EMERGING MARKETS CONTAGION: EVIDENCE AND THEORY

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Resumen

Este trabajo muestra evidencia de contagio en mercados emergentes utilizando precios de deuda en mercados secundarios y ratings de crédito de países. El trabajo muestra que los fundamentales son capaces de explicar el comovimiento a través de países latinoamericanos de indicadores de probabilidad de repago de deuda. También muestra que este contagio no puede ser explicado por grandes eventos noticiosos y que es asimétrico, siendo mayor para innovaciones negativas de probabilidad de repago. Contrariamente a lo anterior, los fundamentales explican toda la correlación observada en grupos de control compuestos por precios de bonos de corporaciones estadounidenses y ratings de crédito de países medianos de la OECD.

El trabajo presenta un modelo simple que trata de explicar la correlación observada. Este combina países ilíquidos con inversionistas que potencialmente necesitan liquidez para cambiar sus portafolios. La intuición básica es que si los inversionistas requieren liquidez y no la encuentran en un país, entonces ellos la buscarán en un segundo país. Bajo dos definiciones alternativas de equilibrio el modelo muestra que el grado de iliquidez de otros países -algo aparentemente idiosincratico a cada uno de esos países- afecta negativamente la probabilidad de repago de un país.

Abstract

Using secondary market debt prices and country credit ratings this paper provides evidence of contagion in emerging markets. 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, in a "control group" composed by US corporate bond prices and credit ratings of a group of medium size OECD countries, fundamentals explain all the observed correlation.

The paper 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 funs 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.

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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 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 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 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

[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.

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

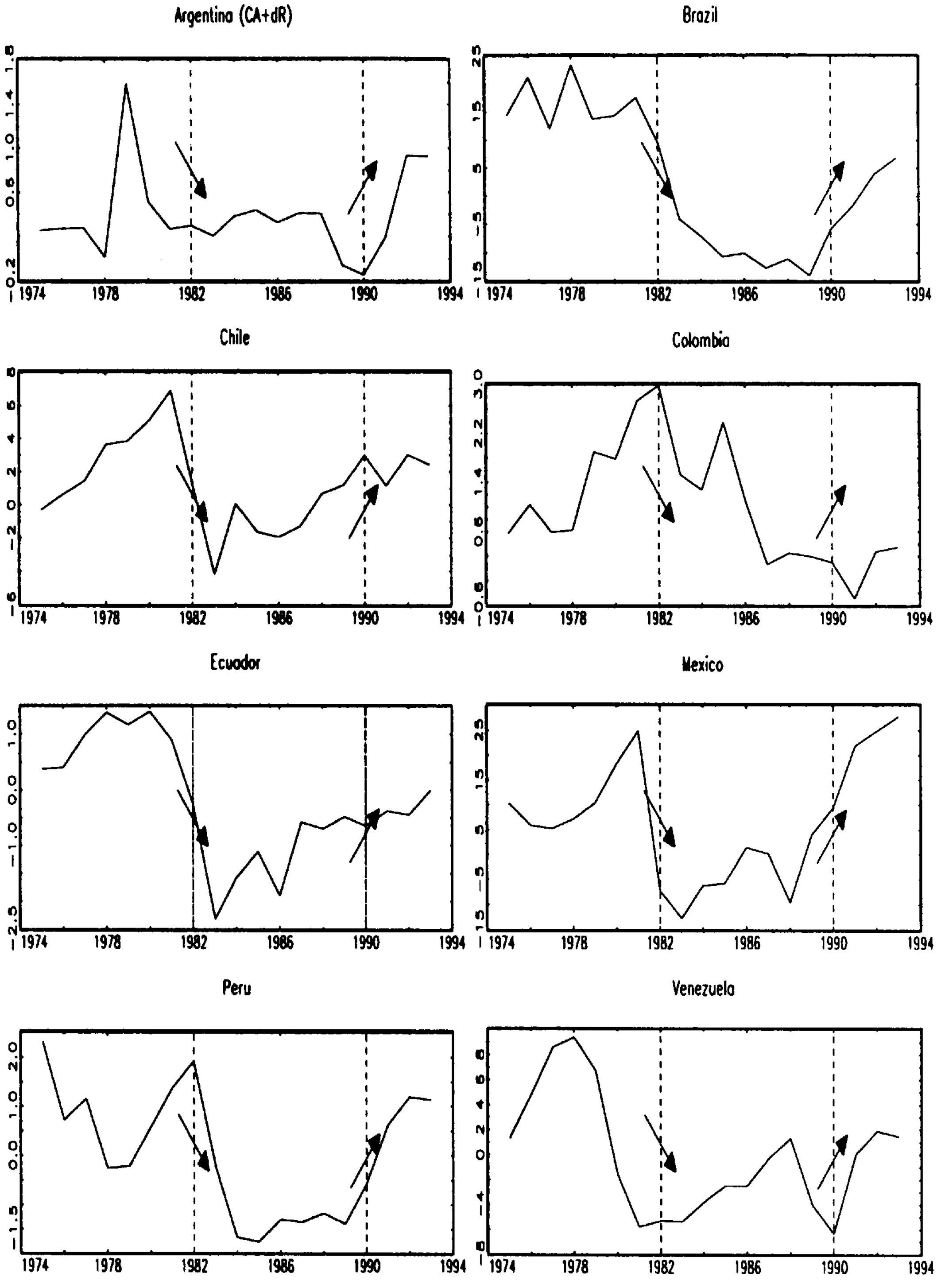

Figure 1: Capital Flows to Latin America: 1974–94 (Source: IFS)

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 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

[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 3.1.

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 reviews some related literature about contagion. Section 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 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 5 presents some concluding remarks.

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

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

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 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 inno-

[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.

vations 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 dividends movements are analyzed. Although there is some evidence of excess co-movement, 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.

[8]Appendix A.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.

3 Empirical Evidence of Contagion: The Case of Latin America

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 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.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

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

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 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.

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

[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.

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 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 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 1 are significantly positive in all 21 cases, and above 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.

3.2.1 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

[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.

[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).

Table 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

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 —given for instance by higher growth— and a higher income variability would im-

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

prove 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 B.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:

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

[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.

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. 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 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 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.

[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: 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	0.84	-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)
$\text{Trend}^2(\div 100)$	-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 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

Table 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

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 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 3.

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

3.2.2 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.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.

The results of the regressions controlling for these events are presented in table 15 of appendix A.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 5 presents the correlation matrix of the residuals of these regressions.

[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 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

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 disregarded.

3.2.3 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 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 16 in appendix A.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.

[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.

[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."

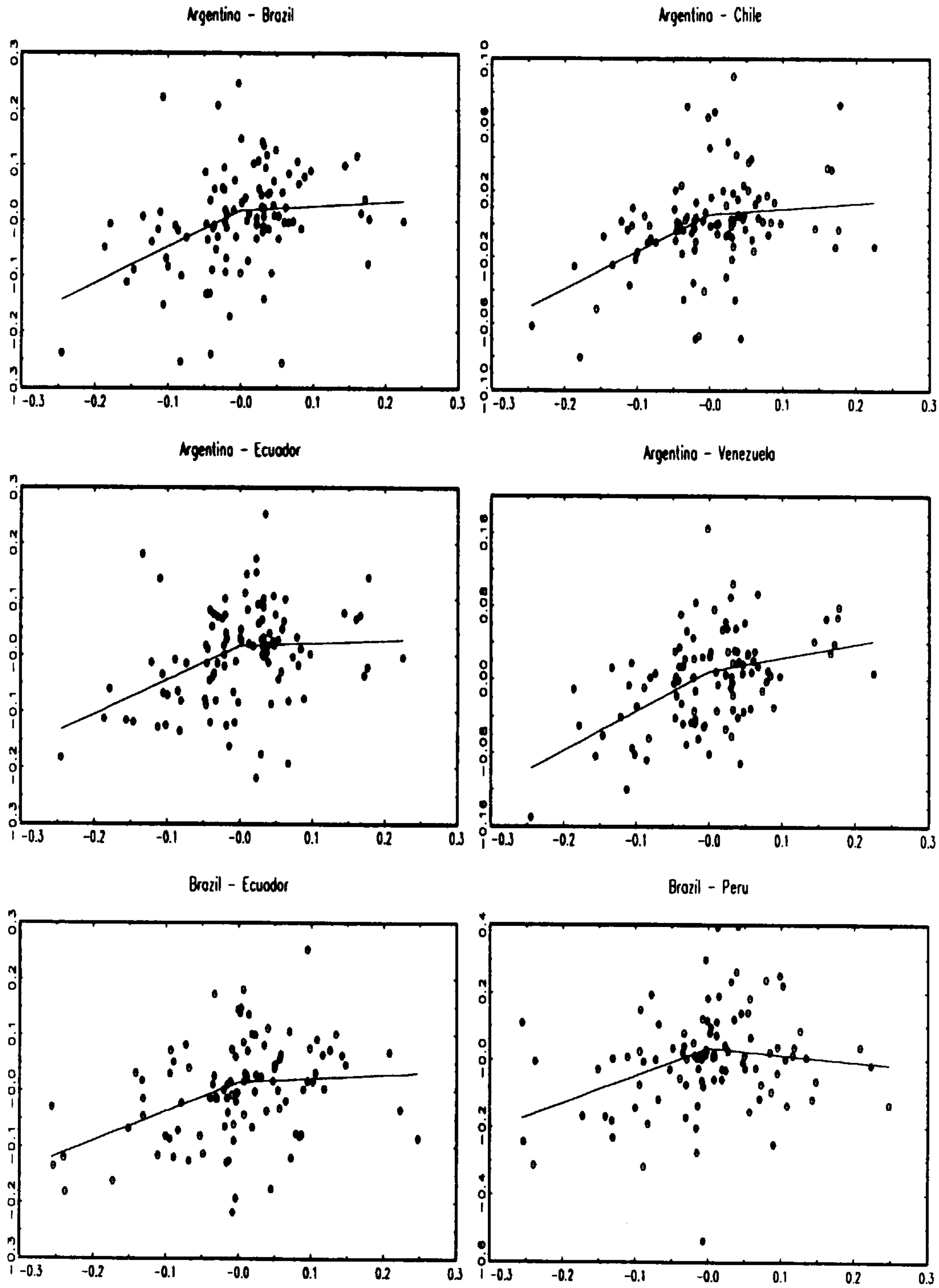

Figure 2: Asymmetric Contagion

Table 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

3.2.4 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 debt, namely March of 1986 to August of 1994. The original data (first differences of logs) correlations are presented in table 6.

As expected, given that they are nominal, US corporate bond price changes are highly correlated across firms. Both pairwise and groupwise correlations are signif-

[23]Interestingly, there is no evidence of stock markets contagion in Latin America. Returns are not significantly correlated in these countries. See table 13 in appendix A.1.

Table 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

icant. 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 17 in appendix A.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 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 these instruments. I will investigate this further in section 4.

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]

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 8. Appendix A.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.

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.

[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.

[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 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

These are France (FRA), Italy (ITA), Spain (SPA), and the UK. Table 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,

Table 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

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 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 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 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,

Table 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.

Table 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

indicating the presence of contagion.[26]

Table 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.

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.

[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 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

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 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). 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.

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

[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.

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, 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

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[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).

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

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

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] 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]

[33] I assume the contracts presented here as given. Chapter ?? 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

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

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 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.

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

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

where $\hat{R}$ is given, W_2 is period 2 wealth, x and y are the proportions of the country

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.

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:

$$\begin{aligned} \mu_{0y} - \mu_{1y} + (\mu - 1)a_0 &= 0 \\ \mu_{0x} - \mu_{1x} + (\mu r - \hat{R})a_0 &= 0 \\ \kappa + \mu_{0z} - \mu_{Iz} - \mu &= 0 \\ 1 + \mu_{0w} - \mu_{1w} - \mu &= 0 \end{aligned} \quad (2)$$

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

$$\{w, x, y, z\} = \begin{cases} \left\{0, \frac{I-a_0}{a_A r}, 1, I\right\} & \text{if } a_0 \leq I, \text{ and} \\ \left\{y' a_0 - I, 0, y' \in (\frac{I}{a_0}, 1), I\right\} & \text{otherwise.} \end{cases} \quad (3)$$

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

$$\begin{aligned} &\{w, x, y, z\} = \\ &\left\{\max\langle I - y' a_0 - a_A q, 0\rangle, 1, y' \in \left(\max\left\langle\tfrac{I-a_A q}{a_0}, 0\right\rangle, 1\right), \min\langle a_0 + q a_A, I\rangle\right\}. \end{aligned} \quad (4)$$

The final equilibrium is determined simultaneously by this set of solutions and equation (1).[35]

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

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

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 (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 (3) and (4), and the fact that $a_0 < I$ one has $0 < (I - a_0)/ra_A \leq x$. Given this lower bound for x there exists a unique cut-off 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

$$q^* = \frac{R(I - a_0)}{a_A(R - r) + (I - a_0)}, \tag{5}$$

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

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*

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

with $q' = RI(R-r+I)$, 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 (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 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 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 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.

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.
- 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:

[36] In this case $q^* = 0$ and the expected return for the portfolio with $a_0^i = 1$ is equal to $p(I\kappa + 1 - I/r) + (1-p)R$, while the expected return of the portfolio with $a_0^i = 0$ is given by $1 + pI(\kappa - 1)$.

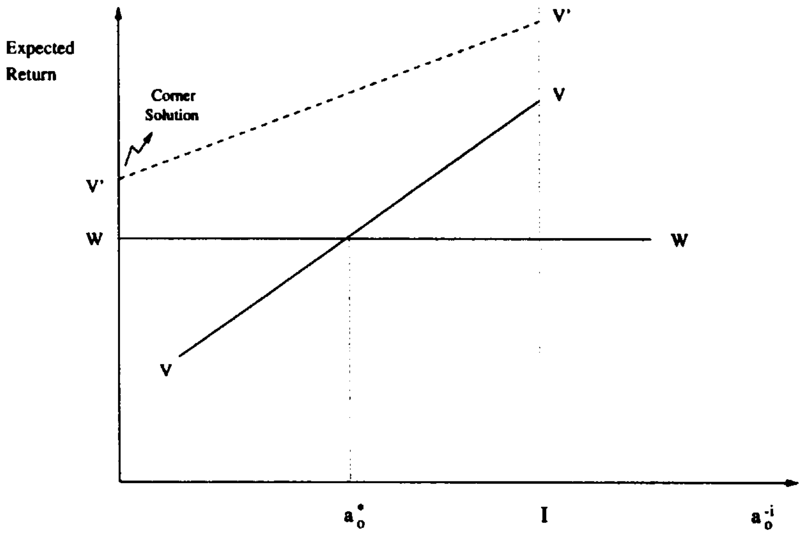

Figure 3: Portfolios and Expected Returns

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

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) in addition to the FOC for x_B

$$\mu_{0x_B} - \mu_{1x_B} + (\mu r - \hat{R}_B)a_0 = 0 \tag{6}$$

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.

4.3.1 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 (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:

$$x_A = \frac{q_A q_B x_B - q_A r x_B}{q_A q_B + q_B r x_B - q_A r x_B - q_B r}. \tag{7}$$

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

[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.

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

$$x_A a_A r + x_B a_B r = I - (1 - a_A - a_B). \tag{8}$$

Figure 4 shows the schedules (7) and (8) for the case in which $q_A < q_B$. The schedule CC represents the budget constraint (8), while OE represents the equilibrium condition (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

$$\overline{x}_A = \frac{q_A (R - r)}{r (R - q_A)}, \tag{9}$$

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

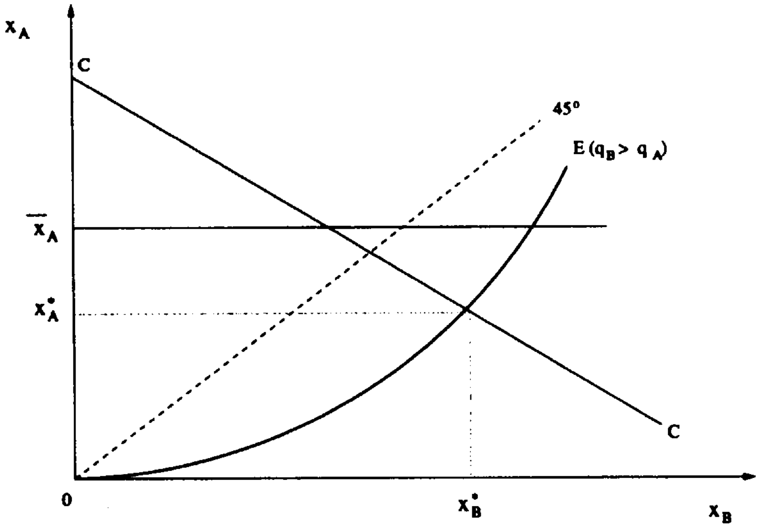

Figure 4: Contingent Ordering with No-Collapse Equilibrium

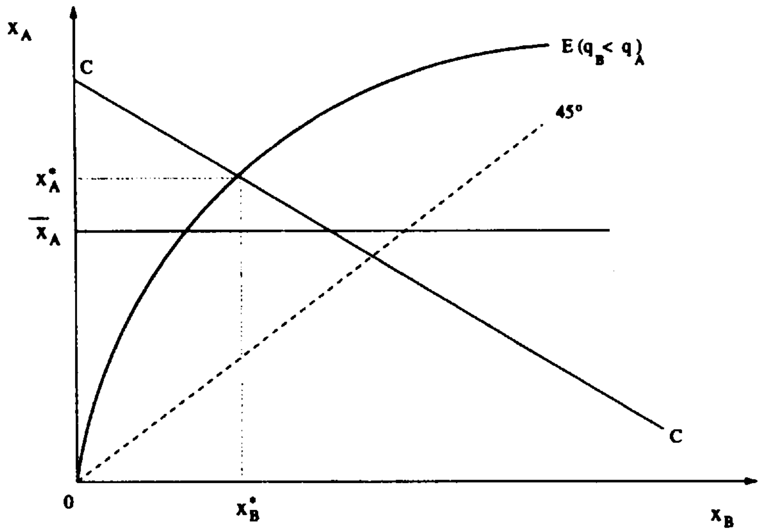

Figure 5: Contingent Ordering with Collapse Equilibrium

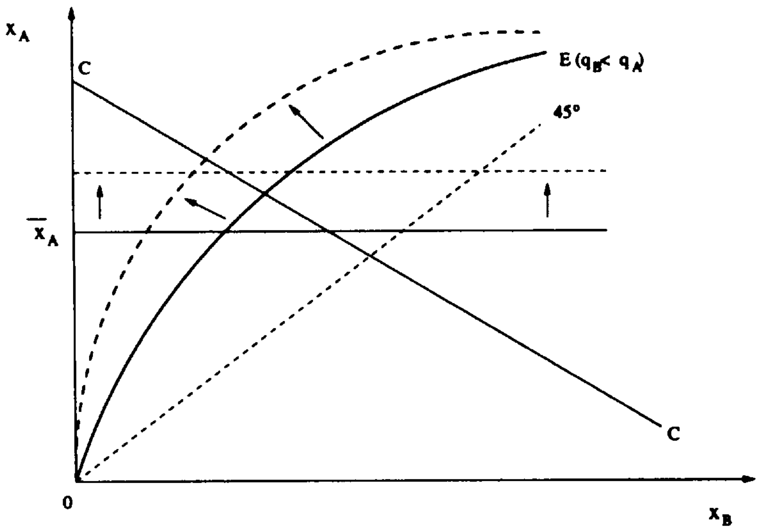

Figure 6: Effects of a Higher Realization of q_A

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

$$\frac{I - a_0}{a_B r (R - r)} - \frac{a_A q_A}{a_B (R - q_A)} = \frac{q_B}{r (R - q_B)}, \tag{10}$$

which results from solving (7) and (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 (10) to get

$$\frac{dq_A^*}{dq_B} = -\frac{a_B (R - q_A)^2}{a_A r (R - q_B)^2}, \tag{11}$$

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 (11) with respect to q_B to get

$$\frac{d^2 q_A^*}{dq_B^2} = -\frac{2a_B (R - q_A)^2}{a_A r (R - q_B)^3}, \tag{12}$$

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

[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.

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 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.

4.3.2 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

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

country the risk free investment is first (and totally) used to finance the investment 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

$$q_\lambda^* = \frac{R(I - a_0)}{a_\lambda(R - r) + (I - a_0)}. \tag{13}$$

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

$$q_{-\lambda}^* = \frac{R(I - a_0 - a_\lambda q_\lambda)}{a_{-\lambda}(R - r) + (I - a_0 - a_\lambda q_\lambda)}, \tag{14}$$

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

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

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.

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 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

[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.

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 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.

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[43] Chapter ?? 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.

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A Appendix

A.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 13: 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.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 14 presents the estimation using OLS and MLE with AR(1) correction.

Table 14: 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.3 Information Events and Regressions

This appendix describes the "big news" events I consider in subsection 3.2.2 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 15: 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 ÷10.

A.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 16: 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.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 17: 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.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 18: 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

B Appendix

B.1 Data Definitions and Sources

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 (± 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 ÷ 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).

B.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.