CURRENCY CRISES AND FINANCIAL VULNERABILITY IN DOLLARIZED ECONOMIES

by

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Para mis Viejos, Lincoln y Reina—lo más grande que tengo.

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Abstract

The dissertation consists of three distinct chapters that contribute to important, yet unresolved topics in Macroeconomics and International Economics.

Macroeconomists have been keenly interested in understanding how financial crisis turn into real recessions in emerging markets. By using a unique data set for 1,300 listed firms from six Latin American countries, the first chapter (co-authored with Sebnem Kalemli-Ozcan and Carolina Villegas-Sanchez) provides systematic evidence on the key channel behind the contractionary nature of financial crises. Using a differences-in-differences methodology, we disentangle the role played by banks' credit crunch and firms' balance sheet currency mismatches in firms' investment behavior in the aftermath of steep devaluations. Our results suggest that the key factor hindering investment and growth in the aftermath of financial crises is the decline in the supply of credit.

Economists and policymakers have also been interested in the response of exchanges rates to central bank intervention in foreign exchange markets. The second chapter considers the recent experience of Colombia between 2004 and 2007, and examines the effectiveness of central bank intervention in stemming domestic currency appreciation under an inflation-targeting regime. The results indicate that the combination of peso-weakening interventions and expansionary monetary policy between 2004 and 2006 seem to have led to a reduction in appreciation pressures. In contrast,

sterilized intervention was ineffective in stemming domestic currency appreciation during 2007, as large-scale intervention was working against a backdrop of intense monetary tightening.

The third chapter (co-authored with Sebastian Auguste, Kathryn Dominguez and Linda Tesar) explores the ways in which cross-border financial markets are used to circumvent capital controls. We study the recent experience of investors in Argentina who while subject to capital controls, were able to purchase cross-listed shares using local currency, convert them into dollar-denominated shares, re-sell them abroad, and deposit the dollar proceeds in foreign bank accounts. We find that capital controls drive a wedge between the price of local shares and their corresponding cross-listed shares. This wedge provides an implicit devaluation forecast and the market's valuation of capital control circumvention.

Chapter 1

What Hinders Investment in the Aftermath of Financial Crises: Insolvent Firms or Illiquid Banks?[1]

1. Introduction

How do financial crises turn into real recessions? There are two leading views. The first view highlights the importance of a troubled banking sector that cuts lending in the face of a negative liquidity shock (bank lending channel). As argued by Bernanke (1983) if firms cannot smooth out the liquidity shortage from their banks, this can have large contractionary real effects. Chang and Velasco (2001) develop a model for a typical emerging market crisis, where deteriorating access to liquidity is at the center of the problem, hindering investment and growth. During the 2007–2009 global crisis central banks around the world spent hundreds of billions of dollars to rescue their banking systems in fear of such shortages in lending.

The second view stresses the relevance of firms' weak balance sheets and the associated decline in their net worth (balance sheet channel).[2] Bernanke and Gertler (1989) show that shocks that affect net worth can amplify fluctuations. Business downturns deteriorate firms' net worth, which increase the cost of borrowing and decrease investment even further (the so-called accelerator effect). The deterioration of firms' net worth can be the result of a "maturity mismatch" and/or a "currency mismatch" in firms' balance sheets. Maturity mismatch refers to the practice of financing relatively illiquid long-term assets with short-term debt (e.g. Bernanke, Gertler, and Gilchrist, 1996). Currency mismatch results from the practice of denominating assets and liabilities

[1] This chapter was co-authored with Sebnem Kalemli-Ozcan and Carolina Villegas-Sanchez.

[2] Note that the literature also refers to this as the collateral channel since a negative (positive) shock to firms' collateral (which is part of the balance sheet) causes firms' borrowing capacity and net worth to go down (up). See Holmstorm and Tirole (1997).

in different currencies and hence exposing the firm to exchange rate fluctuations. Cespedes, Chang, and Velasco (2004) propose a model in which insolvent firms with weak balance sheets cannot borrow and contract production during depreciations.[3] Given the possibility of such balance sheet effects, central banks have been reluctant to let currencies devalue in response to external shocks, as shown by Calvo and Reinhart (2002).

In order to be able to link financial crises to real outcomes, we have to know the relative importance of these financial constraints. Is it the case that firms cannot borrow due to insolvency or is it the case that banks cannot extend credit given the credit crunch? Both of these channels may cause firms to decrease investment and hinder growth. Our contribution in this paper is twofold. First and foremost, we provide systematic evidence on how financial crises turn into recessions by disentangling these two main sources of financing constraints, bank illiquidity versus firm insolvency. Second, we provide first-time evidence on substantial real effects of bank credit supply shocks, namely on firm-level investment. Although, there is an extensive empirical literature on the bank lending channel that tests the link between shocks to bank capital and the decline in credit provision for firms, this literature has so far been unsuccessful in providing evidence on the effects of such shocks on real outcomes.[4]

The main challenge to identification comes from the necessity of separating the demand for credit by firms from the supply of credit by banks while conditioning on changes in firms' creditworthiness as a result of shocks to their balance sheet. To do so, we utilize the experience of six Latin American countries that went through a range of crises during 1990–2005. We rest our identification on the fact that different types of crises—currency versus banking—affect the supply and demand of credit differentially. During a currency crisis and a twin crisis (which involves both currency and banking crises) demand for credit by exporters will be relatively higher given the depreciated

[3] See also Krugman (1999) and Eichengreen and Hausman (1999).

[4] Most of this literature has not focused on real activity. An early exception is the work by Peek and Rosengren (2000), who investigated using state level data from the U.S., changes in real estate activity in states with large presence of Japanese banks after the Japan banking crisis. Two recent exceptions are the work by Paravisini, Rappoport, Schnabl, and Wolfenzon (2011), and the work by Amiti and Weinstein (2011). Both papers focus solely on exports, showing a negative effect of bank supply shocks on exports. See section 2 for a detailed review.

currency, while supply of credit will be relatively lower under a twin crisis. Hence, we assume the demand for credit on the part of exporters goes up under both type of crises while the supply of credit goes down relatively more under twin crises. The key is to compare the investment undertaken by exporters under currency crises episodes, where there is a positive demand shock, with the investment of exporters under a twin crisis. In the latter case, the profit opportunity is still there but there is also an economy wide credit shortage as a result of the negative supply shock to domestic banks. In these twin crisis episodes, prior to the currency crash the banking system collapses, as shown by Kaminsky and Reinhart (1999) and Reinhart and Rogoff (2010).

We identify from *within* firm changes and therefore we must control for changes in firms' creditworthiness to disentangle the financing constraints. Since both types of crises involve a depreciation of the domestic currency in excess of 25 percent, the creditworthiness of exporters with foreign currency denominated debt is at stake under both type of crises. Conditioning on the changes in creditworthiness through holdings of foreign currency debt, we exploit the degree of foreign ownership of the firm, as a proxy for firm-level liquidity. This strategy allows us to investigate the differential response of foreign-owned versus domestic exporters to a positive demand shock—conditioning on their holdings of foreign currency debt—under currency and twin crises, where only the latter involves a big negative supply shock to the local banking sector.[5]

We study four episodes of currency crises (Mexico 1995, Argentina 2002, Brazil 1999 and 2002). Two of these episodes were twin crises since they were combined with a banking crisis (Mexico 1994, Argentina 2001). In order to have firm-level measures of insolvency and liquidity over time, we have hand-collected a unique panel database with annual accounting information for the whole universe of listed non-financial companies in six Latin American countries, spanning the period 1990 to 2005. For these 1,300 listed firms, we observe time-varying measures of the currency denomination and maturity structure of both debt and assets, firm's export revenue, and foreign ownership stakes. To

[5] In a recent paper Jimenez, Ongena, Peydro-Alcalde, and Saurina (2011) propose an alternative strategy to identify the effect of negative supply shocks to banks on domestic credit provision based on matched bank-firm level data. They provide evidence that the bank lending channel is stronger if one accounts for unobserved time-varying firm heterogeneity. Their estimation strategy using firm-year fixed effects, however, prevents studying the effects of shocks to banks on firm-level real outcomes.

our knowledge, the data is unique in an emerging market setting as it contains cross-country, time-varying information on the currency and maturity composition of firms' balance sheets, the breakdown of sales into domestic and export revenues, and a precise measure of foreign ownership.

We define a potentially insolvent firm as one with high leverage and holdings of *short-term* foreign currency denominated debt that are not matched by a dollar denominated stream of income like dollar assets and/or export revenue. This is based on Allen et al. (2002), who argue that maturity and currency mismatch interact to determine firm's solvency risk. These firms are obviously more likely to experience a decline in net worth in the face of a currency crisis. We measure the liquidity shock, first, at the country-level, by focusing on twin crisis episodes that are characterized by a general dry up of credit in the year prior to the currency crisis for *all* firms. Second, we use different firm-level measures that proxy the relative ease of access to finance, such as bond and stock issuance abroad, and also direct foreign investment into the firm. Given that during crises times markets shy away from emerging countries the former may not be the best measures of access to finance during such times, as argued by Reinhart and Reinhart (2010). Instead, we argue that foreign ownership that captures direct and portfolio equity investment by foreigners is a better measure of access to finance during financial crises and use it throughout the analysis as our preferred firm-level measure of access to liquidity. The reason is that foreign-owned firms are likely to have better access to international markets during crises in the absence of well functioning domestic banks. Foreign affiliates also have the possibility of drawing funds from the parent company through internal capital-market lending.[6]

The differences-in-differences identification strategy allows us to investigate the following hypothesis. If the illiquidity channel is the main source of financial constraints, foreign-owned exporters should invest relatively more than domestic exporters during twin crises but not during currency crises, conditional on short-term foreign currency

[6] Desai, Foley, and Forbes (2008) argue that multinational affiliates access parent equity when local firms are most constrained. Similarly, Antras, Desai, and Foley (2009) present evidence that suggests that even during "normal" times, foreign affiliates increase their reliance on capital flows from the parent company in the presence of weak financial institutions in the country of operation.

denominated debt and leverage. The reason is that only the former is associated with an illiquidity problem that does not affect foreign firms (or would affect them relatively less than domestic firms). Notice in this case we are holding the balance sheet channel constant, by comparing exporters holding short-term dollar debt that only differ in ownership status. In other words, given two firms with the same level of short-term dollar debt and exports, only the foreign-owned firm would increase investment during twin crises. We account for unobserved firm-level heterogeneity via firm fixed effects. Hence we solely identify from *within* firm changes. Use of sector-year fixed effects accounts for all macro and industry supply and demand shocks that are common to all exporters in an industry. The panel dimension of our data allows us to condition on many country specific policy changes and other shocks through the use of country-year effects. For example, if the shock is common to all our countries (or to the world) then it will be absorbed by our time effects. The country-year effects will also allow us to account for the different nature of each crisis, valuation effects and the prior country-level trends.

Although the direction of causality between banking and currency crises is debated in the literature (see Kaminsky and Reinhart (1999), for example) for our purposes this is not relevant given our differences-in-differences methodology that identifies from relative changes in firm-level outcomes. In the twin crisis episodes that we consider, the banking crises were not the result of firm bankruptcies as in some other countries and they predated the currency crises. Nevertheless in order to avoid any concerns about anticipating the *currency* crisis we conduct most of our analysis based on predetermined variables that characterized firms according to their economic outcomes three years prior to the first crisis in each country.

A key advantage of our estimation strategy is that it allows quantifying the extra investment undertaken by firms with access to liquidity as well as the decline in investment as a result of a balance sheet weakness. Our main results are summarized as follows. Conditional on exposure to short term dollar debt, foreign-owned exporters invest relatively more than domestic exporters *only* during twin crises, where domestic firms access to finance is limited given the troubled banking sector. There is no difference in investment between these firms during currency crises. This implies that both set of exporters have similar access to liquidity under currency crises. During twin

crises, however, domestic exporters suffer from the credit crunch. Conditional on changes in short term dollar denominated debt, foreign-owned exporters increase investment by 15 percentage points relative to domestic exporters. Domestic exporters in turn, decrease investment by 11 percentage points relative to foreign exporters. The latter effect suggests not only the inability of domestic exporters to take the investment opportunity but the additional hampering effect of not being able to roll over the short-term debt. Overall our results point to the key role of illiquidity rather than insolvency as the main source of financial constraint that hinders investment and growth in the aftermath of financial crises. This result is fully consistent with the model of Chang and Velasco (2001), where adding foreign direct investment precludes the bank run result of their model.

We proceed as follows. Section 2 discusses the relevant literature. Section 3 presents our data. Section 4 discusses the identification strategy. Section 5 presents the empirical results. Section 6 presents robustness analysis and discusses alternative stories and threats to identification. Section 7 concludes.

2. Related Literature

Our paper is related to different strands of the literature. First, the literature on the bank lending channel focuses on establishing the causal link between a shock to bank capital and lower lending to firms. Unfortunately due to data and/or estimation strategy limitations, this literature does not study the real effects of lower credit such as the effects on firms' investment. The aim of this literature is to establish a casual relationship from the negative supply shocks to banks to declining credit provision to firms. The findings in a developing country context show that this is indeed the case.[7]

Second, our paper draws from the literature on the organization of the firm and in particular, the recent theoretical advances that highlight the interplay by firm heterogeneity and incomplete contracts in explaining the degree of vertical integration of

[7] See Khwaja and Mian (2008), Paravisini (2008), and Schnabl (2010).

the firm.[8] Specifically, Antras, Desai, and Foley (2009) develop a model in which firms wanting to exploit technologies abroad will engage in foreign direct investment, acting as multinationals especially in environments with weak investor protection. External funders require multinational companies' participation in the local project to ensure better monitoring of the investment. As a result, weak financial institutions increase the reliance on capital flows from the parent company. This higher reliance on financing through internal capital markets by the foreign affiliate in general plays a critical role during financial crises. There is a growing literature that investigates the role of foreign ownership and FDI during financial crises. Desai, Foley, and Forbes (2008) investigate the response of sales, assets, and capital expenditure of U.S. multinational affiliates and domestic firms in the aftermath of a variety of financial crises from 25 emerging market countries and find that foreign affiliates outperform their local counterparts across these performance measures. Their interpretation is that local firms are constrained due to their limited access to finance. However, as they acknowledge, they are unable to document the exact mechanism by which currency depreciations differentially intensify financing constraints since they lack data on the currency denomination of the debt. The paper by Blalock, Gertler, and Levine (2008) extends the analysis of Desai, Foley, and Forbes (2008) by focusing solely on exporting plants and investigate the role of foreign ownership for this group of establishments in Indonesia. Their strategy allows identification of the local firms who would benefit most from the currency devaluation.[9] They reinforce the conclusion of Desai, Foley, and Forbes (2008) by showing that foreign-owned exporters clearly increase investment relative to domestic exporters. Alfaro and Chen (2010) using a world-wide dataset on multinational subsidiaries show that, establishments sharing stronger vertical production and financial linkages with the parent company increase sales during the recent "Global Financial Crisis."

All these results are consistent with the existence of financial constraints but the source of the constraint is not clear. It is possible that foreign-owned exporters have

[8] See Antras (2003, 2005), and Antras and Helpman (2004).

[9] Note that Desai, Foley, and Forbes (2008) also investigate the differential impact of the depreciation on multinationals that are export-oriented by proxying exports with sales from subsidiaries abroad. They did not find a stronger effect though. In their analysis, multinational affiliates do better than local firms, regardless of the fact that they are export-oriented.

stronger balance sheets through having less dollar denominated debt than their domestic counterparts. Alternatively they may have more dollar denominated debt but at the same time they may have matching dollar revenue from their exports. Or simply, foreigners might be better at managing their balance sheet. In any of these cases foreign exporters will have higher net worth and will not be facing solvency issues. This creates a selection problem, where certain firms with no solvency issues are in the exporter sample, biasing results on export performance. Solving this selection bias caused by omitting the balance-sheet weakness is at the heart of our paper.

Thus, our paper is also related to the literature that investigates the effect of foreign currency borrowing and the associated weak balance sheets on firms' investment. The work by Aguiar (2005) shows that firms with heavy exposure to short-term foreign currency debt before the Mexican crisis decreased investment compared to firms with lower dollar debt exposure. He shows an increase in sales for both groups but a decrease in investment for the exposed group. Hence, his results support the idea that weak balance sheets can hinder investment during a major currency crisis episode. However, in a very similar study using a bigger sample of Latin American countries during the period 1991–1999, Bleakley and Cowan (2008) show the opposite result focusing on total debt: firms holding dollar debt invest more during exchange rate depreciations. They are the first to argue that firms match the currency composition of their liabilities with that of their income streams or assets, avoiding insolvency during a currency depreciation. Our findings can bridge these two set of studies and provide an explanation for seemingly conflicting results.

3. Data and Construction of Regression Variables

The empirical analysis draws on a unique database with accounting information for over 1,300 companies in six Latin American countries, spanning the period 1990 to 2005. The countries covered are: Argentina, Brazil, Chile, Colombia, Mexico, and Peru. The data was assembled from different sources.[10] A distinct feature of this data is that it

[10] Details of the data are provided in Appendix and further details in Kamil (2009).

contains detailed information on the currency and maturity composition of firms' balance sheets, the breakdown of sales into domestic and export revenues, firms' foreign-ownership structure and other measures of access to international markets, such as corporate bond issuances abroad. This issuance data is at transaction-level and obtained from Dealogic database and includes firms' bond and syndicated loan issuance.

Financial statement data was obtained from annual balance sheet reports drawn from local stock markets and regulatory agencies in each country. Data on foreign currency liabilities and assets (and their maturity structure) was hand-collected from the financial explanatory notes of firms' balance sheets. These are all assets or liabilities outstanding which are denominated in—or indexed to—foreign currency, issued domestically or abroad. In the case of liabilities, these include bank loans, commercial debt, trade credit and foreign securities. Foreign currency assets include cash, government securities indexed to the dollar, bank deposits abroad and overseas client credits.

While firms in many cases report both consolidated and unconsolidated financial statements, we use unconsolidated figures, to reduce variations arising from changes in subsidiaries' ownership and to avoid double counting. Information on firms' export revenues was obtained from income statement data. When this was not available, we used countries' customs office records or Central Bank's Balance of Payments trade registries. In the latter case, we merged balance sheet information with firms' export sales using their tax code identifier and/or name.

3.1 Investment

Our left hand side variable is investment in fixed capital. The measure of investment used in the empirical analysis is the annual change in the stock of physical capital scaled by total assets to control for the firm size. This investment to asset ratio is winsorized at the lower and upper 1 percent level at the country level to control for outliers before it is used in the regression. The stock of physical capital, in turn, is defined as the sum of expenditures on property, plant, equipment, plus technical reappraisal (valuation change), minus cumulated depreciation. We attempt to minimize any exchange rate and valuation effects by normalizing investment by total assets and

including country-year fixed effects, that will absorb common exchange rate fluctuations and valuation effects. In addition, we try to minimize the effects of accounting bias in the value of capital stock by estimating the models with firm-level fixed effects.

3.2 Dollar Liabilities, Export Revenue, and Tradable Sector

We measure dollar liabilities as the ratio of total dollar liabilities to total liabilities and short term dollar liabilities as the ratio of short term dollar liabilities to total short term liabilities. Short-term liabilities refer to outstanding debt that must be payed within 12 months. This measure includes foreign currency denominated debt issued at short maturities as well as long-term issues whose terminal date falls over the next 12 months.

The sources of foreign currency financing differ across countries. In Argentina, Chile, Mexico, and Peru firms can borrow in dollars from domestic banks. In the case of Colombia and Brazil, however, most of companies' foreign currency borrowing is obtained abroad (whether bond issuances, bank loans or trade credit).[11] This is because, in these countries, financial dollarization is severely restricted: on-shore foreign currency deposits are banned and private banks cannot lend in dollars. In Colombia, firms cannot borrow in foreign currency from any type of bank (commercial or state-owned). Therefore, firms located in Colombia can only raise foreign currency by issuing bonds, loans and equity abroad or through trade credit with foreign suppliers. In Brazil, firms that want to borrow in foreign currency domestically can only do so through the state development bank (BNDES) under stringent conditions. In fact, only exporters can borrow easily from BNDES by pledging foreign currency revenue as collateral against dollar debt. Given the fact that we will focus on exporters throughout our analysis, we do not worry about firms in Brazil holding significantly less foreign currency denominated debt than firms in the rest of our five Latin American countries. As we show later, exporters hold more dollar debt than non-exporters across all our countries.

Exporter status defined by export to sales ratio where sales is defined as gross sales from main operating activities. We also define two exporter dummy variables, one that takes the value of one if the firm reported export revenue in a given year and zero

[11] We thank Laura Alfaro for pointing this out.

otherwise. The second one aims to identify exporters with a high exports to sales ratio, so that it takes the value of one if the firms' export revenue represents more than 10 percent of the sales and zero otherwise. This is a substantial improvement over previous studies in the literature that typically used aggregate variables to proxy for firms' access to foreign currency revenue (either a binary tradable/non-tradable classification or industry export shares).

To control for selection, we also define exporting firms based on a predetermined dummy variable. A firm is classified as exporter if she reported export revenue at any time during the three years *prior* to the first crisis.[12] In addition, given the severity of the banking crisis in Colombia, exporters in this country are defined based on whether the firm reported export revenue in 1995, 1996, or 1997 (three years prior to the banking crisis). In Peru and Chile where no substantial banking crisis and/or currency crisis took place during our sample period, predetermined exporters are defined based on whether firms reported export revenue at any time during the period of analysis. Reinhart and Rogoff (2008) identify a banking crisis in Peru 1999 however, the decline in credit to the private sector as a percentage of GDP was only of 3 percentage points between 1999 and 2000 and 5 percentage points between 1999 and 2001, as oppose to 50 percent decline in credit to private sector in the case of Mexico.

3.3 Foreign Ownership

One of the contributions of our paper is to construct a continuous measure of foreign ownership for each firm in our sample. Our indicator of foreign ownership is based on precise dates of ownership changes, foreigner's share in the firm and the nationality of the parent and global ultimate parent. The continuous measure will allow us to explore the role of majority foreign-owned companies by defining a dummy variable that takes the value of one if foreigners own more than 50 percent of the firm's capital structure and zero otherwise. To check whether or not the results are driven by firms

[12] In the case of Argentina, we refer to years 1998, 1999, and 2000; Brazil 1996, 1997, and 1998; Mexico 1991, 1992, and 1993.

becoming foreign-owned during the crises, we also define a predetermined foreign dummy variable as in the case of exporters.

To identify the ownership structure of each firm in our sample and track their changes over time, we proceed in two steps, where we provide details on the construction of the foreign ownership variable in the appendix. First, we gathered data on all cross-border Mergers and Acquisitions (M&A) of Latin-American firms between 1981 to 2005 using the SDC Platinum database from Thompson (for the period 1981 to 2001) and Zephyr from Bureau Van Dijk (from 1997 to 2005). We then identified all transactions where the target involved a firm in our sample. Examining M&As from the 1980s onwards ensures that we capture any change in ownership relationship that predates the firm's first appearance in our sample, that is 1990. For each deal, we obtained the date on which the transaction became effective and characteristics of the target and acquiring firms, in particular, the nationality of the target and acquiring firm, and that of the ultimate parent. The database also includes transaction-specific information on percent of shares acquired and the percent of shares owned before and after the transaction was completed. In total, we consider 4,406 completed deals that resulted in a change in majority control in a target firm in our sample as well as acquisitions of minority stakes (some of which involve multiple acquisitions of the same target). Of the firms in our sample, 28 percent were involved in at least one M&A during the period. For each firm involved in an M&A, we constructed a continuous, time-varying measure of foreign ownership based on the percentage fraction of shares held by foreign and domestic investors in each year.

As a result, the foreign ownership measure can take any value between 0 and 100 and represents the percentage of capital owned by foreign investors at a given point in time. Figure 1.1 shows the evolution of *average* foreign ownership over time in our sample, in a balanced panel. Many Latin American countries underwent massive privatization processes during the 1990s. Therefore, as expected, foreign ownership has steadily grown over time. Most of our sampled firms are domestic and hence the distribution of foreign ownership has a high concentration of firms around zero, where 70

percent of the firms are domestic, as shown in Figure 1.2.[13] Figure 1.3 shows that among those firms with positive foreign ownership, 40 percent of the observations are between 85 percent and 100 percent foreign-owned. Hence foreign investors prefer to have a controlling stake in general. These distributions look similar by country.

Figure 1.1. Foreign Ownership Over Time

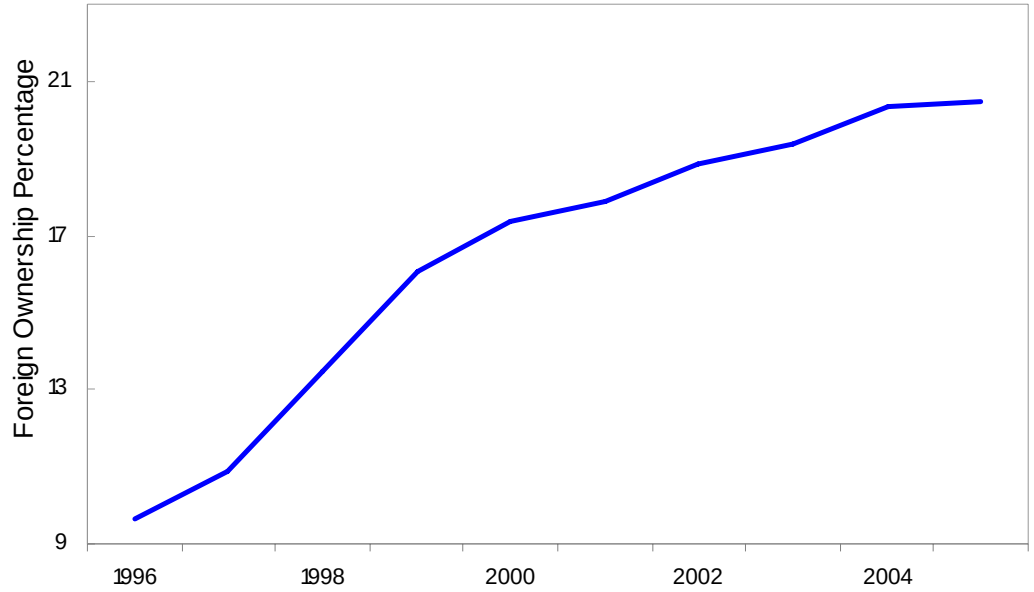
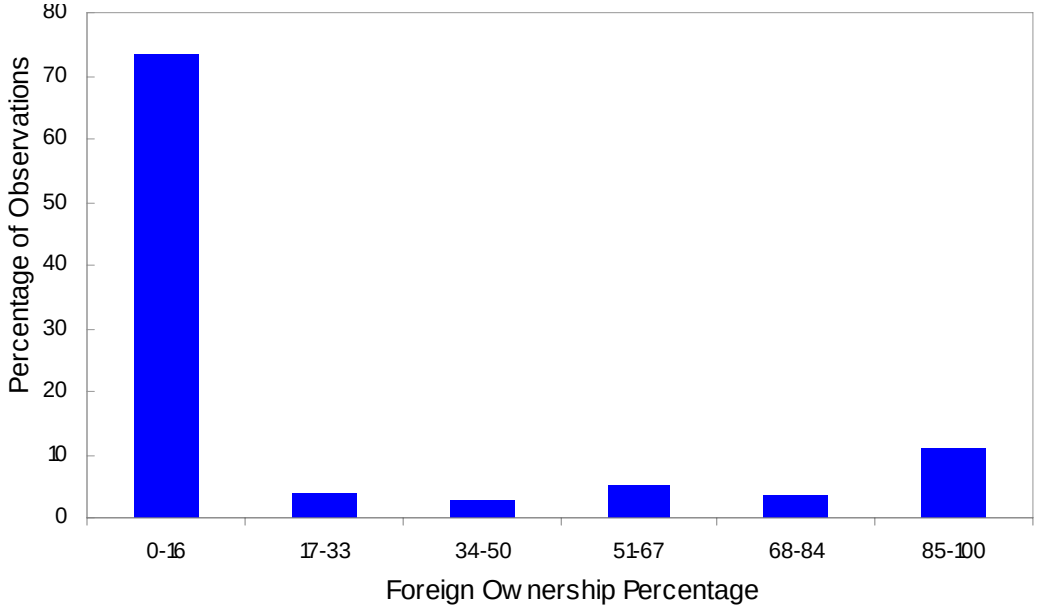
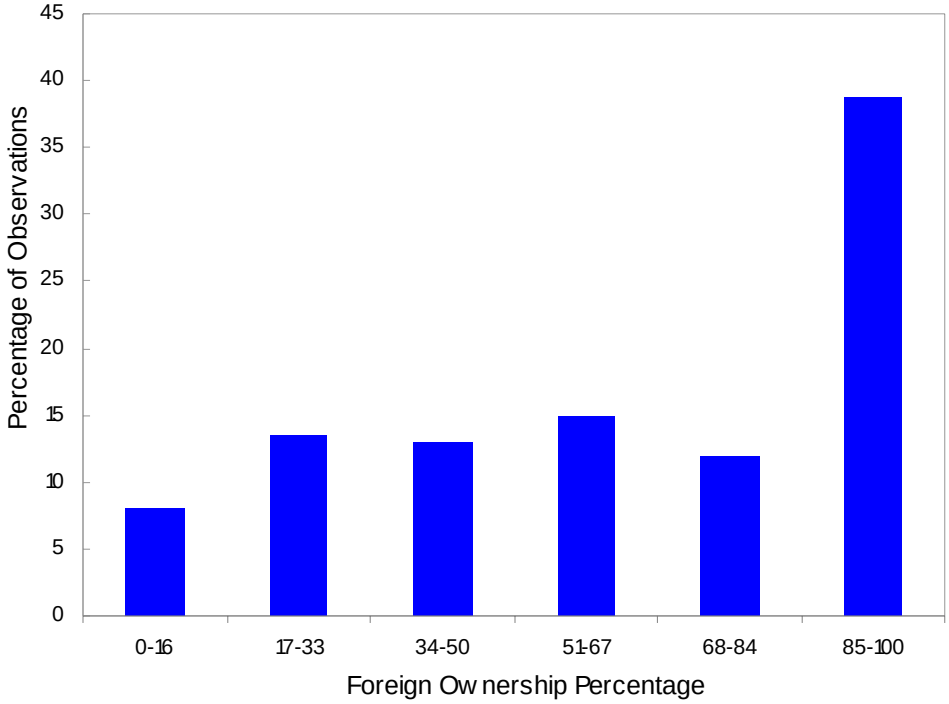


Figure 1.2. Cross-sectional Distribution of Foreign Ownership



[13] We choose 2000 for being an intermediate year but similar figures are obtained using any other year.

Figure 1.3. Cross-sectional Distribution of Foreign Ownership among Foreign Firms



3.4 The Crises Episodes

Table 1.1 shows the currency crisis and banking crisis episodes for our sample of countries together with percent changes in macro aggregates before, during and after the crisis episodes. Following Desai, Foley, and Forbes (2008) we identify a currency crisis in a given year if the real exchange rate increased by more than 25 percent with respect to the previous year. We identify four currency crisis episodes in our sample: Mexico (1995), Brazil (1999), Brazil (2002), and Argentina (2002).[14]

Following Reinhart and Rogoff (2008) we identify the following banking crises: Argentina (1995) and (2001), Brazil (1995), Mexico (1994), and Colombia (1998). Reinhart and Rogoff (2008) base their classification of banking crises on two types of

[14] All four episodes implied a considerable depreciation of the real exchange rate, the two episodes in Brazil amounted to a 34 percent depreciation while Mexico witnessed a 47 percent depreciation and Argentina 96 percent. Notice Mexico abandoned the peg in December 1994 and consequently the end-of year exchange rate only depreciated between December 1994 and December 1995. As expected we do not observe significant differences in the investment rates of foreign-owned exporters relative to domestic exporters during 1994 when the exchange rate had not yet depreciated, since no new investment opportunity had arisen.

events. First, they focus on bank runs that lead to the closure, merging, or takeover by the public sector of one or more financial institutions. Second, in the absence of bank runs, according to their classification, a banking crisis involves the closure, merging, takeover, or large-scale government assistance of an important financial institution (or group of institutions) that marks the start of a string of similar outcomes for other financial institutions.

The banking crises in our analysis, Argentina (2001) and Mexico (1994) were precipitated by different events. In Argentina, in March 2001, a bank run started due to lack of public confidence in government policy actions. There was strong opposition from the public to the new fiscal austerity package sent to the Congress and the amendment to the convertibility law (change in parity from being pegged to the dollar, to being pegged to a basket composed of the U.S. dollar and Euro) as described in Laeven and Valencia (2008). As a result of the bank run, partial withdrawal restrictions were imposed (corralito) and fixed-term deposits (CDs) were reprogrammed to stop outflows from banks (corralon). In Mexico the 1994 banking crisis had different origins. Until 1991 banks were nationalized. With the privatization process in 1991-1992, investors with scarce previous experience in banking wanting to quickly recover their investment extended large amounts of loans without a proper credit risk analysis. This behavior, together with the stagnation of real estate prices and the increase in U.S. real interest rates eroded banks' balance sheets. In 1994, 9 out of 34 banks were intervened and 11 banks participated in the loan/purchase recapitalization program of 34 commercial banks. The 9 banks accounted for 19 percent of the financial system assets.

Table 1.1 shows that, in terms of macroeconomic preconditions in these countries at the time of the crisis, with the exception of Argentina, the other countries were showing similar growth rates of GDP, investment and trade balance. All these percent changes are averages over two years. During and post crisis experiences differ from country to country, showing the importance of including country-year effects. A common feature of recovery in all countries is the increase in investment and exports leading to a positive growth in the trade balance.

Table 1.1. Macroeconomic Outcomes of Twin and Currency Crises

		Argentina	Mexico	Brazil	Brazil
Outcome	Period	2002	1995	1999	2002
GDP per capita growth	prior crisis	-3.7%	1.3%	0.2%	1.3%
	crisis	-2.5%	-2.4%	0.8%	0.5%
	post crisis	7.8%	4.2%	1.3%	3.1%
GFKF to GDP	prior crisis	-12.0%	2.7%	4.0%	2.7%
	crisis	-6.5%	-9.5%	-1.8%	-5.0%
	post crisis	25.0%	14.4%	2.7%	6.1%
Trade Balance to GDP	prior crisis	1.0%	3.9%	3.1%	11.9%
	crisis	29.4%	24.0%	15.7%	2.6%
	post crisis	6.1%	1.1%	11.9%	-0.8%

Notes: Using data on CPI, the real exchange rates were obtained as the deflated end of period exchange rates. A currency crisis is defined as a 25 percent increase in the real exchange rate relative to the previous year. We identify four depreciation episodes in our sample: Argentina (2002), Mexico (1995), Brazil (1999), and Brazil (2002). Mexico abandoned the peg in December 1994, Brazil in January 1999 and finally, Argentina in January 2002. Following Reinhart and Rogoff (2008) we identify the following banking crises that predated a currency crisis: Argentina (2001) and Mexico (1994). Therefore, there are two twin crises episodes (simultaneous currency and banking crisis) in our sample: Argentina (2002) and Mexico (1995). Consequently the crises years are Argentina 2002 and 2003; Mexico 1995 and 1996; Brazil 1999 and 2000; Brazil 2002 and 2003. We report percentage changes over a two year period. GDP stands for Gross Domestic Product. GFKF to GDP stands for the ratio of Gross Fixed Capital Formation to GDP. Trade Balance to GDP stands for the ratio of Exports minus Import to GDP.

3.5 Sample Selection

All firms in the sample are publicly-traded companies. Following previous research, we excluded financial firms. Focusing solely on publicly listed firms was dictated by data availability, and has the disadvantage that the patterns observed for publicly traded firms might not be representative of the corporate sector as a whole. Yet, it has the advantage that financial statistics being more accurate and comprehensive. Moreover, relative to other available databases the coverage of small and medium-sized publicly traded firms is better since we have the whole universe of listed firms. The database covers all firms that are listed—or have been listed—in the six countries' stock exchanges, rather than just the most liquid or with the biggest market capitalization, as has been common in other data sets used widely in cross-country studies such as Worldscope.

Most of our variables are expressed as ratios; where this is not the case, we deflate the nominal magnitudes with 2000 values using December-to-December changes in the

consumer price index and converting them to U.S. dollars using December 2000 market exchange rates. Since we identify of off time variation we exclude all firms with non-consecutive yearly observations (i.e., which appear disappear and reappear in the sample), which constitute 10 percent of the sampled firms. The size of the sample changes as new firms enter and exit the sample. Only less than 10 percent of the firms delisted and hence we believe the survivorship bias is negligible.[15]

This cleaning procedure outlined in the appendix leave us with complete information for an unbalanced panel of 6,175 firm-year observations, which consist of 931 firms with an average of around 7 years each. Finally, data on additional controls included later on in the estimation leaves us with a sample of 5,063 observations or 864 firms.

3.6 Descriptive Statistics

Although our sample is restricted to listed companies there is nevertheless great heterogeneity across firms regarding whether a firm exports or not, their foreign debt holdings and the degree of foreign ownership. Table 1.2 reports the percentage of observations by type of firm, averaged over our sample period. *Foreign* is a dummy that takes the value of one if the company is majority owned (more than 50 percent) by a foreign investor and zero otherwise. In Argentina 53 percent of the sampled firms are foreign-owned while in Colombia only 16 percent would be considered foreign-owned. Another important variable in our analysis is export status. Around 56 percent of the observations report some export revenue and half of those observations report a ratio of export revenue to sales greater than 10 percent. Regarding dollar assets and liabilities, 81 percent of the sample reports some positive debt holding denominated in foreign currency while only 59 percent of the sample reports positive dollar assets. Again these figures vary by country. In Argentina, Brazil, Mexico, and Peru, we have a greater number of observations with positive values of dollar debt.

[15] In order to explore sample bias due to delisting/bankruptcy we look at the original sample that included all firms that were listed at some point in any of these Latin American countries. In Mexico 1995 and Brazil 1999 none of the firms delisted due to a change in ownership. In Argentina 2002 and Brazil 2002 only one of the delisting firms actually changed ownership status the first year of the crisis.

Table 1.2. Percentage of Observations by Country

	Argentina	Brazil	Chile	Colombia	Mexico	Peru	Total
Foreign	0.53	0.29	0.21	0.16	0.18	0.32	0.25
Exporter	0.57	0.48	0.40	0.53	0.68	0.84	0.56
HighExporter	0.29	0.34	0.18	0.31	0.36	0.34	0.30
DumTotalDollarDebt	0.98	0.86	0.66	0.60	0.90	1.00	0.81
DumShortDollarDebt	0.94	0.67	0.65	0.59	0.89	1.00	0.76
DumDollarAssets	0.88	0.21	0.57	0.44	0.95	0.99	0.59
Number of Observations	539	1292	1552	639	1634	519	6175

Notes: Observations refer to the sample of firms left after the cleaning procedure. The number of observations does not coincide with the final number of observations in the estimation due to missing data. *Foreign* is a dummy that takes a value of one if foreigners own more than 50% of the company's capital. *Exporter* is a dummy that takes a value of one if the firm reports export revenue and zero otherwise. *HighExporter* is a dummy that takes a value of one if the firm reports export revenue greater than 10% of sales. *DumTotalDollarDebt* is a dummy that takes a value of one if the firm reports positive total dollar denominated liabilities. *DumShortDollarDebt* is a dummy that takes a value of one if the firm reports positive short-term dollar denominated liabilities. *DumDollarAssets* is a dummy that takes a value of one if the firm reports positive total dollar denominated assets.

There is also extensive variation in the main variables used in the analysis. Table 1.3 reports summary statistics for these variables. On average firms hold 26 percent of their short-term debt denominated in foreign currency while exporters hold on average higher values of their debt denominated in foreign currency (35 percent). 20 percent of total liabilities correspond to short-term bank debt and exporters seem to exhibit only a slightly higher dependence on short-term bank debt at 22 percent. Finally, bonds and equity issuance abroad is limited at 2 percent and loan issuance abroad is only 5 percent. Appendix Table 1.A1 shows correlations.

Table 1.3. Summary Statistics

	Total Sample			Exporter Sample		
	Mean	sd	Obs	Mean	sd	Obs
Investment	0.001	0.07	5063	0.001	0.10	2988
TotalAssets	18.72	2.00	5063	19.00	1.79	2988
ShortDollarDebt	0.26	0.28	5063	0.35	0.29	2988
ExportShare	0.11	0.21	5063	0.17	0.24	2988
HighExporter	0.28	0.45	5063	0.42	0.49	2988
Foreign	0.15	0.36	5063	0.17	0.38	2988
ShortBankDebt	0.20	0.19	5063	0.22	0.20	2988
BondAbroad	0.02	0.14	5063	0.02	0.16	2988
LoanAbroad	0.05	0.21	5063	0.06	0.24	2988
EquityAbroad	0.02	0.15	5063	0.02	0.15	2988

Notes: Statistics refer to the final sample of firms used in the estimation. The exporter sample is based on a predetermined export dummy that is equal to one if the firm reported export revenue during the three years prior to the first crisis and zero otherwise. *Investment* is physical stock of capital at time *t* minus physical stock of capital at time *t*–1 normalized by total assets. *TotalAssets* is the log of lagged total assets. *Foreign* is the percentage of capital owned by foreign investors (lagged). *ShortDollarDebt* is the ratio of short-term dollar denominated liabilities to short-term debt (lagged). *ExportShare* is the ratio of export revenue to total sales (lagged). *HighExporter* is a dummy that takes a value of one if the ratio of exports to sales is higher than 10% (based on lagged *ExportShare*). *ShortBankDebt* is the ratio of short-term bank debt to total liabilities (lagged). *BondAbroad* dummy that takes a value of one if the firm has issued bonds abroad (lagged). *LoanAbroad* dummy is similarly defined if the firm has issued syndicated loans abroad (lagged). *EquityAbroad* dummy is equal to one if the firm has issued equity abroad (lagged).

There is also great heterogeneity in dollar debt holdings across different types of firms. This is the crucial variation that we exploit in the paper. Table 1.4 shows that on average exporters hold more dollar debt than non-exporting firms. Moreover, foreign-owned and domestic exporters hold similar average ratios of short-term debt denominated in foreign currency. However, there is great variation across countries. While in Argentina, Brazil, and Colombia, foreign-owned exporters hold a higher share of their short-term debt denominated in dollars than domestic exporters, in Mexico and Peru domestic exporters show a higher tendency to hold short-term dollar denominated debt.

Table 1.4. Dollar Debt by Firm Type: Summary Statistics

	Exporter			Non-Exporter		
	Mean	Median	Observations	Mean	Median	Observations
Argentina	0.52	0.58	106	0.44	0.41	58
Brazil	0.28	0.24	331	0.13	0.02	458
Chile	0.28	0.21	936	0.07	0.00	608
Colombia	0.10	0.04	328	0.07	0.00	293
Mexico	0.44	0.43	974	0.24	0.15	644
Peru	0.53	0.54	313	0.52	0.55	14
Total	0.35	0.31	2988	0.15	0.02	2075
	Foreign			Domestic		
	Mean	Median	Observations	Mean	Median	Observations
Argentina	0.56	0.60	74	0.43	0.42	90
Brazil	0.17	0.08	105	0.19	0.11	684
Chile	0.17	0.04	362	0.21	0.07	1182
Colombia	0.09	0.08	37	0.09	0.01	584
Mexico	0.31	0.32	130	0.36	0.32	1488
Peru	0.48	0.46	109	0.56	0.57	218
Total	0.26	0.17	817	0.26	0.16	4246
	Foreign Exporter			Domestic Exporter		
	Mean	Median	Observations	Mean	Median	Observation
Argentina	0.58	0.61	47	0.47	0.52	59
Brazil	0.30	0.34	42	0.28	0.23	289
Chile	0.21	0.11	224	0.30	0.23	712
Colombia	0.09	0.08	37	0.10	0.03	291
Mexico	0.33	0.33	119	0.45	0.45	855
Peru	0.47	0.44	105	0.56	0.57	208
Total	0.31	0.27	574	0.35	0.31	2414
	Foreign High Exporter			Domestic High Exporter		
	Mean	Median	Observations	Mean	Median	Observation
Argentina	0.61	0.69	25	0.47	0.51	27
Brazil	0.35	0.41	19	0.29	0.25	238
Chile	0.21	0.11	62	0.40	0.37	352
Colombia	0.13	0.15	8	0.16	0.07	107
Mexico	0.33	0.31	42	0.55	0.58	445
Peru	0.53	0.54	46	0.65	0.70	108
Total	0.37	0.35	202	0.43	0.43	1277

Notes: Mean, median and number of observations for the variable *ShortDollarDebt* are reported. *ShortDollarDebt* is the ratio of short-term dollar denominated liabilities to short-term debt. *Exporter* is a dummy variable that takes a value of 1 if the firm reports any export revenue at any time during the three years prior to the first crisis and 0 otherwise. *Foreign* is a dummy variable that takes a value of 1 if the firm is more than 50% owned at any time during the three years prior to the first crisis and 0 otherwise. *HighExporter* is a dummy variable that takes a value of 1 if the firm reports export revenue higher than 10% of sales at any time during the three years prior to the first crisis and 0 otherwise.

4. Identification Strategy

Our objective is twofold: We want to identify whether financial crises translate into lower firm-level investment, and, if so, through which channel this happens. The main challenge to identification is to separate the demand for credit by firms from the supply of credit by banks, holding firm creditworthiness constant. Exploiting firm-level variation during different type of crises that moves demand and supply for credit in opposite direction is key for our identification. A currency crisis is a positive demand shock for exporters and a banking crisis is a negative supply shock.

Currency crises can also impact firms' creditworthiness by inflating the value of dollar denominated debt holdings. In order to account for the balance sheet channel we incorporate into the analysis the dollar debt holdings of these exporting firms. Exporting firms without dollar debt holdings would not experience a decrease in net worth due to a depreciated currency. The decline in net worth experienced by exporting firms holding dollar debt would ultimately depend on their ability to match dollar denominated income (exports) and dollar debt holdings. As a result, we focus on the sample of exporting firms that are the ones expected to increase investment and at the same time have the opportunity to avoid a mismatch on their balance sheet. Table 1.4 shows that the median exporting firm holds on average 31 percent of short-term debt denominated in foreign currency while the median non-exporting firm holds less than 1 percent of the short-term debt denominated in dollars (notice the high variation across countries).

Regarding the liquidity channel, we exploit both country and firm-level heterogeneity. We observe more than one depreciation episode and some of these episodes are combined with banking crises. Hence, *all* the currency crises episodes share the depreciation of the currency and consequently, a potential balance sheet weakness. However, in *some* of the depreciation episodes there is in addition, an economy-wide liquidity shock resulting from the troubled domestic banking sector (these are the so-called twin crises episodes). As argued by Kaminsky (2006) not all currency crises are the same. Twin and currency crises are different treatment events. They are both characterized by the depreciation of the currency but in addition, twin crises involve a general dry up of available funds. During twin crises, even firms that do not experience a

deterioration of their net worth might have difficulties in accessing external financial resources and therefore invest less.

We exploit firm-level heterogeneity in liquidity under different crisis episodes utilizing data on the ownership structure of the firm. As discussed before, several recent papers have shown that foreign-owned companies outperform domestic companies during financial crises. This evidence is consistent with an access to finance explanation where foreign-owned firms outperform the domestic counterparts during a crisis given their connections to international financial markets and/or deeper internal capital markets. An alternative explanation for the higher investment of foreign owned firms is that these firms may not suffer from weak balance sheets since they are insulated from exchange rate fluctuations. Our identification strategy will allow us to disentangle these two sources of liquidity constraints, insolvency versus illiquidity. We compare investment of foreign owned exporting firms with dollar debt holdings to that of domestic exporting firms who also have dollar debt holdings. This will allow us to identify the exact mechanism for the financial constraint. Conditional on the assumption that during a currency crisis the financial sector does not face liquidity constraints, we should observe no significant differences between foreign-owned and domestic exporting firms holding their creditworthiness constant. During a twin crisis, on the other hand, foreign-owned exporting firms should invest relatively more than domestic exporting firms since domestic firms that are heavily reliant on the domestic banking system will witness a sharp decline in the availability of credit. Our data on bank dependence (i.e., the ratio of short-term bank debt to total liabilities) confirm that on average the ratio of short-term bank debt to total liabilities for exporting firms is 16 percent while that of high exporters is 25 percent. This is in line with the channel outlined in Amiti and Weinstein (2011) where exporting firms rely heavily on short-term debt for operation. Within the sample of high exporters there are no major significant differences across domestic and foreign-owned companies regarding their reliance on short-term bank debt (both types of firms show a bank dependence ratio of around 24 percent).[16] Despite the similar reliance of domestic and foreign-owned companies on bank credit, which confirms the suitability of

[16] Notice that we are not able to determine whether the bank debt is from domestic or international banks that might be more or less exposed to the national country shock

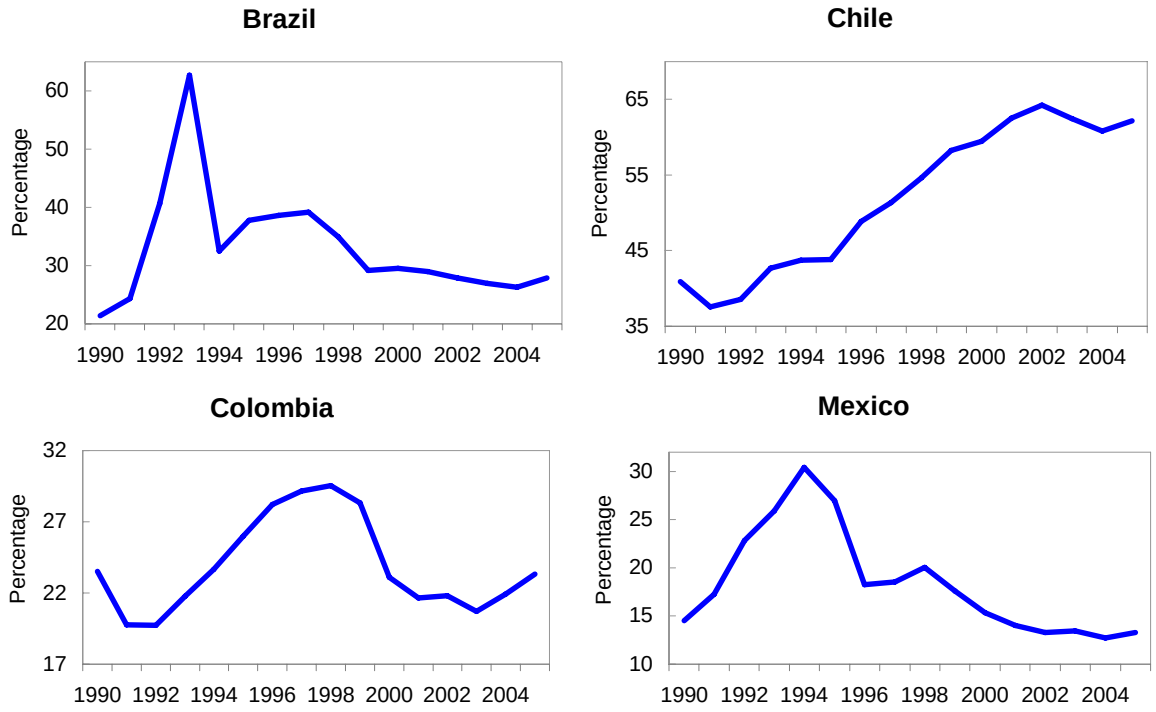
comparing these firms, foreign-owned exporting firms would still have access to international financial markets either directly or through the parent company.

A critical assumption for our study is that banks are illiquid only during twin crises and not during currency crises. Notice that our results do not rest on the very strict form of this assumption. We only need banks to be *relatively* more illiquid during twin crises compared to currency crises. Since the seminal work of Kaminsky and Reinhart (1999), there has been an extensive literature highlighting the role of a troubled banking sector that turns a currency crisis into a twin crisis. This is especially relevant for emerging markets where stock and bond markets are less developed and banks are the main source of credit. Therefore, bank illiquidity means a halt in domestic credit provision. Banks can also be insolvent if they have a balance-sheet mismatch of their own. For our purposes of focusing on the real effects of the crisis, where the investment decision is taken by the firm, the key factor is whether or not banks can provide liquidity to firms, regardless of whether they are themselves illiquid or insolvent. The extensive literature on the bank lending channel also provides evidence on the causal link between a negative shock to banks and the credit provision to firms in a developing country context, as reviewed in section 2. The critical issue here is that all the banking crises predate the currency crises and were not originated by firm bankruptcy, which was the case as discussed in section 3.4. If banks become insolvent under a currency crisis and halt domestic credit provision as much as in the case of a twin crisis, then our firm-level access to finance measure—foreign ownership—should not have differential explanatory power among the types of crisis, i.e., domestic firms should do worse than foreign-owned firms under both types of crisis.

Figure 1.4 demonstrates the case in point and shows that in our sample, countries that experienced a twin crisis witnessed a significant decline in domestic credit provision, whereas this did not happen in countries that went thorough currency crisis episodes. The top left panel shows domestic credit to the private sector (as a percent of GDP) in Chile, a country that had no crises during our sample period. The top right panel shows the case of Colombia, who had a banking crisis in 1998. The 15 percentage point decline in domestic credit is clearly visible. The bottom left panel shows the case of Mexico where the banking crisis of 1994 is followed by the currency crisis in 1995. Again domestic

credit as percent of GDP dropped sharply, corresponding to a 50 percent decline in credit provision to the private sector. Finally, the bottom right panel represents Brazil who did not suffer from a collapse in bank lending during the currency crises of 1999 and 2002.[17]

Figure 1.4. Banks' Credit to the Private Sector as a share of GDP



For our identification strategy, summarized above, we need to run a triple difference-in-difference specification that we estimate for the sample of exporting firms:

[17] Notice the beginning of the 90s was a very turbulent period in Brazil. Inflation was rampant with a peak of 82.4 percent in March 1990. A new government designed a stabilization program, Plano Real, aimed to reduced fiscal deficit and introduced a new currency. During the 1980s, banks acted as intermediaries of the public sector debt and benefited from high inflation and indexation. To avoid reducing their profits once inflation was brought down, banks initially expanded credit (mostly through consumer and commercial loans). Although the new currency brought down inflation, it could not prevent the banking crisis in 1995. The sharp decline in domestic credit to the private sector is clear from Figure 1.4. The scale does not show the 15 percentage point decline in credit from 1995 to 1998 and the subsequent slightly increase from 1998 to 1999. Similarly, prior to the currency crisis of 2002, domestic credit to GDP slightly increased.

$$
\begin{aligned}
y_{i,c,j,t} = {} & \beta_1 Foreign_{i,c,j,t-1} \times SDDebt_{i,c,j,t-1} \times Post_{c,t} \\
& + \beta_2 Foreign_{i,c,j,t-1} \times SDDebt_{i,c,j,t-1} \\
& + \beta_3 Foreign_{i,c,j,t-1} \times Post_{c,t} \\
& + \beta_4 SDDebt_{i,c,j,t-1} \times Post_{c,t} \\
& + \beta_5 Foreign_{i,c,j,t-1} \\
& + \beta_6 SDDebt_{i,c,j,t-1} \\
& + \phi_{j,t} + \varphi_{c,t} + \alpha_i + \xi_{i,c,j,t}
\end{aligned} \tag{1.1}
$$

where $y_{i,c,j,t}$ is the outcome of firm *i*, in country *c*, in sector *j* at time *t*. For the outcome variables, we use sales and investment scaled by total assets to control for firm size.

Foreign can be used as a continuous variable and also as a dummy that takes the value of one if the company is foreign-owned and zero otherwise. *SDDebt* measures lagged short-term dollar denominated liabilities, which are liabilities with residual maturity of twelve months. We focus on short-term debt since as mentioned in the introduction, the literature argues that this is the most relevant variable determining balance sheet mismatch vulnerability (see Setser et al., 2005).[18] *Post* is the depreciation dummy and equals to one in the year of crisis and one year after. We include $\phi_{j,t}$ that controls for sector-year fixed effects, $\varphi_{c,t}$ that captures country-year fixed effects, α_i are firm-specific effects, and $\xi_{i,c,j,t}$ is the error term.[19] By using firm fixed effects we will be identifying solely from firm changes over time. Country-year effects will absorb the effects of any other macroeconomic shock.

The triple interaction turns out to be crucial in correctly identifying the groups of firms that will benefit or will be hurt by the crisis. To see why, we compare the interpretation of the coefficients in equation (1.1) to those that would result from estimating the following equation:

[18] We have also experimented with the ratio of short-term dollar debt in total debt obtaining similar results. The correlation between the two is 0.87.

[19] Notice that the Post dummy is captured in the country-year fixed effects. Time dummies are also absorbed by this fixed effect.

$$
\begin{aligned}
y_{i,c,j,t} = {} & \beta_3 Foreign_{i,c,j,t-1} \times Post_{c,t} \\
& + \beta_4 SDDebt_{i,c,j,t-1} \times Post_{c,t} \\
& + \beta_5 Foreign_{i,c,j,t-1} \\
& + \beta_6 SDDebt_{i,c,j,t-1} \\
& + \phi_{j,t} + \varphi_{c,t} + \alpha_i + \xi_{i,c,j,t}
\end{aligned} \tag{1.2}
$$

In equation (1.1), β_4 is the effect of holding dollar debt after the crisis *only* for the sample of domestic exporting firms. This is not the case for β_4 in equation (1.2) since now this coefficient will reflect a combined effect of foreign-owned and domestic exporting firms. Similarly, β_3 in equation (1) captures the investment behavior of foreign-owned exporting companies with no dollar debt relative to those foreign-owned exporting companies with dollar debt at the time of the crisis, β_1. Compared to equation (1.2) the advantage is that the coefficient β_3 in equation (1.1) does not confound the effect of foreign-owned exporting companies holding and not holding dollar debt as it would be the case of the coefficient β_3 in equation (1.2).

If exporting firms match their dollar holdings with export revenue, we expect β_4 in equation (1.1) to be insignificant since the investment rate of domestic exporting firms who hold dollar debt should not be significantly different than that of foreign-owned exporting firms with dollar debt. We expect them both to have strong balance-sheets as a result of matching their dollar debt to their export revenue. Hence, β_1 compared to β_4 is the incremental effect of being a foreign-owned company among exporting firms holding dollar debt. If $\beta_1 > \beta_4$ (i.e., foreign-owned exporting firms holding dollar debt outperform domestic exporters holding dollar debt) we interpret this as the "access to finance" effect or evidence for the liquidity channel. Both foreign-owned and domestic exporting firms experience a similar change in their net worth but foreign-owned exporting firms manage to increase investment *relative* to domestic exporting firms. This means that there is something different about foreign-owned exporting firms with dollar debt at the time of the crisis. Our interpretation of this difference is access to external funds. The potential finding $\beta_1 < \beta_3$ (i.e., foreign-owned exporting firms with dollar debt under-investing relative to foreign-owned exporters without dollar debt holdings) would highlight the importance of insolvency since comparing firms that have the best access to liquidity

(i.e., foreign-owned companies), those with a deterioration in their balance sheet would under-invest.

Therefore, to summarize, if both foreign-owned and domestic exporters with dollar debt holdings can avoid a mismatch on their balance-sheet and hence insolvency, then the differential response between the two captures access to liquidity. This result should only hold when domestic companies suffer from a liquidity problem. Hence, we should see foreign-owned exporters with dollar debt investing more relative to domestic exporters with dollar debt holdings only under twin crises. This can only be done by means of a triple interaction rather than a double interaction that would mask the groups of interest. In addition, one of the key advantages of this specification is that it allows quantifying the total effect of dollar debt holdings and identifying those firms that are benefited/hurt by the crisis. Finally, the identification strategy relies on the fact that there are no prior differential trends in outcomes of foreign versus domestic exporters with dollar debt, especially during a twin crisis. Our robustness section will show this is indeed the case. Next, we turn to the regression analysis.

5. Results

Table 1.5 shows the results from estimating equation (1.1) for the sample of exporting firms.[20] Following Aguiar (2005), an exporter is defined as a firm whose export revenue to sales ratio is more than 10 percent. The 10 percent cut off level corresponds to the 75 percentile of the distribution of exports to sales ratio. The main reasoning behind choosing this sample is to consider firms with enough export revenue to compensate any potential mismatch derived from dollar debt holdings. According to our estimation strategy, columns (1) to (4) of Table 1.5 concentrate on the twin crises episodes, (i.e., Argentina (2002) and Mexico (1995) where both countries had a banking crises in the year prior to the currency crisis). Columns (5) to (8) refer to the currency crises episodes

[20] In order to properly implement country-year and sector-year fixed effects in the presence of triple interactions and continuous variables, through out the analysis we demean all continuous variables by removing country-year and sector-year averages from firm-level values.

(i.e., Brazil (1999, 2002) which involved a depreciation of the currency of more than 25 percent but there was not a decline in the supply of credit (see Figure 1.4)).[21]

Column (1) in Table 1.5 shows our main result: foreign-owned exporters holding dollar debt increase investment (0.211) relative to domestic exporters holding dollar debt (-0.150) and foreign-owned exporters with no dollar debt (0.127) during twin crises. On the contrary, column (5) shows that foreign-owned exporters holding dollar debt (-0.068) do not behave significantly differently than domestic exporters with dollar debt (0.053) or foreign-owned exporters without dollar debt (-0.033) during currency crises. Notice that according to the F-test in column (5) the total effect from dollar debt or foreign ownership is not significant during the currency crises years. In fact none of the total effects are significant under currency crisis episodes.

Columns (2) and (6) show similar results when the exporting sample is defined according to whether the firm reported export revenue that accounted for more than 10 percent of sales during the three years prior to the crises. The recent literature on firm heterogeneity and trade shows that it is most productive firms that enter the export market and among those, only the ones with the highest productivity will engage in FDI activities (Helpman, Melitz, and Yeaple, 2004). Therefore, the depreciation episode would make firms near the threshold productivity cut-off level enter the export market. These firms would be more productive than the non exporting ones but less productive than the ones that were already exporting. Changes in export status from nonexporter to exporter at the time of the crisis were relatively limited in our sample and accounted for 5 percent of the exporting observations at the time of the crisis. These findings are similar to those in Gopinath and Neiman (2011) that show how during the 2002 Argentinean financial crisis there was not a significant change in the number of exported varieties.[22] Nevertheless, to avoid concerns about selection into the export market at the time of the crises columns (2) to (4) and (6) to (8) use a predetermined export dummy to define the exporter sample.

---

[21] Notice the post dummy always refers to the year of depreciation and year after. Given that the treatment is based on a time dummy, standard errors are clustered at the year level throughout the analysis. However, similar results where obtained for most specifications when clustering at the country level.

[22] Gopinath and Neiman (2011) also show that the extensive margin of imports played a small role during the 2002 Argentinean crisis and it was mainly driven by small importers. However, the churning of inputs within firms played a sizeable role in aggregate adjustment. For our purposes the important finding is that they show how these differences are not driven by differences between domestic and MNCs.

Table 1.5. The Differential Response of Foreigners Holding Dollar Debt During Crises. Dependent Variable: Investment. Subsample Of Exporters

Crisis	Twin Crises				Currency Crises			
Exporter Definition	Benchmark		Predetermined		Benchmark		Predetermined	
Foreign Definition	B-mark	B-mark	Predeter.	Predeter.	B-mark	B-mark	Predeter.	Predeter.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ShortDollarDebt × *Foreign* × *Post*	0.211**	0.280**	0.183*	0.191**	-0.068	-0.013	-0.060	-0.063
	(0.07)	(0.11)	(0.09)	(0.06)	(0.07)	(0.10)	(0.09)	(0.09)
ShortDollarDebt × *Foreign*	0.017	0.045*	0.007	0.017	0.034	0.056**	0.020	0.025
	(0.03)	(0.02)	(0.03)	(0.03)	(0.03)	(0.02)	(0.03)	(0.03)
Foreign × *Post*	0.127*	0.143*	0.113*	0.043	-0.033	0.003	-0.019	-0.011
	(0.07)	(0.07)	(0.06)	(0.04)	(0.03)	(0.05)	(0.03)	(0.04)
ShortDollarDebt × *Post*	-0.150**	-0.190**	-0.182**	-0.182**	0.053	0.060	0.063	0.063
	(0.06)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)
Foreign	0.012	0.018	..		0.016	0.020	.	.
	(0.02)	(0.02)	..		(0.02)	(0.02)	.	.
ShortDollarDebt	-0.013	0.009	0.015	0.016	-0.025	-0.003	0.003	0.005
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
ShortBankDebt	-0.023	-0.037**	-0.037**	-0.041**	-0.021	-0.036**	-0.036**	-0.042**
	(0.02)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)
BondAbroad	0.029*	0.030	0.030	0.026	0.033**	0.035	0.035	0.031
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
InternationalLoan	0.000	0.011	0.012	0.011	0.001	0.011	0.011	0.011
	(0.01)	(0.02)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)	(0.02)
Equity	0.002	-0.004	-0.006	-0.005	-0.001	-0.009	-0.011	-0.008
	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)	(0.02)
Observations	1394	1445	1445	1445	1394	1445	1445	1445
Firms	305	233	233	233	305	233	233	233
Firm Fixed-Effects	yes	yes	yes	yes	yes	yes	yes	yes
Sector*year	yes	yes	yes	yes	yes	yes	yes	yes
Country*year	yes	yes	yes	yes	yes	yes	yes	yes
Foreign*year	no	no	no	yes	no	no	no	yes
F-test								
ShortDollarDebt	0.039	0.007	0.034	0.008	0.703	0.079	0.855	0.751
Foreign	0.006	0.009	0.230	0.016	0.731	0.219	0.883	0.692
ShortDollarDebt × *Post*	0.014	0.020	0.013	0.004	0.630	0.651	0.647	0.662
Foreign × *Post*	0.007	0.028	0.139	0.008	0.524	0.908	0.784	0.566

Notes: Standard errors are corrected for clustering at the year level and are reported in parenthesis. *Investment* is normalized by total assets. In columns (1) to (4) *Post* is a dummy variable that takes a value of one in the year of the twin crisis and one year after; the starting year is 2002 for Argentina and 1995 for Mexico. Columns (5) to (7) refer to currency crises; the starting year is 1999 and 2002 in Brazil. Starting years are the depreciation years in both cases. In columns (1) and (5) the subsample of exporters refers to those firms with export to sales ratios greater than 10 percent lagged one period. In columns (2), (3), (4), (6), (7), and (8) the subsample of exporters is based on whether the firm reported export revenue greater

than 10% of sales at any time during the three years prior to the first crisis. *Foreign* is a dummy variable that takes a value of one if foreign investors own more than 49 percent of the company and zero otherwise and it is lagged one period except in columns (3), (4), (7), and (8) where foreign is a dummy variable that takes a value of one if foreign investors own more than 49 percent of the company at any time in the three years prior to the first crisis. *ShortDollarDebt* is the ratio of short-term dollar denominated liabilities to total short-term liabilities. *ShortBankDebt* is the ratio of short term debt from banks to total liabilities. *BondAbroad* is a dummy that takes a value of one in the year the firm issues a corporate bond abroad. *InternationalLoan* is a dummy that takes a value of one in the year the firm issues syndicated loans abroad. *Equity* is a dummy that takes a value of one in the year the firm issues equity abroad. All variables are lagged one period. The F-test reports the corresponding p-values associated to the joint significance of the coefficients associated with each variable of interest. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

We include in all columns firm-specific control variables to account for the following concerns. First, dollar debt holdings might not be an issue if the firm is not leveraged, i.e., the short-term debt might not be a big fraction of total debt, then it would not be a concern even if most of the short-term debt is denominated in dollars. This type of firm may not face an insolvency problem. Second, we assume that firms in countries that experienced a twin crisis cannot finance investment and/or working capital at the time of the crisis through banks. Several studies have highlighted the dependence of firms on the local banking system in Latin America, such as Demirguc-Kunt and Levine (2001). Therefore, we control for the ratio of short-term bank debt to total liabilities to proxy for bank dependence and leverage, which enters as negative and significant. Third, we also assume that firms are not able to borrow in international markets at the time of the crisis. This is a typical characteristic of emerging market crises where foreign investors are dissuaded by the bad economic conditions of any lending to these firms in the eve of or during the crisis. To check this, using data from Dealogic Bondware and Loanware, we include measures of access to international markets like "bond abroad" dummy that takes the value of one in the year the firm issues a corporate bond abroad, "international loan" dummy that takes the value of one in the year the firm issues a syndicated loan abroad, and "equity abroad" dummy that takes the value of one in the year the firm issues stock abroad (either as ADR or GDR, whether in the US or other stock market). Although these measures are good proxies for external sources of financing during tranquil times we believe these measures will be relatively weak during financial turbulent times as argued by the sudden stop literature since markets shy away from emerging markets during such times (see for example Calvo and Mendoza, 2001,

and Reinhart and Reinhart, 2010). Indeed these measures turn out to be insignificant in all specifications. We rely on foreign ownership as a main arms' length source of financing for foreign affiliates located in emerging markets, especially during financial crises.

A potential threat to a proper identification arises from the possibility that productive firms are bought out by foreigners during the crisis although the evidence so far seems to be showing the opposite. Aguiar and Gopinath (2005) show that foreign investors buy inferior firms at fire-sale prices. Nevertheless, we define foreign status as a dummy based on the ownership status of the firm three years prior to the crisis in columns (3) and (7). Clearly, the results are not sensitive to the way foreign and export status are defined. This is expected since although, there are 17 cases in which a domestic firms changed ownership status to majority foreign-owned at the time of the devaluation in the total sample, in the exporter subsample there are only 7 of such cases. Finally, columns (4) and (8) explore whether the results could be driven by foreign-owned firms being on a different trend than domestic firms. To shed some light on this possibility columns (4) and (8) add foreign-year fixed effects. The results stay the same.

If insolvency through a worsening of the balance sheet was the dominant channel hindering investment we should observe no difference between foreign-owned and domestic exporters that hold dollar debt under any type of crisis. Clearly, foreign-owned firms do not suffer an illiquidity problem during a twin crisis and do better relative to domestic exporters, regardless of their solvency issues. The results imply sizeable impact. Results in column (1) indicate that comparing a domestic exporter in the 90th percentile of the distribution of short-term dollar debt to a domestic exporter in the 10th percentile, implies a decrease of investment of 11 percentage points for the former. At the same time, a foreign exporter experiencing a similar increase in the short-term dollar debt ratio would have increased investment by 15 percentage points relative to a domestic exporter. These effects are economically significant especially given the variation absorbed by the battery of fixed effects.

6. Robustness and Threats to Identification

6.1 Robustness

We conduct a series of robustness checks for our main results obtained in column (4) of Table 1.5 and present the results in Table 1.6.

Table 1.6. Robustness. Dependent Variable: Investment
Subsample of Exporters

Exporter Definition	Predetermined			
Foreign Definition	Predetermined			
	(1)	(2)	(3)	(4)
ShortDollarDebt × *Foreign* ×	0.236**	0.178**	0.121**	0.191**
	(0.12)	(0.07)	(0.06)	(0.07)
ShortDollarDebt × *Foreign*	0.026	0.024	0.026	0.031
	(0.04)	(0.03)	(0.03)	(0.03)
ShortDollarDebt	0.012	0.008	0.022	0.016
	(0.02)	(0.03)	(0.02)	(0.03)
ShortDollarDebt × *Post*	-0.238**	-0.152**	-0.209**	-0.182**
	(0.11)	(0.07)	(0.08)	(0.07)
Foreign	.	.	.	.
	.	.	.	.
Foreign × *Post*	0.083	0.037	0.030	0.053
	(0.07)	(0.03)	(0.04)	(0.04)
DollarAssets	-0.019			
	(0.04)			
DollarAssets × *Post*	-0.362			
	(0.30)			
Cash		0.216***		
		(0.04)		
Cash × *Post*		-0.521		
		(0.32)		
Leverage			-0.086***	
			(0.02)	
Leverage × *Post*			0.245*	
			(0.14)	
LongBankDebt				-0.056**
				(0.02)
ShortBankDebt	-0.048**	-0.039**	-0.036**	-0.054**
	(0.02)	(0.01)	(0.01)	(0.02)
BondAbroad	-0.002	0.009	0.031	0.022
	(0.03)	(0.02)	(0.02)	(0.02)
InternationalLoan	0.021	0.007	0.011	0.016
	(0.02)	(0.02)	(0.02)	(0.02)
Equity	0.004	-0.011	-0.003	-0.004
	(0.02)	(0.02)	(0.02)	(0.02)
Observations	1188	1409	1445	1392
Firms	200	230	233	231
Firm Fixed-Effects	yes	yes	yes	yes

Sector*year	yes	yes	yes	yes
Country*year	yes	yes	yes	yes
Foreign*year	yes	yes	yes	yes
F-test				
ShortDollarDebt	0.199	0.034	0.016	0.006
ShortDollarDebt × *Post*	0.080	0.020	0.007	0.005
Foreign × *Post*	0.102	0.025	0.136	0.028
NewControl × *Post*	0.443	0.000	0.002	

Notes: Standard errors are corrected for clustering at the year level and are reported in parenthesis. *Investment* is normalized by total assets. In columns (1) to (4) *Post* is a dummy variable that takes a value of one in the year of the twin crisis and one year after in Argentina (2002) and Mexico (1995). The subsample of exporters is based on predetermined values and it refers to those firms with export to sales ratios greater than 10 percent at any time during the three years prior to the first crisis. Foreign is similarly defined in terms of predetermined values and takes a value of one if foreign investors own more than 49 percent of the company at any time during the three years prior to the first crisis and zero otherwise. All specifications control for foreign*year trends. *ShortDollarDebt* is the ratio of short-term dollar denominated liabilities to total short-term liabilities. *DollarAssets* is the ratio of dollar assets to total assets. *Foreign* is a dummy that takes a value of one if foreign investors own more than 49 percent of the company at any time in the three years prior to the first crisis. *Cash* is the ratio of cash holdings to total assets. *Leverage* is the log of the ratio of total liabilities to total assets. *LongBankDebt* is the ratio of long term debt from banks to total liabilities. *ShortBankDebt* is the ratio of short term debt from banks to total liabilities. *BondAbroad* is a dummy that takes a value of one in the year the firm issues a corporate bond abroad. *InternationalLoan* is a dummy that takes a value of one in the year the firm issues syndicated loans abroad. *Equity* is a dummy that takes a value of one in the year the firm issues equity abroad. All variables are lagged one period. The F-test reports the corresponding p-values associated to the joint significance of the coefficients associated with each variable of interest. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

First, although we have emphasized the role of hard currency denominated income as the main channel to avoid balance sheet mismatches, there are other factors that can contribute to improve firms' solvency. The potential negative effect of foreign denominated short-term liabilities on firms' balance-sheets during crises could be mitigated by significant holdings of foreign currency denominated assets. Column (1) shows that results are robust to controlling for dollar assets as a share of total assets during crises. Notice ideally we would like to control for the share of short term dollar assets denominated in foreign currency however, this will severely limit the sample. Thus, we control for cash holdings in column (2) instead since the increase in debt service via the inflated dollar denominated debt would not translate into a balance sheet worsening if firms hold enough cash. Our main results are not affected.

Columns (3) and (4) look at other measures of leverage. All the results in Table 1.5 controlled for the ratio of short term bank debt to total liabilities. Similarly, column

(3) adds the ratio of total liabilities to total assets and column (4) the ratio of long term bank debt to total liabilities, with no significant effect on our main results.

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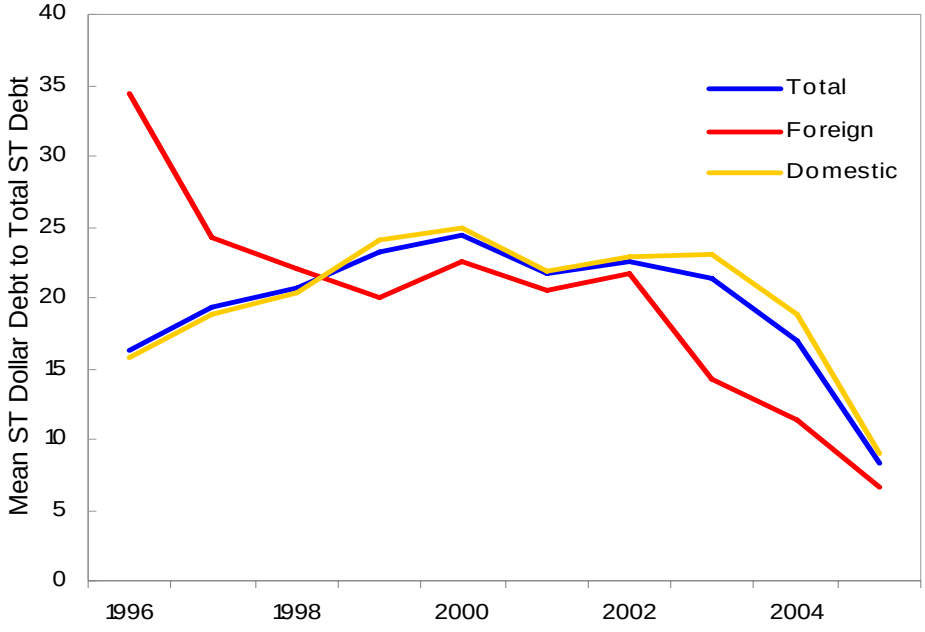
Another possible explanation for the higher investment of foreign-owned exporters with dollar debt relative to domestic exporters holding dollar debt is that foreign-owned exporters had better access to export markets. As already mentioned we do not find many companies starting to export as a result of the devaluation (only 5 percent of the exporting observations at the time of the crises). However, it might be that foreign-owned exporters have better connections or information about international markets and are better able to increase their sales abroad. This effect would be absorbed by the foreign-year effects. We also worry that due to contagion effects, exporters in the crisis country do not face a *relative* improvement in their investment prospects if exporters in neighboring countries undergo a parallel depreciation (relevant for Argentina and Brazil (2002)) or if the instability in the area reduces the demand for imports from the crisis country. However, there is no reason to believe that foreign and domestic

exporters serve different markets (unfortunately we do not have firm-level data on the destination of exports).[23]

Finally, it is also possible that both foreign-owned and domestic firms reduce their dollar liabilities in anticipation to the crisis. This can explain the no-difference result between foreign-owned and domestic exporting firms in the case of currency crises. Thus, we show in Figure 1.5, that there was no systematic decrease in dollarization for foreign-owned firms relative to domestic firms in the eve of crisis. Nevertheless, we repeat our basic results using a predetermined dummy for dollar debt holdings. A firm is defined as having high dollar debt if her share of short term dollar debt in total short term debt is greater than 35 percent at any time during the three years prior to the crises.[24] Results (available upon request) confirm that our main results are not driven by foreigners decreasing dollar debt holdings faster at the time of the crisis.

Figure 1.5. Short-Dollar Debt over Time



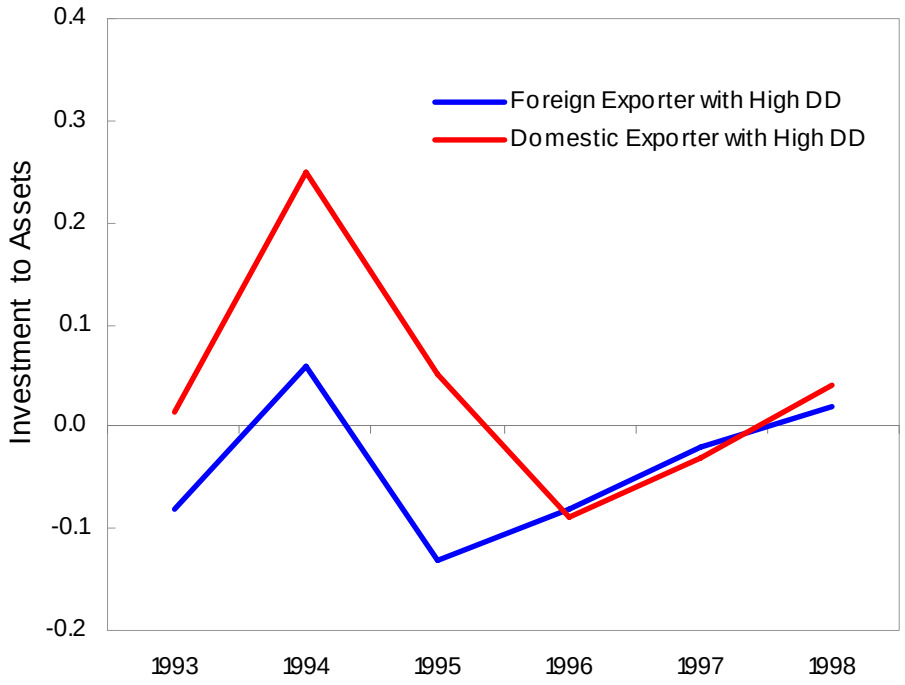
[23] An alternative explanation for the better investment of foreign-owned exporters is related to the role of imported materials. Although the depreciation makes exported goods relatively cheaper, firms importing materials from abroad would now witness an increase in the relative price of imports. Unfortunately, we could not obtain data on imports. Nevertheless, to test for this possibility, we defined tradable sectors with a dummy variable that is equal to one if the firm operates in a SIC sector classified as tradable (see Forbes, 2002), and obtained similar results. The lack of data prevents us from exploring the possibility that foreign-owned exporters have access to cheaper imported goods through the parent company.

[24] Recall 35 percent corresponds to the mean holdings in the exporter sample.

6.2 Threats to Identification

Given our differences-in-differences strategy we might have several threats to identification. Foreign owned exporters that choose to hold dollar denominated debt could be different from domestic exporters that chose to do so, irrespective of the depreciation, and these differences might be correlated with investment rates. In practice, most of the firm unobservable characteristics are time invariant and therefore, this concern should be lessened by the firm fixed effect estimation. As shown before our results are also robust to controlling for foreign-year fixed effects to account for different trends between foreign-owned and domestic companies. In addition, the triple interaction regression controls for the term *ShortDollarDebt* × *Post* which accounts for the different trends in investment between exporters holding dollar debt and those not holding dollar debt, at the time of the crisis. Nevertheless, Figure 1.6 shows the average investment rates for two types of firms: foreign-owned exporters holding above median dollar debt and domestic exporters holding above median dollar debt in Mexico. Graphical inspection reveals that there are no major differences in trends between foreign and domestic firms holding high levels short-term dollar debt prior to the depreciation episode in Mexico.

Figure 1.6. Trends in Investment according to Foreign Currency Denominated Debt



Similarly, results are based on the assumption that firms across countries freely choose the percentage of their short-term debt that is denominated in foreign currency. We do not want our results to be driven by differences across countries in dollar debt practices. As we explained in detail in the data section most of Brazilian companies foreign currency borrowing is obtained abroad (whether bond issuances or bank loans). Exporters can borrow from the BNDES in foreign currency though. In fact, Table 1.4 shows that although lower than the Argentinean and Mexican levels, short-term dollar debt in Brazil represents on average 20 percent of short-term debt. Most importantly, most of the variation in short-term dollar debt takes place within the sample of exporters (i.e. non-exporting companies do not hold significant amounts of dollar debt) which is our sample of interest given that they are the ones faced with the investment opportunity. Although the median domestic exporter in Brazil holds lower levels of dollar debt than the foreign-owned counterpart, so do Argentinean domestic exporters and it does not seem to be something specific to Brazil.

A related issue is whether we can directly compare twin and currency crises. According to Kaminsky (2006) crises are the result of different factors that might question the suitability of comparing crises that were not originated from the same economic failure. Kaminsky (2006) identifies 6 different types of currency crises according to the way in which they were generated. Four of the categories are associated with domestic economic fragility, with vulnerabilities related to current account deterioration, fiscal imbalances, financial excesses, or foreign debt unsustainability. But crises can also be provoked by just adverse world market conditions, such as the reversal of international capital flows. The so-called sudden-stop phenomenon identifies the fifth variety of crises. As emphasized by the second generation models, crises also happen in economies with immaculate fundamentals. Thus, the last variety of crises is labeled self-fulfilling crises. She classifies both Brazil 1999 and Mexico 1995 as being the result of the same cause: financial excesses.

Table 1.7 repeats the main specification in Table 1.5 by country and episode. Column (1) shows that foreign-owned exporters holding dollar debt in Mexico are the ones increasing investment relative to domestic exporters with dollar debt (although the total effects are not significant in this case notice that we are dealing with a small sample size). Column (2) examines the case of Brazil 1999 and as expected there are no

significant differences between domestic and foreign exporters holding dollar debt. Therefore, comparing columns (1) and (2) we can say that results are robust to focusing on currency crises that share the same origin and are not driven by the different nature of the depreciation but rather by the existence of a banking crisis in the preceding year. For completeness column (3) shows the case of Brazil 2002 where as expected there are no differences across foreign-owned and domestic exporters with dollar debt.

Table 1.7. The Differential Response of Foreigners Holding Dollar Debt During Crises: By Country. Dependent Variable: Investment
Subsample of Exporters

Exporter Definition		Predetermined	
Foreign Definition		Predetermined	
	Mexico1995	Brazil 1999	Brazil 2002
	(1)	(2)	(3)
ShortDollarDebt × *Foreign* × *Post*	0.242**	0.540	-0.025
	(0.09)	(0.34)	(0.13)
ShortDollarDebt × *Foreign*	-0.189	0.191**	0.160
	(0.15)	(0.07)	(0.09)
ShortDollarDebt	0.016	-0.058	-0.031
	(0.06)	(0.06)	(0.06)
ShortDollarDebt × *Post*	-0.158	0.142	0.006
	(0.10)	(0.09)	(0.07)
Foreign	-	-	-
	-	-	-
Foreign × *Post*	0.187	0.153	0.092
	(0.13)	(0.13)	(0.09)
ShortBankDebt	-0.027	-0.068	-0.045
	(0.04)	(0.06)	(0.07)
BondAbroad	0.043*	-0.033	-0.056
	(0.02)	(0.07)	(0.07)
LoanAbroad	-0.029	0.062	0.066
	(0.02)	(0.05)	(0.05)
EquityAbroad	0.014	0.034	0.038
	(0.02)	(0.03)	(0.03)
Observations	393	212	212
Firms	71	49	49
Firm Fixed-Effects	yes	yes	yes
Sector*year	yes	yes	yes
year	yes	yes	yes
Foreign*year	yes	yes	yes
F-test			
ShortDollarDebt	0.032	0.000	0.000
ShortDollarDebt × *Post*	0.010	0.067	0.980
Foreign × *Post*	0.031	0.289	0.260

Notes: Standard errors are corrected for clustering at the year level and are reported in parenthesis. *Investment* is normalized by total assets. In column (1) *Post* is a dummy variable that takes a value of one in the year of

the twin crisis in Mexico (1995) and one year after. In column (2) *Post* is a dummy that takes a value of one in the year of the 1999 currency crisis and one year after in Brazil. In column (3) *Post* is a dummy that takes a value of one in 2002 and one year after corresponding to the currency crisis in Brazil. The subsample of exporters is based on predetermined values and it refers to those firms with export to sales ratios greater than 10 percent at any time during the three years prior to the first crisis. Foreign is similarly defined in terms of predetermined values and takes a value of one if foreign investors own more than 49 percent of the company at any time during the three years prior to the first crisis and zero otherwise. All specifications control for foreign*year trends. *ShortDollarDebt* is the ratio of short-term dollar denominated liabilities to total short-term liabilities. *ShortBankDebt* is the ratio of short term debt from banks to total liabilities. *BondAbroad* is a dummy that takes a value of one in the year the firm issues a corporate bond abroad. *InternationalLoan* is a dummy that takes a value of one in the year the firm issues syndicated loans abroad. *Equity* is a dummy that takes a value of one in the year the firm issues equity abroad. All variables are lagged one period. The F-test reports the corresponding p-values associated to the joint significance of the coefficients associated with each variable of interest. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

6.3 Alternative Estimation Strategy

The results in Table 1.5 are consistent with the interpretation that the real problem is illiquidity. To further substantiate this point we propose an alternative specification instead of a triple interaction. This strategy involves defining a sample of solvent firms (i.e., firms with high leverage and holdings of *short-term* foreign currency denominated debt that are not matched by a dollar denominated stream of income like export revenue). Table 1.8 shows how foreign-owned firms invest relative to domestic firms when we focus in a sample of firms with no currency mismatch. To avoid any selection issues at the time of the crisis, we define matched balance sheets based on whether the firm had revenue in excess to short-term dollar liabilities at any time during the three years prior to the crises.[25] Columns (1) to (3) show the results under twin crises while columns (4) to (6) refer to currency crises. Column (1) shows how foreign-owned firms invest 5 percentage points more relative to domestic firms during twin crises. It is reassuring that results are robust to the use of a predetermined variable that classifies firms into foreign-owned and domestic according to their ownership status three years *before* the crises (see columns (2) and (3)). Finally, column (3) examines the sample of exporters. Within solvent firms we expect exporting firms to be the ones taking the investment opportunity generated by the depreciation of the currency. To avoid concerns about selection into the

[25] We define firms with no mismatch is defined based on whether $\frac{Exports - ShortDollarLiab}{Assets} > 0$. Notice we control for leverage in all the columns in Table 1.8. Appendix Table 1.A2 shows similar regression in total sample of firms.

export market at the time of the crises column (3) uses a predetermined export dummy to define the exporter sample. Within this sample of solvent exporters, foreign-owned exporters increase investment by 8 percentage points relative to domestic exporters.[26] In addition, these columns show that results are robust to controlling for measure of access to international markets. It seems to be the case in which parent companies inject liquidity into foreign-owned firms during crises.[27]

Table 1.8. Performance of Foreign Companies: Sample of Solvent Firms
Dependent Variable: Investment

	Twin Crises			Currency Crises		
Sample of Firms	All	All	Exporter	All	All	Exporter
Foreign Definition	Benchmark	Predeterm.	Predeterm.	Benchmark	Predeterm.	Predeterm.
Exporter Definition			Predeterm.			Predeterm.
	(1)	(2)	(3)	(4)	(5)	(6)
Foreign × *Post*	0.045*	0.054*	0.083**	0.002	-0.000	-0.009
	(0.03)	(0.03)	(0.04)	(0.02)	(0.02)	(0.03)
Foreign	0.007			0.009		
	(0.01)			(0.01)		
ShortBankDebt	-0.031**	-0.032**	-0.046**	-0.030**	-0.030**	-0.042**
	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)
BondAbroad	0.063*	0.063*	0.047	0.063*	0.063*	0.049
	(0.04)	(0.03)	(0.03)	(0.04)	(0.04)	(0.03)
InternationalLoan	-0.012	-0.012	0.002	-0.012	-0.013	0.002
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Equity	-0.015	-0.016	-0.006	-0.016	-0.016	-0.006
	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Observations	2956	2956	1849	2956	2956	1849
Firms	454	454	278	454	454	278
F-test						
Foreign	0.049	..		0.602	.	.
Firm Fixed-Effects	yes	yes	yes	yes	yes	yes
Sector*year	yes	yes	yes	yes	yes	yes
Country*year	yes	yes	yes	yes	yes	yes

Notes: Standard errors are corrected for clustering at the year level and are reported in parenthesis. *Investment* is normalized by total assets. In columns (1) to (3) *Post* is a dummy variable that takes a value

[26] The earlier estimate of 15 percentage points raise in investment of foreign-owned exporters was calculated based on the 10th to 90th percentile change in short term dollar debt.

[27] The Argentina Renault is a case in point. In 2001, the parent firm contributed $300 million to assure the survival of its affiliate. In January 2003 it received an additional $160 million from parent Renault to accommodate its bank creditors. The company lost $71 million in 2003 and ended the year with debt of about $276 million. However, during the first half of 2004, the company made a small profit.

of one in the year of the twin crisis and one year after in Argentina (2002) and Mexico (1995). In columns (4) to (6) *Post* is a dummy variable that takes a value of one in the year of currency crises and one year after in Brazil (1999) and (2002). The "solvent" firm sample refers to the sample of firms with no mismatch and is defined as firms with $\frac{Exports - ShortDollarLiab}{Assets} > 0$. In columns (3) and (6) the subsample of exporters is based on predetermined values and it refers to those firms with positive export to sales ratios at any time during the three years prior to the first crisis. *Foreign* is a dummy that takes a value of one if foreign investors own more than 49 percent of the company. In columns (2), (3), (5), and (6) Foreign is defined in terms of predetermined values and takes a value of one if foreign investors own more than 49 percent of the company at any time during the three years prior to the first crisis and zero otherwise. *ShortBankDebt* is the ratio of short term debt from banks to total liabilities. *BondAbroad* is a dummy that takes a value of one in the year the firm issues a corporate bond abroad. *InternationalLoan* is a dummy that takes a value of one in the year the firm issues syndicated loans abroad. *Equity* is a dummy that takes a value of one in the year the firm issues equity abroad. All variables are lagged one period. The F-test reports the corresponding p-values associated to the joint significance of the coefficients associated with each variable of interest. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

6.4 The Role of Exporters: Reconciling with the Literature

Finally, we would like to explore previous seemingly conflicting results in the literature and argue that proper measurement of access to international liquidity via foreign ownership can account for those findings.

First, we would like to establish whether or not exporters are financially constrained in the aftermath of a crisis. We do this by estimating the following equation:

$$y_{i,c,j,t} = \beta_1(ExportShare_{i,c,j,t-1} \times Post_{c,t}) + \beta_2 ExportShare_{i,c,j,t-1} + \phi_{j,t} + \varphi_{c,t} + \alpha_i + \xi_{i,c,j,t} \quad (1.3)$$

ExportShare refers to the lagged ratio of export revenue to sales. Instead of lagged ratio we use a predetermined export dummy in the regressions below, where exporter is defined according to whether the firm reported export revenue at any time during the three years *prior* to the crises, obtaining similar results. The rest of the notation is same as in equation (1.1).

The traditional textbook theory on the effect of exchange rate depreciations on output, concludes that the depreciation episode should increase sales and investment of exporting firms due to a competitiveness effect. The literature generally finds that this is not the case, as shown in column (1) of Table 1.9. There might be various explanations why exporters do not increase investment in the aftermath of currency crises such as adjustment costs and the role of inventories. The literature has suggested financial constraints as a major reason for exporters not undertaking new investment during

financial crises. Column (2) includes short-term dollar debt as a control for financial constraints but the result do not change. Notice that we would have expected a positive coefficient on the export propensity variable once dollar debt holdings were taken into account if the associated mismatch on the balance sheet was the reason hindering investment on the part of exporters. However, this is not the case, suggesting that controlling for dollar debt holdings is not enough to explain the investment behavior of exporters during crises. The result in column (2) is consistent with Aguiar (2005).

Table 1.9. Performance of Exporters during Crises
Exporter Definition: Predetermined Dummy

	All Crises				Twin Crises	Currency Crises
	Sales Growth	Investment	Sales Growth	Investment	Investment	Investment
	(1)	(2)	(3)	(4)	(5)	(6)
Exporter × *Post*	0.077**	0.000	0.059**	0.007	-0.007	0.024**
	(0.03)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)
ShortDollarDebt × *Post*			0.154**	-0.056**	-0.078**	-0.013
			(0.07)	(0.03)	(0.03)	(0.04)
ShortDollarDebt			-0.013	-0.004	-0.007	-0.012
			(0.03)	(0.01)	(0.01)	(0.01)
Observations	5063	5063	5063	5063	5063	5063
Firms	864	864	864	864	864	864
F-test						
ShortDollarDebt			0.054	0.040	0.001	0.395
Firm Fixed-Effects	yes	yes	yes	yes	yes	yes
Country*year	yes	yes	yes	yes	yes	yes
Sector*year	yes	yes	yes	yes	yes	yes

Notes: Standard errors are corrected for clustering at the year level and are reported in parenthesis. Sales regressions control for size by including the log of total assets lagged one period. *Investment* is normalized by total assets. *Post* is a dummy variable that takes a value of one in the year of the depreciation and one year after. Columns (1) and (2) refer to all crises so that the starting depreciation year is 2002 for Argentina and Brazil, 1999 for Brazil, and 1995 for Mexico. Column (3) refers to twin crises so that the starting depreciation year is 2002 for Argentina and 1995 for Mexico. Finally column (4) refers to currency crises and the starting depreciation year is 1999 and 2002 in Brazil. *Exporter* is a dummy variable that takes the value of 1 if the firm reports export revenue at any time during the three years prior to the first crisis and 0 otherwise. Only in column (5) *Exporter* is defined as one if the firm exported more than ten percent of sales. *ShortDollarDebt* is the ratio of short-term dollar denominated liabilities to total short-term liabilities and it is lagged one period. The F-test reports the corresponding p-values associated to the joint significance of the coefficients associated with each variable of interest. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Columns (3) and (4) investigate the role of different crises: under currency crises, where there are no liquidity constraints, exporters do increase investment however, under twin crises exporters do not do better than non exporters (conditional on dollar debt). Why do exporters behave differently during twin and currency crises and second, why firms holding higher levels of short term dollar denominated debt decrease investment in the aftermath of twin crises, but not in the aftermath of currency crises? This is because under currency crisis there is no illiquidity problem and solvency problem should not be an issue for exporters who can hedge using their dollar income. Column (5) shows that this is indeed the case since now the triple interaction specification show that exporters with short term dollar debt do better than non-exporters with short term dollar debt, which is consistent with Bleakley and Cowan (2008).[28] Our results show that Aguiar (2005) results are driven by domestic exporters who do not have access to liquidity under a twin crisis and Bleakley and Cowan (2008) results are driven by ability of exporters to avoid insolvency as they highlight and take advantage of investment opportunity during depreciations.

7. Conclusion

This paper provides systematic evidence on the key channel behind the contractionary nature of financial crises. The main reason why firms are constrained and hence investment and growth are hindered in the aftermath of a financial crisis is international and domestic illiquidity. By using a unique hand-collected data set for 1,300 listed firms from six Latin American countries between 1990–2005, we disentangle the illiquidity channel from the insolvency channel. Our measure of liquidity is foreign

[28] The equation we estimate is given by:

$$y_{i,c,j,t} = \beta_1 Exports_{i,c,j,t-1} \times SDDebt_{i,c,j,t-1} \times Post_{c,t} + \beta_2 Exporter_{i,c,j,t-1} \times SDDebt_{i,c,j,t-1} + \beta_3 Exporter_{i,c,j,t-1} \times Post_{c,t} + \beta_4 SDDebt_{i,c,j,t-1} \times Post_{c,t} + \beta_5 Exporter_{i,c,j,t-1} + \beta_6 SDDebt_{i,c,j,t-1} + \phi_{j,t} + \varphi_{c,t} + \alpha_i + \xi_{i,c,j,t} \quad (1.4)$$

Notice that in order to be able to compare to Bleakley and Cowan (2008) and show that exporters with high export revenue can match their balance sheets we follow Aguiar (2005) and define a high exporter as one that exports more than ten percent of the sales.

ownership. We proxy insolvency by balance-sheet mismatch caused by short-term foreign currency debt conditional on leverage.

Our main result is that foreign-owned exporters with dollar debt invest relatively more than domestic exporters with dollar debt *only* during twin crises, where domestic firms access to finance is limited given the troubled banking sector. There is no difference in investment between these firms during currency crises. This implies foreign currency denominated debt is not a problem for exporters per-se since they match their short-term dollar debt with export revenue to avoid insolvency. During twin crises, however, domestic exporters suffer from the problem of illiquidity and hence contract investment and production as oppose to foreign-owned exporters.

Our results have important policy implications. First, to the best of our knowledge, this paper is first in quantifying the significant real effects of shocks to banking sector using firm-level investment data. Second, short-term foreign currency borrowing may not be detrimental to firms' balance sheets as long as their access to finance is not limited during periods of instability. Hence it is important to provide liquidity to the banking sector during financial crises especially if the domestic banking sector is the main source of financing for the firms.

Appendices

1. Cleaning Procedure

We drop all firm/year observations in which the accounting data are not self-consistent. In particular, we drop observations if dollar liabilities (assets) exceed total liabilities (assets) or if the ratio of exports to sales is greater than one. We drop firm-year observations with zero or missing sales. Finally, we drop firm-year observations in the top (low) 1 percent of the distribution of the ratio of sales to total assets and total liabilities to total assets. These adjustments led to dropping 16 percent of the remaining firm-year observations. To ensure that results are not driven by outliers, we then dropped all firm/year observations for explanatory variables that exceeded the sample mean by more than five standard deviations. We compute the change in total assets, sales and physical capital stock and construct a Z-score using the sample mean and standard deviation for each country/year. We drop firm/year observations that have absolute value of $Z > 5$. We drop firm/year observations for which the ratio of investment over assets is greater than one or less than minus one. This controls for outliers (either because of inadequate accounting, typing errors or extreme values). These adjustments led to dropping 19 percent of the remaining firm-year observations. These exclusions leave us with complete information for an unbalanced panel of 6,175 firm-year observations, which consist of 931 firms with an average of around 7 years each. Notice throughout the analysis we use lagged values of the main variables and therefore, we lose one year. Finally, data on additional controls included later on in the estimation leaves us with a sample of 5,063 observations or 864 firms.

2. Foreign Ownership Variable

We gathered information on all cross-border Mergers and Acquisitions (M&A) in Latin America between 1981 and 2005 using the SDC Platinum database from Thompson (for the period 1981 to 2001) and Zephyr from Bureau Van Dijk (from 1997 to 2005). Given that there was no common firm-identifier across databases, we used a search algorithm based on firms' names and economic sectors to match M&A transactions to firms in our sample. We took into account possible changes in firms' names drawing on a list of company name changes from the Economatica database. In addition, we doubled checked with various internet resources, including the information provided by the company on its own web page and that of the Funding Universe website (www.fundinguniverse.com/companyhistories/) that provides information on companies' history.

We construct a continuous, time-varying measure of foreign ownership based on the percentage fraction of shares held by foreign and domestic investors in each year. For example, the M&A databases would identify an M&A transaction where a foreign company that already owned 50 percent of a company in a target country, buys 10 percent more of that company. Our foreign ownership variable would be 50 until the time of the transaction and 60 thereafter. In the case where we had more than one foreign investor in the same year we faced the problem of not knowing if the foreign companies were buying from each other, from other domestic investors, or rather directly from the target company. In those cases we checked the company history profile, the Funding Universe website and other specialized newspaper information. In the rare case that information was not available, we decided on a conservative measure of foreign ownership and assumed that the foreign companies bought from each other. We then merged this information with annual balance sheet data. In the few cases of target firms being renamed after the acquisition, we kept the old id number rather than creating a new company after the M&A.

Of course there might be ways other than M&As for foreign investors to invest in firms. First, foreign ownership acquisitions can arise by means of IPOs, venture capital activity, or private equity deals, which are not covered in M&As hence in our procedure. Second, several foreign-owned firms could have been established before 1980, and not involved in a M&A since then. To remedy this, we used the *Corporations Affiliations* database to identify Latin American firms in our sample that are affiliates, subsidiaries and/or divisions of global multinational firms. This database contains international public and private business profiles and corporate linkage ("who owns whom") for approximately 184,000 public and private companies worldwide. Notice, in addition to the "formal" sources of foreign ownership data we checked firm by firm company's history. After this extensive search of all these alternative sources, if we find no evidence of foreign ownership we assume the company is domestic.

3. Appendix Tables

Table 1.A1. Basic Correlations

Panel A: Total Sample											
	Sales	Assets	Investment	DollarDebt	ExportShare	Exporter	Foreign	BankDebt	Bond	Loan	Equity
Sales Growth	1										
Total Assets	0.0432*	1									
Investment	0.2130*	0.0005	1								
ShortDollarDebt	0.0201	0.2736*	-0.0128	1							
ExportShare	0.0101	0.1150*	-0.0651*	0.3902*	1						
HighExporter	0.0014	0.1554*	-0.0887*	0.3768*	0.7814*	1					
Foreign	0.0166	0.1346*	0.0068	0.0195	-0.0316*	-0.0264	1				
ShortBankDebt	-0.025	-0.0617*	-0.0318*	0.2960*	0.2103*	0.1965*	-0.0601*	1			
BondAbroad	0.0206	0.2026*	0.0776*	0.0909*	0.0112	0.0333*	0.0393*	-0.0569*	1		
LoanAbroad	0.0191	0.3066*	0.0083	0.1626*	0.0426*	0.0511*	0.0617*	-0.0438*	0.2656*	1	
EquityAbroad	0.0253	0.1721*	0.021	0.0576*	0.0158	0.0049	0.0027	-0.0340*	0.1358*	0.1130*	1
Panel B: Exporter Sample											
	Sales	Assets	Investment	DollarDebt	ExportShare	Exporter	Foreign	BankDebt	Bond	Loan	Equity
Sales Growth	1										
Total Assets	0.0377*	1									
Investment	0.2101*	-0.0086	1								
ShortDollarDebt	0.0267	0.2178*	0.0043	1							
ExportShare	0.0213	0.0232	-0.0465*	0.2850*	1						
HighExporter	0.0076	0.0703*	-0.0787*	0.2269*	0.7008*	1					
Foreign	-0.0101	0.0225	0.0035	-0.0502*	-0.0708*	-0.0703*	1				
ShortBankDebt	-0.0374	-0.1514*	-0.0418*	0.2877*	0.1952*	0.1616*	-0.0857*	1			
BondAbroad	0.0295	0.2358*	0.1017*	0.0776*	-0.0151	0.011	0.0046	-0.0832*	1		
LoanAbroad	0.0242	0.3640*	0.0177	0.1344*	0.0118	0.0171	0.0067	-0.0825*	0.2907*	1	
EquityAbroad	0.0259	0.2023*	0.0205	0.0328	0.0016	-0.0184	-0.0204	-0.0682*	0.0984*	0.1247*	1

Notes: Sales Growth is the change in log sales. Investment is physical stock of capital at time t minus physical stock of capital at time t - 1 normalized by total assets. *TotaiAssets* is the log of lagged total assets. *Foreign* is the percentage of capital owned by foreign investors (lagged). *ShortDollarDebt* is the ratio of short-term dollar denominated liabilities to short term debt (lagged). *ExportShare* is the ratio of export revenue to total sales (lagged). *HighExporter is* a dummy that takes value of one if the ratio of exports to sales is higher than 10% (based on lagged *ExportShare. Exporters* refers to those firms whose export to sales ratio is greater than O (based on lagged exports). *ShortBankDebt* is the ratio of short-term bank debt to total liabilities (lagged). *BondAbroad* dummy that equals one if the firms issued bond abroad (lagged). *LoanAbroad* dummy that equals one if the firms issued loans abroad (lagged). *EquityAbroad* dummy that equals one if the firms issued equity abroad (lagged). *DollarAssets* is the ratio of total dollar assets to total assets (lagged).

Table 1.A2. Performance of Foreigners during Crises
Dependent Variable: Investment

Crisis	All Crises		Twin Crises		Currency Crises		
Sample	All	All	Exporter	Exporter	All	Exporter	Exporter
Foreign Definition	B-mark	B-mark	B-mark	Predeterm.	B-mark	B-mark	Predeterm.
Exporter Definition			Predeterm.	Predeterm.		Predeterm.	Predeterm.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Foreign × *Post*	0.036***	0.042***	0.051**	0.058**	0.031**	0.021	-0.002
	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Foreign	-0.005	-0.000	0.003		-0.003	0.004	
	(0.01)	(0.01)	(0.01)		(0.01)	(0.01)	
ShortBankDebt	-0.021**	-0.020**	-0.037***	-0.037***	-0.021**	-0.037***	-0.036***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
BondAbroad				0.049*			0.049*
				(0.03)			(0.03)
InternationalLoan				0.002			0.002
				(0.01)			(0.01)
Equity				-0.003			-0.004
				(0.01)			(0.01)
Observations	5063	5063	2967	2967	5063	2967	2967
Firms	864	864	470	470	864	470	470
F-test							
Foreign	0.002	0.002	0.004	.	0.127	0.364	.
Year Fixed-Effects	yes	yes	yes	yes	yes	yes	yes
Firm Fixed-Effects	yes	yes	yes	yes	yes	yes	yes
Sector*year	yes	yes	yes	yes	yes	yes	yes
Country*year	yes	yes	yes	yes	yes	yes	yes

Notes: Standard errors corrected for clustering at the year level are reported in parenthesis. Notice *Investment* is normalized by total assets. *Post* is a dummy variable that takes the value of one in the year of the depreciation and one year after. Column (1) refers to all crises so that the starting depreciation year is 2002 for Argentina and Brazil, 1999 for Brazil and 1995 for Mexico. Columns (2) to (4) refer to twin crises so that the starting depreciation year is 2002 for Argentina and 1995 for Mexico. Finally, columns (5) to (7) refer to currency crises and the starting depreciation year is 1999 and 2002 in Brazil. Columns (3), (4), (6), and (7) report results for the sample of exporters where *Exporter* is a dummy variable that takes the value of 1 if the firm reports export revenue at any time during the three years prior to the crisis and 0 otherwise. In columns (4) and (7) *Foreign* is a dummy variable that takes the value of 1 if the firm is more than 50% owned at any time during the three years prior to the crisis and 0 otherwise. *ShortBankDebt* is the ratio of short term debt from banks to total liabilities. *BondAbroad* is a dummy that takes the value of one in the year the firm issues a corporate bond abroad. *InternationalLoan* is a dummy that takes the value of one in the year the firm issues syndicated loans abroad. *Equity* is a dummy that takes the value of one in the year the firm issues equity abroad. All variables are lagged one period. The F-test reports the corresponding p-values associated to the joint significance of the coefficients associated with each variable of interest. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

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Chapter 2

Does Sterilized Foreign Exchange Intervention Work for Inflation Targeters?

1. Introduction

Assessing the effectiveness of central bank intervention in foreign exchange markets, and the conditions under which it can be an effective policy tool, have become key issues for emerging markets (EM). In a remarkable shift from the 90s—when many EM were battling currency crises—many central banks have tried to resist domestic currency appreciation by intervening actively in currency markets, accumulating large amounts of international reserves. While there is a huge literature on the impact of foreign exchange market intervention in advanced economies, very few studies have looked at central banks of emerging market countries, which nowadays account for the bulk of intervention activity.

A key issue for these economies is the tension that can arise between interventions in currency markets and monetary policy strategy. Many of these EM countries have officially adopted inflation-targeting regimes to anchor inflation expectations, most often rising short-term interest rates to curb inflation. Rising interest rate may have the consequence of luring in more foreign capital, thereby exacerbating appreciation pressures. At the same time, resisting currency appreciation blunts the pass-through channel to changes in import prices, making it more difficult to attain the inflation target. This policy dilemma that could arise when exchange rate and monetary policies work at cross-purposes has been discussed at length (see e.g. Ho and McCauley, 2003) but seldom investigated empirically.

In this chapter, I take advantage of a unique data set on daily official intervention by the Central Bank of Colombia between 2004 and 2007 to assess the effects of foreign

exchange interventions in the context of an inflation targeting framework. Colombia is an interesting case study for at least two reasons. First, Colombia faced strong exchange rate appreciation pressures during this period. Between December 2006 and May 2007, for example, Colombia ranked as the country with the *highest* nominal domestic currency appreciation in the world—both vis-à-vis the U.S. dollar and in nominal effective terms. Second, the period under study is punctuated by frequent, and at times large, discretionary purchases of foreign exchange to resist domestic currency appreciation. Figure 2.1 shows the two distinct episodes of discretionary intervention in the foreign exchange rate market analyzed in this study: the first period, spanning from September 2004 to March 2006, and a more recent period from January 2007 to April 2007.[29] During these periods, the Central Bank of Colombia (Banco de la República, henceforth BdR) intervened on almost 70 percent of business days and the scale of official intervention was significant relative to the daily turnover in the market, reaching 50 percent on some days.

To correctly identify the impact of interventions on exchange rates in the case of Colombia, is crucial to take into account the fact that the two periods of discretionary intervention were associated with significant differences in the monetary policy stance and in the degree of credibility of the inflation targeting regime. The first period was characterized by a loosening of monetary policy and highly credible inflation targets. In particular, I show that during this period, foreign currency purchases by the BdR were not fully sterilized, and thus intervention influenced the central bank's provision of liquidity in the financial system. Thus, to disentangle the influence of foreign exchange intervention as an independent policy tool from the effects of the expansionary monetary policy during this period, is essential to control for the extent to which interventions were sterilized (and whether the market expected interventions to be sterilized).[30]

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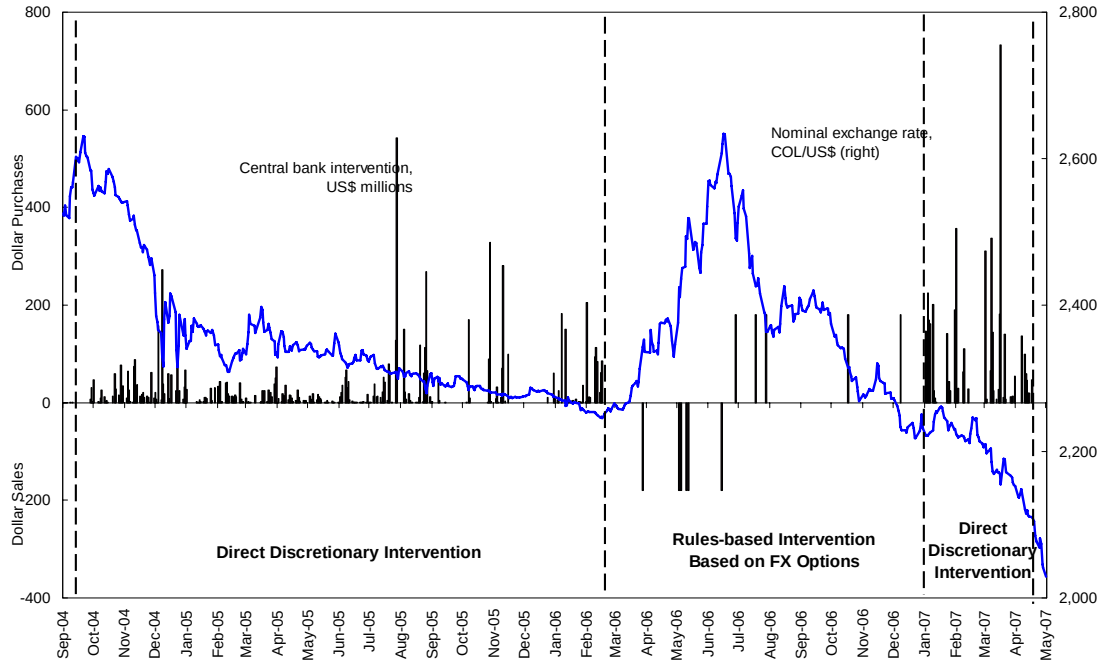
[29] As shown in Figure 2.1, the BdR stopped discretionary purchases of foreign currency from March 2006 until mid-January 2007. During this period, the central bank only intervened through rules-based, non-discretionary foreign currency options to smooth exchange rate volatility. A more detailed description is provided in Section 3.

[30] The focus of the analysis should be on sterilized interventions only, as the effect of unsterilized operations is arguably more straightforward: the expansion of the money supply (beyond monetary growth consistent with inflation targets given changes in money demand) would typically lead to a loss of value of the domestic currency. In other words, unsterilized interventions can be thought of as two distinct policies applied at the same time: a loosening of the monetary stance together with (or by means of) FX intervention.

During the second episode in 2007, however, large-scale intervention occurred against a backdrop of strong monetary tightening (to reduce inflationary pressures) and very low credibility of the inflation target. During this period, exchange rate and monetary policies goals came into conflict: the BdR sought simultaneously to maintain price stability by raising interest rates, and preserve competitiveness by resisting currency appreciation through foreign currency purchases. As inflation rose well above the target, markets perceived that BdR's dollar purchases would undermine its ability to meet the inflation target by year-end, and the credibility of BdR's inflation target fell to close to nil.[31] Thus, to identify the causal effect of intervention operations during this period is important to control for high-frequency proxies on the level (and changes in the level) of credibility of the inflation target.

Figure 2.1. Central Bank of Colombia's Intervention Operations and Movements in the Nominal Exchange Rate



Source: Banco de la República.

[31] In quantity terms, this is often thought of simply as insulating the normal path of the monetary base from changes in the central bank's net FX position.

In this study, I estimate the impact of central bank intervention on exchange rates using a two-stage instrumental variable model based on estimates of the central bank's intervention reaction function. I find that during the first period, there is a statistically significant and positive correlation between intervention operations and the exchange rate. The coefficient for the effect of contemporaneous intervention implies that a US$30 million purchase (the average daily amount of intervention within this period) was associated with a depreciation of the value of the domestic currency of approximately 0.23 percent. This result, however, does not provide evidence of a causal link from intervention to exchange rates (i.e., that intervention as an independent policy tool was effective). Rather, it suggests that the combination of large-scale foreign currency purchases and a credible expansionary monetary policy seem to have led to a reduction in appreciation pressures. In the absence of detailed data on the degree of sterilization of intervention operations (and market's expectation of sterilization), the current identification strategy cannot tease out the influence of peso-weakening interventions from the effects of a loosening monetary policy.

The results for the second period, on the other hand, suggest that sterilized intervention operations had no statistically significant contemporaneous effect on exchange rate returns. I show that during this period, sterilized intervention operations aimed at depreciating the currency were dwarfed by offsetting increases in domestic interest rates and the market's reaction to higher-than-expected inflation announcements—both of which tended to appreciate the domestic currency.

My study contributes to the literature on the effects of central bank intervention in two descriptive ways. First, I use a new data set that includes official statistics on daily foreign exchange intervention by the BdR, thus opening a rare window into the workings of central bank intervention operations for an inflation targeting country. Research on intervention in EM has remained a challenge, hampered by the dearth of high frequency data on central bank intervention operations (because of valuation changes, the magnitude of intervention operations cannot be inferred simply from changes in

reserves).[32] A key advantage of the intervention data used in this study is that it accurately reflects discretionary purchases of dollars made with the explicit intention to depreciate the value of the domestic currency vis-à-vis the U.S. dollar.[33] This allows for a cleaner identification of the impact of central bank intervention on the exchange rate.

The second contribution of the chapter is to analyze in detail the tensions that can arise between interventions in currency markets to stem currency appreciation and monetary policy goals, when the cyclical position of the economy calls for interest rate tightening.[34] I show that during the second period markets expected monetary policy to remain firmly geared towards the goal of reducing inflation—even if that meant increasing interest rates and, thereby, defeating intervention efforts. Thus, the lack of effectiveness of sterilized intervention during the second period was rooted in its inconsistency with current and expected monetary policy actions.

The rest of the chapter is organized as follows. Section 2 provides a review of existing studies on the effectiveness of intervention in emerging and developing countries. Section 3 describes the exchange rate and monetary policies in Colombia during the sample period and describes the intervention data used here. Section 4 lays out the estimation strategy and Section 5 provides the main empirical results on the effectiveness of daily exchange rate intervention by the BdR. Section 6 distills policy lessons from the Colombia experience for other emerging markets and Section 7 concludes.

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[32] Moreover, it is often not possible to know, a priori, whether the authorities accumulate international reserves with the intent of affecting the exchange rate or for other reasons, such as self-insuring against external financial shocks. Because central banks rarely publish targets on precautionary reserve accumulation, disentangling both motives for intervention without official data is almost impossible. Jeanne and Rancière (2006) and Aizenman and Lee (2007) analyze competing interpretations for the large increases in the hoarding of international reserves by developing countries.

[33] Data on official intervention was kindly provided by the Banco de la República, and is not disclosed to the public at a daily frequency. For this reason, the use of the daily data in this chapter is subject to confidentiality agreements.

[34] To my knowledge, Gersl and Holub (2004) is the only paper in the empirical literature on foreign exchange intervention in emerging markets that has looked at the interdependencies between discretionary intervention operations and the conduct of monetary policy under an inflation targeting regime for the case of the Czech Republic.

2. Literature Review

A large body of economic literature explores the efficacy of sterilized intervention in developed economies.[35] The evidence suggests that sterilized intervention by industrialized countries has, at times, effectively influenced the value of currencies.[36] However, these effects are typically small in economic terms. Collectively, the recent literature for advanced economies has shown that intervention systematically moves the spot exchange rate only if the intervention is announced publicly, coordinated across countries, and is consistent with the underlying stance of fiscal and monetary policy (Sarno and Taylor, 2001).[37] Additionally, a number of papers have examined the influence of intervention operations on daily exchange rate volatility and generally find evidence that intervention increases volatility.[38]

Compared with the sizeable literature for advanced economies, studies on the effectiveness of intervention in emerging market economies are still sparse, in large part because governments are reluctant to provide official data on their operations.[39] The few papers that analyze central bank intervention at daily frequencies using official data find mixed results on its effectiveness.[40] Domac and Mendoza (2002) conclude, in the context of Mexico and Turkey in the period 2001–02, that central bank foreign exchange sales

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[35] Edison (1993) surveys the literature on central bank intervention from the 1980s through early 1990s; Sarno and Taylor (2001) and Humpage (2003) provide more recent surveys of theory and empirical evidence.

[36] Dominguez and Frankel (1993) and Dominguez (2003) provide empirical evidence in this regard. For Japan, Ito (2002) found that large and infrequent intervention had quantitatively small but statistically significant effects on the dollar-yen nominal exchange rate.

[37] Using recent advances in market microstructure theory, a number of papers have examined the influence of intervention operations using intra-daily data on exchange rate returns. These studies typically find that central banks' intervention has significant impact on the first two moments of the exchange rate (e.g. Evans and Lyons, 2001; Dominguez, 2003; Payne and Vitale, 2003).

[38] Dominguez (2006) and Cashin, Edison, and Liang (2006) found that intervention increases exchange rate volatility, in contrast with claims by central banks that intervention does not increase (or is not associated with an increase in) volatility (Neely, 2007).

[39] Canales-Kriljenko (2003) discusses some of the reasons why foreign exchange intervention may be more effective in developing and transition economies than in industrialized countries. Given the lower degree of international substitutability of emerging market assets, and the large size of interventions relative to currency market turnover in these countries, foreign exchange intervention could—in principle—have a sizeable effect on exchange rates.

[40] Disyatat and Galati (2007) provide a thorough review of the existing literature on the effectiveness of intervention in emerging market countries. BIS (2005) contains descriptive case studies for a large number of emerging economies.

(but not purchases) had a statistically significant influence on the exchange rate in both countries. In contrast, Guimarães and Karacadag (2004) find that in Mexico foreign exchange sales had a small impact on the exchange rate level, but official intervention does not appear to systematically affect exchange rate levels in Turkey.[41] For Chile, Tapia and Tokman (2004) found that actual intervention appeared to have a generally insignificant effect on contemporaneous exchange rate movements.[42]

Empirical evidence for Mexico, Turkey, and Chile, however, cannot be easily generalized to other emerging markets. First, given policy objectives, the finding that intervention has no impact on the spot exchange rate must be interpreted with caution. For example, the bulk of intervention undertaken in Mexico after the 1994 crisis was aimed at accumulating reserves, rather than influencing the level of the exchange rate. Moreover, the mechanisms used in Mexico and Turkey for intervention (auctioning put and call foreign exchange options and pre-announced foreign exchange sale auctions, respectively), are very different from the ways developing countries today intervene (usually through outright purchases or sales in the spot market on a discretionary basis). Finally, in Chile, the intervention strategy mostly relied on public announcements of potential (i.e., verbal), as opposed to actual, interventions.[43]

The papers closest to this study are Gersl and Holub (2006) and Disyatat and Galati (2007), which analyze the role of direct foreign exchange interventions in the Czech Republic. Disyatat and Galati (2007) find a very small (cumulative) impact of intervention on the spot exchange rate for the period 2001–02. Gersl and Holub (2006) also find some evidence that the intervention had a statistically significant impact on the

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[41] Guimaraes and Karacadag (2004) use a different sample period for Mexico (1996 to 2003) and Turkey (2001 to 2003). For the case of Turkey, see also Ozge, Olcay, Ozlale, and Sahinbeyoglu (2005).

[42] Other studies using monthly changes in gross reserves as a proxy for intervention operations typically find that intervention has either no effect, or is of little economic importance. Pattanaik and Sahoo (2003) concluded that intervention operations of the Reserve Bank of India had very little influence on exchange rate levels. More recent cross-country empirical evidence suggests intervention is unlikely to be effective in dealing with capital flows. Using a sample of emerging markets and small advanced countries, Lall, Jaumotte, Papageorgiou, and Topalova (2007) find that resisting nominal exchange rate appreciation through sterilized intervention is likely to be ineffective when capital flows are persistent. Looking at the experience of five managed-float countries (India, Indonesia, Korea, the Philippines, and Thailand) over the period 2000–2007, Edison, Guimarães, Kramer, and Miniane (2007) find limited evidence of systematic links between exchange rates and intervention.

[43] Tapia and Tokman found that public announcements of potential interventions—as opposed to actual interventions—had significant effects on the level and trend of the exchange rate.

koruna's exchange rate, but that it was short-lived and economically-unimportant. Gersl and Holub also discuss the consistency of the interventions with inflation objectives of the central bank. [44]

3. Discretionary Intervention and Monetary Policies: A Tale of Two Episodes

3.1 Intervention Operations

On September 17, 2004, facing an escalating appreciation of the peso, the BdR announced its decision to introduce direct and discretionary foreign exchange intervention operations in the spot market.[45] The announcement indicated that the BdR would buy up to US$1,000 million in international reserves by year end.[46] By December 22, 2004, the BdR upended its discretionary intervention strategy, announcing that direct foreign currency purchases would continue indefinitely, with no fixed amount or duration.

Table 2.1 provides descriptive information on BdR's discretionary intervention operations.[47] Between September 20, 2004, and March 2, 2006—the first period of

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[44] Ho and McCauley (2003) provide an earlier analysis of the use of intervention in the context of money or inflation targets, while Mohanty and Turner (2006) discuss the possible distortions in the domestic financial system caused by sustained sterilization efforts of central bank intervention. Edwards (2006) and Chang (2007) provide a discussion on whether the exchange rate should play a role in determining the monetary policy stance under inflation targeting in emerging markets, and analyze the rationale for reserve accumulation and foreign exchange intervention in these countries. More recently, Lavigne (2008) discusses the recent trends in sterilized intervention among emerging market economies, the fiscal costs associated to them, and the recent increase in alternative sterilization methods, such as the rise in reserve requirement ratios.

[45] The peso had appreciated 13.3 percent in real terms between April 2003 and September 2004. A policy response to the appreciation was also deemed necessary because further appreciation was expected to reduce inflation significantly below the 2004 inflation target of 5.5 percent.

[46] Up to that moment, the BdR had been following a rules-based intervention mechanism based on auctioning foreign currency options. The rules, timing, and magnitude of these interventions were largely predetermined and known by market participants. A detailed description of the operational aspects can be found in Uribe and Toro (2004). Mandeng (2003) and Ramirez (2004) analyze the experience of options-based foreign exchange intervention in Colombia before 2004.

[47] As constructed, this data set excludes changes in reserves for reasons other than—and not related to—influencing the level of the exchange rate. These include valuation effects, capitalization of interest gains, portfolio adjustment operations, or other foreign exchange transactions not aimed at influencing the exchange (such as the trading of foreign exchange to meet the needs of the central government). Historical data on official intervention is not available to the public at a daily frequency, and the BdR only publishes the aggregate monthly amount of its net purchases of dollars, ten days after the end of each month.

discretionary intervention—Colombian authorities intervened in the peso-dollar exchange rate market on 251 days, or approximately 70 percent of the total trading days. The average size of daily foreign currency purchases was almost US$30 million, approximately 5 percent of total market turnover. The amounts purchased varied considerably, however, with the largest intervention exceeding 40 percent of daily volume traded in the market. During this period, the BdR carried out intervention on several successive business days, with the longest intervention spell reaching 36 days.

Table 2.1. Summary Statistics on Daily Central Bank Intervention in the Foreign Exchange Market

	Regimes of Un-Announced Discretionary Intervention	
	First Period Sept. 2004– Mar. 2006	Second Period Jan. 2007– Apr. 2007
Frequency		
Number of trading days	357	73
Number of intervention days	251	44
Frequency of central bank intervention (in percent) 1/	70.3	60.3
Intensity		
Average value of intervention (in US$ millions) 2/	29	103
Maximum daily intervention (in US$ millions)	542	733
Average relative value of intervention (in % of mkt. turnover) 2/	5.1	10.7
Maximum relative value of intervention (in percent)	40.9	48.6
Duration		
Longest intervention spell (in business days) 3/	36	9

Sources: Author's calculations based on data provided by the Banco de la República.
Note: Purchases are in millions of U.S. dollars. The first period goes from September 20, 2004, to March 1, 2006. The second period starts on January 15, 2007, and ends on April 30, 2007.
1/ Number of days in which central bank intervened, as a fraction of total trading days.
2/ Average magnitudes calculated over days on which intervention occurred.
3/ The longest continuous stretch of central bank intervention within each sub-period.

The BdR stopped its discretionary interventions at the beginning of March 2006, when uncertainty about the U.S. Federal Reserve policy led to a reversal of capital inflows and a sudden moderation of appreciation pressures. Starting in March 2006, the

Colombian government only intervened in the foreign exchange market by buying and selling foreign exchange options to smooth exchange rate volatility.[48]

Beginning in July 2006, however, the exchange rate resumed its path of sustained appreciation, accumulating an appreciation of 15 percent by the end of 2006. On January 15, 2007, after a pause of nine months, the BdR re-initiated discretionary interventions to counteract the mounting appreciation pressures.[49] During the second intervention episode (from January 15, 2007, to April 30, 2007), the frequency of BdR activity in the market was lower (60 percent of business days), but the amount of intervention was on average larger—especially when compared to the total activity in the foreign exchange rate market (see Table 2.1 above). During the first four months of 2007, the BdR accumulated US$4.5 billion by actively intervening in the market.[50]

During the period under study, official discretionary intervention operations were conducted exclusively in the spot market, and the BdR did not intervene in the foreign exchange forward market nor did it conduct off-market foreign exchange operations.[51] Daily intervention operations were secret, and the BdR did not make explicit the rules for discretionary intervention or pre-announced a target level for the exchange rate.[52]

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[48] Under this mechanism, the Central Bank auctions call (put) options to sell (buy) foreign exchange for up to 180 million when the peso depreciates (appreciates) by more than 2 percent from its 20-day moving average. They expire one month after the auction date and can only be exercised when the official exchange rate is above (US$ call) or below (US$ put) its 20-day moving average. During this period, the volatility rule was triggered 11 times and led to a net reduction of reserves of US$360 million.

[49] Almost two weeks later, in its official Communiqué dated January 26, the BdR made public its determination to carry out 'massive' foreign exchange rate intervention, aimed at preventing what the central bank perceived as temporary appreciation pressures derived from the conversion of large privatization revenues to the domestic currency.

[50] Over the whole sample period, the BdR accumulated approximately US$17 billion through discretionary intervention operations, almost doubling the amount outstanding in September 2004. As a share of short-term debt, reserves rose from 92 percent in September 2004 to 172 percent in April 2007.

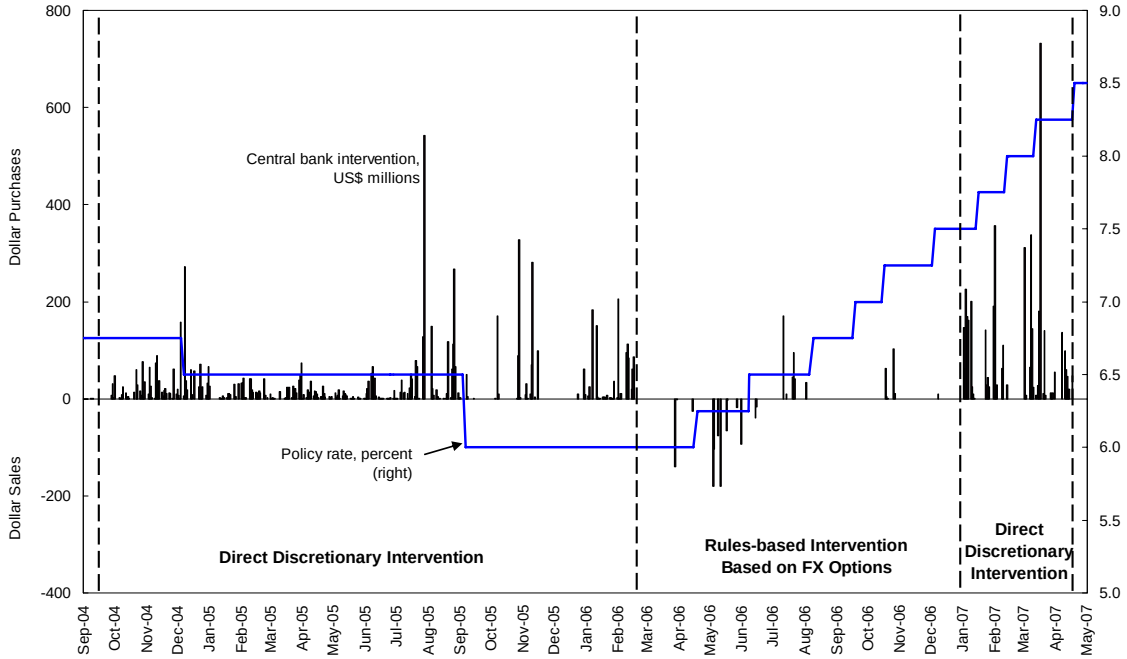
[51] Central banks in several developing countries (Croatia, Czech Republic, Mexico, and South Africa, among others) have at times engaged in "passive intervention," i.e., outright transactions conducted off-market aimed at insulating the foreign exchange market from large external receipts (such as oil revenue sales by state-owned enterprises, proceeds from privatization revenues, foreign aid, or surrender requirements). Moreno (2005) notes that in Mexico, for example, the Mexican oil company Pemex can only acquire pesos by depositing its dollars at the central bank.

[52] For carrying out discretionary interventions, the central bank participates in the foreign exchange market as any other trader, secretly announcing its bids for buying or selling foreign exchange.

3.2 Monetary Policy Stance and Sterilization Policies

The two periods of discretionary intervention described above were associated with two starkly different monetary policy stances.[53] The first period was characterized by relatively low interest rates and a loosening of monetary policy. Over most of the period between September 2004 and March 2006, output was below potential and the central bank twice decreased the policy interest rate.

Figure 2.2. Central Bank of Colombia's Intervention and Movements in the Policy Lending Rate



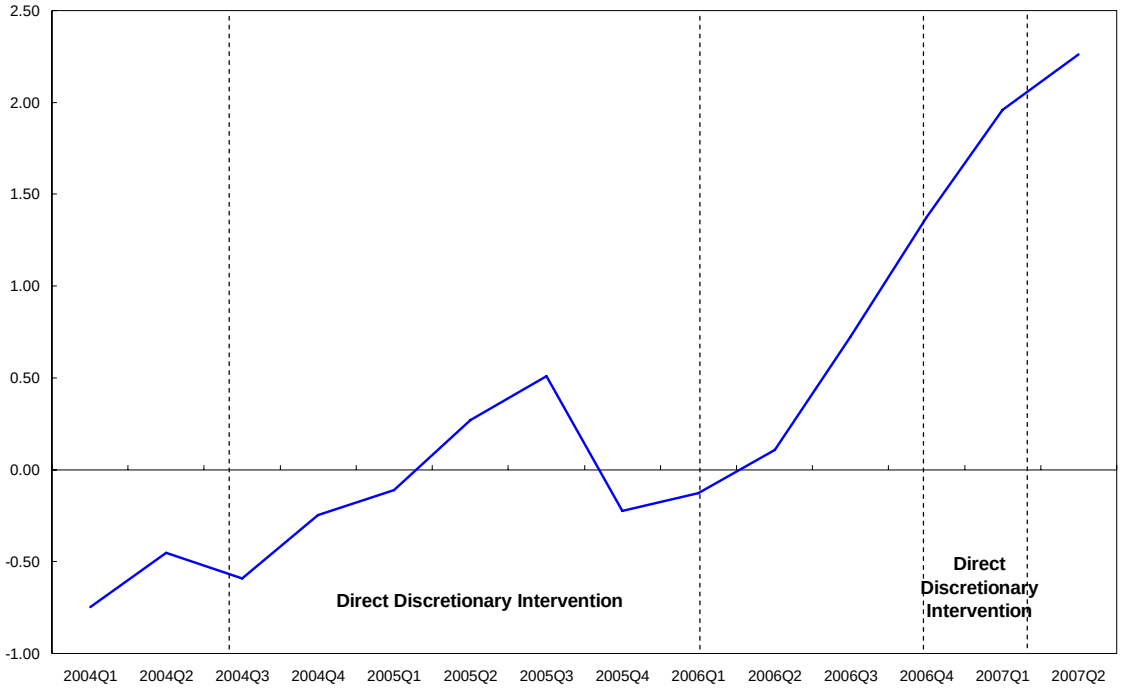
Source: Banco de la República.

During the second intervention episode in 2007, however, BdR's dollar purchases occurred against a backdrop of tightening monetary policy. Since April 2006 the BdR had started to raise interest rates progressively in a bid curb inflationary pressures in an overheating economy (Figure 2.3). By January 2007 it had accumulated increases

[53] The BdR adopted an inflation-targeting scheme with a floating exchange rate in October 1999, using the overnight repo (and reverse repo) interest rate as the main instrument of monetary policy. This reform replaced a system of pre-announced exchange rate bands that had been in place since 1994 and was subject to speculative attacks during 1998–99. See Vargas (2005) for a detailed account of monetary policy since 1999.

amounting to 175 basis points, and continued to raise interest rates throughout the period of discretionary intervention. These rate increases led to a considerable upward shift in interest rate differentials with the U.S., which widened from 125 bps at the end of April 2006 to 325 bps at the end of April 2007.

Figure 2.3. Output Gap in Colombia
(In percentage deviation from trend, quarterly frequency)



Sources: Banco de la República; and author's calculations.

The different stance of monetary policy across the two intervention episodes is reflected in the different sterilization strategies pursued by the BdR across these two periods. Figure 2.4 shows the different mechanisms that the BdR could use to offset the impact of reserve accumulation, and their net contribution to changes in the domestic monetary base in each period. During the first period of discretionary intervention, the BdR mainly relied in non-market instruments to mop-up liquidity, by selling foreign exchange reserves to the government (which represented slightly more than 60 percent of total foreign currency intervention) and by transferring government deposits from the commercial banking system to the BdR. Over the whole period, the net sterilizing effect

of open-market operations (net sales of Treasury debt instruments) was close to zero.[54] Repo liquidity operations, on the other hand, were not used to offset, but rather had a net *expansionary* effect on the monetary base.[55] Overall, FX intervention was only partially sterilized and intervention influenced the central bank's provision of liquidity in the financial system. In other words, during this period in which the BdR was accumulating reserves, it also sought to deliberately expand the monetary base to support its choice of a more accommodative policy stance.[56]

During the second episode of discretionary intervention, on the other hand, the increase in net foreign asset holdings of the Central Bank was fully sterilized, and all available mechanisms were deployed to offset the expansion of money supply associated to foreign currency purchases (see Figure 2.4).[57] The transfer of deposits of the government to the Central Bank was the key instrument of sterilization, and repo operations—traditionally expansive— were also used heavily to neutralize the effect on reserve money. Overall, the monetary base contracted slightly during this period even though the economy (and money demand) was growing fast—consistent with Central Bank's more restrictive short-term interest rate target.

[54] Since 1999 the Central Bank is not allowed, by law, to issue its own securities.

[55] The Central Bank controls the amount of short-term liquidity supplied to the domestic banking system through the use of expansionary and contractionary REPO auctions (mostly overnight and at one-day maturities).

[56] For example, in December 2004, when the BdR announced that direct foreign currency purchases would continue indefinitely, it almost simultaneously notified the public of the closing of the contraction window and reduced the minimum interest rate on the monetary expansion auctions by 25 basic points.

[57] The only exception was the mechanism of selling foreign currency to the government, which was not used during this period.

Figure 2.4a. Sources of Changes in Monetary Base across the Two Intervention Episodes
(Billions of pesos)
First Episode: 2004-2006

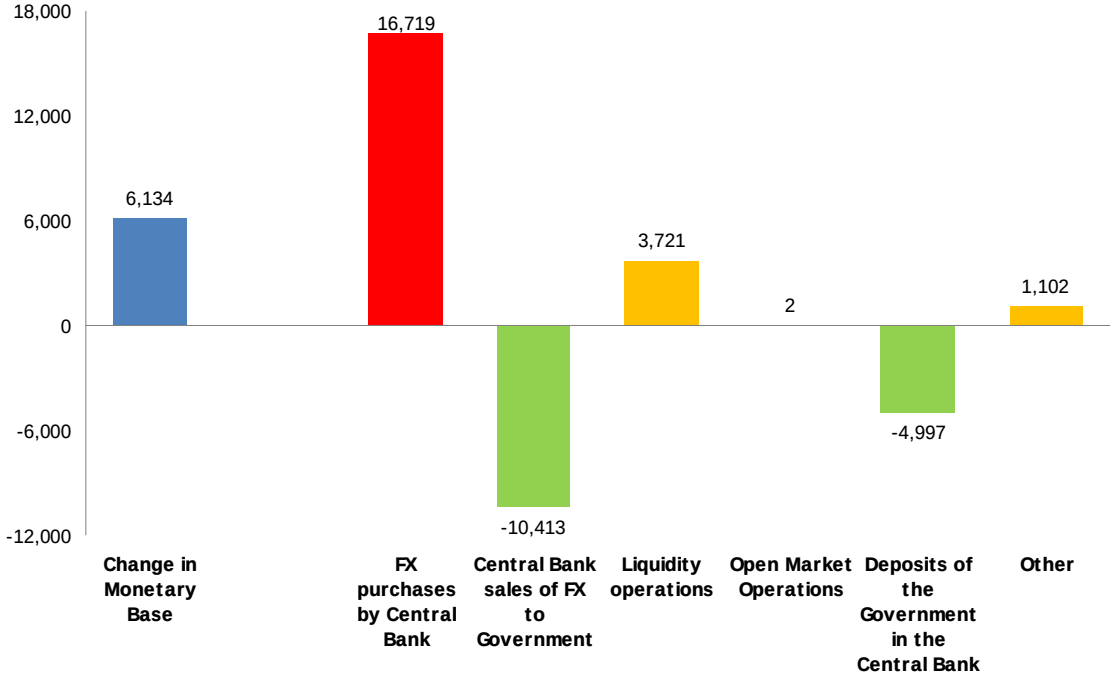


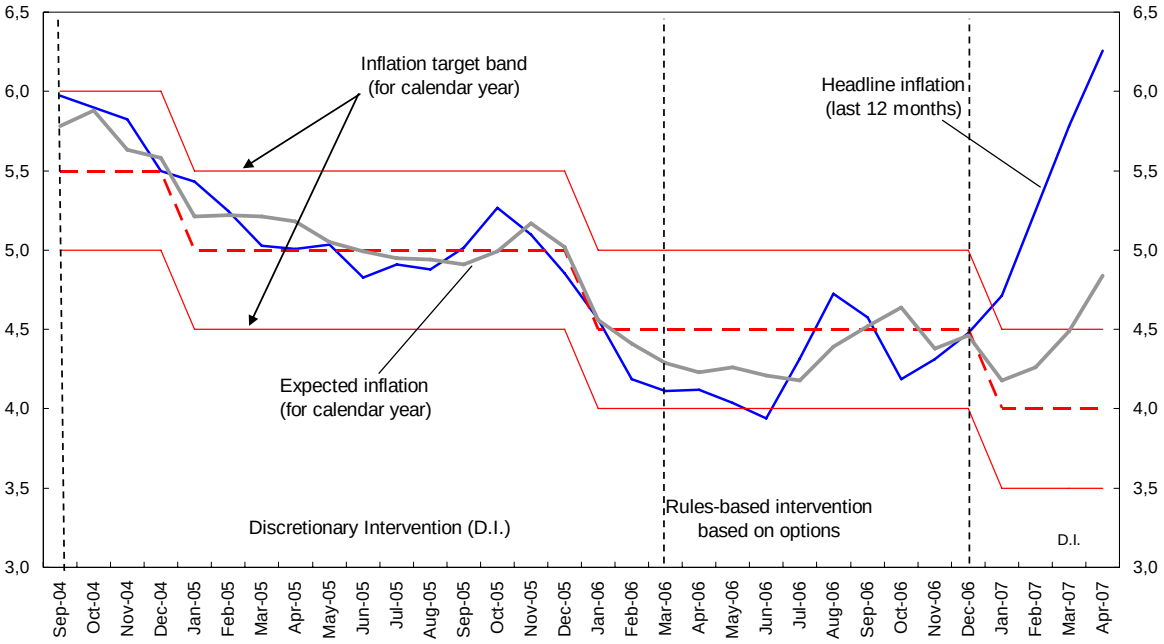
Figure 2.4b. Sources of Changes in Monetary Base across the Two Intervention Episodes
(Billions of pesos)
Second Episode: 2007

Source: Author's calculations based don data provided by Banco de la República.

3.3 Credibility of the Inflation Target: Differences Across Periods and Changes within Periods

Not only did the monetary policy goals differ markedly across the two intervention episodes, but there was also a significant change in the credibility of the inflation targeting regime. During the first period, the inflation target announced by the Central Bank was highly credible: every quarter, between 80 and 90 percent of survey respondents (on average across the three years) thought that the inflation goal would be met.[58] During the second intervention wave (January to April 2007), however, credibility was much lower and fell dramatically over time. The fraction of respondents that thought the inflation target would be attained was 24 percent during the first quarter, and fell to only 6 percent in the second quarter of 2007 (Figures 2.5 and 2.6).

Figure 2.5. Evolution of Inflation and Inflation Expectations vis-à-vis the Inflation Target

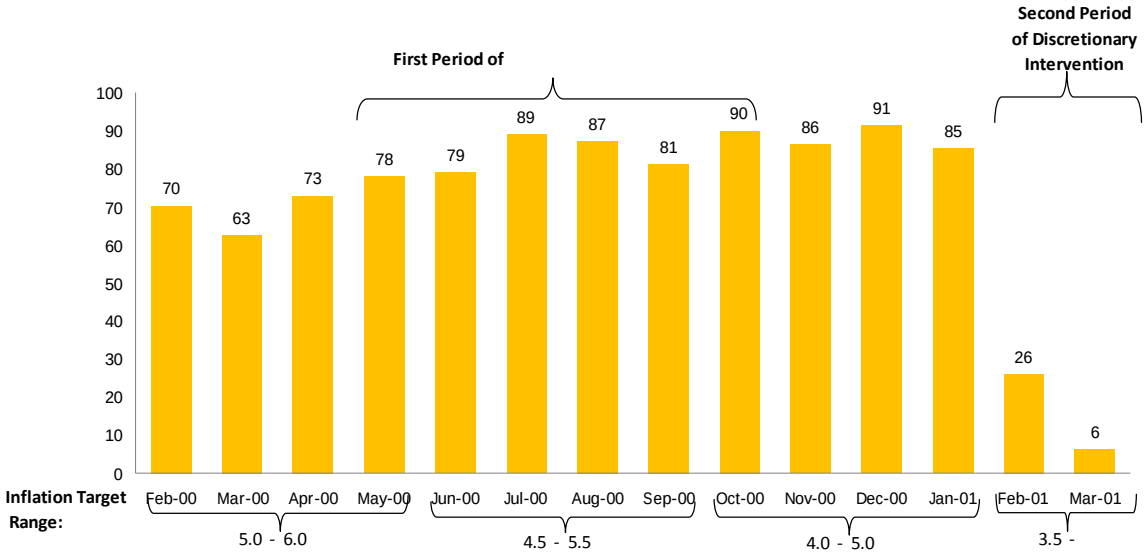


Sources: Banco de la República; and author's calculations.

[58] This numbers are based on quarterly survey data collected by the Central Bank on the percentage of respondents who believed that the inflation target would be attained at year-end.

What explains this change in the market's trust that the Central Bank would achieve the target? During the first episode, purchases of international reserves were made in the context of a negative output gap and decreasing inflation rates. For this reason, the BdR was able to achieve the inflation targets with remarkable precision (Figure 2.5). Moreover, inflation expectations were unhinged by the intervention in the foreign exchange because markets perceived that exchange rate and monetary policies were fully coherent. That is, the stated goal of weakening the peso (through partially sterilized intervention operations) was consistent with the loosening of monetary policy. In other words, because macroeconomic objectives were well aligned, foreign currency purchases unambiguously and credibly signaled an easing of monetary policy—even if intervention operations were not publicly announced.[59]

Figure 2.6. Credibility of the Inflation Target
(Percentage of respondents who believe that the inflation target would be attained at year-end)



Source: Author's calculations based on data provided by Banco de la República.

During the second period, however, there was a tension between monetary and exchange rate policy goals. By the time the Central Bank launched its discretionary

[59] Toro and Julio (2006) provide additional support for this conclusion.

interventions in January 2007, inflation was already above the target and rising (Figure 2.5). Thus, the BdR sought simultaneously to maintain price stability by raising interest rates, and preserve competitiveness by resisting currency appreciation through sterilized interventions. In this context, markets perceived that BdR's dollar purchases would undermine its ability to meet the inflation target by year-end, as resisting currency appreciation blunted the pass-through channel that would have helped offset higher import prices. [60]

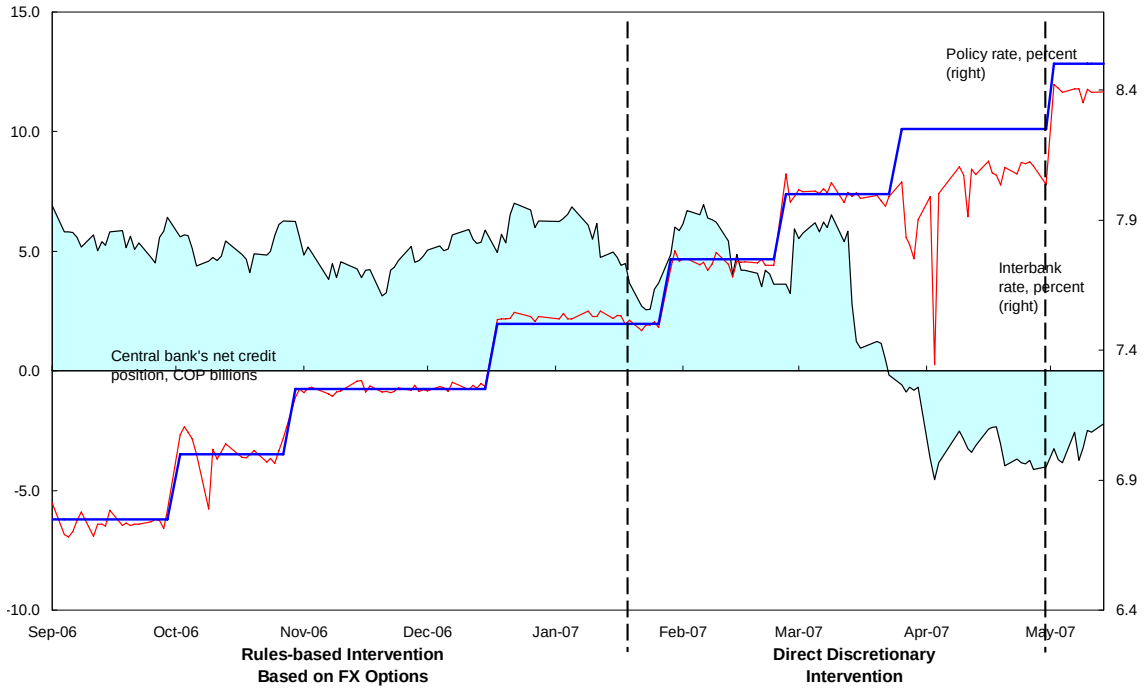
As a consequence of the large-scale intervention, the Central Bank found it increasingly difficult to offset its massive foreign currency purchases and increase the short term interest rate at its desired level. By end-March 2007, the Central Bank switched from being a net creditor to a net debtor position vis a vis the financial system (Figure 2.7). This stifled the primary transmission channel of monetary policy, as the inter-bank interest rate drifted (albeit, temporarily) below and away from the BdR's lending rate which was being increased. [61] This further complicated attaining the inflation objective, and explains why credibility of the inflation target fell dramatically by the end of the second period.[62]

[60] See Holub (2004) for a very similar finding based on the experience of the Czech Republic with central bank intervention.

[61] In practice, a central bank is better positioned to move short-term interest rates to its desired level if the monetary authority is a net lender of liquidity to the financial sector. This was evident in the behavior of policy and inter-bank interest rates depicted in Figure 7. While the average inter-bank rate tracked very closely the reference rate until the end of March 2007, the relationship weakened after that. The possibility that large scale foreign currency purchases could eventually turn the BdR from a net provider of short-term liquidity to being a net borrower vis-à-vis the financial sector was correctly anticipated in Vargas (2005).

[62] At the time, the outstanding stock of government paper at the BdR was not enough to mitigate the monetary consequences of large-scale foreign currency purchases. To preserve the control of monetary conditions, the BdR opened its own deposit facility on April 2, 2007, to mop up the excess liquidity from the financial system. Finding it increasingly difficult, however, to offset their aggressive intervention, the authorities decided to stop intervening on April 30, 2007. On the 6th of May, the authorities imposed restrictions on debt and portfolio inflows and derivative positions, in an attempt to isolate spot and forward exchange rate movements from interest rate policy.

Figure 2.7. Net Creditor Position of the Colombian Central Bank vis-à-vis the Financial Sector and Behavior of Interest Rates during Second Period of Intervention



Source: Author's calculations based don data provided by Banco de la República.

4. Empirical Strategy

There are two main challenges in assessing the impact of intervention on exchange rates in the case of Colombia. First, the decision (and extent) of intervention may have been endogenous to past exchange rate movements. That is, the central bank could have been more likely to buy foreign currency when the domestic currency was strengthening. Failing to account for the two-way causality between exchange rate changes and intervention is likely to bias the analysis toward finding that the latter has no impact on exchange rates.[63] Second, the descriptive evidence presented in Section 3 indicates that part of the intervention operations conducted during the first period were

[63] In other words, simultaneous observation of foreign exchange purchases and domestic currency appreciation cannot be interpreted as evidence that intervention was ineffective. For instance, in the absence of intervention, the exchange rate might have followed a more appreciated path. The lack of a counterfactual is typical of policy evaluation, as described in the literature of treatment effects (see Imbens, 2004, for a recent survey). However, in the case of the exchange rate intervention literature, the problem is compounded by the lack of a consensus model on exchange rate determination to estimate the counterfactual.

not sterilized, i.e., the monetary authority did not fully offset the increase in the domestic money base from its increase in net foreign assets holdings. By itself, an unsterilized intervention is simply another way of conducting expansionary monetary policy and would be normally expected to depreciate the exchange rate. Thus, to assess the effectiveness of intervention as an independent policy tool, it is necessary to take into account the degree of sterilization and market expectations on the extent to which interventions would be sterilized.

The empirical strategy aims to overcome the econometric identification problem by using a two-stage instrumental variable model based on estimates of the BdR's reaction function.[64] For each period of discretionary intervention, I estimate a foreign exchange intervention function for the amount of intervention. I then use the predicted values from the first stage as an instrument for actual interventions in a reduced-form model of exchange rate returns.[65] However, in the absence of detailed daily data on the degree of sterilization of intervention operations, however, the current identification strategy would not be able to tease out the influence of peso-weakening interventions from the effects of monetary policy. This caveat should be borne in mind when interpreting the results for the first period presented below.

In the first-stage, foreign exchange intervention policy is described as a dynamic censored regression (Tobit) model of the following form:[66]

$$INT_t = \max\left(0\,,\, \gamma_0 + \gamma_1 INT_{t-1} + \gamma_2\left(\Delta \ln s_{t-1}\right) + \gamma_3\left(\ln s_{t-1} - \ln s_{t-1}^{T}\right) + \gamma_4 NewsInf_{t-1}\right) + u_t \qquad (2.1)$$

[64] The same methodology is used in Guimarães and Karacadag (2004) and Disyatat and Galati (2007). For recent reviews of the empirical literature on the impact of foreign exchange interventions on the level and variance of exchange rates, see Hutchinson (2003) and Neely (2005).

[65] The model allows for GARCH effects in the conditional variance.

[66] Almekinders (1995) and, more recently, Gnabo, Mello, and Moccero (2008) survey empirical work on the determinants of intervention. The conventional strategy is to estimate a Probit or Tobit model on spot-market intervention as a function of exchange rate deviations from fundamentals and volatility, as well as other controls. In cases where intervention is sporadic and tends to be clustered around specific days, other authors have estimated friction models (see Neely, 2006).

where *INT* denotes the actual amount of dollar purchases, s_t is the nominal exchange rate (expressed in terms of local currency per U.S. dollar), and s^T is a backward-looking, 20-day moving-average component, a proxy for the (time-dependent) 'target' nominal exchange rate:

$$s_t^T = \frac{1}{20}\sum_{j=1}^{20} s_{t-j} \tag{2.2}$$

The specification in (1)-(2) allows interventions to be motivated by two exchange rate factors: a very short-term one (the daily percentage change in the exchange rate, $\Delta \ln s_{t-1}$), and by the percentage deviation of the exchange rate from 'target.'[67] This enables to test if the BdR systematically "leaned against the wind" and/or attempted to counter short-term exchange rate trends. In addition, the model controls for the possibility that official announcements of inflation data can influence the decision to intervene. *NewsInf* is the "news" contained in the announcement—the difference between the actual announced level of monthly inflation and the market's expectation of that announcement.[68] Finally, because interventions usually come in clusters, we include the lagged dependent variable as a regressor to account for persistence effects.

In the second stage, we estimate a GARCH (1,1) model of the peso-dollar exchange rate return with the following general specification:[69]

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[67] The order of the moving average representation has varied across studies. In the case of Colombia, I set it to a 20-day moving average, which is the trigger used in operations with options under the rules-based intervention scheme.

[68] Market expectation is measured as the median forecast of the monthly inflation value culled from opinion surveys conducted by Bloomberg News Service. The surveys are taken very close to the time of the announcement, and ask about expectations of the change in domestic CPI over the previous month.

[69] The nominal exchange rate data is provided by the BdR and corresponds to the value-weighted average of all foreign exchange rate transactions in the spot market throughout the day (officially known as TRM, or *Tasa Representativa de Mercado*). The daily returns for the peso/dollar exchange is calculated as the difference in the logarithm of the exchange rate of two consecutive business days. Table A1 in the Appendix reports various descriptive statistics on the unconditional distribution of exchange rate returns. All the series appear to have non-normal distributions, with significant linear and non-linear serial correlations, especially during the first period. Thus, I follow Baillie and Bollerslev (1989) and Dominguez (1998) and use a univariate Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model for the analysis.

$$\Delta(\ln s_t) = \mu + \beta_0 \Delta(\ln s_{t-1}) + \beta_1 \overline{INT}_t + \beta_2 \left(i - r^*\right)_t + \beta_3 \Delta(EMBI\ spread)_t + \beta_4 NewsInf_{t-1} + \beta_5 AutomINT_t + \varepsilon_t \quad (2.3)$$

$$\varepsilon_t \left| \Omega_{t-1} \sim \mathrm{N}(0, \sigma_t^2) \right. \quad (2.4)$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 \sigma_{t-1}^2 + \alpha_2 \varepsilon_{t-1}^2 + \alpha_3\ INT_t + \alpha_4 \left(i - r^*\right)_t + \alpha_5 \Delta(EMBI\ spread)_t + \alpha_6 \left| NewsInf_{t-1} \right| + \alpha_7 AutomINT_t + \sum_{i=1}^{4} \delta_i D_{it} + \delta_5\ PostH_t + v_t \quad (2.5)$$

where: $\Delta(\ln s)$ is the daily percentage change in the nominal exchange rate (such that a positive change is a depreciation of the Colombian peso); $\overline{INT}$ is the instrumented level of BdR intervention in the foreign exchange market, as explained above; $\left(i - r^*\right)$ is the interest rate differential between the domestic interbank rate and the U.S. Fed's fund rate, in percent per year; *EMBI spread* is the yield spread on a sovereign foreign currency bond over a comparable U.S. treasury bond in percent per year;[70] *AutomINT* is a dummy variable denoting the days in which the automatic intervention rule through options was triggered;[71] D_{it} are day-of-the-week dummy variables (for example, $D_{1t} = 1$ for Mondays, where Friday is the omitted category); $PostH_t$ is a holiday dummy variable that is equal to one on the day following the market being closed for any reason other than a weekend; $|\ |$ denotes the absolute number operator and ε_t is the unexpected return which is used to model the conditional volatility of the exchange rate in the volatility equation (5). Finally, σ_t^2 is the conditional variance and allows for the possibility of time-varying and clustering conditional volatility. The conditional distribution of the disturbance term is normal with variance σ^2.

Several features of the specification are worth noting. Equation (3) of the empirical model (the "mean" equation) analyzes changes in the exchange rate return

[70] This is measured in first differences to achieve stationarity.

[71] During the discretionary intervention episodes, the intervention rule was triggered twice: on December 20, 2004, and on March 30, 2007. The empirical model above accounts for the impact of these automatic interventions in assessing the effects of discretionary intervention.

(depreciation or appreciation against the dollar) as a function of intervention, controlling for other factors affecting exchange rates at a daily frequency.[72] The main focus is on the estimate of β_1, the contemporaneous impact of intervention on the level of the exchange rate. If central bank intervention is effective, then purchases of foreign currency $(INT > 0)$ will depreciate the domestic currency $(\Delta(\ln s) > 0)$ and so β_1, the parameter of interest, will be positive and statistically significant.

The estimation controls for financial developments affecting short term exchange rate movements. The interest differential aims to capture the possible impact of monetary policy actions and local money market conditions on the exchange rate. This is especially important during the first period, when the Central Bank was easing monetary policy.[73] Yield spreads on sovereign external debt are included as a measure of country risk and foreign investor sentiment, which are potential key determinants of foreigners' demand for local currency. I also account for the possible influence of surprises in inflation announcements, that may arrive on the same day on which intervention is carried out.

5. Summary of Results

5.1 Central Bank Reaction Function

Table 2.2 reports the results on the determinants of foreign exchange intervention activity. Results for the first period of intervention are consistent with the hypothesis that the BdR attempted to "lean against the wind," i.e., to smooth the speed of adjustment of the exchange rate and thus avoid large appreciations on a given day. The coefficient for the reaction on the short-term change in the spot exchange rate has the right sign and is statistically significant, suggesting that between 2004 and 2006, the BdR reacted systematically to previous-day exchange rate changes in deciding the amount to intervene. The estimate of γ_2 implies that, on average, a 1 percent appreciation of the

[72] Given the reduced-form nature of the estimation, the framework can only identify the average response of exchange rate returns to intervention operations. It does not, however, identify a structural relationship or the channels through which intervention may affect exchange rates.

[73] The distinction between unsterilized and sterilized intervention is important: changes in the monetary supply would naturally affect the exchange rate, so it would not be surprising to find that unsterilized intervention is effective in depreciating the currency.

exchange rate was met by a central bank purchase of US$14 million the following day (see Table 2.2). At the same time, results shown in the first column of Table 2.2 suggest that another motivation for BdR's intervention was to slow or reverse the trend of appreciation during this period. The point estimates imply that an appreciation of the peso of 1 percent relative to target, triggered purchases of US$13 million on average by the BdR during the first period.[74]

Table 2.2. Determinants of Colombia Central Bank's Daily Discretionary Intervention in FX Spot Market

	First Period September 2004– March 2006	Second Period January 2007– April 2007
γ_1 (Lagged Dependent Variable)	0.16	0.40**
	(0.13)	(0.19)
Exchange Rate Acceleration		
γ_2 (Exchange Rate change, in percentage) (t-1)	-14.10**	-67.80
	(5.5)	(55.85)
Deviation of Exchange Rate Level		
γ_3 (Percentage Deviation from *Target*) (t-1)	-13.40***	-54.78**
	(4.13)	(26.3)
Unexpected Component of Inflation Announcement		
γ_4 (Actual minus Expected Value of Inflation) (t-1)	-90.340**	52.15
	(40.1)	(55.16)
Diagnostics		
Cragg & Uhler's R2	0.10	0.19
Prob > LR	0.00	0.00
Included observations	356	73
Censored Observations (in percent)	29.7	39.6

Source: Author's calculations.

Note: This table reports estimation of a Tobit model for equation (1) in the text. The dependent variable is the amount of dollars purchased by the Central Bank (in millions) in the domestic foreign exchange market to influence the value of the home currency. Estimated coefficients are the marginal effects of a unit change in the explanatory variables, evaluated at sample means. Robust standard errors are reported in parentheses. The model includes a constant, not shown. Asterisks denote significance of coefficients, with ***, **, and * indicating significance at the 1%, 5%, and 10% level, respectively.

[74] Since the motivation for BdR intervention was not announced, the policy criteria of 'leaning against the wind' and 'reverse the trend of appreciation' are only indicative of actual policy intentions. However, the negative estimated coefficients on γ_2 and γ_3 conforms to our priors and those of market participants, as well as unofficial BdR statements.

The results for the second period of intervention, however, suggest that Colombian authorities did not appear to intervene in response to an acceleration of peso appreciation, that is, to smooth out exchange rate fluctuations. Indeed, the value for γ_2 in the second column of Table 2.2 has the expected sign but is estimated very imprecisely. Rather, results indicate that a key motivation for discretionary interventions during the second period was a desire to correct the deviation of the exchange rate from its (moving) target value. The point estimate for γ_3 implies that in response to a 1 percent negative deviation of the exchange rate with respect to target, the BdR would purchase on average US$54 million during 2007 to slow appreciation. These intervention efforts to guide the exchange rate toward a target value were more pronounced than during the first period of intervention.[75]

During the second period, foreign exchange interventions became more highly correlated over time. In particular, the results suggest that once intervention was carried out one day, another intervention of a similar magnitude (and in the same direction) was likely to take place the following day.[76] This observation provides important insights into the muted impact of the BdR's activity in the foreign exchange: as intervention became more predictable, its ability to surprise the market diminished. In effect, market participants may have been better able to anticipate the BdR's operations, especially considering the high frequency of intervention and that all interventions were carried out in the same direction.[77]

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[75] These results are robust to the inclusion of volatility of the exchange rate as a possible determinant of discretionary intervention in equation (1). The estimated coefficient is statistically insignificant in both periods, suggesting that the BdR did not intervene in response to a rise in market uncertainty. This pattern is consistent with the idea that the authorities engaged in discretionary intervention only to affect the level of the exchange rate, and resorted to rules-based, non-discretionary intervention to dampen the volatility of the exchange rate (as discussed in Section 3).

[76] Dynamic considerations did not play an important role in determining the intervention strategy used by the BdR in the first period.

[77] The model seems to capture only a small fraction of the variance of the intervention variable as suggested by the R-square statistic, in particular during the first period. This may suggest that other variables not captured in the model—such as political factors—were also important. See Vargas (2005) for a discussion of political economy issues related to intervention.

5.2 Effects on exchange rates

The estimates in Table 2.3 suggest that unsterilized intervention during the first discretionary period had a moderately sizable effect on the exchange rate, and in the direction intended by the authorities.[78, 79] The coefficient for the effect of contemporaneous intervention (0.78) is statistically significant, and implies that a US$30 million purchase (the average daily amount of intervention within this period) was associated to a depreciation of the value of the domestic currency by approximately 0.23 percent.[80] That is, the intervention required to contemporaneously move the nominal exchange rate by 1 percent on a given day represented approximately 2 percent of the country's reserve money.

The results in the second column of Table 2.3 also suggest that intervention operations had no statistically significant contemporaneous effect on exchange rate returns during the second episode of discretionary intervention.[81] Instead, the results of the model points to the theoretically sensible finding that high and increasing interest rate differentials, positive domestic inflation surprises and improvements in sovereign creditworthiness (as represented by decreases in the EMBI spread) were key factors driving the appreciation of the peso during this period.[82]

Importantly, during this second period, the exchange rate became much more responsive to the interest rate differential. The coefficient on the interest rate differential is almost 15 times larger than in the 04–06 period, and is equally significant in statistical terms. The greater impact of positive interest rate differentials on exchange rate

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[78] These results are consistent with Toro and Julio (2006), who use ultra-high frequency data to analyze the impact of intervention on exchange rate dynamics in Colombia between 2004 and 2006.

[79] Maximum likelihood estimation was carried out using the Berndt-Hall-Hall-Hausmann algorithm using *Eviews* 5.1 package. In all cases, the skewness and kurtosis of the standardized regression residuals indicate that the assumption of conditional normality in equation (2) does not hold. Therefore, robust standard errors using the method described in Bollerslev and Wooldridge (1992) were reported.

[80] The appreciation of the Colombian peso in 2005 was fairly moderate and less acute than the corresponding appreciation that took place in other countries in the region such as Brazil and Chile.

[81] It is telling that—in spite of massive foreign currency purchases by the BdR that reached US$4.53 billion (39 percent of monetary base) in the first four months of 2007—the exchange rate continued its steep appreciation path, the second-highest among emerging markets during this period.

[82] The fit of the exchange rate model (R-square of 0.42) is significantly higher than in previous studies, indicating a high explanatory power for exchange rate changes during this period.

appreciation provides indirect evidence of the importance of carry trade operations during this period, as discussed in the next section.[83]

Exchange rates also appear to have been responsive to announcements on economic news during both periods. Two results stand out. First, news on inflation announcements had a significant impact on exchange rate dynamics, suggesting that fundamentals also drive the exchange rate at higher frequencies.[84] Second, the effect of these announcements was exactly the opposite across periods (Table 2.3). During the first period of intervention, higher-than-expected inflation was on average associated with a depreciation of the peso. During 2007, however, the sign on the unexpected inflation variable was negative and statistically significant, indicating that higher-than-expected inflation resulted in a strong currency appreciation (a reduction in the nominal exchange rate) the subsequent day. The point estimate is economically important: for example, if announced inflation was 1 percentage point above expectations during the second period, the estimated effect was an appreciation of the peso of almost half a percent the next day. The results thus indicate that during the second period, "bad news" about inflation—inflation higher than expected—was "good news" for the nominal exchange rate (that is, the exchange rate appreciated following this news).[85]

[83] Offshore players shorted the dollar in the forward market to gain exposure to the Colombian peso, and indirectly to the prevailing interest rate differential. Kamil and Reveiz (2008) analyze in detail the role of derivatives markets as a conduit for this carry trade, and discuss its policy implications.

[84] The systematic relationship between the surprise component of macroeconomic releases and one-day exchange rate changes is noteworthy, given that the literature has pointed out that this connection is weak and hard to detect (Edison, 1997).

[85] Results for the second period of intervention are consistent with the recent findings by Clarida and Waldman (2007), who look at the reaction of nominal exchange rates to inflation surprises using intra-daily data across 10 countries. The authors show that if a central bank has an inflation target that it implements via a Taylor rule, an unexpectedly high inflation announcement leads to a stronger domestic currency.

Table 2.3. Impact of Central Bank Intervention on Exchange Rate Level
(GARCH Model: Mean Returns Equation)

	First Period September 2004– March 2006	Second Period January 2007– April 2007
β_0 (Lagged Dependent Variable) (t-1)	0.228***	0.148*
	(0.07)	(0.08)
Intervention Indicator		
β_1 (Instrumented Amount of Dollar Purchases by Central Bank) (t)	0.782***	0.055
	(0.29)	(0.09)
β_2 (Overnight Interest Rate Differential) (t)	-0.024**	-0.371**
	(0.01)	(0.16)
β_3 (Daily Change in EMBI Sovereign Spread) (t)	1.287***	2.023**
	(0.22)	(0.92)
Unexpected Component of Inflation Announcement		
β4 (Actual minus Expected Value of Inflation) (t-1)	0.286***	-0.464***
	(0.10)	(0.08)
Dummy for Days with Automatic FX Intervention	Yes	Yes
Diagnostics		
Log *L*	-66.160	-7.460
R-Squared	0.150	0.430
Included observations	356	73

Source: Author's calculations.
Note: This table reports estimation of the Mean Equation of the GARCH(1,1) model in equation (3)–(5) in the text. The dependent variable is the daily rate of change of the nominal exchange rate, in percent. The coefficient on the intervention variables measures the percentage change in the exchange rate for a US$100 million in foreign currency purchases. Asterisks denote significance of coefficients, with ***, **, and * indicating significance at the 1%, 5%, and 10% level, respectively.

The fact that the peso consistently and significantly appreciated in response to unexpectedly high inflation during the second period suggests that markets apparently believed that the BdR would react to such news by increasing interest rates.[86] Consistent

[86] During the first discretionary intervention episode, 75 percent of the monthly announcements of inflation were higher than what the market was expecting. The average value of these positive inflation surprises was 0.25 percent. During the second intervention episode, however, all four inflation announcements between January 15 and April 30, 2007, were above market expectations and the average value of the inflation surprises was five times higher than during the first period (1.3 percent).

with the notion that exchange rates are forward looking asset prices that react to changes in the market's expectation of future fundamentals, the prospect of an increase in domestic interest rates made Colombian assets more attractive, inducing an immediate dollar depreciation (peso appreciation) to equilibrate the asset market. This market reaction provides insight into the reasons why sterilized intervention was ultimately not effective in 2007: markets expected that monetary policy would remain committed to the goal of reducing inflation, even if that meant increasing interest rates and—by encouraging more capital inflows—undoing intervention efforts.

Also of interest is how central bank intervention affects exchange rate volatility. Volatility often reflects, among other things, uncertainty in economic policies and other fundamental determinants of exchange rates, which the market may be struggling to price accurately. As indicated by Dominguez (1998), central bank intervention is expected to reduce volatility as long as intervention is both credible and unambiguous. The results shown in Table 2.4 are consistent with this hypothesis. During the first period, BdR intervention had a stabilizing effect on the exchange rate. Controlling for other factors affecting short-term exchange rate volatility, the results indicate that BdR's discretionary intervention had the un-intended consequence of dampening the volatility of exchange rate returns.[87] This empirical finding is noteworthy, given that the smoothing effect of intervention on exchange rate volatility is at odds with most of the intervention literature for developed countries and developing economies.[88] In contrast, during the second period, official discretionary intervention had no discernible impact on exchange rate volatility.[89]

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[87] In unreported results, I find that the stabilizing effect on the exchange during the first intervention period was stronger after December 20, 2004, when the BdR reduced interest rates and simultaneously announced that interventions would continue indefinitely, with no predetermined amount or duration.

[88] Guimarães and Karacadag (2004), for example, find that intervention led to increased exchange rate volatility in Mexico and Turkey.

[89] During the first period, monthly inflation announcements led to an economically significant drop in conditional volatility of exchange rates in the subsequent day. Interestingly, during the second period foreign exchange market uncertainty did not decrease in the day following the official announcement of inflation. As noted in Footnote 45, during the second period, the actual inflation rates announced were systematically underestimated by the market, possibly leading to major revision in expectations following these official announcements.

Table 2.4. Effect of Central Bank Intervention on Volatility of Exchange Rate
(GARCH Model: Conditional Variance Equation)

	First Period September 2004–March 2006	Second Period January 2007–April 2007
a_0 (GARCH Term)	0.560***	0.544***
	(0.13)	(0.23)
a_1 (Squared Innovation)	0.210***	0.098
	(0.08)	(0.09)
Intervention Indicator		
β1 (Actual Amount of Dollar Purchases) (t)	-0.019***	-0.009
	(0.01)	(0.01)
β_2 (Overnight Interest Rate Differential)	-0.004	-0.003
	(0.00)	(0.03)
β_3 (Daily Change in EMBI Sovereign Spread)	0.095	-0.153
	(0.14)	(0.16)
Unexpected Component of Inflation Announcement		
β4 (Actual minus Expected Value of Inflation, in absolute terms) (t-1)	-0.223***	-0.028
	(0.04)	(0.02)
Fixed Effects for Days-of-the Week and Post-Holiday Trading Days	Yes	Yes
Dummy for Days with Automatic FX Intervention	Yes	Yes

Source: Author's calculations.
Note: This table reports estimation of the Mean Equation of the GARCH(1,1) model in equation (3)–(5) in the text. The dependent variable is the daily rate of change of the nominal exchange rate, in percent. The coefficient on the intervention variable measures the percentage change in the exchange rate for a US$100 million in foreign currency purchases. Asterisks denote significance of coefficients, with ***, **, and * indicating significance at the 1%, 5%, and 10% level, respectively.

In Appendix II, I report on a number of sensitivity tests that probe the central results regarding the treatment for endogeneity and the possibility that the "surprise" element of BdR's interventions (rather than its predicted component) had a significant effect on exchange rates during the second period. The results of such tests are virtually identical to those reported above.

6. The Role of Derivatives Markets in Blunting Central Bank Intervention

During 2007, markets perceived the BdR as pursuing two mutually inconsistent—and ultimately unsustainable—goals. Foreign investors, trusting that the Central Bank would eventually focus on taming inflation (and eventually let the exchange rate appreciate), speculated heavily on exchange rate appreciation by building-up large long-positions in pesos through the onshore forward market.[90] The turnover value in peso forwards bought by off-shores to local banks increased more than three times between end-2006 to its peak in March 2007 (Figure 2.8).[91] The unprecedented size and sheer speed of execution of these leveraged positions resembled a speculative attack against the dollar, reducing the ability of the central bank to influence exchange rate market conditions by buying international reserves to prop up the exchange rate.[92] In summary, the Colombian experience shows that large, persistent, and one-sided central bank foreign exchange purchases that go against the perception of the majority of market has little possibility of success. In such circumstances, intervention can actually lead to greater financial instability, as investors engage in one-way bets against the central bank in the expectation of a high return once the official resistance to the exchange rate adjustment is overpowered.

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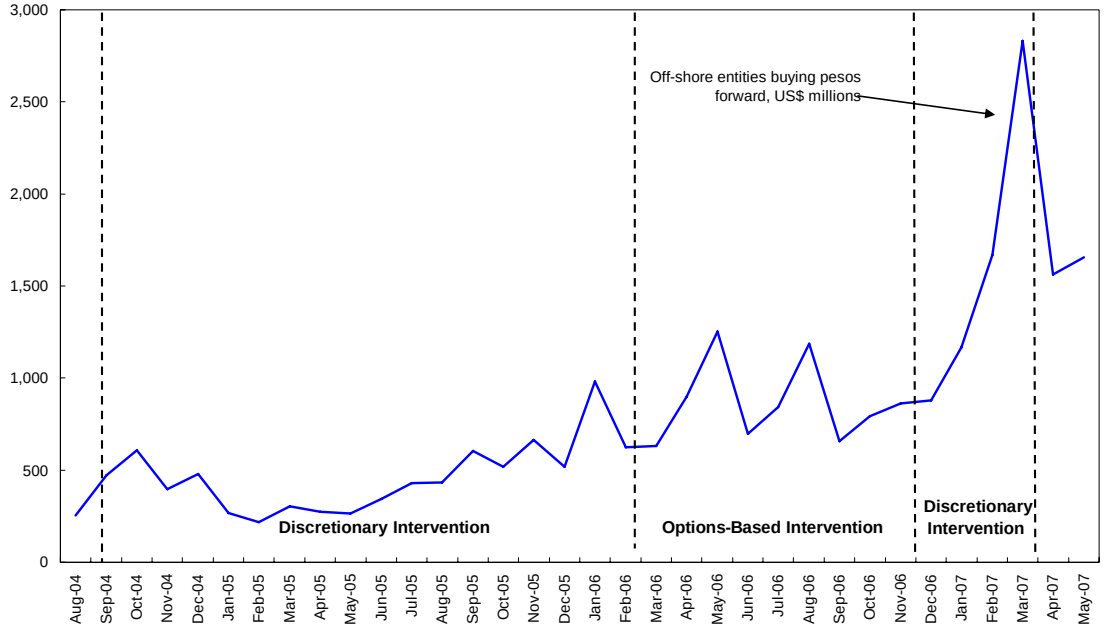
[90] Speculative demand for the peso was also buttressed by the prospect that the underlying forces putting upward pressure on the real exchange rate (such as the improvement in the security situation, better terms of trade and strong inflows of foreign direct investment) were expected to persist over time.

[91] Investors knew that if the BdR became a net debtor of the banking system, this would greatly weaken its ability to conduct monetary policy, other things remaining equal. Under this net debtor scenario, the authorities would be forced to discontinue intervening and the exchange rate would appreciate on impact. As opposed to the information on intervention operations, the net creditor position of the BdR is updated daily in the BdR's official website. Thus, as the BdR soon approached a position in which it would become a net debtor, financial markets may have perceived that the scope for additional intervention would be coming to an end.

[92] As far as I am aware of, the only other instance of a speculative attack *against* a foreign currency in an emerging market occurred in Hungary in 2002 (see Barabas, 2003). Lall (1997) describes a theoretical model that resembles the experience of Colombia but in reverse, where forward markets are the main channel used by speculators to mount a speculative attack *against* the domestic currency in a fixed exchange rate regime. Kumhof, Li, and Yang (2007) analyze a small open economy model under inflation targeting, and show that an inflation-targeting regime can be also vulnerable to speculative attacks. In their model, however, the central bank intervenes to avert a currency depreciation and the attack depletes central bank's reserves.

Figure 2.8. Traded Value in On-Shore Currency Derivatives Market Between Local Colombian Banks and Off-Shore Entities



Source: Banco de la República.

7. Conclusions

This chapter examines Colombia's experience with central bank foreign exchange intervention between 2004 and 2007 under an inflation targeting regime. During most of this period, the BdR engaged in large-scale, discretionary purchases of foreign exchange to resist appreciation of the domestic currency.

Results suggest that during the first period of discretionary intervention (September 2004–March 2006), the combination of peso-weakening intervention and a credible expansionary monetary policy seem to have led to a reduction in appreciation pressures. During the second period (January–April 2007), however, there was no statistically significant correlation between foreign currency purchases and exchange rates. A possible explanation for this result is that large-scale intervention during the second period worked against a backdrop of intense monetary tightening and low credibility in the inflation target.

The identification strategy used in this study does not allow disentangling the causal effect of intervention on exchange rates. Doing so would require properly accounting for the degree of sterilization of interventions (and whether the market expected interventions to be sterilized) and changes in the credibility of the inflation target. This will be the subject of my future research.

Appendices

Appendix 1

Table 2.A1. Summary Statistics on the Unconditional Distribution of Daily Exchange Rate Returns

	Regimes of Un-Announced Discretionary Intervention	
	First Period	Second Period
	September 2004–March 2006	January 2007–April 2007
Daily exchange rate statistics		
Mean (percent)	-0.03	0.01
Variance (percent)	0.17	0.07
Skewness 1/	0.82	0.04
Kurtosis	9.11	-0.02
$Q_{Ds}(20)$ 2/	76.60	23.86
$Q_{Ds2}(20)$	349.20	16.34

Sources: Author's calculations based on data provided by the Banco de la República.

1/ The kurtosis statistic is normalized so that a value of zero corresponds to the normal distribution.
2/ $Q_{Ds}(20)$ and $Q_{Ds2}(20)$ are Ljung-Box tests for high-order serial correlation for the returns and square returns up to the 20th lag, respectively.

Appendix 2: Robustness Tests

Endogeneity

A fundamental assumption of our analysis so far is that the amount of dollars bought by the BdR on a given day depends on past exchange rate returns, but is independent of movements in the exchange rate *within* that day. Admittedly, this is a strong identifying assumption, as it rules out the possibility that the BdR could have acted strategically by also taking into account the intraday evolution of the exchange rate in deciding how much to intervene. If this were the case, aggregate daily interventions and exchange rate changes would simultaneously determine each other, and thus estimates of the effect of central bank intervention would be biased downwards.[93]

Unfortunately, the exact timing and magnitudes of BdR's intervention in foreign exchange markets are not available at an intra-daily frequency. Data are available, however, on the opening exchange rates quotes each day from the Colombian foreign-exchange electronic transactions system, known as SET-FX. Given that exchange rates are quoted at the beginning of the trading day while intervention data is reported at the close of the day, exchange rate returns at time *t* (the percentage change in opening prices between *t* and *t-1*) are predetermined with respect to the amount of intervention at *t*. I exploit this differential timing to attenuate simultaneity problems and check the robustness of the baseline results.[94]

Table 2.A2 re-estimates the impact of BdR's intervention on exchange rate returns for both periods, using opening exchange rates quotes to measure daily exchange rate returns.[95] Results are virtually identical to the benchmark estimates presented in Table 2.3 in the text, except that the positive impact of central bank intervention on

[93] Using a novel identification strategy, Kearns and Rigobon (2005) exploit exogenous structural breaks in the Japanese and Australian authorities' intervention strategies to estimate the effects of central bank intervention. Their identification method, however, hinges crucially on the assumption that the parameters of the authorities' intervention reaction function are stable across periods—something that is very difficult to justify in the Colombian case in light of the evidence presented in Section V.

[94] The same empirical strategy is used in Naranjo and Nimalendran (2000).

[95] As in the previous section, I also use a two-stage instrumental variable model based on estimates of the BdR's reaction function. Results from the first-stage are available upon request.

exchange rate returns during the first discretionary period is somewhat lower. For the second period, I again fail to detect a significant effect of intervention on exchange rate levels, confirming the baseline result that intervention was not a useful short-term policy instrument for exchange rate management during 2007.

Table 2.A2. Effects of Central Bank Intervention: Robustness Test for Endogeneity Concerns

(Mean Returns Equation)

	First Period September 2004–March 2006	Second Period January 2007–April 2007
β_0 (Lagged Dependent Variable) (t-1)	-0.095	-0.130
	(0.07)	(0.10)
Intervention Indicator		
β_1 (Instrumented Amount of Dollar Purchases by Central Bank) (t-1)	0.488*	0.067
	(0.29)	(0.07)
β_2 (Overnight Interest Rate Differential) (t-1)	-0.027*	-0.413***
	(0.01)	(0.14)
β_3 (Daily Change in EMBI Sovereign Spread) (t-1)	1.609***	3.868***
	(0.29)	(0.17)
Unexpected Component of Inflation Announcement		
β4 (Actual minus Expected Value of Inflation) (t-1)	0.272	-0.333***
	(0.31)	(0.12)
Dummy for Days with Automatic FX Intervention	*Yes*	*Yes*
Diagnostics		
Log *L*	-28.001	-7.581068
R-Squared	0.088	0.585
Included observations	356	73

Source: Author's calculations.

Note: This table reports estimation of the Mean Equation of the GARCH(1,1) model in equation (3)–(5), modified to account for the timing in exchange rate quotes as discussed in Section VI in the text. Explanatory variables are lagged one period because exchange rates are quoted at the beginning of the trading day, while intervention is as of the end of the business day, and interest rate and differential and EMBI spread are calculated as averages within the day. The coefficient on the intervention variable measures the percentage change in the exchange rate for a US$100 million in foreign currency purchases. Asterisks denote significance of coefficients, with ***, **, and * indicating significance at the 1%, 5%, and 10% level, respectively.

Unexpected Intervention

By using the fitted values from the reaction function as instruments, the analysis up to this point has tested whether the systematic (i.e., expected) component of foreign exchange intervention could affect exchange rates. However, it is possible that the "surprise" element of intervention (rather than its expected component) has a significant effect on exchange rates.

To test this hypothesis, I try two alternative specifications. First, I decompose the actual amount of intervention into an expected component and unexpected one, the latter given by the residual term in the Tobit model used in the first stage. I then include both measures of intervention in the exchange rate equation (3) described in Section IV. The results in Table 2.A3 show that, in line with the benchmark results, the effects of the predictable component of discretionary intervention is significant during the first period, but has no significant measurable impact during the second period. The unexpected amount of intervention, on the other hand, seems to have a consistently *perverse* effect in both periods: higher unexpected intervention actually led to a contemporaneous appreciation of the currency.

An alternative way to measure the effect of unexpected intervention is to test whether central bank intervention was more effective on days when monetary authorities were perceived as least likely to have intervened. To implement this second specification, I first estimate a Probit model for the decision to intervene using a dummy variable that takes the value of 1 in days when the central bank intervened, and 0 otherwise. As explanatory variables, I use the same determinants as in the benchmark model. Using the fitted values of the discrete choice models as a measure of the ex-ante likelihood of central bank's presence in the market, I define days with a predicted probability below 0.5 as days with a low likelihood of intervention.[96] I then include in the baseline model a multiplicative term capturing the interaction between the instrumented level of intervention and a dummy indicating days in which the BdR was less likely to have

[96] The median daily value of the predicted probability of intervention using the Probit model is 0.84 and 0.74 during the first and second period, respectively.

intervened. Results in Table 2.A4 indicate that the effects of BdR intervention were not significantly different in days with low perceived likelihood of central bank intervention.

Table 2.A3. The Impact of the Unexpected Component of Central Bank Intervention
(Mean Returns Equation)

	First Period September 2004–March 2006	Second Period January 2007–April 2007
β_0 (Lagged Dependent Variable) (t-1)	0.251***	0.102
	(0.08)	(0.09)
Intervention Indicators		
β_{11} (Predicted Amount of Dollar Purchases by Central Bank) (t)	0.860**	0.024
	(0.42)	(0.09)
β_{12} (Unexpected Amount of Dollar Purchases by Central Bank) (t)	-0.039***	-0.124***
	(0.01)	(0.04)
β_2 (Overnight Interest Rate Differential) (t)	-0.031***	-0.587***
	(0.01)	(0.17)
β_3 (Daily Change in EMBI Sovereign Spread) (t)	1.472***	1.835**
	(0.21)	(0.84)
Unexpected Component of Inflation Announcement		
β4 (Actual minus Expected Value of Inflation) (t-1)	0.432**	-0.461***
	(0.21)	(0.10)
Dummy for Days with Automatic FX Intervention	*Yes*	*Yes*
Diagnostics		
Log *L*	-28.001	-3.251016
R-Squared	0.157	0.512
Included observations	356	73

Source: Author's calculations.
Note: This table reports estimation of the Mean Equation of the GARCH(1,1) model in equation (3)–(5), augmented to account for the unexpected component of central bank intervention. The unexpected amount of intervention corresponds to the estimated residual values of the foreign exchange intervention policy reaction model fitted in the first stage. The coefficient on the intervention variable measures the percentage change in the exchange rate for a US$100 million in foreign currency purchases. Asterisks denote significance of coefficients, with ***, **, and * indicating significance at the 1%, 5%, and 10% level, respectively.

Table 2.A4. The Impact of Intervention in Days when the Central Bank was Less Likely to Have Intervened

(Mean Returns Equation)

	First Period September 2004–March 2006	Second Period January 2007–April 2007
β_0 (Lagged Dependent Variable) (t-1)	0.261***	0.132
	(0.08)	(0.22)
Intervention Indicators:		
β_{11} (Predicted Amount CB Intervention) (t)	0.864**	0.085
	(0.39)	(0.23)
β_{12} (Dummy for Days in Which CB was Less Likely to Have Intervened) (t)	-0.116	0.083
	(0.16)	(0.25)
β_{13} (Predicted Amount CB Intervention) X (Dummy for Less Likely CB Intervention) (t)	0.845	-0.187
	(0.66)	(0.42)
β_2 (Overnight Interest Rate Differential) (t)	-0.018	-0.377
	(0.01)	(0.25)
β_3 (Daily Change in EMBI Sovereign Spread) (t)	1.479***	2.114**
	(0.25)	(0.91)
Unexpected Component of Inflation Announcement		
β4 (Actual minus Expected Value of Inflation) (t-1)	0.469**	-0.454***
	(0.19)	(0.12)
Dummy for Days with Automatic FX Intervention	*Yes*	*Yes*
Diagnostics		
Log *L*	-108.442	-5.81293
R-Squared	0.157	0.436
Included observations	356	73

Source: Author's calculations.

Note: This table reports estimation of the Mean Equation of the GARCH(1,1) model in equation (3)–(5), augmented to account for the interaction between the predicted amount of intervention and the ex-ante probability of central bank's presence in the foreign exchange market. The dummy variable takes the value of 1 in those days when the predicted probability of intervention was less than 0.5. The coefficient on the intervention variable measures the percentage change in the exchange rate for a US$100 million in foreign currency purchases. Asterisks denote significance of coefficients, with ***, **, and * indicating significance at the 1%, 5%, and 10% level, respectively.

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Chapter 3

Cross-Border Trading as a Mechanism for Implicit Capital Flight: ADRs and the Argentine Crisis[97]

1. Introduction

The role and consequences of capital controls continues to be a subject of controversy for many developing countries. Governments that under normal circumstances advocate financial integration with global markets are often tempted to resort to capital controls in the face of economic crisis. Argentina and Venezuela are two recent cases in point. In December 2001, after a decade of open capital markets, the Argentine government imposed a series of financial market controls in an ultimately unsuccessful bid to forestall economic crisis. In early 2003, Venezuela established capital controls in the wake of a 20 percent devaluation. These experiences with capital controls afford an opportunity to examine the reactions of investors within and outside of the country to a drastic change in financial market conditions.

The same economic conditions that encourage governments to impose capital controls also give residents and investors in these countries incentives to remove their wealth. Capital flight can be accomplished through various channels. In this chapter we examine one potential channel for capital flight that is made possible by the existence of cross-listed shares. By converting locally-purchased shares into their corresponding shares listed abroad, investors can effectively move their wealth out of the country, thereby confounding government efforts to control capital outflows.

[97] This chapter was co-authored with Sebastian Auguste, Kathryn Dominguez and Linda Tesar.

There is an extensive literature on cross-listed shares and their role in the global integration of financial markets (see, for example, the survey by Karolyi (1998). Cross-listing of shares on the U.S. stock market allows firms to enjoy the advantages of greater liquidity, transparency, and access to the U.S. capital market.[98] From the perspective of U.S. investors, cross-listed shares are a convenient way of obtaining global diversification.[99] This chapter describes a new, and largely unstudied, role for cross-listed shares as a mechanism for capital flight.[100]

In the absence of capital controls, the law of one price should hold for cross-listed shares in the home and foreign market after controlling for the exchange rate and various transaction costs. When capital controls are in place, however, the factors that determine demand for cross-listed shares in the home market may diverge from those in the foreign market resulting in a wedge between the two prices. In Section 2 below, we show how controls on capital inflows into the firm's home market will result in a premium on the firm's cross-listed shares in the foreign market relative to the corresponding shares in the local market, while controls on capital outflow will lead to a premium on shares in the local market relative to their corresponding cross-listed shares in the foreign market. We test this relationship in a cross-section of countries and find limited evidence of a systematic link between capital controls and the difference between the local price of shares and their corresponding (exchange rate adjusted) price in the foreign market. Lack of information about the specifics of the capital controls and their impact on the relative prices of cross-listed shares in the home and foreign markets, however, makes it difficult to draw strong conclusions about the relationship between violations of the law of one price for cross-listed shares and capital controls in general. Therefore, we turn to two specific cases of countries with capital controls and cross-listed shares, Argentina and

[98] See, for example, Alexander, Eun, and Jankiramanan (1987), Foerster and Karolyi (1999), Miller (1999), Ahearne, Griever, and Warnock (2004), Melvin and Valero-Tonone (2003), and Doidge, Karolyi, and Stulz (2001).

[99] See, for example, Officer and Hoffmeister (1987), Wahab and Khandala (1993), and Jiang (1998). Domovitz, Glen, and Madhavan (1997), Errunza, Hogan, and Hung (1999), and Karolyi and Stulz (2003) examine the broader influences of cross-listed shares on the development and integration of markets.

[100] Melvin (2003) and Kadiyala and Kadiyala (2004) also examine the role of cross-listed shares during the recent Argentine capital control regime.

Venezuela, in which we can precisely track changes in government policy and the consequent impact of these policies on share prices.

The financial regulations put in place during the crises in Argentina and Venezuela allow us to study how cross-listed shares can provide investors with a means of circumventing capital controls. In Section 3 we discuss the particular controls faced by investors in Argentina and calculate American Depositary Receipt (ADR)[101] discounts[102] based on the transactions costs that U.S. and Argentine investors faced during the December 2001 to May 2002 period. We find evidence that local investors were willing to pay a substantial price to move their deposits out of the domestic market through the conversion of local shares to ADR shares in the U.S. At their peak, some ADRs in Argentina and Venezuela were trading at a discount (relative to their corresponding local price converted to dollars) of more than 50 cents on the dollar.

In the presence of capital controls, ADR discounts include the value of circumventing capital controls as well as the value of converting one's assets into dollars. We use ADR discounts in Argentina to estimate the market's expectation of the peso devaluation in January 2002 and to price capital control circumvention. We find that ADR discounts just before the actual devaluation indicate an expected 40–45 percent fall in the value of the peso relative to the dollar, similar to reports in a number of financial newspapers during this period. Our estimates of capital control circumvention value using the most liquid ADR, Perez Companc, average 3 percent over the full period, and rise to just under 6 percent before the devaluation.

In Section 4 we test whether the imposition of capital controls leads to changes in the underlying pricing structure of cross-listed stocks in Buenos Aires and New York. We find evidence that local market factors became more important for pricing cross-listed

[101] Although Depositary Receipts (DRs) can be issued in a number of markets, all of the cross-listed firms from Argentina and Venezuela issued DRs in the United States; consequently, we will refer to Argentine and Venezuelan cross-listed shares as ADRs. ADRs are classified by the U.S. SEC as: Rule 144a, OTC, Level II or Level III. Level II and III ADRs require basic to full compliance with U.S. GAAP and SEC disclosure rules. Level III ADRs are capital raising.

[102] ADR discounts are measured as the difference between the local price in U.S. dollars and the ADR price, as a fraction of the local price in dollars (where the local price is adjusted for the ADR conversion ratio). See equation 6.

shares in Argentina, and less important for pricing the same cross-listed shares in New York during the period when capital controls were in place. Section 5 concludes.

2. Cross-listed Returns and Capital Controls

In order to understand how capital controls influence the relative price of cross-listed securities in the local and foreign markets, it is useful to define the pay-offs of holding these stocks in the two markets. Consider a security *i* that is traded on the local market but is also cross-listed in the United States. We will use the following definitions:

p_{it}^{L} = price of share for firm *i* on the local market, in local currency

p_{it}^{ADR} = price of the associated ADRs for firm *i* in the United States, in dollars

S_t = spot exchange rate, U.S. dollars per local currency

ξ_i = conversion ratio between local share *i* and its corresponding ADR[103]

Each period *t*, the local share *i* pays out a dividend in local currency, denoted d_{it}^{L}. The ex dividend market valuation of the share, in local currency, is equal to the expected stream of dividends, discounted by the period rate of time discount, β, and adjusted by the local consumer price index, CPI_{t+j}^{L}:

$$p_{it}^{L} = \sum_{j=1}^{\infty} \beta^{j} E_t \frac{d_{it+j}^{L}}{CPI_{t+j}^{L}} \tag{3.1}$$

Assuming the foreign investors have the same rate of time discount β, the market valuation of the corresponding ADR, in dollars, is:

$$p_{it}^{ADR} = \sum_{j=1}^{\infty} \beta^{j} E_t \frac{S_{t+j} d_{it+j}^{L}}{CPI_{t+j}^{US}} \tag{3.2}$$

[103] Local shares are often bundled into groups of shares per ADR. Gompers and Metrick (2001) find that low-priced shares have higher transaction costs suggesting that bundling is likely done for cost reasons. Another reason for bundling is that the NYSE has minimum price requirements. Bundling can help companies avoid their stock being delisted (which occurs when share prices fall below the NYSE minimum). The conversion ratio is fixed at the time of the initial listing.

Note that ADRs represent claims against the same stream of risky cash flows in pesos as their corresponding local shares. Dividends on the ADRs, however, are paid in dollars, and the appropriate deflator is the U.S. consumer price index, CPI_{t+j}^{US}. If firms fail (or are expected to fail) to pay dividends to shareholders of ADRs (possibly because of government restrictions in the issuing country) this will drive a wedge between the local share price and the currency-adjusted ADR price.

2.1 The Law of One Price for ADRs

In the absence of capital controls and foreign exchange controls (and abstracting for now from transactions costs and time delays in ADR conversion), the law of one price should prevail for ADRs and their corresponding local shares. Equation (3.3) shows the return in local currency from round-trip arbitrage between the local market and the United States via ADRs:

$$p_{it}^{L} \cdot \xi_i \cdot \left(\frac{1}{p_{it}^{ADR}} \right) \cdot S_t = 1 \tag{3.3}$$

Investors purchase a local share at price p_{it}^{L}. The share is then converted into $(1/\xi_i)$ units of an ADR and the ADR is sold for dollars. Finally the dollars are converted back into local currency at the prevailing market exchange rate.

To see the impact of capital controls on the return from conversion of local shares into ADRs, consider the return, R_{it}^{L}, on round-trip arbitrage from the perspective of a local investor currently holding a domestic share:

$$R_{it}^{L} = \frac{\left(\frac{p_{it}^{ADR}}{S_t \xi_i} \right) - p_{it}^{L}}{p_{it}^{L}} \tag{3.4}$$

We assume that investors can conduct this arbitrage instantaneously. Note that if the transaction were to take time, the expected change in the exchange rate over the transaction interval would also affect the investor's return.

Now suppose the government of the country in which the investor resides imposes controls on capital outflows and/or restricts access to foreign exchange. We denote this tax on capital outflows as τ_{KO}. Also suppose that investors in the local market can freely convert a local share of security *i* into its ADR and sell the ADR on the U.S. stock market for U.S. dollars (thereby avoiding τ_{KO}).[104] All other cross-border investments must include the tax on capital outflows, τ_{KO}. However, because investment in ADRs legally circumvents this tax, demand for local shares with corresponding ADRs will increase, driving up the local price. In equilibrium, local investors will pay a premium on local shares (or a discount on ADRs) for the right to convert local shares into foreign-currency denominated ADRs. The wedge between the ADR price and the price on the corresponding local share reveals the extent to which controls on capital outflows are binding.

Conversely, consider the impact of controls on capital inflows. Equation (3.5) shows the return, R_{it}^{US}, to round-trip arbitrage from the perspective of a U.S. investor currently holding an ADR:

$$R_{it}^{US} = \frac{S_t \xi_i p_{it}^{L} - p_{it}^{ADR}}{p_{it}^{ADR}} \tag{3.5}$$

A tax on capital inflows, τ_{KI}, into the local market reduces the return U.S. investors receive on alternative investments in the local market. If the ADR channel remains open, arbitrage through ADRs will result in a premium on ADRs relative to local shares. In this case, U.S. investors are willing to pay a premium for the privilege of bringing capital into the local market (and avoiding τ_{KI}).

The discussion above implies a strict dichotomy between the impact of controls on capital inflows and outflows on the sign of ADR discounts. In practice, however, this dichotomy may not be so clear. Controls on capital outflows could cause U.S. investors

[104] We will discuss in detail the controls on investors in Argentina in section 3. In both Venezuela and Argentina local investors faced prohibitive controls on capital outflows and on foreign exchange but were able to convert local shares to ADRs, thereby legally circumventing the capital control.

to worry about their ability to repatriate profits, and thereby effectively reduce capital *inflows*. In the empirical Section below, we will see that it is difficult to separately identify the effects of controls on capital inflows and capital outflows.

Note also that in both cases arbitrage implies that the wedge between the local and exchange-rate adjusted U.S. price should reflect the cost of avoiding the capital control through an alternative mechanism. Therefore, the price gap reflects not only the *de jure* control, but also the ability of investors to circumvent that control. If the alternatives are relatively cheap, capital controls would not bind and we would expect the wedge between the local price and the corresponding ADR price to be small. In Section 3 below we provide a measure of the Capital Control Circumvention Value (CCCV) for Argentina during the period when capital controls were in place.

2.2 Cross-Sectional Evidence on ADR Discounts and Capital Controls

The previous discussion suggests that, in principle, the discount on ADRs should be positively related to controls on capital outflow, and negatively related to controls on capital inflow. To test this relationship we collected country-level data on capital control indices[105] and firm-level data on ADRs and their underlying local shares. We select a representative cross-listed firm for each of 42 countries,[106] and calculate the ADR discount, defined as:[107]

---

[105] We first compute daily ADR discounts on days when there were transactions in both markets (to avoid non-synchronous trading biases) and take a weekly average. We then compute the average for the calendar year 1999 as the average of the weekly averages. Results based on daily data are qualitatively similar and are available upon request.

[106] We selected one representative level II or level III ADR from each country on the basis of liquidity. Unfortunately many countries that have capital controls do not have ADRs or their ADRs are only traded infrequently. The countries (firms) included in our analysis are: Argentina (Banco Francés), Australia (News Corp. Ltd.), Austria (EVN AG), Belgium (Solvay S.A.), Brazil (Embratel Participações S.A.), Chile (Enersis S.A.), China (Sinopec Shanghai Petrochemical Co. Ltd.), Colombia (Bancolombia), Czech Republic (Komercni Banka A.S.), Denmark (Novo-Nordisk A/S), Finland (Nokia), France (Total S.A.), Germany (Pfeiffer Vacuum Technology AG), Greece (Hellenic Telecommunications Organization S.A.), Hungary (Matáv Rt), India (Infosis), Indonesia (Indonesian Satellite Corp. Tbk PT), Ireland (ELN), Israel (Matav-Cable Systems Media Ltd.), Italy (Benetton Group S.A.), Japan (Sony), Korea (SK Telecom Co. Ltd.), Luxembourg (Espirito Santo Financial Group S.A.), Mexico (Grupo Televisa, S.A.), Netherlands (Koninklijke Philips Electronics N.V.), New Zealand (Fletcher Challenge Forests Ltd.), Norway (Norsk Hydro ASA), Peru (Cía. de Minas Buenaventura S.A.), Philippines (San Miguel Corp.), Portugal (Portugal Telecom Sgps S.A.), Russia (Vimpel-Communications), Singapore (Keppel Corp. Ltd.), South Africa

(continued)

$$D_{it} = 1 - \frac{p_{it}^{ADR}}{S_t \xi_i p_{it}^{L}} \tag{3.6}$$

We selected the year 1999 for our cross-sectional analysis because it was a year for which we had the largest overlap of information on ADR discounts and on capital controls, and because it was a year of relative calm for most financial markets in the wake of the Asian crisis.[108]

We study the relationship between ADR discounts and four different indices of capital controls: (i) the IMF index;[109] (ii) the capital account openness index (CAOI) index;[110] (iii) the Chinn-Ito index;[111] and (iv) the Edison and Warnock index.[112] Each capital control series has some advantages and some disadvantages. Each series covers a different sample of countries. Although we have 42 countries with data on ADR discounts and some measure of capital controls, the largest sample we were able to use in a regression contained 37 country observations. The IMF index is probably the most widely used in studies of the impact of capital controls on financial market development and growth. The index is essentially a dummy variable indicating whether or not a country has capital controls in place in a given calendar year based on the information provided in the IMF's *Annual Report on Exchange Arrangements and Exchange Restrictions.* The advantage of this measure is that it covers a large sample of countries. The drawback is that the index contains no information about whether the controls restrict capital inflow or outflow, the particular type of transaction that is restricted, or the

(Durban Roodepoort Deep Ltd.), Sweden (Volvo AB), Switzerland (Logitech International SA), Taiwan (Macronix International), Thailand (Advance), Turkey (Turkcell Iletisim Hizmet A.S.), United Kingdom (Barclays Plc), Venezuela (Cía. Anónima Nacional Teléfonos de Venezuela – CANTV).

[107] Note that this definition of the ADR discount is equivalent to equation (4) except that the terms in the numerator are reversed (making the discount positive when the price of local shares exceeds the price of the corresponding ADR). We use this definition of the ADR discount in all the empirical work to follow.

[108] There were no capital controls in place in Argentina in 1999 so this analysis will not capture the significant deviations between the prices of local shares and their corresponding ADRs that occurred in 2001 and 2002.

[109] See Alesina, Grilli, and Milesi-Ferreti (1993).

[110] See Brune, Garrett, Guisinger, and Sorens (2001).

[111] See Chinn and Ito (2002).

[112] See Edison and Warnock (2003).

intensity of the control. The CAOI measure is similar to the IMF index in that a dummy variable is created for each category of capital flow. The dummies are then added up so that the more controls that are in place, the bigger the index number. This provides a rough gauge of capital control intensity, but does not give a clear indication of how tightly each type of capital flow is restricted. The Chinn-Ito measure is based on the same underlying information, but attempts to aggregate the information in a way so as to better capture the intensity of the restrictions. The Edison-Warnock index takes a completely different approach by computing the ratios of the market capitalization of "investable" stocks (i.e. those available to foreign investors) to the full set of stocks in a given market. In effect, the Edison-Warnock index provides a measure of the extent to which a market is closed to foreign investors. It does not, however, provide information about the intensity of controls on capital outflow from a given market. Edison and Warnock provide two measures of their index: the basic index (labeled "unsmooth" in Table 1) and an index that corrects for shifts due to changes in sectoral market capitalizations and not due to shifts in capital controls (the "smooth" index in Table 1).

Table 1 shows the results of the regression of the ADR discount on the various capital control indices:

$$D_i = \beta_0 + \beta_1 cc_i + \mu_i \tag{3.7}$$

where D_i is the average ADR discount for a representative firm in country i in 1999, cc_i is the value of the capital control index for country i in 1999, and μ_i is the error term. Each index is adjusted so that the higher the index, the more intense the capital control. As shown in the top panel of Table 3.1, we find some evidence of a positive relationship between ADR discounts and the various measures of capital controls. The coefficients on the IMF, CAOI, and Chinn-Ito indices are statistically significantly different from zero at the 5 percent level, while the smooth Edison-Warnock index is significant at the 10 percent level.[113] Because the indices provide only *de jure* classifications and little

[113] If we exclude China, as suggested in Edison and Warnock (2003a), and include developed countries with zero restrictions, as was done in Ahearne et al. (2004), the smooth Edison-Warnock index is significant at the 1 percent level.

information about whether the controls are on capital inflows or outflows, it is difficult to know how to interpret the results. It could be that most of the controls are on capital outflows, and the positive coefficient can be taken as evidence that controls on outflows result in an increase in the ADR discount. If this were the correct interpretation, however, we would have expected the coefficient on the Edison-Warnock indices, which reflect only restrictions on capital *inflows*, to be negative. Alternatively, it may be that, in practice, controls on inflows ultimately serve to control outflows.

Table 3.1. Testing for the Relationship between ADR discounts and Capital Controls in a Cross-section of Countries, 1999

	Alternative indices of capital controls:				
	IMF	CAOI	Chinn-Ito	Edison-Warnock	
				smooth	unsmooth
A. Dependent variable: ADR discount					
β	0.106	0.019	0.059	0.436	0.250
Std error	0.048	0.008	0.018	0.214	0.179
P-value	0.036	0.028	0.002	0.058	0.173
Number of Obs	37	36	33	19	19
R^2	0.12	0.13	0.27	0.2	0.11
B. Dependent variable: Absolute value of ADR discount					
β	0.100	0.018	0.060	0.436	0.260
Std error	0.048	0.008	0.017	0.212	0.177
P-value	0.045	0.032	0.003	0.056	0.159
Number of Obs	37	36	33	19	19
R^2	0.11	0.13	0.25	0.15	0.06

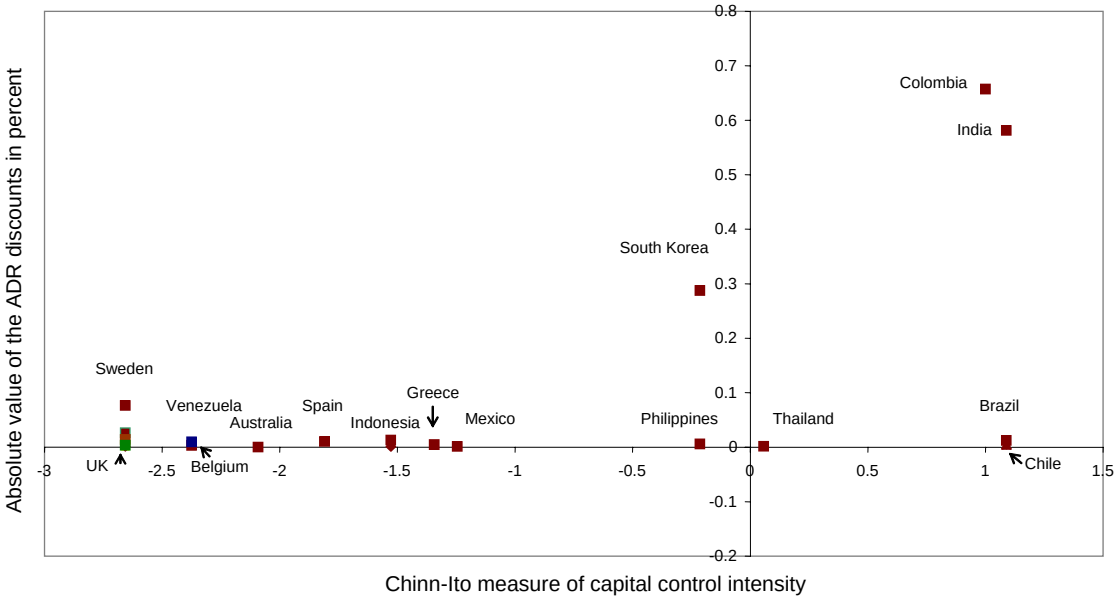
Sources: Bloomberg; Alesina, Grilli, and Milesi-Ferreti (1993) for the IMF index; Brune, Garrett, Guisinger, and Sorens (2001) for the CAOI (Capital Account Openness Index); Chinn and Ito (2002); Edison and Warnock (2003).

Note: The dependent variable is the average ADR discount (measured as the difference between the local price in U.S. dollars and the ADR price, as a fraction of the local price in dollars) for a representative cross-listed firm (based on liquidity) in selected countries in 1999. Local prices are adjusted for the ADR conversion ratio. Beta is the coefficient on the capital control index (where the higher the index, the more intense the capital control).

Given the ambiguities in the capital controls series, we repeat the regression using the absolute value of the ADR discount as the dependent variable. The hypothesis tested here is whether capital controls, regardless of whether they affect inflows or outflows,

drive a wedge between local share prices and their corresponding ADRs. The results in the second panel provide some support for this hypothesis. The estimated coefficients are again all positive and four of the five are significant at the five percent level. Figure 3.1 provides a plot of the ADR discounts (expressed in percent) and the Chinn-Ito measure of capital control intensity. The figure suggests that in most countries, the ADR discount is very close to zero and that the positive relationship between controls and discounts is driven by two countries, Colombia and India.[114] When those two countries are dropped from the regression, none of the coefficients are statistically different from zero.

Figure 3.1. Capital Control Intensity and ADR discounts



Sources: Bloomberg, Chinn-Ito (2002).
Note: Scatter plot summarizes the relationship between capital control intensity (as measured by Chinn and Ito) and average ADR discount for a representative firm (based on liquidity) in selected countries in 1999.

[114] Colombia's capital controls involved a tax on short-term investment repatriation which provided incentives for investors to purchase ADRs (which are not subject to the tax) rather than local shares. In India (before 2002) there was only one-way fungibility for ADR conversions. ADRs could be converted back into local shares, but not vice versa. Over time the reduction in ADR liquidity (due to the fall in supply) resulted in high premiums on ADRs relative to the underlying stocks. Taiwan and South Korea are also special cases. The Taiwanese and South Korean governments restrict foreign ownership of companies making it very difficult to purchase stocks in the local market. Taiwan also restricts the size of the ADR program. The case of one Taiwanese firm, Taiwan Semi Conductor, has been widely cited in the press because its ADR price so greatly exceeded its local price.

The cross-sectional analysis suggests that there is a tenuous relationship between available measures of capital controls and ADR discounts. As shown in Figure 3.1, there is a great deal of cross-country heterogeneity in the capital control indices, but in most countries those controls have no impact on ADR discounts. There are a number of factors that could account for this weak relationship in the cross-section. First, the dependent variable in the regression is the average ADR discount over the calendar year. Even a cursory glance at ADR discounts reveals that discounts can swing dramatically over time, particularly during periods of volatility in financial markets. These are precisely the periods when capital controls tend to be imposed, but such information is lost in taking annual averages (which we do in order to match these data with the annual capital control indices). Thus, the particular window chosen for the analysis can have a large impact on the results. Second, and more importantly, the capital control measures are only crude indicators of the particular restrictions that could affect transactions in ADRs. Controls on some types of capital flow may be largely irrelevant for stock market participants, whereas other types of legal restrictions—seemingly unrelated to capital flow—could have a large effect on ADR discounts. For example, restrictions on withdrawals from bank accounts in Argentina (which are neither controls on capital inflow or outflow) contributed to a run up in local stock prices and on ADR discounts. Third, the cross-sectional analysis ignores transactions costs and other taxes (e.g. brokerage fees, local sales taxes, etc.) and short sales restrictions,[115] which could distort ADR discounts. Finally, we have calculated ADR returns assuming instantaneous arbitrage. If investors know that there is a significant time delay in ADR conversions, the wedge between the prices of local shares and their corresponding ADRs will also reflect the risk premium associated with holding the asset over the conversion interval.

For these reasons, we think that the cross-sectional analysis yields at best an imprecise measure of the relationship between restrictions on capital markets and the wedge between the prices of local shares and their corresponding ADRs. To probe this

[115] Bris, Goetzmann, and Ning (2003) examine whether short-sales restrictions in different countries affect market efficiency.

relationship more deeply, we next turn to the role played by ADRs in the unfolding of two recent events, the financial crises in Argentina and Venezuela.

3. Case Study: Argentine Capital Controls and ADRs

Although the exact timing and causes of Argentina's economic fall from grace are contentious, there is little disagreement that by the last quarter of 2001 Argentina was on the brink of a full-scale collapse.[116] Between July and November, 2001, Argentines withdrew over US$15 billion from banks—on November 30, 2001, alone, banks saw withdrawals of US$1.3 billion. On December 3, in a desperate effort to prevent further massive capital outflows, financial market controls were established (these are known as the "Corralito"), which among other restrictions, imposed a ceiling of US$1,000 a month on bank withdrawals.[117] In January, the Argentine peso was officially devalued and all bank deposits and some (small denomination) debts were "*pesofied*."[118]

3.1 The Corralito

Under the *Corralito*, depositors were limited to withdrawals of Arg$250 per week per account[119] but could access their accounts to transfer funds within the banking system. Wire transfers required Central Bank approval, foreign currency futures transactions were prohibited, and in effect, all investors, foreign and domestic, were prohibited from

[116] Mussa (2002) makes the case that the persistent inability of the Argentine government to run responsible fiscal policy was the primary cause of the economic collapse. Others point to the deleterious effects of an over-valued currency on exports (see, for example, Feldstein 2002) and the sudden stop in foreign capital inflows (Calvo, Izquierdo, and Talvi 2003). Also, see Dominguez and Tesar (2005) for a detailed description of the factors that let to Argentina's collapse.

[117] A literal translation of "Corralito" is little corral. It is also the word for "playpen."

[118] On February 3, 2002, an asymmetric pesofication (based on type of borrower) of debts was announced. See Appendix 1 for more details.

[119] Perhaps unsurprisingly there was a sudden increase in the number of new bank accounts in early December. The government promptly changed the regulations so that the deposit limits applied per person rather than per account. According to the press, some 500,000 accounts were opened in the two days following the imposition of bank restrictions.

transferring funds abroad. The restrictions were announced as temporary measures that would remain in place until the danger of the speculative attack had passed.[120]

The *Corralito* did not, however, restrict investors from trading Argentine securities including those that were cross-listed on another market. Indeed, to do so would have seriously destabilized the local market as it would have prevented investors from trading in some of the largest and most liquid stocks on the market. The Argentine ADR "loophole" worked as follows: Argentine residents were allowed to use bank deposits to purchase Argentine stocks. If a stock happened to be cross-listed in the U.S., those shares could be legally converted from Argentine shares into ADRs. The ADRs could then be sold in the United States and the dollar proceeds deposited in a U.S. account. Under normal circumstances the dollar proceeds would appear in the Argentine Balance of Payments as a capital inflow, as foreign residents have acquired claims on Argentine firms. Under the *Corralito,* however, the capital inflows did not occur, and the dollars and/or shares remained outside of Argentina. In effect, the ADR "loophole" allowed Argentines to transfer monies abroad, but the transactions did not result directly in a fall in Argentina's international reserves (or a fall in Argentine bank deposits). ADR conversions, however, did reduce the number of (underlying) shares available on the local stock exchange in Buenos Aires, La Bolsa.

3.2 Decomposition of the Argentine ADR Discount under the Corralito

To see the impact of the *Corralito* on the ADR discounts, we modify equation (3.3) to take into account the restrictions on bank deposits:

$$\left(\frac{1}{p_t^D}\right)\cdot p_{it}^L \cdot \xi_i \cdot \left(\frac{1}{p_{it}^{ADR}}\right)\cdot S_t = 1 \qquad (3.3')$$

[120] Some of the original withdrawal limits were eventually modified, though the main restrictions on capital outflow remained in place until December 2, 2002 (exactly one year after they were first introduced). See Appendix 1 for a detailed timeline of the changes in financial market regulations in Argentina beginning in October 2001.

where p_t^D is the price of local-currency denominated bank deposits in terms of local stock (or cash). During the *Corralito,* p_t^D was less than one because investors were willing to pay for the opportunity to cash out their bank deposits (which had limited convertibility). In the absence of controls on bank deposits, we would expect p_t^D to be equal to one. Arbitrage now involves cashing out one's bank deposits at a discount, purchasing local shares, converting those shares into ADRs and then selling the ADRs for dollars in the U.S. Consider the return from ADR conversion on the day the capital controls are imposed, denoted *t*+1, relative to the day before. Taking the log difference of equation (3.3') yields:

$$\begin{aligned}(\ln p_{it+1}^L - \ln p_{it}^L) - (\ln p_{t+1}^D - \ln p_t^D) + (\ln \xi_i - \ln \xi_i) \\ -(\ln p_{it+1}^{ADR} - \ln p_{it}^{ADR}) + (\ln S_{t+1} - \ln S_t)\end{aligned} \tag{3.8}$$

The first effect, $(\ln p_{it+1}^L - \ln p_{it}^L) - (\ln p_{t+1}^D - \ln p_t^D)$, we term the **liquidity value** of shares. This reflects the impact of the banking restrictions on the relative price of local shares to bank deposits. This effect will only exist if controls restrict access to bank deposits but at the same time allow investors to transform frozen bank deposits — which could potentially be expropriated by the government or lost in a full-scale bank run — into stocks. In the absence of controls liquidity value is zero. Note that the prices of all local market stocks will reflect this liquidity value, not just those that are cross listed. The premium associated with asset transformation should remain until all depositors in the local market have re-optimized their portfolios or the deposit restrictions are removed.

The second effect is the **capital control circumvention value** (CCCV) of cross-listed shares. ADRs provide a legal means of acquiring foreign assets in capital outflow control regimes. Note that in equation (8) the rate of conversion of local stock *i* into its ADR equivalent, ξ_i, is a constant. Therefore, holding changes in ADR prices and the exchange rate constant, the increase in the local price of cross-listed shares relative to the (fixed) rate of conversion, ξ_i, reflects the value of being able to circumvent the capital controls. In the absence of capital controls this effect is clearly zero. During a capital control regime, ADRs carry an additional premium over other non-cross listed shares and

the premium should last until all local investors are indifferent between holding their assets at home or abroad. This could be achieved either when all of the available funds have left the country, the cost of moving funds becomes prohibitively high, the emergence of alternative mechanisms to channel funds abroad reduces the demand for local shares with a corresponding ADR, or the capital controls are removed.

The third effect is the **currency value** of ADRs. This effect has two parts. The first part, reflected in the change in p_{it}^{ADR}, is due to the fact that holders of ADRs own claims to dollar-denominated dividends, paid out at the official exchange rate (recall equation (2)). Depending on the impact of the capital controls on the expected path of the official exchange rate, this would alter the market valuation of the ADR relative to its local share equivalent. The second part of the currency effect is the change in the exchange rate itself. Because investors receive dollars, rather than local currency, for the sale of the asset, this will affect the expected profit from ADR conversion.

3.3 Trading Volume in Argentine ADRs

Table 3.2 provides a list of the eleven ADRs listed in Argentina as of December 1, 2001, and traded on either the NYSE or Nasdaq.[121] In November 2001 trade in these eleven ADRs accounted for 36 percent of the Merval Index and 27 percent of total market volume. Table 2 also provides pre-*Corralito* information on each ADR's market capitalization and trading volume as a percent of the market, as well as the mean and standard deviation of returns (over the period January 2001 to November 2001).

[121] Our list of Argentine ADRs is drawn from JP Morgan's ADR Universe Directory. Our focus is on eleven of the thirteen exchange-listed shares, referred to as Level II and Level III (capital-raising) programs. The two shares we do not include, Nortel and APSA, had very few transactions over the period of study. APSA ADRs only traded on one day during the *Corralito* while Nortel (a preferred stock) had very few transactions over this period. There are also eleven (Rule 144a and OTC) ADR shares that we do not include in our analysis because there was virtually no trading of these stocks over the period we study.

Table 3.2. Pre-Corralito ADR Information (January 2001-November 2001)

Name	Ratio ADR:local	Industry	Market Cap as % of Total Market	Trading volume as % Market	Mean Return (%)	Standard Deviation (%)
			Nov. 2001	Nov. 2001	(daily)	(daily)
BBVA Banco Francés	1:3	Banking	0.26	1.92	-0.40	4.76
Cresud S.A.C.I.F. Y A.	1:10	Food-Agribus-Tobacco	0.04	0.39	-0.06	1.64
Financiero Galicia	1:10	Fin Serv-Investment	0.22	7.09	-0.54	4.24
Irsa Inversiones	1:10	Real Estate	0.06	0.60	-0.44	2.79
Metrogas S.A.	1:10	Oil & Gas-Service	0.15	0.06	-0.13	2.39
Pérez Companc (PC)	1:10	Util-Gas, Elec&Water	1.03	9.82	-0.18	3.17
Siderca S.A.I.C	1:10	Steel	0.61	2.75	-0.16	2.62
Telecom Arg						
Stet-France	1:5	Telecom-DatNtwk	0.61	3.43	-0.35	3.82
Telefónica	1:10	Telecom-DatNtwk	1.42	0.03	-0.31	3.41
TGS	1:5	Oil & Gas-Service	0.39	0.84	-0.11	2.88
YPF S.A.	1:1	Oil & Gas-Service	3.11	0.09	-0.21	1.74
All ADRs			7.91	27.03	-0.26	1.83

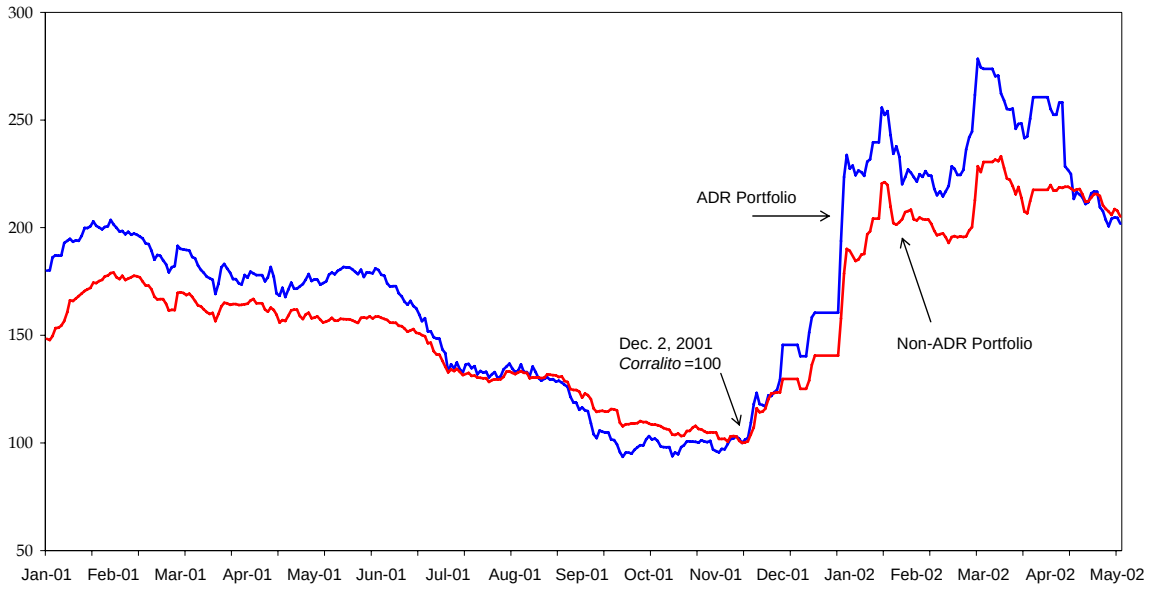
Source: JP Morgan.
Note: The "All ADRs" row corresponds to an equal-weighted ADR portfolio. The "Ratio ADR:local" is the number of local shares bundled into one ADR share.

Figure 3.2 shows price indices for value-weighted portfolios of ADRs[122] and all other Argentine stocks from January 1, 2001, to May 31, 2002. Both portfolios reverse their downward trend in the pre-*Corralito* period, increasing immediately following the freezing of bank accounts and the imposition of capital controls. As our discussion above predicted, the ADR portfolio price index experiences a bigger increase than the non-ADR portfolio price index, reflecting the additional capital circumvention and currency values

[122] The figure using price indices for equal-weighted portfolios of ADRs and non-ADRs is qualitatively similar.

of cross-listed stocks.[123] We formally test for differences in ADR and non-ADR portfolio returns just after the imposition of the *Corralito* in Section 3.4 below.

Figure 3.2. Price Indices of ADR and non-ADR Portfolios, Value Weighted
(Value at the time of the imposition of *Corralito*, November 30, 2001=100)



Source: Bloomberg.
Note: The non-ADR portfolio includes all non-cross-listed local shares.

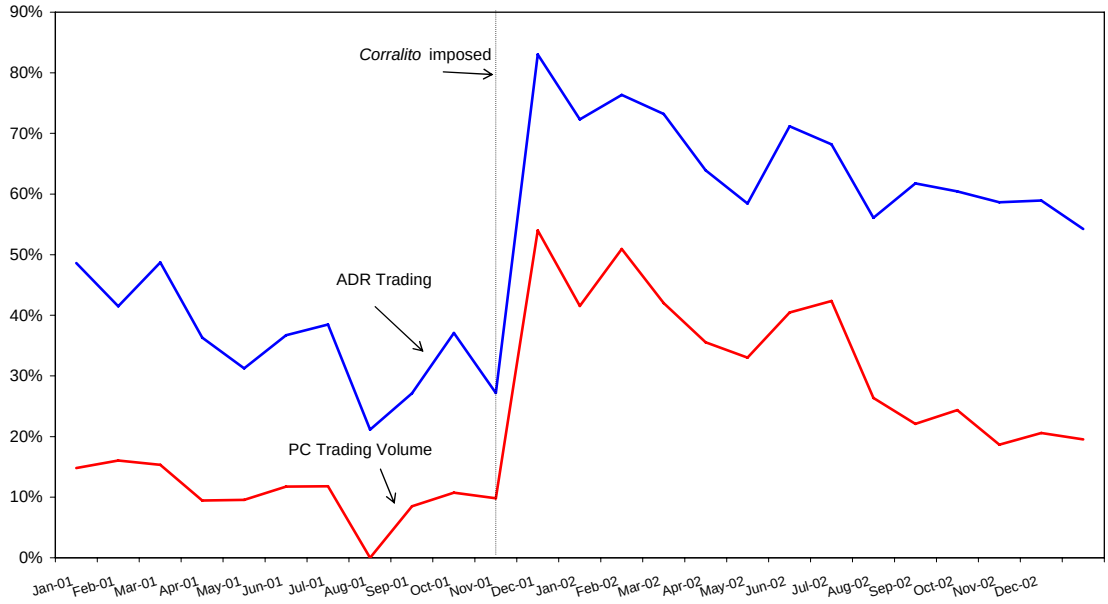
We also observe a dramatic change in the trading volume in cross-listed shares in Argentina over this period. Although the aggregate trading volume on La Bolsa steadily declines, the fraction of ADRs in the total volume traded jumps dramatically at the time of the *Corralito* from roughly 40 percent of the total volume to over 80 percent. Pérez Companc alone accounted for nearly 50 percent of the total volume of trading in December 2001. In late February 2002, volume in the ADR market leveled off.[124] Although the *Corralito* continued to be in effect, several regulatory changes, starting in

[123] Levy-Yeyati, Schmukler, and van Horen (2003) argue that it was the most liquid stocks (not ADRs) that had the largest increase in price after the *Corralito*. We find that while liquidity played a role, in regressions explaining Argentine stock returns, a dummy variable for ADR shares is significant and positive even after controlling for liquidity.

[124] ADR volume also declined in New York falling from its peak in December 2001. Volume in February 2002 was 18 percent lower than the previous December, and by May 2002, volume was a mere 23 percent of what it had been in December 2001.

February 2002, may have diminished investor's incentives to use the stock market as a means to gain access to frozen assets.[125]

Figure 3.3. Volume Traded in Local Shares with ADRs and Pérez Companc (PC) as a Fraction of Total Volume Traded (in all Shares) in Buenos Aires (monthly, in %)



Source: Bolsar.

3.4 Changes in prices of Argentine ADRs

Table 3.3 presents the results of tests for whether the differences in the ADR and non-ADR portfolios seen visually in Figure 3.2, at the time of the *Corralito*, are statistically significant. The table presents changes in ADR and non-ADR portfolio prices in Argentina and New York following the imposition of the *Corralito*. (All prices are measured in U.S. dollars.) On the day following the imposition of the *Corralito* (see the first column of the table), the equal-weighted ADR portfolio price in Argentina jumped 2.93 percent while the equal-weighted portfolio of non-ADRs increased by 0.7 percent. If we measure the change in ADR and non-ADR portfolio prices one week after the imposition of the *Corralito* the ADR portfolio price change is even more dramatic,

[125] In February 2002, investors were allowed to withdraw (once and for all) US$7,000 from any of their bank accounts. In March 2002 investors were given the option to convert deposits into bonds (in pesos or dollars) and they were allowed to use their deposits to purchase properties and subsequently cars.

increasing by 13.92 percent, while the non-ADR portfolio rise is 9.43 percent. Similar results hold for the value-weighted portfolios. These changes are statistically significantly different from the price movements one would have anticipated based on the pre-*Corralito* distribution and are consistent with the view that there was an increase in the liquidity value of all Argentine stocks.

We also examine differences in the prices of the equally-weighted ADR and non-ADR portfolios (after the imposition of the *Corralito*) and find that the wedge between the two portfolios is 2.23 percent one day after (and 4.5 percent one week after) the capital controls were put in place. The *t*-statistics indicate that one would not have been able to forecast the wedge between ADR and non-ADR portfolio returns that arose during the *Corralito*, based on the distributions of returns for the two portfolios in the pre-*Corralito* period.[126] The impact of the *Corralito* on share prices is consistent with the predictions of equation (8). The liquidity of shares relative to bank deposits drives up the prices of all shares in Argentina. However, ADR prices increase by more due to the other benefits of ADR convertibility. The results in Table 3 are suggestive that there was an additional premium associated with ADRs relative to non-ADRs during the *Corralito.*

In the lower panel of Table 3.3 we examine the same ADR and non-ADR portfolio price changes, now using the ADR portfolio price in New York. The ADR portfolio price in New York increases too, but by a fraction of the price changes of the same portfolio in Argentina. We also find that the difference between the (equally-weighted) ADR portfolio price in New York and the non-ADR portfolio price (in Buenos Aires) one day after the *Corralito* is only 0.5 percent. The difference in the New York ADR portfolio price and non-ADR portfolio price the week after the imposition of the *Corralito* is actually negative (and statistically significant) suggesting that the New York price on the ADR portfolio fell below the non-ADR portfolio price during this period. Taken together, the data suggest that New York ADR prices changed little following the *Corralito*, while prices on the corresponding shares in Argentina rose dramatically. This

[126] It is worth noting, however, that the distribution of ADR and non-ADR portfolio prices may well have changed after the imposition of the *Corralito.* If the distribution of prices changed, *t*-stats based on the pre-*Corralito* period will not be appropriate. It is, however, unclear in this case what assumption one should make about the distribution of prices in the immediate aftermath of the *Corralito*.

is consistent with the argument made in Section 2 that controls on capital outflows would increase demand for local shares with corresponding ADRs relative to demand for non-cross listed local shares.

Table 3.3. Price Impact of Corralito on ADRs in Argentina and New York

	Day before to day after	*t*-stat	Day before to week after	*t*-stat
I. Percent change in Argentine prices (in US$)				
Equal weighted portfolios				
ADRs (ARG)	2.93	41.78	13.92	44.50
NON-ADRs	0.70	22.32	9.43	42.75
Difference in Wedge Between ADRs (ARG) and Non-ADRs (ARG)	2.23	43.80	4.50	19.95
Value weighted portfolios				
ADRs (ARG)	1.68	25.99	21.47	63.22
NON-ADRs	0.29	8.13	16.22	54.14
Difference in Wedge Between ADRs (ARG) and Non-ADRs (ARG)	1.39	25.91	5.25	19.31
II. Percent change in New York price (in US$)				
Equal weighted portfolios				
ADRs (NY)	1.21	19.57	-1.27	-0.82
Difference in Wedge Between ADRs (NY) and Non-ADRs (ARG)	0.51	10.56	-10.70	-38.41
Value weighted portfolios				
ADRs (NY)	0.39	8.33	1.15	5.14
Difference in Wedge Between ADRs (NY) and Non-ADRs (ARG)	0.10	2.68	-14.59	-44.40

Source: Economatica.
Note: t-stats are tests that the return on ADR and non-ADR portfolios on the day after and the week after the imposition of the *Corralito* differ significantly from the mean daily and weekly ADR and non-ADR portfolio returns in the pre-*Corralito* period. "Day before to day after" is the return between 12/3/2001 and 11/30/2001; "Day before to week after" is the return between 12/7/2001 and 11/30/2001. Tests assume that the distribution of returns in the ADR and non-ADR portfolios did not change after the imposition of the *Corralito*.

3.5 Argentine ADR discounts

It is clear from Table 3.3 that Argentine share prices increased following the imposition of the *Corralito,* consistent with our prediction that share prices reflect the liquidity value of stocks relative to bank deposits. One of the difficulties in studying

share price movements, however, is that it is difficult if not impossible to control for changes in fundamentals that could have affected firms around the time of the *Corralito*. The advantage of studying ADRs is that one can use the price of ADRs in New York as a benchmark for gauging the impact of changes in policies that were specific to investors in Argentina. We therefore turn to the discounts on ADR shares in New York relative to their corresponding price in Buenos Aires.

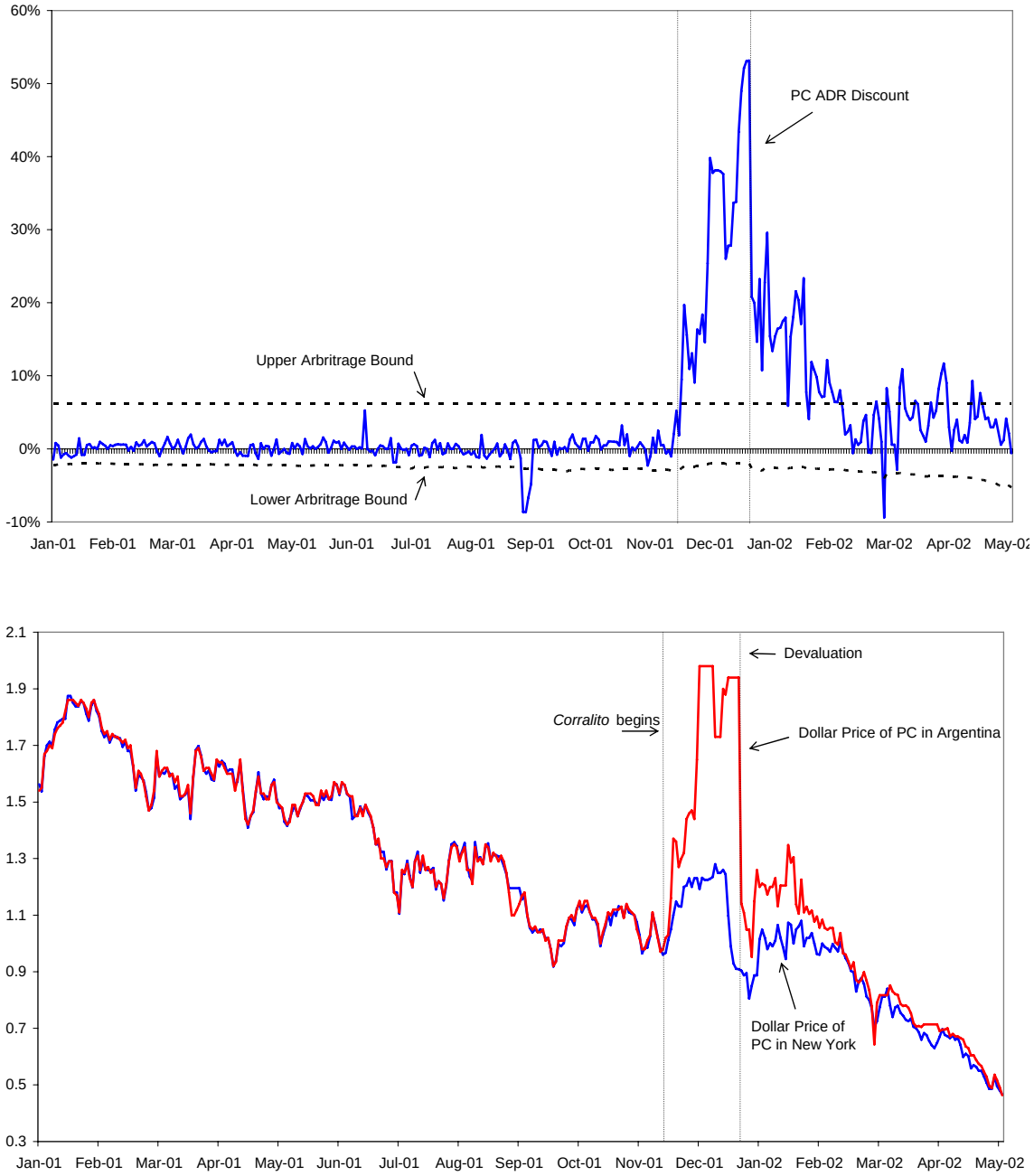
Figures 3.4 and 3.5 show prices of local and ADR shares (both in dollars) and the ADR discounts for two (Pérez Companc and Siderca) of the eleven companies in our sample of ADRs over the January 1, 2001, to May 31, 2002, period.[127] The figures also show the arbitrage bounds based on our estimates of transactions costs (described in Appendix 3.2 and detailed in Table 3.A1).[128] Table 3.4 summarizes the maximum and average discounts during pre-*Corralito*, *Corralito* pre-devaluation and *Corralito* post-devaluation periods for each company and the averages across the eleven companies. The top panel of the table calculates the discounts excluding transactions costs and the bottom panel includes transactions costs.[129]

[127] Similar figures for the rest of the ADRs are available upon request.

[128] The transactions costs we use in the calculations include the Argentine brokerage fees in both Buenos Aires and New York (τ_1=0.3025, τ_3=0.3025), the Buenos Aires stock exchange fee (τ_2=0.1025), the ADR conversion fee (τ_4=0.15) and the fees to open a NY bank account and wire transfer ADR proceeds (τ_5=1.0). These costs are explained in detail in Appendix Table A1. We ignore the time delay in our calculations of premia/discounts. The difference between the lower and upper arbitrage bound in our estimations is around 500 basis points. Rabinovitch, Silva, and Susmel (2003), using data for 6 Argentinean stocks with ADRs for the period 1993–2000 estimate arbitrage bands of around 270 basis points, suggesting that transactions costs increased during the *Corralito*.

[129] We use the same transactions costs for the pre-*Corralito* and post-*Corralito* periods for consistency, even though it is likely that these costs increased substantially after the imposition of the *Corralito* (so that we are biasing our results against finding differences in the two periods).

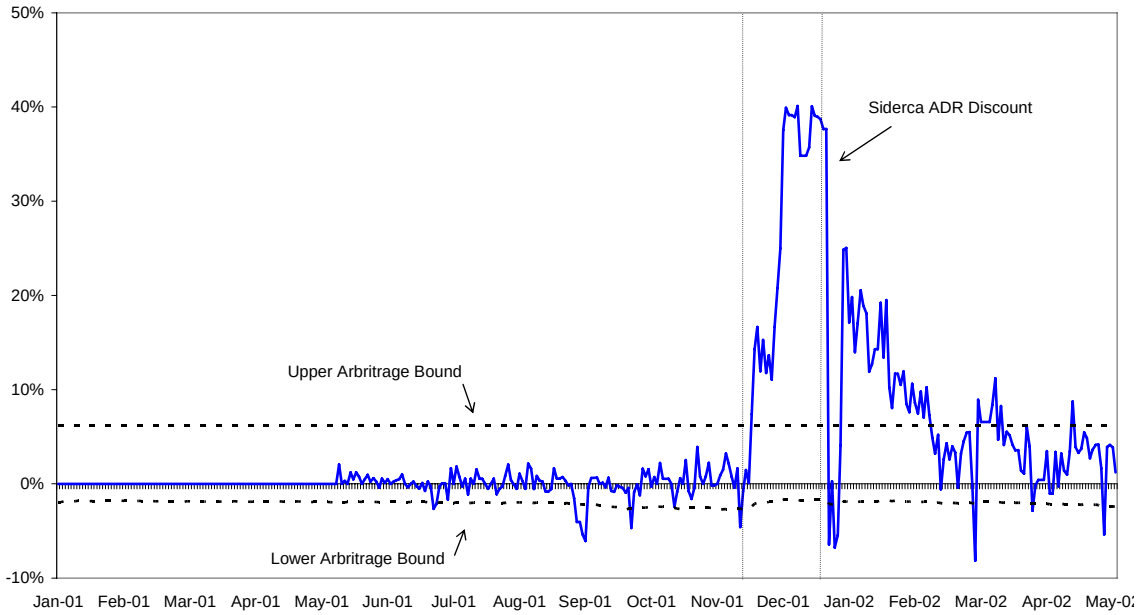
Figure 3.4. Daily PC (Pérez Companc) prices in NY and Argentina and PC's ADR Discount Before and During the *Corralito*

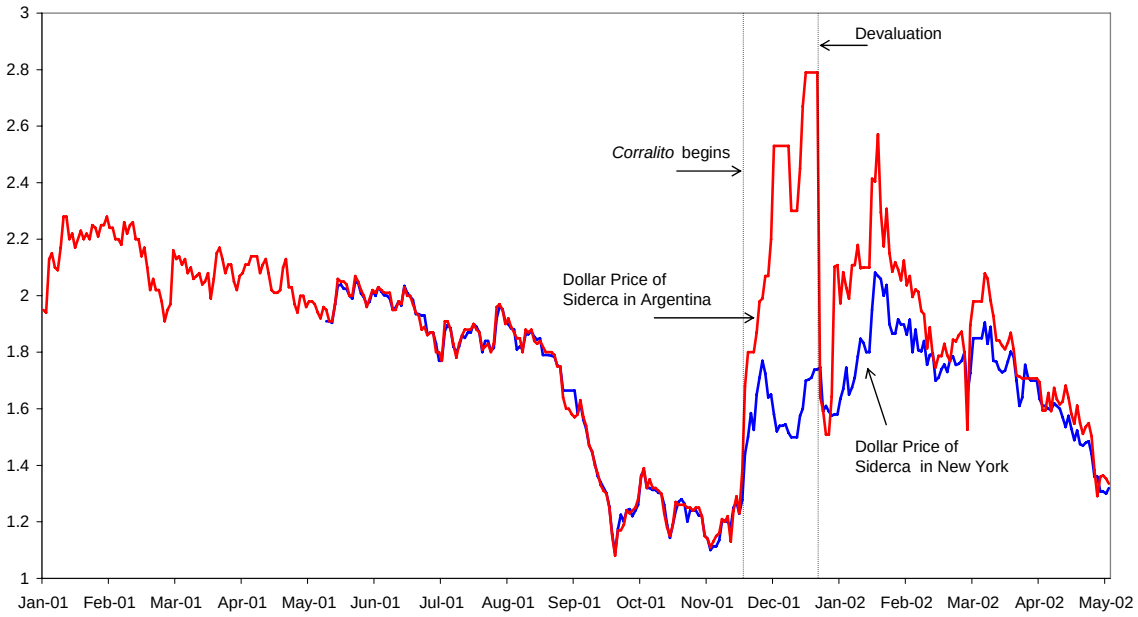


Source: Bloomberg.

Note: Arbitrage bounds are calculated based on the derivations described in Appendix 3.2.

Figure 3.5. Daily Siderca prices in NY and Argentina and Siderca's ADR Discount Before and During the *Corralito*





Source: Bloomberg.
Note: Arbitrage bounds are calculated based on the derivations described in Appendix 2.

Table 3.4. Average ADR Discounts Before and During the *Corralito*

	Pre-*Corralito*	*Corralito* pre-deval			*Corralito* post-deval		
	Jan. 1, 2000– Nov. 30, 2001	Dec. 3, 2001– Jan. 10, 2002			Jan. 11, 2002– May 31, 2002		
A. Excluding transactions costs	mean	max	mean	*t*-stat	max	mean	*t*-stat
BBVA Banco Francés	-0.02	52.09	20.43	7.96	21.89	7.00	9.73
Cresud S.A.C.I.F. Y A.	0.01	32.35	21.47	2.91	22.61	3.27	2.28
Financiero Galicia	0.35	43.89	20.04	6.90	18.42	3.66	3.69
Irsa Inversiones	0.08	38.27	15.74	11.56	14.11	2.01	1.47
Metrogas S.A.	-0.81	27.03	10.94	1.65	19.63	-1.05	-0.12
Pérez Companc (PC)	0.08	53.14	19.56	7.00	23.36	6.36	9.53
Siderca S.A.I.C	0.13	40.12	20.35	5.63	24.85	6.77	9.52
Telecom Arg Stet-France	0.13	39.71	19.23	8.00	23.56	5.64	7.05
Telefónica	-0.59	23.52	13.95	8.09	17.39	-14.25	-3.68
TGS	0.22	45.45	20.14	8.68	19.94	4.36	4.13
YPF S.A.	-0.08	31.79	15.96	4.87	24.72	8.14	7.30
Portfolios							
Equal-weighted	0.02	38.85	17.93	8.63	19.88	4.71	6.48
Value-weighted	-0.02	37.30	17.27	9.84	20.49	5.91	22.18
B. Including transactions costs							
BBVA Banco Francés	2.48	54.35	23.50	8.48	27.55	14.13	18.51
Cresud S.A.C.I.F. Y A.	3.43	35.26	24.70	3.00	26.38	7.20	2.75
Financiero Galicia	3.37	47.83	24.70	7.71	30.09	15.86	17.73
Irsa Inversiones	2.67	41.16	19.37	12.90	19.06	6.57	3.10
Metrogas S.A.	2.92	30.28	14.57	1.66	24.50	5.69	1.49
Pérez Companc (PC)	2.79	54.71	21.97	7.14	26.45	9.78	11.38
Siderca S.A.I.C	2.78	41.73	22.49	5.66	27.48	9.17	9.44
Telecom Arg Stet-France	2.75	42.19	22.58	8.73	27.44	12.88	14.86
Telefónica	1.67	26.01	16.72	8.49	20.41	-10.48	-3.41
TGS	4.01	48.32	24.13	9.27	26.17	13.62	12.89
YPF S.A.	2.13	33.47	18.08	4.97	27.31	10.64	7.66
Portfolios							
Equal-weighted	2.78	41.39	21.15	9.20	24.61	10.94	13.11
Value-weighted	2.51	39.28	19.87	10.71	23.62	9.61	24.44

Sources: Bloomberg and Economatica.

Note: Mean ADR discounts (measured as the difference between the local price in U.S. dollars and the ADR price, as a fraction of the local price in dollars) are calculated only on days when the security was traded in both markets. Local prices are adjusted for the ADR conversion ratio. *T*-stats are tests that the mean ADR discount during the *Corallito* differs significantly from the mean ADR discount in the pre-*Corralito* period. The test corrects for differences in sample size and unequal variances across the sub-periods. Transaction costs are assumed to be the same in the pre- and post-*Corralito* periods.

The information in Table 3.4 and the plots indicate that the average pre-*Corralito* discount for all companies was close to zero, suggesting that arbitrage between Argentina and the U.S. kept prices of local shares and their corresponding ADRs in close alignment. During the C*orralito*, the average ADR discount (the local price less the ADR price) jumped to 17.93 percent (excluding transaction costs). And, even after the devaluation in January the average ADR discount remained at 4.71 percent (or 10.94 percent including transactions costs). Unfortunately many of the ADRs traded only sporadically in the December 2001 through January 2002 period, so that it is not possible to do a full-fledged event study analysis of the impact of the *Corralito* and the devaluation on the ADR discounts. To get a sense of whether the changes in discounts over this period are statistically significant we provide *t*-statistics that suggest that the discounts observed in the *Corralito* period are far outside the range that we would have expected based on the distribution of pre-*Corralito* discounts.[130]

Figures 3.4 and 3.5 suggest that the ADR discounts were relatively small at the beginning of the *Corralito* and peaked just prior to the devaluation. One interpretation of this evidence is that the value of converting to dollar-denominated assets increased as the devaluation became more likely in early January 2002. At their peak, the discount exceeded 50 cents on the dollar for Banco Francés and Pérez Companc.[131]

3.6 ADR Discounts Prior to the Devaluation

By late December 2001, it was clear that a devaluation of the Argentine peso was imminent.[132] On December 21, the Argentine foreign exchange market was closed,

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[130] Non-parametric kernel density estimates (available upon request) suggest that along with differences in the first moment of the ADR discount, there were statistically significant changes in the shape, dispersion, and skewness of the distribution of ADR discounts during the *Corralito* relative to the pre-*Corralito* distribution.

[131] According to brokers and the financial press, the most demanded ADRs for capital outflow purposes in this period were (in order of importance): Pérez Companc (PC), Grupo Financiero Galicia, Siderca, and Telecom. In December 2001, the number of shares of PC traded on the NYSE increased 170 percent.

[132] Although President Dualde initially promised that he would not devalue the peso before March, financial press reports in this period suggest that the market expected a devaluation to come much sooner. On January 4[t]reports in the press (apparently based on official leaks) indicated that the Government was likely to devalue before mid-January. The Argentine Congress voted to establish the Law of Economic Emergency and abolish the Convertibility Law on (Sunday) January 6. The decision to devalue the peso

(continued)

although the official exchange rate remained at Arg$1 per dollar. Reports in the press suggest that there was an active parallel market for dollars on the streets of Buenos Aires during this period, and there were trades in the one-week ahead non-delivery forward (NDF) peso-dollar market in New York. It is in this context that the Argentine ADR market was also able to serve as a shadow foreign exchange market, allowing us to back out the market's implicit forecast of the size of the devaluation. Recall from equation (8) that the ADR discount can be decomposed into 3 components: the liquidity premium (for which we have data),[133] the capital control circumvention value (CCCV), and the currency value. We use two different identification schemes to disentangle the CCCV from the currency value. First, we use data from financial press reports as well as non-delivery forward (NDF) prices[134] to measure currency expectations. The CCCV in this approach is then the residual, after subtracting off the liquidity premium and the expected devaluation from the ADR discount. Alternatively, going back to equation (8), we make the assumption that the CCCV and the liquidity premium did not change in the interval of one-day-before to the day of the devaluation, allowing us to directly back out devaluation expectations from the one-day change in the ADR discount on the eve of the actual devaluation.

1. In the week before the announcement of the devaluation (and on the days between the announcement and the actual devaluation) the range of forecasts for the size of the devaluation varied widely. Uncertainty about the magnitude of the devaluation was further complicated by the fact that when the Government announced that a devaluation would take place (on January 7), they also announced that a new dual-exchange rate

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and establish a dual exchange rate regime was officially announced on (Monday) January 7. The actual devaluation occurred on (Friday) January 11 when the peso-U.S. dollar exchange rate was officially changed from 1 to 1.4. The free float of the peso started on February 11. See Appendix 3 for more information regarding exchange rate developments over this period.

[133] The sources for this data are Nosis S.A. and Broda Consultores. The liquidity premium is calculated as the daily average market discount on checks relative to cash. These data are available for January through November 2002. In keeping with anecdotal evidence from Argentine brokers, we assume that the liquidity premium rises gradually (linearly) from 0 percent to 9 percent (the average premium in January) by December 20, the day that President De la Rúa resigned and it became more likely that a devaluation would be necessary (and the *Corralito* would remain in place for the indefinite future).

[134] The NDF data are a composite index of one-week forward peso-dollar contracts available on Bloomberg.

system would be established, in effect indicating that there would be two simultaneous devaluations. *Clarín*, the leading newspaper in Argentina, reported on January 3 that a devaluation was imminent and that it was expected to be 30 percent. On January 4, *Clarín* revised its forecast of the devaluation to a range of between 35–40 percent. In contrast, the one-week ahead NDF market was predicting a devaluation of just 25 percent on January 9 and 10 (down from 30 percent in the previous week). Reuters, which collected data on the peso-U.S. dollar black market rate in this period, did not track the rate in the week prior to the devaluation apparently because of the wide dispersion of quotes in the broker market. In our decomposition calculations we use the (high-end) 40 percent devaluation forecast reported in the financial press starting on January 4 through January 10. For the rest of the days in our sample we use the NDF market forecasts.

In Figure 3.6 we provide a visual picture of our first method of decomposing the ADR discount for Pérez Companc (PC) into its 3 components. We focus on PC because it was the stock with the highest trading volume in the United States and Argentina during the days surrounding the devaluation, and information from brokers suggests that PC was the stock primarily used to conduct ADR conversions. The liquidity premium (the price of deposits) ranged from zero to 9 percent, declining very gradually from mid-January through May 2002. The expected devaluation—based on the NDF series and media reports as described above—shows three sharp spikes on December 6, December 20, and January 4. The capital control circumvention value—which is the residual—averages 5 percent in the week before the announcement of the devaluation. It then falls back down to around 3 percent in the post-devaluation period.

In the upper panel of Table 3.5 we calculate the CCCV for each of the eleven ADRs over the week before the devaluation assuming a liquidity premium of 9 percent and an expected devaluation of 40 percent. The Argentine Merval was closed in the days surrounding the devaluation, so changes in the ADR discount reflect movements of the stock price in New York. It is interesting to note that only two of the ADRs, Banco Francés and Pérez Companc, have positive CCCVs in this period. If actual devaluation expectations were lower than 40 percent (as suggested by the NDF prices) a number of

the CCCV estimates would turn positive.[135] It is also the case that in the period just prior to the devaluation liquidity in some of the ADRs was extremely low (as reflected in the trading volume numbers in the last two columns of the upper panel shown in Table 3.5). This is especially true for those ADRs with relatively low rates of discount (Irsa, Metrogas, and YPF).[136]

One way to think about the CCCV in this context is as a measure of the degree to which the Argentine capital controls were binding. If there were other less costly means of circumventing the *Corralito* we should see the CCCV embedded in the ADR discount decline. Indeed, the Argentine government eased some of the more draconian restrictions on capital outflows in the months following the devaluation, which likely lowered the ADR CCCV. Also, a number of other cross-listed financial instruments, including CEDEARs (U.S. firms cross-listed on the Argentine stock market), became more liquid in early 2002 which provided additional vehicles for capital outflow,[137] further lowering the CCCV for ADRs. Finally, it should be noted that a negative CCCV for a particular stock does not necessarily mean that there are costless profits available to investors through ADR conversions. The calculation of the CCCV assumes that the trade can occur instantaneously. If the stock is held for any period of time, and this period will be longer for more illiquid stocks—investors will also take into account any additional covariance risks that they would incur in holding the stock. These additional risk factors are not included in our calculations.

Our second method of disentangling the capital control circumvention value (CCCV) from the currency value contained in the ADR discount is presented in the last two columns of Table 3.5. We make the assumption that the CCCV value (and the

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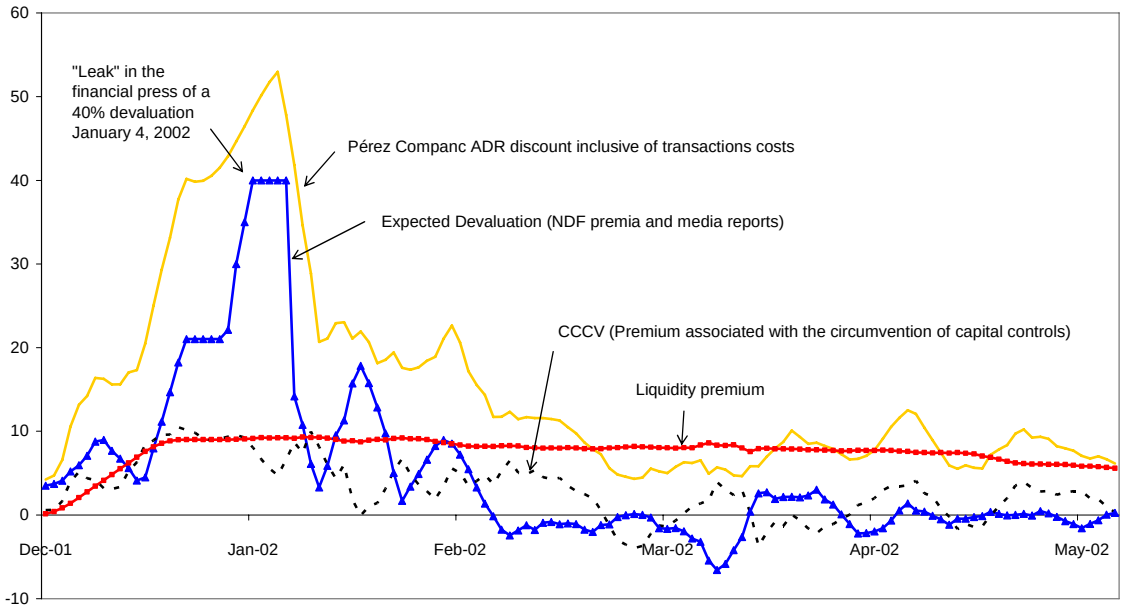
[135] If we calculate the CCCV on January 4, when both the Argentine and New York markets were open, and use the NDF estimate of expected devaluation of 30 percent and a liquidity of premium of 9.2 percent, the CCCVs for Financiero Galicia, Siderca, and TGS all become positive at 5.1, 1.4, and 0.4 percent, respectively.

[136] Amihud (2002) provides an alternative measure of liquidity (designed to capture the daily price impact of order flow) that takes the average ratio of the daily absolute return on share *i* to the daily value of trading volume for share *i*. Using this measure of liquidity, the five most liquid shares in Argentina during the *Corralito* are PC, Financiero Galicia, Siderca, Telecom, and Banco Francés. Further, using this measure of liquidity, PC is at least 4 times as liquid as any of the other cross-listed shares.

[137] See Auguste, Dominguez, Kamil, and Tesar (2002) for a further discussion of the role of CEDEARs.

liquidity premium) did not change on the eve of the devaluation. If we take the difference in ADR discounts just before and just after the devaluation on January 11 we find an average expected devaluation of between 40 and 45 percent, depending on whether we use the ADR discounts on January 10 (when only the New York market was open) or on January 4 (the last trading day on the Argentine Stock Market before the devaluation) in our calculations.[138] These changes in discounts are significantly larger than the typical daily or weekly discount changes in the pre-*Corralito* period and they suggest that, on average, the ADR market did a good job predicting the magnitude of the official devaluation (which was 40 percent). However, it is interesting to note that the devaluation forecasts implicit in the ADR discounts were generally far from predicting the 70 percent devaluation that took place for the floating component of the dual-exchange rate system that was also established on January 11.

Figure 3.6. Decomposition of Pérez Companc's ADR discount



Sources: Bloomberg, Nosis S.A., Broda Consultores, and Clarín.
Note: Observations are based on weekly moving averages

[138] Over this period there are days when only the U.S. market is open (although there exist local prices in Argentina based on the previous trading day) as well as days when particular ADRs did not trade in one or both markets. If we calculate changes in the ADR discounts on January 17 (when the Argentine stock market reopened), rather than January 11 , the average change in the ADR discount ranged between 32 and 33 percent.

Table 3.5. Estimated CCCV and Expected Devaluation After January 4, 2002

Individual ADRs	Decomposition of ADR discount in week before the devaluation				Difference in ADR discounts discounts around devaluation	
	Jan. 4–10, 2002					
	Max ADR discount (%)	CCCV (%)	Volume in Arg	Volume in NY	Jan. 4–11 (%)	Jan. 10–11 (%)
BBVA Banco Francés	54.4	5.4	886	1872	19.29	35.52
Cresud S.A.C.I.F. Y A.	35.3	-13.7	8026	40	58.82	62.35
Financiero Galicia	47.8	-1.2	5887	3678	33.29	36.89
Irsa Inversiones	41.2	-7.8	807	619	28.64	43.21
Metrogas S.A.	30.3	-18.7	372	200	23.72	45.34
Pérez Companc (PC)	54.7	5.7	16757	16429	22.62	32.36
Siderca S.A.I.C	41.7	-7.3	4470	817	45.52	44.12
Telecom Arg Stet-France	42.2	-6.8	4251	25674	76.00	69.67
Telefónica	na	na	0	878	na	na
TGS	48.3	-0.7	410	284	38.97	37.96
YPF S.A.	33.5	-15.5	219	795	48.72	45.61
Average	42.92	-6.08	3826	4662	39.56	45.30

Sources: Bloomberg, Economatica, Nosis S.Z. and Broda Consultores, and Clarín.
Note: ADR discounts are measured as the difference between the local price in US dollars and the ADR price, as a fraction of the local price in dollars. Local prices are adjusted for the ADR conversion ratio. The Argentine Stock Market was closed January 5–17 so that the reported ADR discounts are based on Argentine trading on January 4. The CCCV column is calculated as the "max ADR discount" minus a liquidity premia of 9 percent, and an expected devaluation of 40 percent. Volume is in thousands of dollars. Telefónica is excluded as its shares did not trade in Argentina on January 4. Using Amihud's (2002) measure of liquidity, PC is at least 4 times more liquid than all the other ADRs, and the five most liquid shares in Argentina during the *Corralito* are PC, Financiero Galicia, Siderca, Telecom, and Banco Francés.

3.7 Venezuela's CANTV ADR discount

Just two months after Argentina's *Corralito* was finally abolished, Venezuela found itself in the midst of an economic crisis that resulted in a 20 percent devaluation of the bolívar against the dollar and the establishment of capital controls on February 6, 2003. The Venezuelan controls were less severe than those in Argentina in that they did not involve the freezing of bank deposits, but all conversions of Venezuelan bolívares into U.S. dollars (including the purchase of dollars to pay dividends to ADR holders) became subject to government approval. In the period immediately following the imposition of the capital controls ADR conversions were suspended, although trading in CANTV shares (the most liquid Venezuelan ADR) continued both in Venezuela and New

York.[139] Starting in May 2003, the Bank of New York announced that it would resume CANTV ADR conversions and the CANTV discounts (the difference between the ADR price in New York and the corresponding local price in U.S. dollars) increased dramatically from below 10 percent to between 30 and 45 percent peaking at 50 percent in January 2004.[140]

Figure 3.7 shows the CANTV ADR discount together with the "dollar-transfer" rate[141] and the "dollar-CANTV" rate[142] over the period May 2002 through February 2004 (the capital controls are still in place at the time of this writing). During the period when CANTV ADR conversions were suspended (February 6 through May 20, 2003) and arbitrage was not possible, the "dollar-CANTV" is much lower than the "dollar-transfer" rate. Once ADR conversions resumed, and arbitrage could again take place, the "dollar-CANTV" rate closely tracks the "dollar-transfer" rate. In June 2003, *The Economist* reported that "shares in CANTV, the telephone company, which is also quoted in New York, rose by 68 percent in May, as investors realized that they could swap them for a dollar-denominated ADR, and thus for dollars".[143] Unfortunately, there does not exist an alternative measure of currency value in Venezuela that will allow us to disentangle the CCCV from the expected devaluation.[144] If we assume that the CCCV was in the 3–5

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[139] The other Venezuelan firm that was cross-listed on the NYSE in 2003 was Corimon. It was de-listed in June 2003 after it failed to pay dividends to ADR holders and its ADR price in NY dropped so steeply that its market capitalization fell below the NYSE minimum value. The other eleven Venezuelan ADRs were OTC and extremely illiquid during 2003.

[140] As of February 2004, the Institutional Investor Relations Department of CANTV indicated that 92 percent of all possible ordinary shares of CANTV which can be transformed into ADRs (class-D shares), have been converted and are outstanding in New York.

[141] The dollar transfer market (also described as "money tables" or "mesas de dinero") provides the price in bolívares of buying dollars and transferring them to a foreign bank, so that this price will include the CCCV. These data are available from Venanacham (the Venezuelan-U.S. Chamber of Commerce in Caracas) and are for "large transactions" in an informal broker market. The transaction fee for these transfers is typically fixed at US$25 per operation.

[142] The dollar CANTV is the effective cost of buying dollars using CANTV ADR conversions inclusive of transactions costs. Our estimates of transactions costs for this market were provided by Activalores.

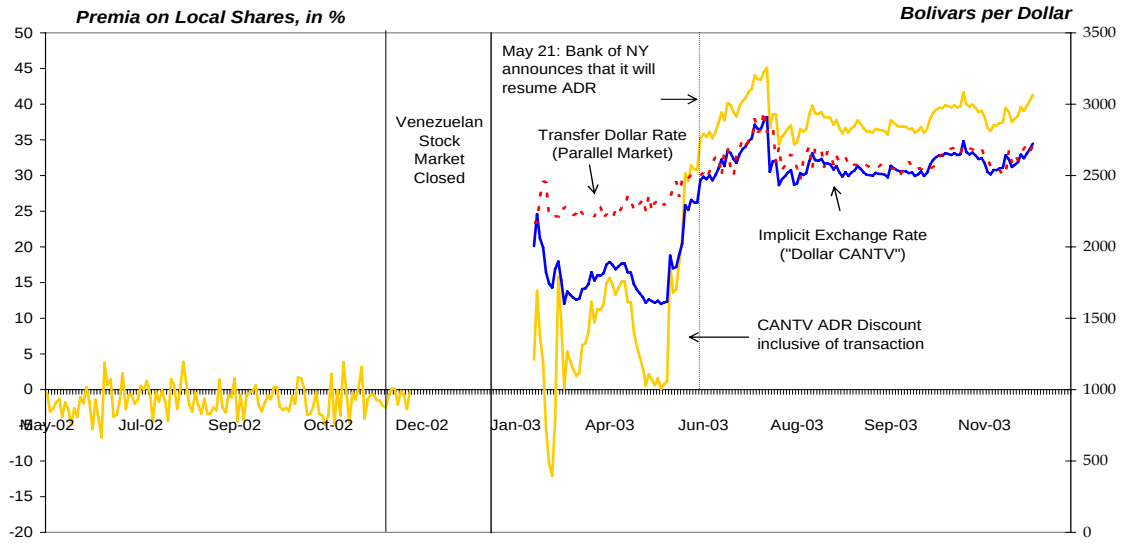
[143] *The Economist*, June 12, 2003. It is interesting to note that CANTV posted negative earnings in the same quarter that its share price rose by 68 percent. Venezuela's Caracas General Index also rose 63 percent as a direct consequence of CANTV's price boom, even as Venezuelan GDP was contracting 25 percent.

[144] The official Venezuelan exchange rate was fixed over this period at 1598 bolívares to the dollar. It is not possible to use bolívar NDF prices to decompose the ADR discount because the market was extremely

(continued)

percent range that we found for Argentina, this would imply an ADR market expectation of a 55–62 percent devaluation of the bolívar relative to the dollar in early December 2003.

Figure 3.7. CANTV's ADR Discount and the "Dollar CANTV" rate



Sources: Bloomberg and Activalores.

The Venezuelan ADR market, and particularly the CANTV ADR discount, continues to provide market participants with a timely indicator of the effective exchange rate in an organized, legal, and transparent asset market. Indeed, it is interesting to note that in November 2003 Morgan Stanley Capital International (MSCI) announced that it would use CANTV's ADR discount to proxy for the bolívar-U.S. dollar exchange rate in their calculation of the MSCI Venezuela Index.[145]

illiquid over this period. The dollar transfer rate is also not useful because it includes both transaction costs and a CCCV component.

[145] On November 26, 2003, MSCI announced its decision to change its standard spot rate for the Venezuelan bolívar to a notional exchange rate based on the relationship between the price of CANTV in the local market in bolívares and the price of its ADR in U.S. dollars

4. Market Factors and the Pricing of ADRs

In Section 3 of this chapter we analyze the time series of Argentine ADR and local prices in isolation. We now turn to the pricing of ADR stocks in the context of overall market movements in Argentina and New York.

In theory, in a fully liberalized and integrated financial environment, we would expect ADRs to be priced based on global market factors. Investors with access to global assets should expect returns to be based on covariances of individual stocks and the global market portfolio. That said, in practice, Karolyi and Stulz (2003) and Gagnon and Karolyi (2004) find that home bias tends to increase local influences on asset prices. They find that local market portfolios often better explain the cross-sectional variation in expected returns for local stocks, though they also find that equity flows and cross-country correlations increase global influences on asset prices.[146] The pricing of Argentine ADRs provides an interesting natural experiment in the context of this literature. Prior to the imposition of the *Corralito*, Argentina's financial markets were considered fully liberalized. The *Corralito*, although allowing ADR transactions to continue, was intended to control capital outflows and therefore presumably led to a less globally integrated Argentine capital market.[147] In terms of the market model, we might therefore expect to find that the influence of local and global market factors in pricing Argentine cross-listed stocks changed during the period in which capital controls were in force.

We test whether the imposition of the *Corralito* led to changes in the pricing of Argentine stocks with associated ADRs using a multi-factor market model; where R_{it} is the return on asset *i* at time *t*, R^{G}_{mt} is the return on the global market portfolio at time *t*, R^{L}_{mt} is the return on the local market portfolio at time *t*, and ΔS_t is the change in the exchange rate at time *t*:

[146] Also see Errunza and Losq (1985), Eun and Janakiramanan (1986), and Alexander et al. (1987) who examine the pricing of ADR portfolios in the context of the market model and generally find evidence that global market factors dominate local factors in explaining ADR returns. In a large cross-country study, Gagnon and Karolyi (2004) find evidence of significant differences in the prices of local shares and their corresponding ADR shares, though they also find that these differences rarely persist for more than one day.

[147] Schmukler and Kaminsky (2000), however, find little evidence that capital controls (in six emerging market economies during the 1990s) effectively segmented domestic markets especially over longer horizons.

$$R_{it} = \beta_0 + \beta_1 R_{mt}^G + \beta_2 R_{mt}^L + \beta_3 \Delta S_t + \varepsilon_{it} \quad (3.9)$$

Table 3.6 presents daily time series results[148] from regressions of returns from the value-weighted ADR portfolio (in Argentina and the U.S.) on the Morgan Stanley Capital International (MSCI) world index, an orthogonalized[149] local Argentine value-weighted portfolio index (excluding the stocks with associated ADRs), and the change in the peso-dollar exchange rate. Regression results are presented both for the period prior to the imposition of the *Corralito* (specifically January 2000 through November 2001) and for the *Corralito* period (December 2001 through May 2002).

The results in Table 3.6 suggest that both local (Argentine) market factors and global market factors were important in pricing Argentine stocks with associated ADRs even before the imposition of the *Corralito*. Our estimates of the betas on the global market portfolio are close to one while the betas on the local market factor are 0.8 for the portfolio returns in Argentina and 0.7 for the corresponding ADR portfolio returns in the U.S. Focusing first on the results for the regression using the portfolio price in Argentina we find that in the *Corralito* period the local market portfolio beta rises (both in absolute magnitude and in relation to the beta on the global market portfolio) following the imposition of the *Corralito.* If we examine what proportion of the variance of portfolio returns in Argentina is explained by the local market portfolio (using the partial R^2), we find that prior to the *Corralito* this was 42 percent, whereas during the *Corralito* this rises to 76 percent.[150] The opposite is true of the global market factor, the proportion of the

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[148] Daily returns correspond to close-to-close prices including dividends and excluding weekends and holidays.

[149] We orthogonalized the non-ADR Argentine portfolio by regressing it on the MSCI (separately over the pre- and post-*Corralito* sub-periods) and use the residuals from these first stage regressions for R_{mt}^L in the estimation of equation (8).

[150] This result is based on a market model which includes dummies to control for the many market closures that occurred during the *Corralito*. In order to determine whether non-frequent trading introduces bias in our regression results, we re-estimated equation (8) using the Scholes and Williams (1977) non-synchronous trading correction. Specifically, we estimate equation (8) allowing for up to 10 lags and leads of the local and global market portfolios. We compute $\beta_n^{SW} = \frac{\sum_{i=-n}^{n} \beta_i}{1 + \sum_{i=1}^{n} 2\rho^i}$ where ρ is the autocorrelation coefficient. We find that the local market portfolio beta is robust to the choice of leads and lags, whereas

(continued)

variance of portfolio returns in Argentina explained by the global market factor falls from 16 percent prior to the *Corralito* to just 1 percent during the *Corralito*. These results suggest local market factors in Argentina became more important in pricing stocks with associated ADRs (and presumably all Argentine stocks), and global factors became less important, during the period in which capital controls were in force.

Table 3.6. Explaining ADR portfolio returns in Argentina and the U.S. using a Global Market Portfolio and an Argentine (Non-ADR) Local Market Portfolio over the Pre-*Corralito* and *Corralito* Periods

Independent Variable	Pre-*Corralito*		*Corralito*	
	Local Shares	ADRs	Local Shares	ADRs
Local Market Portfolio	0.834**	0.736**	1.011**	0.157**
	(0.053)	(0.050)	(0.094)	(0.046)
Global Market Portfolio	0.961**	0.992**	0.668*	0.651**
	(0.057)	(0.053)	(0.256)	(0.174)
Exchange Rate Change			0.069	-0.011
			(0.097)	(0.029)
Constant	0.000	0.000	-0.002	-0.004*
	(0.001)	(0.001)	(0.002)	(0.002)
Number of Obs	477	483	104	124
R^2	0.45	0.47	0.81	0.2
F-statistic	190.7	208.9	58.2	5.5
DW statistic	2.11	1.89	1.89	1.88
Partial R^2 (local MP)	0.42	0.43	0.76	0.16
Partial R^2 (global MP)	0.16	0.23	0.01	0.09

Sources: Economatica and Bloomberg.

Note: Standard errors are in parenthesis. The global market portfolio is the MSCI world index and the local market portfolio is an orthogonalized value-weighted portfolio (in dollars) of all the stocks traded in Buenos Aires except those with an associated ADR. The dependent variable is the return in Argentina or the U.S. on a value-weighted portfolio of the 11 stocks with associated ADRs. The pre-*Corralito* period is 1/1/2000 to 11/30/2001 and the *Corralito* period is 12/3/2001 to 5/31/2002. ** denotes significance at the 1 percent level, and * denotes significance at the 5 percent level. The regressions over the *Corralito* period include dummy variables for days when the Argentinean market was closed. Partial R^2 (market x) corresponds to the R^2 when we exclude the other market index in the regression (in the *Corralito* sample the Exchange Rate Change variable is also excluded).

the global market portfolio beta is sensitive to the lag specification in the *Corralito* period, though the main qualitative results remain robust. These lead and lag estimates of the betas are available upon request.

The discussion in Sections 2 and 3 of this chapter suggests that the pricing of cross-listed shares in Argentina and New York may have diverged during the *Corralito* period. And, in particular, we might expect that while local factors influenced prices in Argentina, they may not have been as important for prices of the same stocks sold in New York (given that investors in New York were not subject to the restrictions of the *Corralito*). Indeed, we find that estimates of equation (3.9) using ADR portfolio returns in New York indicate that the beta on the local market portfolio falls dramatically from 0.73 in the pre-*Corralito* sub-period to 0.16 in the *Corralito* period. The beta on the global market portfolio in this regression also falls in the *Corralito* period (from 0.99 to 0.65), as does the regression goodness of fit which falls from 0.47 in the pre-*Corralito* period to 0.2 during the *Corralito*.[151] Further, the percentage of variation in the return of the ADR portfolio in New York explained by the local market portfolio (based on the partial R^2) falls from 43 percent before the *Corralito* to 16 percent during the *Corralito*, while the explanatory power of the global market index falls from 23 to 9 percent.

In order to more formally test the hypothesis that the influence of local and global market factors for pricing Argentine cross-listed shares changed after the imposition of the *Corralito*, we use a Chow breakpoint test for structural change. Table 3.7 presents the results of four such Chow tests for no structural change in the local and global market betas in the two markets (over the full sample period January 2000 through May 2002). The results indicate strong rejections of the hypothesis of no structural change in both the local and global market betas after the imposition of the *Corralito* for the ADR portfolios in both markets. These results together with the results presented in Table 6 indicate that Argentine ADRs in New York became less like other Argentine stocks (including those with associated ADRs) with the advent of capital controls.

[151] We analyze beta stability in the post-*Corralito* period by running recursive least squares regressions. These estimates (available upon request) suggest that in the first two months following the imposition of the *Corralito* (and when the volume in the ADR market was at its peak) neither the global market index nor the Argentine market index explain ADR portfolio returns in New York (whereas in Argentina local market factors become more important in explaining the pricing of stocks with associated ADRs over this period). In the subsequent two-month rolling subsamples the global market index beta regains statistical significance and rises in magnitude for the ADR portfolio returns in New York.

Table 3.7. Chow Breakpoint Test for local and global market portfolio beta stability after the imposition of the *Corralito*

Local Shares	Local Market Portfolio β	Global Market Portfolio β	Both Market β
F-statistic	12.931	3.440	3.796
P-value	0.000	0.017	0.005
ADRs			
F-statistic	6.719	3.230	30.050
P-value	0.001	0.040	0.000

Note: The dependent variable is the return (in dollars) in Argentina (Local Shares) or in the U.S. (ADRs) on a value-weighted portfolio of the 11 stocks with associated ADRs. The global market portfolio is the MSCI world index and the local market portfolio is an orthogonalized value-weighted portfolio (in dollars) of all the stocks traded in Buenos Aires except those with an associated ADR. The full sample is 1/1/2000 to 5/30/2002 and the breakpoint is 11/30/2001.

5. Conclusions

Argentina in late 2001 and early 2002 and Venezuela in 2003 provide an unusual opportunity to analyze the reactions of investors to capital controls. The Argentine *Corralito*, originally put in place to stave off a devaluation of the peso, effectively served to provide incentives for Argentines to invest in the Argentine stock market, and provided a new role for cross-listed shares as a (legal) mechanism for capital flight. Venezuelan investors also learned to use CANTV ADRs to evade similar capital controls. Investors in both countries were able to purchase cross-listed stocks for local currency, convert them into ADRs, re-sell them in New York for dollars and deposit the dollar proceeds in U.S. bank accounts.

In this chapter, we show that Argentine and Venezuelan ADR discounts went as high as 55 percent, indicating that investors were willing to pay significant amounts in order to move their funds abroad and to hedge the dollar value of their assets. In effect, ADR discounts serve as a shadow exchange rate in the presence of capital controls. In Venezuela, the implicit value of the dollar in CANTV ADR discounts serves as timely indicator of the effective exchange rate in an organized, legal, and transparent asset market. On the eve of the Argentine devaluation, the ADR market anticipated a fall in the value of the peso relative to the dollar in the range of 40 to 45 percent. We also estimate

that the capital control circumvention value for Argentine ADRs averaged 3 percent during the *Corralito.*

We find that the imposition of the *Corralito* led to changes in the underlying pricing structure of ADR stocks in Argentina and New York. The *Corralito*, although allowing ADR transactions to continue, was intended to control capital outflows and therefore should have led to a less globally integrated Argentine capital market. We find evidence of an increase in Argentine market segmentation after the imposition of the *Corralito*. Local market factors in Argentina became more important in pricing peso denominated stocks with associated ADRs, while the reverse was true (local factors became less important) for the same ADRs in New York.

In the chapter we have focused on the recent Argentine experience with capital controls and the role that cross-listed securities can play in such an environment. But there are general lessons to be learned. Our analysis suggests that once having established ADRs and other kinds of contractual arrangements across markets, it is difficult if not impossible to reverse the process of capital market integration. Indeed Venezuela tried to halt ADR conversions by restricting firms from paying out dollar dividends, but the government ultimately succumbed to pressures and allowed ADR conversions to resume. ADRs also give insights into the extent to which capital controls are binding by providing a market measure of the effectiveness of those controls.

Appendices

Appendix 1: Argentina's Financial Market Event Time Line

October 28, 2001	Minister Cavallo starts negotiations with the IMF and the U.S. Treasury to purchase collateral for new Argentine bonds to be issued in an exchange for the nearly US$100 billion of local and external debt.
October 29, 2001	Mr. Cavallo defines the debt exchange operation as voluntary. The old debt would exchange for bonds paying seven percent per year and be guaranteed by tax revenues. The IMF and U.S. Treasury require compliance with a zero deficit and an agreement with the provinces on tax revenue sharing before any kind of financial support is given.
November 19, 2001	The IMF announces it will not make any new disbursements without being satisfied that Argentina has secured the goals previously designated.
November 30, 2001	End of a debt swap with local banks and pension funds for more that US$55 billion (over a total public debt of US$160 billions).
December 2, 2001	The government announces temporary capital control regime (termed *Corralito*) involving bank withdrawal limits and limits on dollar transfers abroad as a last-ditch effort to fend off a devaluation and prevent a major banking crisis. Withdrawals are limited to Arg$250 (in dollars) per week per account. Depositors, however, may still access funds for larger purchases through checks or debit cards and transfer their money among banks. Holders of deposits may also exchange them for federal bonds (BODENs) maturing in 2005, 2007, or 2012 in a Canje exchange. No limits are placed on domestic payments made with checks, credits, debit cards and electronic MEP (*Método Electrónico de Pagos*) payments.

December 3, 2001	The capital control measures announced on Dec 2 come into full effect through Decree 1570-01 on Dec 3: a) Wire transfers suspended except with prior Central Bank approval. b) Cash withdrawals from the Banking System limited to US$1000 per month. c) Financial Argentine institutions prohibited from foreign currency futures transactions. d) Financial Argentine institutions prohibited from issuing new bank loans denominated in Argentine pesos. All new loans must be issued in U.S. dollars and existing peso loans must be converted to U.S. dollar loans at a one to one rate. e) Foreign investors trading in the Argentine Securities Market subject to repatriation restrictions. Funds related to securities transactions must remain in the country until government approval is obtained or the measure is officially revoked.
December 19, 2001	Mr. Cavallo and all other ministers resign.
December 20, 2001	President De la Rúa resigns and Mr. Ramón Puerta becomes interim president. Country Risk reaches 4618 points**.** Global (sovereign) bond yields reach their historical maximum of 49 percent annual return in dollars.
December 21, 2001	The official Foreign Exchange Rate market is closed.
December 23, 2001	Mr. Rodríguez Saa becomes the new interim president for 60 days. He declares the suspension of external debt payments for at least 60 days, totaling US$166 billion in federal and provincial debt.
December 24, 2001	The government announces that a new fiat currency (i.e., without foreign-currency backing) will be created (the *argentino*).
December 30, 2001	Interim president Mr. Rodríguez Saa resigns and the legislative assembly elects Mr. Eduardo Duhalde as new president.
January 2, 2002	Mr. Duhalde assumes power.
January 4, 2002	"Leak" reported in the financial press suggests that a 40 percent devaluation is imminent.
January 5, 2002	The Argentine stock market is closed.
January 6, 2002	The Argentine Congress votes to establish the Law of Economic Emergency and abolish the Convertibility Law.
January 7, 2002	The new Minister of Finance, Mr. Lenicov, announces the devaluation of the peso and the establishment of a new dual foreign exchange rate regime, to be implemented on January 9, 2002.

January 11, 2002	After several delays, the exchange rate market re-opens and the new dual exchange rate system is put in place: a) 1 Argentinean peso= 1 U.S. dollar parity (Convertibility Plan) is abolished. b) All debts (capital and interests) agreed in Argentinean currency with financial entities—converted into U.S. dollars according to the Decree 1570/2001—will be reconverted into the original currency agreed (pesos). c) The official, fixed conversion rate of US$1 U.S.=Arg$1.4 is relevant for foreign trade operations. The free or floating rate is relevant for all other transactions and freely determined by the market.
January 17, 2002	Argentine stock market re-opens.
January 21, 2002	The government announces the easing of bank withdrawal restrictions: a) Up to Arg$7,000 can be withdrawn from term deposits in pesos (transferring that money to a checking account) b) Up to US$5,000 can be withdrawn from term deposits in dollars (transferring that money to a checking account at the official exchange rate, 1.40). c) Up to US$5,000 in a saving account can be *pesofied* at the official exchange rate.
February 3, 2002	Mr. Lenicov announces an asymmetric *pesofication* and the end of the dual exchange rate regime: a) *pesofication* of all dollar deposits at Arg$1.4 per dollar. b) corporate and consumer debts are also *pesofied*, but at the exchange rate prevailing during the Convertibility period. Both deposits and credit will be indexed to inflation. c) the end of the dual exchange rate regime and a unified floating exchange rate determined by market forces. d) the right to withdraw wage and pension income from the *corralito* without any amount restrictions (before workers could only extract up to Arg$1,500). *Corralón* starts which freezes bank term deposits (holders of term deposits had the option to convert them into CEDROs or BODENs maturing in 2007 or 2012 in a Canje exchange).
February 4, 2002	The official foreign exchange market is closed.
February 11, 2002	The BCRA establishes a new unified free foreign exchange market, which replaces the two markets—official and free—implemented in January. The exchange rate market re-opens and the floating dollar exchange rate reaches Arg$2.1, well below the devaluation expectations built-into asset prices.

March 26, 2002	The Central Bank announces new measures related to foreign exchange transactions and ADR/CEDEAR conversions aimed at improving the functioning of the foreign currency market and regulating the buying and selling of foreign currency by order and for the account of the Central Bank. The press communication also mentions that there will be coordination between the *Comisión Nacional de Valores* (CNV) and the *Bolsa de Comercio de Buenos Aires* (BCBA) in order to adopt new measures to regulate capital outflows via ADR and CEDEAR transactions.
September, 2002	The Central Bank passes very restrictive regulation (circular #3723) that mandates that every stock be traded in its underlying currency. After intense opposition from the financial community, the central bank rescinds #3723 and instead passes a resolution (circular #3727) that forbids "contra cable" operations. These operations allowed brokers to sell stocks purchased in Buenos Aires instantaneously in New York (or any foreign market) using the Mercado de Valores as a clearinghouse. Under #3727 it was still possible for investors in Argentina to convert CEDEARs and sell them in New York, but this new restriction significantly increased the transactions costs to do so.
December 2, 2002	2. *Corralito* rescinded.

Sources: Ámbito Financiero, *La Nación*, and *Clarín* (various issues) and Pictet.

Appendix 2: Transactions costs and computation of arbitrage bounds

Appendix Table A1 shows transaction cost ranges that reflect amounts that were charged to both small and large Argentine investors during the *Corralito*. The standard length of time required for an ADR conversion was nine days.[152] Large investors, institutional investors, and bankers faced substantially lower costs than smaller investors, and could also complete the ADR conversion in a shorter period of time.[153]

[Appendix Table A1 here]

Taking into account these various transactions costs and defining n_0 as the minimum time required to sell an ADR in New York, the expected return (at period t) in U.S. dollars of converting local share i into its corresponding ADR is:[154]

$$\frac{E_t[p_{it+n}^{ADR}\ (1-\tau_3)(1-\tau_5)]-\tau_4-[\xi_i p_{it}^{L}(1+\tau_1+\tau_2)S_t]}{[\xi_i p_{it}^{L}(1+\tau_1+\tau_2)S_t]} \qquad \text{(A1)}$$

where $n \geq n_0$, $\xi_i p_{it}^{L}(1+\tau_1+\tau_2)$ is the local currency the investor needs to buy ξ_i local shares to obtain one ADR corresponding to stock i, and $E_t[p_{it+n}^{ADR}\ (1-\tau_3)(1-\tau_5)]$ is the dollar amount that the local investor expects to obtain after selling the ADR in the U.S. at time $t+n$ after taxes and expenses. Local investors typically face a broker's fee, τ_1, and a transactions fee, τ_2. A second broker's fee, τ_3, is incurred when the asset is sold in the United States. We also include a fixed fee in dollars, τ_4, that the investor must pay to transform the local shares into an ADR. Finally, the cost of opening a bank account in the United States is τ_5. Note that the investor does not have to physically obtain dollars to

[152] Information from brokers in Buenos Aires suggests that the time to conversion varied considerably across type of investor and across time. We use contemporaneous prices and exchange rates as a benchmark in computing arbitrage returns, which can be interpreted as the minimum cost investors would incur for ADR conversion.

[153] The costs reported in the table are based on phone interviews with portfolio managers and investors in Buenos Aires and on information published on the websites of various Argentine brokerages advertising the ADR-conversion process.

[154] Here we are assuming the conversion fee is paid in dollars in the U.S. once the operation is complete, and the amount is withdrawn from the investor's banking account.

carry out this operation (the return is simply expressed in dollar units) so the investor does not pay a fee for obtaining foreign exchange.

If the local investor were instead to use the dollar amount $[\xi_i p_{it}^{L}(1+\tau_1+\tau_2)S_t]$ to buy local share *i* and sell it in the local market in period *t+n* for the expected (net of taxes) price, her expected return at time *t* will be:

$$\frac{E_t \xi_i p_{it+n}^{\mathrm{L}} (1-\tau_1-\tau_2)S_{t+n} - \xi_i p_{it}^{L}(1+\tau_1+\tau_2)S_t}{\xi_i p_{it}^{L}(1+\tau_1+\tau_2)S_t} \tag{A2}$$

where $\xi_i p_{it}^{L}(1+\tau_1+\tau_2)S_t$ is the amount, expressed in dollars, the investor needs in order to buy enough shares of the local stock *i* to reach the equivalent of one ADR, and $E_t \xi_i p_{it+n}^{\mathrm{L}} (1-\tau_1-\tau_2)S_{t+n}$ is the amount of money she receives for selling the shares after *n* periods. The returns are calculated net of the broker's fee and the local transactions fee.

For the investor to be willing to convert shares to ADRs, it must be the case that:

$$E_t[p_{it+n}^{ADR}(1-\tau_3)(1-\tau_5)] - \tau_4 - E_t[\xi_i p_{it+n}^{\mathrm{L}}(1-\tau_1-\tau_2)S_{t+n}] \geq 0 \tag{A3}$$

U.S. investor

The trade-off facing a U.S. investor is different from that of an Argentine investor because of the asymmetries in fees, taxes and institutional regulations in the two markets. The expected return to holding ADR *i* for *n* periods is:

$$\frac{E_t p_{it+n}^{ADR} - p_{it}^{ADR}}{p_{it}^{ADR}} \tag{A4}$$

U.S. investors do not face a broker's fee or a stock market transactions fee.[155]

The return to converting the ADR to local shares, and repatriating the earnings is given by:

[155] It is not strictly true that U.S. investors face zero transactions costs. However, our empirical analysis focuses on the arbitrage conducted by Argentine investors during the *Corralito*, so we abstract from the relatively small U.S. transaction costs for simplicity.

$$\frac{E_t \xi_i p^{\mathrm{L}}_{it+n} \ (1 - \tau_1 - \tau_2)(1 - \tau_6) S_{t+n} - p^{ADR}_{it}}{p^{ADR}_{it}} \tag{A5}$$

When selling the shares in the local market, we assume that the U.S. investor incurs charges in using a local broker and must pay the stock market transactions fee. Since we assume that he would like to return the profits from the sale back to the U.S., he incurs an additional tax (τ_6) for transferring the funds.

A risk-neutral investor will cancel an ADR when:

$$E_t \xi_i p^{\mathrm{L}}_{it+n} \ (1 - \tau_1 - \tau_2)(1 - \tau_6) S_{t+n} - \ p^{ADR}_{it} \geq 0 \tag{A6}$$

This suggests that if local prices (expressed in dollars) exceed the ADR price investors should buy ADRs, convert them back to local shares and sell them in the local market.

Arbitrage bounds

The trade-offs faced by local and U.S. investors yield arbitrage bounds for capital inflow into and outflow from the local market. Equation (A6) can be re-written to show the bound facing a local investor who is contemplating converting his local stocks *i* into their corresponding ADR:

$$\frac{(1 - \tau_1 - \tau_2)}{(1 - \tau_3)(1 - \tau_5)} + \frac{\tau_4}{(1 - \tau_3)(1 - \tau_5) E_t \xi_i p^{L}_{it+n} S_{t+n}} - 1 \geq \frac{E_t p^{ADR}_{it+n} - E_t \xi_i p^{L}_{it+n} S_{t+n}}{E_t \xi_i p^{L}_{it+n} S_{t+n}} \tag{A7}$$

Capital outflows to the U.S. will not occur if the transaction costs on the left-hand-side of (A7) (which are a function of the local price and the exchange rate) exceed the returns to the conversion. The Argentine data show that local prices moved well outside of the arbitrage bands because of the value investors attached to being able to convert their frozen bank deposits into dollars in overseas accounts.

Equation (A8) shows the corresponding arbitrage bound for capital inflows into the local market. Transactions costs faced by a U.S. investor that exceed the returns of selling ADRs for local shares will choke off capital inflows into the local market.

$$(1-\tau_1-\tau_2)(1-\tau_6)-1 \geq \frac{E_t\xi_i p^L_{it+n} S_{t+n} - E_t p^{ADR}_{it+n}}{E_t\xi_i p^L_{it+n} S_{t+n}} \qquad \text{(A8)}$$

If the ADR premium/discount lies between the bounds in (A7) and (A8) neither investor would engage in arbitrage between the markets. Premia outside of the bounds should, in the absence of capital controls, be arbitraged away.

Appendix 3: Argentine Exchange Rate Market Developments

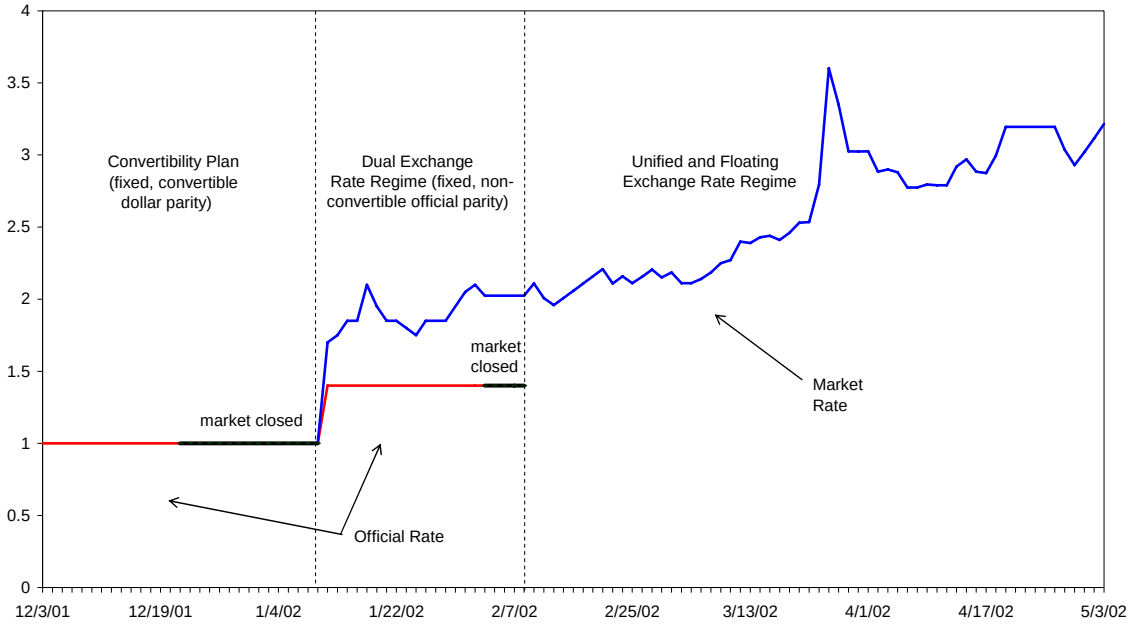
The Argentine foreign exchange rate market was closed (*feriado cambiario*) from the December 21 until January 10 (inclusive). During this period the shadow (or parallel) market exchange rate quoted at around 1.5–1.6 pesos per dollar, well above the official parity of Arg$1 per dollar prevailing before markets were closed.

On January 4, the Minister of Finance announced the discontinuation of the currency board and on January 7, the Minister of Finance announced the devaluation of the peso and a new exchange rate regime. The new exchange rate regime was a dual one, featuring an official, fixed non-convertible rate of Arg$1.4 per dollar (relevant for exporters and financial institutions) and a free or floating dollar, for all other operations and determined by supply and demand. This new dual regime *came into full effect* on Friday, January 11, when the markets were re-opened.

On January 11 there were two different values for the free exchange rate: dollars purchased with cash at 1.7–1.8 "free pesos" per dollar, and a higher exchange rate for dollars purchased with checks from funds in the C*orralito* (1.9–2 "trapped pesos" per dollar).

Exchange rate market operations were again suspended from February 4 to February 8, inclusive. On Sunday, February 3, the new Minister of Finance announced the end of the dual exchange rate regime and a unified floating exchange rate was put in place on Monday, February 11. On February 11, the floating exchange rate opened at Arg$2.10 per dollar.

Figure A1. Foreign Exchange Rate Regimes in Argentina
(Daily Exchange Rate in Pesos per Dollar: Dec. 3, 2001–May 31, 2002)



Source: Bloomberg.
Note: Thick black lines denote periods when the official foreign exchange market was closed.

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