quality of the adjustment. Weights for each country index are presented below (because of rounding they may not add up to 1).

Argentina

Exports ($\bar{R}^2$= 0.76)		Imports ($\bar{R}^2$= 0.94)	
Maize	.50	Industrial Goods	.74
Beef	.39	Metal Index	.22
Soybeans	.09	Petroleum	.04
Wheat	.02		

Brazil

Exports ($\bar{R}^2$= 0.93)		Imports ($\bar{R}^2$= 0.96)	
Iron Ore	.33	Industrial Goods	.51
Finished Goods	.26	Oil	.36
Aluminum	.16	Metal Index	.13
Cocoa	.10		
Soybeans	.07		
Coffee	.06		
Sugar	.02		

Chile

Exports ($\bar{R}^2$= 0.87)		Imports ($\bar{R}^2$= 0.87)	
Copper	.58	Machinery	.94
Fish Meal	.23	Petroleum	.06
Pulp	.19		

Colombia

Exports ($\bar{R}^2$= 0.97)		Imports ($\bar{R}^2$= 0.98)	
Coffee	.56	Industrial Goods	.59
Petroleum	.22	Agriculture	.32
Cotton	.16	Metal Index	.09
Banana	.06		

Ecuador

Exports ($\bar{R}^2$= 0.95)		Imports ($\bar{R}^2$= 0.91)	
Petroleum	.61	Industrial Goods	.78
Banana	.26	Metal Index	.22
Coffee	.13		

Mexico

Exports ($\bar{R}^2$= 0.89)		Imports ($\bar{R}^2$= 0.91)	
Industrial Goods	.47	Industrial Goods	.76
Petroleum	.32	Metal Index	.24
Metal Index	.21		

Peru

Exports ($\bar{R}^2$= 0.91)		Imports ($\bar{R}^2$= 0.75)	
Food Index	.48	Finished Goods	1.00
Metal Index	.41		
Fish Meal	.11		

Venezuela

Exports ($\bar{R}^2$= 0.91)		Imports ($\bar{R}^2$= 0.89)	
Petroleum	.62	Agriculture	.67
Industrial Goods	.34	Machinery	.33
Metal Index	.04		

Price data definitions and sources are (all are index with 1985=100):

Agriculture: Agricultural raw materials index. IFS.

Aluminum: Canada aluminum in London. IFS

Banana: Latin American bananas in US ports. IFS.

Beef: New York price. IFS.

Cocoa: Cocoa beans in Brazil. IFS.

Coffee: Other milds in New York. IFS.

Copper: London price. IFS.

Cotton: 10 markets in

Finished Goods: Finished goods producer prices in the US. IFS.

Fish Meal: All origins in Hamburg. IFS.

Industrial Goods: Industrial goods producer prices in the US. IFS.

Iron Ore: Brazil iron ore in North Sea ports. IFS.

Maize: US maize in US Gulf ports. IFS.

Metal Index: Metals and minerals index, IFS.

Machinery: Machinery price index. Economic Report of the President.

Petroleum: Spot price. IFS.

Pulp: Sweden pulp in Swedish ports. IFS.

Soybeans: US soybeans in Rotterdam. IFS.

Sugar: Brazil sugar. IFS.

Wheat: US wheat in US Gulf ports. IFS.

Appendix B

Further Results and Data used in Chapter 4

B.1 Further Results

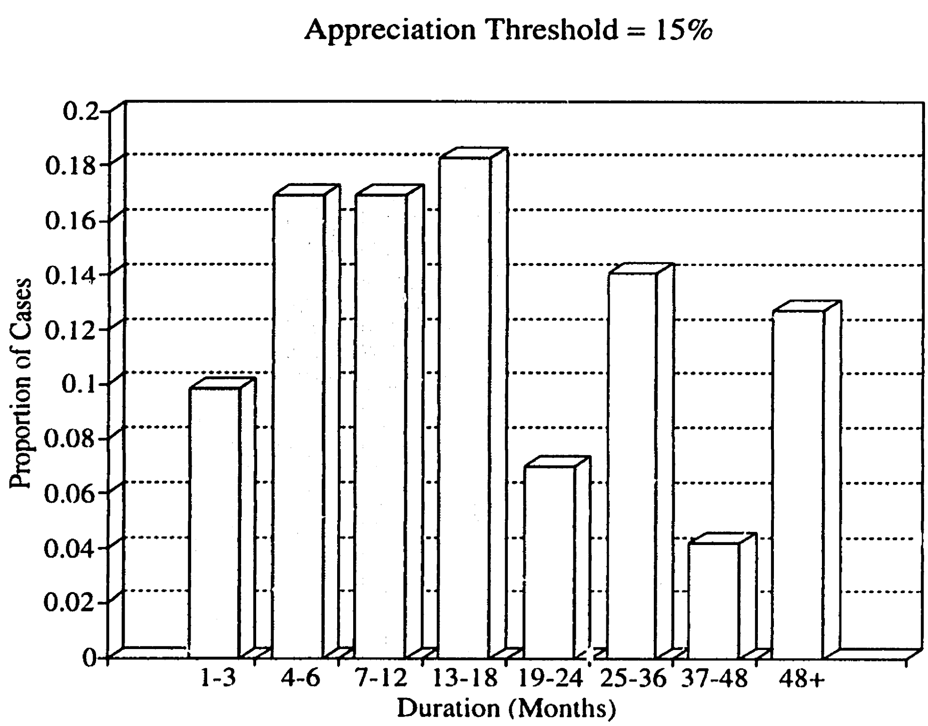

Figure B-1: Histogram of Duration - Trends Only

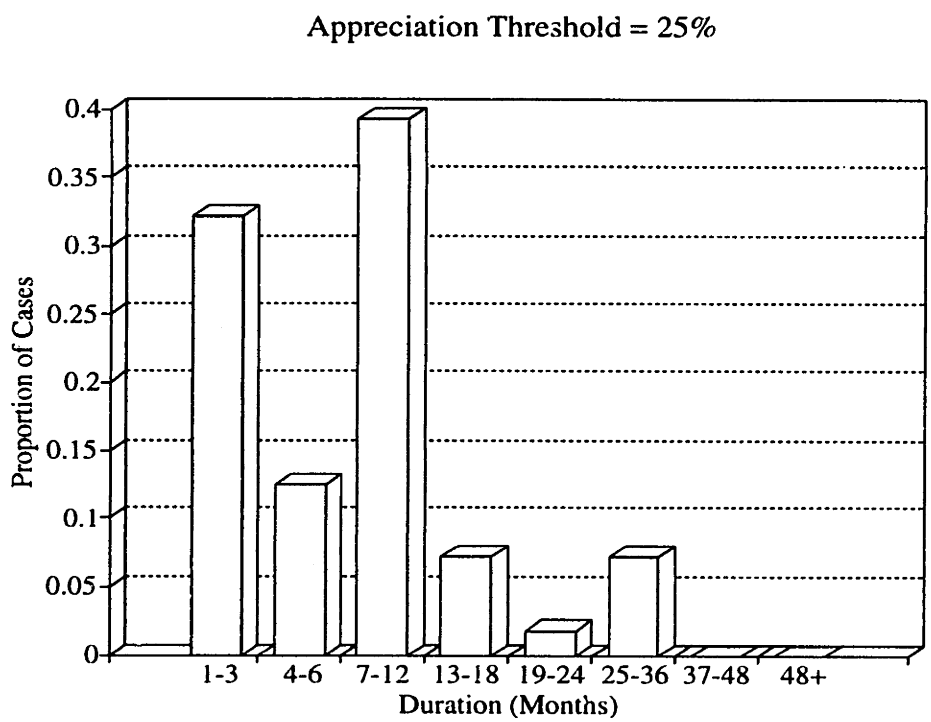

Figure B-2: Histogram of Duration - Fundamentals

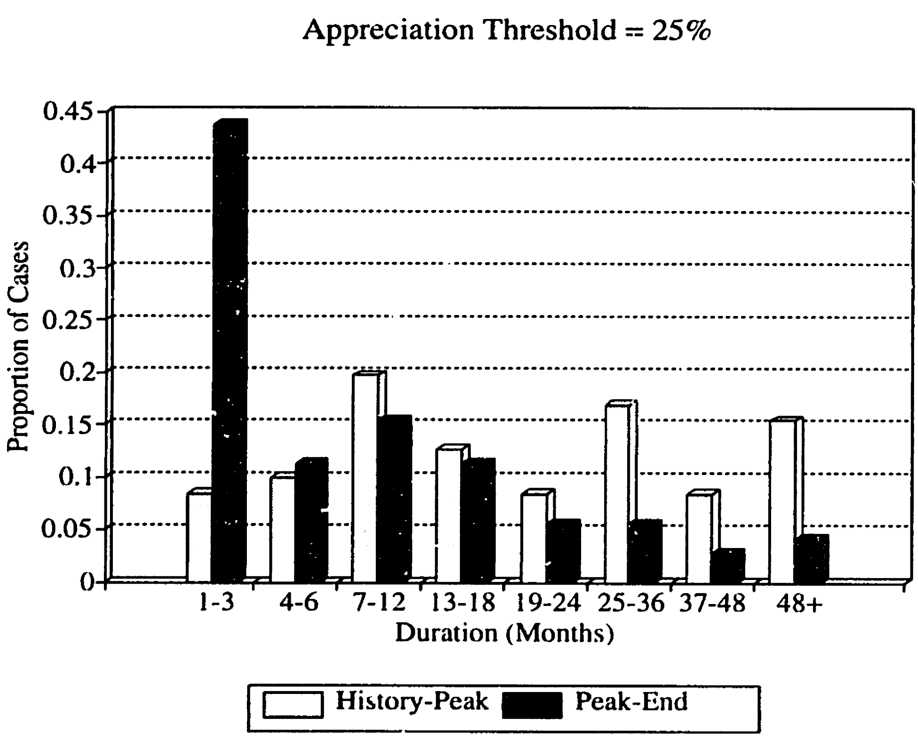

Figure B-3: Phases Duration - Trends Only

Appreciation Threshold = 25%

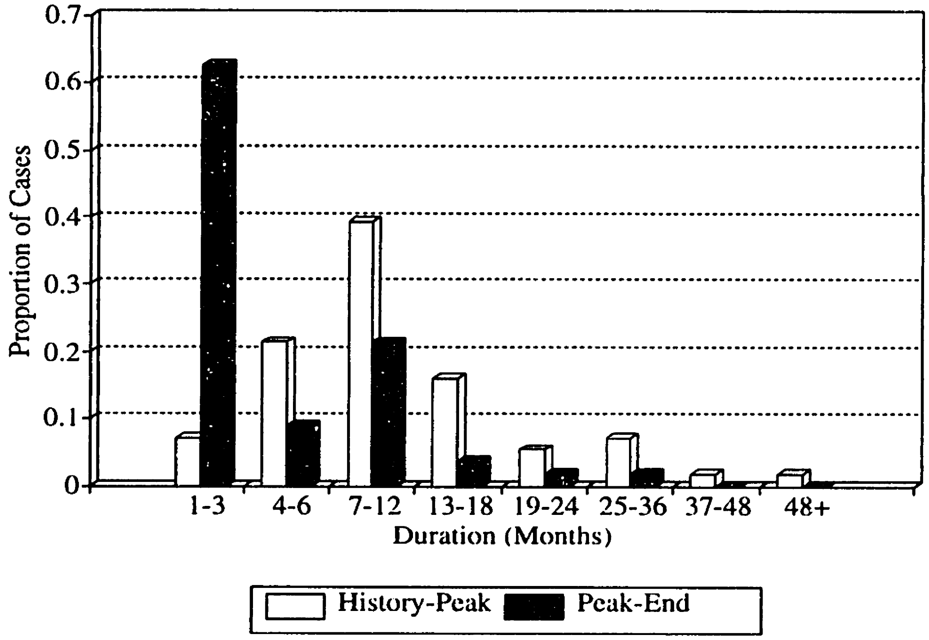

Figure B-4: Phases Duration - Fundamentals

Appreciation Threshold = 25%

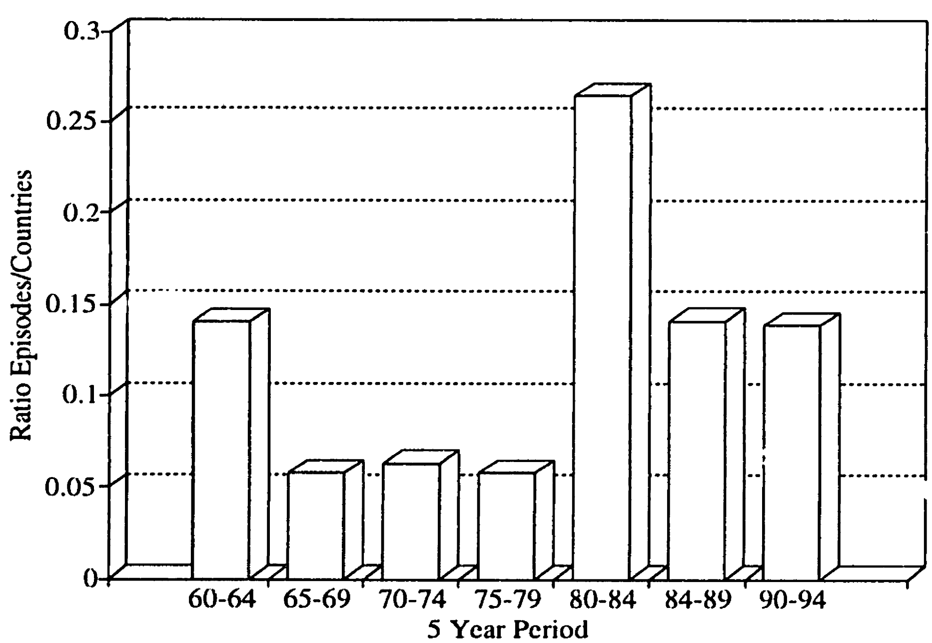

Figure B-5: Temporal Distribution - Trends Only

Table B.1: Transition Matrices of Appreciations - 24 and 48 Months

Detrended RER
Appreciation Threshold = 15%

24 Months Matrix

RER Appreciation in t+24 months

	30+	30-25	25-20	20-15	15-10	10-5	5-
30+	0.22	0.02	0.05	0.01	0.02	0.01	0.66
30-25	0.15	0.05	0.08	0.07	0.04	0.04	0.56
25-20	0.09	0.05	0.09	0.06	0.07	0.05	0.59
20-15	0.04	0.05	0.06	0.06	0.07	0.07	0.65
15-10	0.02	0.03	0.03	0.05	0.09	0.08	0.71
10-5	0.02	0.01	0.02	0.02	0.03	0.03	0.87

48 Months Matrix

RER Appreciation in t+48 months

	30+	30-25	25-20	20-15	15-10	10-5	5-
30+	0.06	0.01	0.01	0.02	0.01	0.01	0.88
30-25	0.07	0.01	0.05	0.04	0.02	0.02	0.79
25-20	0.04	0.02	0.04	0.02	0.04	0.03	0.80
20-15	0.03	0.03	0.03	0.02	0.02	0.02	0.85
15-10	0.03	0.01	0.00	0.00	0.00	0.01	0.94
10-5	0.03	0.00	0.00	0.00	0.00	0.00	0.97

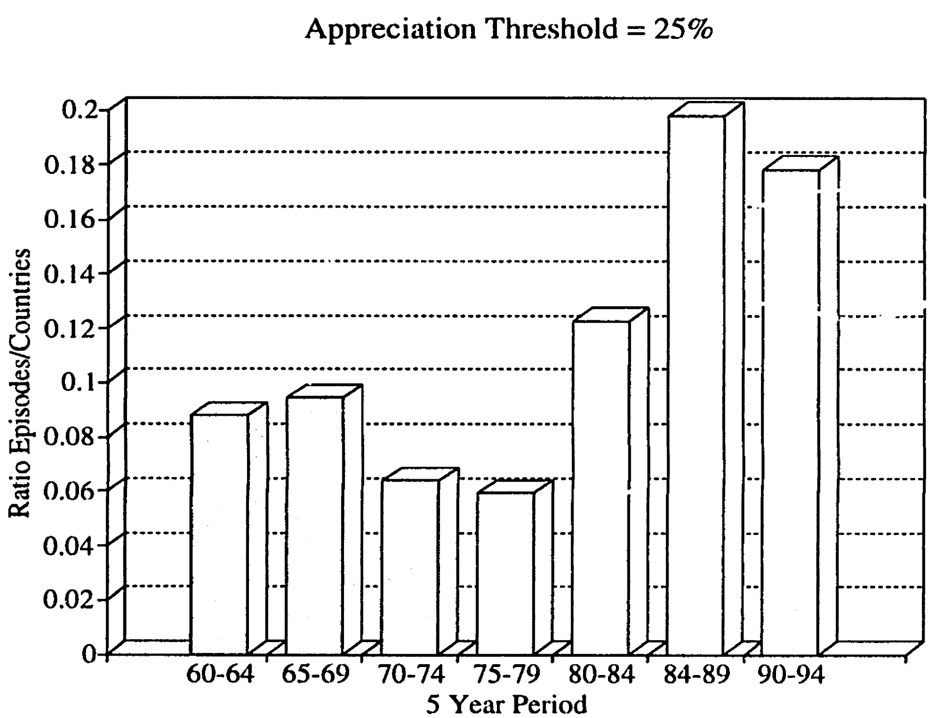

Figure B-6: Temporal Distribution - Fundamentals

B.2 Exchange Arrangements Description

We classify exchange arangements along two dimension using the following coding:

Exchange Arrangements
1. Peg to American Dollar
2. Peg to British Pound
3. Peg to French Franc
4. Peg to other currency (flagged)
5. Peg to SDR
6. Cooperative arrangements (e.g. EMS)
7. Peg to basket (incl. frequent adjustments)
8. Managed floating and other flexible arrangements
9. Free floating

Dual-Multilateral Arrangements
0. Unique exchange rate for trade transactions
1. One or more rates for trade transactions

We consider arrangements 1 to 6 as fixed regimes, 7 and 8 as flexible, and 9 as floating. Table B.2 presents the distribution of the proportion of each of these aggregates, while table B.3 presents the distribution of the 9 types of regime and the proportion of dual and multiple exchange rate arrangements.

Table B.2: Exchange Arrangements
Proportion of Each Aggregate in Population

Regime	60–64	65–69	70–74	75–79	80–84	85–89	90–94
Fixed	0.98	0.97	0.90	0.65	0.53	0.47	0.42
Flexible	0.01	0.03	0.07	0.29	0.40	0.45	0.46
Float	0.01	0.00	0.03	0.06	0.07	0.09	0.12

Table B.3: Exchange Arrangements - Original Classification
Proportion of Each Type in Population

Regime	60–64	65–69	70–74	75–79	80–84	85–89	90–94
1	0.78	0.77	0.64	0.37	0.26	0.21	0.18
2	0.07	0.07	0.08	0.03	0.00	0.00	0.01
3	0.11	0.11	0.13	0.11	0.10	0.10	0.10
4	0.01	0.01	0.01	0.01	0.00	0.01	0.01
5	0.01	0.01	0.01	0.05	0.08	0.06	0.02
6	0.00	0.00	0.03	0.08	0.09	0.09	0.10
7	0.00	0.00	0.02	0.12	0.13	0.12	0.12
8	0.01	0.03	0.05	0.17	0.27	0.33	0.34
9	0.01	0.00	0.03	0.06	0.07	0.09	0.12
Dual	0.14	0.16	0.20	0.16	0.18	0.20	0.14

B.3 Initial Sample

This appendix describes the initial sample of countries, data coverage for each country, original frequency of series, and the price index used in the construction of the RER.

Country			Price Index	Original Frequency	RER Coverage
1	Austria	AUT	WPI	Monthly	60–94
2	Belgium	BEL	CPI	Monthly	60–94
3	Denmark	DNK	WPI	Monthly	60–94
4	Finland	FIN	WPI	Monthly	60–94
5	France	FRA	CPI	Monthly	60–94
6	Germany	GER	WPI	Monthly	60–94
7	Greece	GRC	WPI	Monthly	60–94
8	Hungary	HUN	WPI	Monthly	68–94.6
9	Ireland	IRL	WPI	Monthly	60–94.10
10	Italy	ITA	WPI	Monthly	60–94
11	Netherlands	NLD	WPI	Monthly	60–94
12	Norway	NOR	WPI	Monthly	60–94
13	Poland	POL	WPI	Monthly	80–94
14	Portugal	PRT	CPI	Monthly	60–94
15	Romania	ROM	CPI	Monthly	81–94
16	Spain	SPA	WPI	Monthly	60–94
17	Sweden	SWE	CPI	Monthly	60–94
18	Switzerland	SWT	WPI	Monthly	60–93.5
19	Turkey	TUR	CPI	Monthly	69–94
20	UK	UKG	WPI	Monthly	60–94
21	Argentina	ARG	WPI	Monthly	60–94
22	Bolivia	BOL	CPI	Monthly	60–94

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Country			Price Index	Original Frequency	RER Coverage
23	Brazil	BRA	WPI	Monthly	60–94
24	Canada	CAN	WPI	Monthly	60–94
25	Chile	CHL	WPI	Monthly	60–94
26	Colombia	COL	WPI	Monthly	60–93
27	Costa Rica	CRI	WPI	Monthly	60–94.1
28	Ecuador	ECU	WPI	Monthly	75–94
29	El Salvador	SLV	WPI	Monthly	60–94.10
30	Guatemala	GTM	CPI	Monthly	60–94.10
31	Haiti	HTI	CPI	Monthly	60–94
32	Honduras	HND	CPI	Monthly	60–94
33	Jamaica	JAM	CPI	Monthly	60–94
34	Mexico	MEX	WPI	Monthly	60–94
35	Paraguay	PRY	WPI	Monthly	60–94.4
36	Peru	PER	CPI	Monthly	60–94
37	Trinidad & Tobago	TTO	CPI	Monthly	60–94.10
38	US	USA	WPI	Monthly	60–94
39	Uruguay	URY	CPI	Monthly	60–94
40	Venezuela	VEN	WPI	Monthly	60–94
41	Australia	AUS	WPI	Monthly	60–94
42	Indonesia	IDN	CPI	Monthly	71–94
43	New Zealand	NZL	CPI	Quarterly	60–94
44	Papua New Guinea	PNG	CPI	Quarterly	71–94
45	Bahrain	BHR	CPI	Monthly	75.7–94
46	Bangladesh	BGD	CPI	Monthly	74.7–94
47	China	CHN	Infl.	Monthly	69.3–94.9
48	Hong Kong	HKG	CPI	Monthly	69.3–94.9

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Country			Price Index	Original Frequency	RER Coverage
49	India	IND	WPI	Monthly	60–94
50	Iran	IRN	WPI	Monthly	60–94
51	Israel	ISR	WPI	Monthly	68–94
52	Japan	JAP	WPI	Monthly	60–94.9
53	Jordan	JOR	CPI	Monthly	76–94
54	Korea	KOR	WPI	Monthly	60–94
55	Kuwait	KWT	WPI	Monthly	73–9.6
56	Malaysia	MYS	CPI	Monthly	60–94
57	Nepal	NPL	CPI	Monthly	63.7–94.6
58	Pakistan	PAK	WPI	Monthly	61.7–94
59	Philipines	PHL	WPI	Monthly	60–94
60	Saudi Arabia	SAU	CPI	Monthly	80.2–94
61	Singapore	SGP	CPI	Monthly	60–94
62	Sri Lanka	SLK	CPI	Monthly	60–94
63	Syrian Arab Rep.	SYR	WPI	Monthly	60–94.9
64	Thailand	THA	WPI	Monthly	60–94
65	Algeria	ALG	CPI	Monthly	74–94
66	Burkina Faso	BFA	CPI	Monthly	60–93
67	Burundi	BDI	CPI	Monthly	74–94
68	Cameroon	CMR	CPI	Monthly	68–90.9
69	Central Africa.Rep.	CAF	WPI	Monthly	65–94.7
70	Congo	COG	CPI	Monthly	64–94.7
71	Egypt	EGY	WPI	Monthly	60–94.11
72	Ethiopia	ETH	CPI	Monthly	66–94.10
73	Gabon	GAB	WPI	Monthly	63–94.6
74	Ghana	GHA	WPI	Monthly	63–94.9

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Country			Price Index	Original Frequency	RER Coverage
75	Ivory Coast	IVC	CPI	Monthly	60–94.9
76	Kenya	KEN	CPI	Monthly	68–94.2
77	Liberia	LBR	CPI	Monthly	68–90.6
78	Madagascar	MDG	CPI	Monthly	64–94
79	Malawi	MWI	CPI	Monthly	80–94.7
80	Morocco	MAR	CPI	Monthly	60–94
81	Niger	NER	CPI	Monthly	68–94
82	Nigeria	NGA	CPI	Monthly	60–94.9
83	Rwanda	RWA	CPI	Monthly	65.4–93
84	Senegal	SEN	CPI	Monthly	68–94.9
85	Sierra Leona	SLE	CPI	Monthly	86.10–94.9
86	Somalia	SOM	CPI	Monthly	63.10–89.11
87	South Africa	SAF	WPI	Monthly	60–94
88	Sudan	SDN	CPI	Monthly	60–94.6
89	Togo	TOG	WPI	Monthly	70–93
90	Tunisia	TUN	CPI	Monthly	87.7–94
91	Zaire	ZAR	Infl.	Monthly	63–94
92	Zambia	ZMB	CPI	Monthly	67.4–94
93	Zimbabwe	ZWE	CPI	Monthly	78–94

B.4 Trade Weights

	Trade Partners														
	USA	JAP	GER	FRA	ITA	SPA	UKG	NLD	ARG	BRA	SAF	SAU	SGP	AUS	Others
BEL	.06		.33	.26			.12	.23							
DNK	.10		.37	.10			.16	.05							.22
FIN	.13	.06	.29	.07			.18								.27
FRA	.13		.34		.21		.15								.17
GER	.12	.06		.22	.16		.13	.16							.13
GRC	.05	.05	.35	.14	.26		.10	.05							
HUN			.51		.09										.41
IRL	.16	.04	.14	.08			.54	.04							
ITA	.12		.38	.29		.05	.11	.05							.01
NLD	.08		.39	.14	.05		.13								.21
NOR	.12		.21	.08			.29								.30
POL			.63		.11		.18								.08
PRT	.06		.30	.26	.12	.26									.01
ROM	.13		.49		.19							.18			
SPA	.12		.26	.30	.18		.14								
SWE	.17		.34				.18								.31
SWT	.11		.45	.17	.16		.10								
TUR	.19		.41	.12	.17		.11								
UKG	.24		.29	.20	.11			.16							
ARG	.36	.05	.15					.12		.31					
BOL	.33	.08					.10		.29	.20					
BRA	.51	.17	.16					.09	.08						
CAN	.92	.08													
CHL	.36	.25	.18						.07	.14					
COL	.68	.11	.14												.07
CRI	.75	.06	.13												.06
ECU	.68	.09	.08					.09		.06					
SLV	.57		.20												.23
GTM	.76	.07	.11												.07
HTI	.81			.06	.03			.06							.04
HND	.81	.10	.08												
JAM	.57						.15	.07							.21
MEX	.84	.06	.06			.04									
PRY	.15	.13						.13	.16	.42					
PER	.52	.15	.14						.09	.10					
TTO	.87						.08								.05
USA		.35	.09				.09								.47
URY	.18		.13						.19	.50					
VEN	.82		.13					.05							
AUS	.37	.44					.10								.08
IDN	.22	.58	.09										.11		
NZL	.25	.26	.05				.12							.32	
PNG	.09	.34											.09	.40	.09
BHR	.10	.07					.08					.74			
BGD	.44	.15	.07		.09		.09								.16
CHN	.16	.23	.04												.57
HKG	.26	.18	.05												.50
IND	.31	.20	.19				.16					.07			.08
IRN		.21	.45		.19		.15								

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	Trade Partners														
	USA	JAP	GER	FRA	ITA	SPA	UKG	NLD	ARG	BRA	SAF	SAU	SGP	AUS	Others
ISR	.44		.17		.06		.15								.18
JAP	.66		.14												.20
JOR	.31		.10	.09			.10					.17			.22
KOR	.54	.46													
KWT	.21	.21	.13		.09		.10					.26			
MYS	.31	.36											.33		
NPL	.28	.11	.26	.04			.05						.21		.06
PAK	.35	.27	.20				.10					.08			
PHL	.54	.36	.09												
SAU	.42	.33	.07		.06		.12								
SGP	.36	.28										.05			.32
SLK	.53	.28	.10				.09								
SYR	.14		.11	.32	.35							.08			
THA	.34	.50											.15		
ALG	.22		.08	.29	.24	.05		.07							.05
BFA		.06	.20	.41	.02			.03							.28
BDI		.26	.17	.27											.29
CMR	.12	.04	.11	.47		.04		.07							.15
CAF		.05	.03	.51											.40
COG	.16			.57	.16	.05		.06							
EGY	.67	.07	.06		.05			.09		.06					
ETH	.13	.26	.32		.20		.09								
GAB	.26	.05	.04	.60		.05									
GHA	.20	.14					.48	.08							.10
IVC	.07		.13	.42				.22							.15
KEN	.07	.15	.22	.08			.39								.10
LBR	.32	.04	.34	.07	.13										.10
MDG	.17	.13	.15	.56											
MWI	.09	.14	.12				.28				.36				
MAR	.06		.11	.53	.13	.17									
NER	.07	.04	.05	.60		.04									.20
NGA	.42	.06	.16	.06	.08	.11	.10								
RWA		.10	.14	.12											.64
SEN	.05			.65	.13										.17
SLE	.29	.08					.27	.19							.17
SOM			.04		.26		.05					.65			
SAF	.30	.24	.22				.24								
SDN	.09	.07	.09		.07		.13					.32			.23
TOG	.06		.06	.43	.06	.07		.10							.22
TUN	.04		.21	.41	.28										.05
ZAR	.30		.07	.12	.06					.13					.32
ZMB	.08	.32	.10	.11			.14				.15	.05			.05
ZWE	.16	.05	.18				.20				.40				

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