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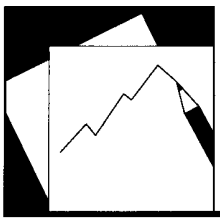

IMF Working Paper

How Do Exchange Rate Regimes Affect Firms' Incentives to Hedge Currency Risk? Micro Evidence for Latin America

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How Do Exchange Rate Regimes Affect Firms' Incentives to Hedge Currency Risk? Micro Evidence for Latin America

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Abstract

Using a unique dataset with information on the currency composition of firms' assets and liabilities in six Latin-American countries, I investigate how the choice of exchange rate regime affects firms' foreign currency borrowing decisions and the associated currency mismatches in their balance sheets. I find that after countries switch from pegged to floating exchange rate regimes, firms reduce their levels of foreign currency exposures, in two ways. First, they reduce the share of debt contracted in foreign currency. Second, firms match more systematically their foreign currency liabilities with assets denominated in foreign currency and export revenues—effectively reducing their vulnerability to exchange rate shocks. More broadly, the study provides novel evidence on the impact of exchange rate regimes on the level of un-hedged foreign currency debt in the corporate sector and thus on aggregate financial stability.

Key Words: Dollarization, currency mismatches; foreign currency exposure; exchange rate regimes.

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Contents Page

Figures

Appendices

I. INTRODUCTION

Firms' heavy reliance on foreign-currency debt has been singled out as a key source of financial fragility in emerging market countries (Calvo (2001) and Frankel (2005)). In the late 1990s and during the last decade, sharp currency depreciations in several countries in Latin America and East Asia turned firms' foreign currency liabilities into crippling debt burdens—especially for those companies that had a large mismatch between foreign-currency denominated debt and earnings in local currency. This, in turn, impaired many firms' ability to service debt or drove them into bankruptcy, triggering banking crisis and economic recessions.

An intense debate on academic and policy circles in the aftermath of these crises has centered on the extent to which the exchange rate regime affects firms' incentives to hedge their exposure to currency risk. In particular, the debate has focussed on whether fixed or pegged regimes encourage firms to take on excessive foreign currency debt that leaves them exposed to a sudden depreciation of the domestic currency. This debate has considerable relevance for economic policy, as foreign currency indebtedness has been cited as a key factor deepening output contractions during emerging market crisis, with persistent effects on economic growth (Domaç and Martinez-Peria (2003), Calvo et al. (2004), Cerra and Saxena (2008), and Bordo, Meissner, and Stuckler (2009)). It is especially relevant today for Central and Eastern Europe, where the growing exposure of the private sector to currency risk has been highlighted as having potentially significant implications for financial stability (Rosenberg and Tirpak (2009), Ranciere, Tornell, and Vamvakidis (2010), and Zettelmeyer, Nagy, and Jeffrey (2010)).

Economists are sharply divided over the role of the exchange rate regime in contributing to currency mismatches in firms' balance sheets. Views here fall into two camps. Proponents of flexible regimes argue that authorities' commitment to defend a peg offer the private sector an implicit guarantee against short-term movements of the exchange rate, which leads to moral hazard and excessive foreign currency borrowing (see Burnside, Eichenbaum, and Rebelo (2001), Goldstein and Turner (2004), and Schneider and Tornell (2004), among others). A natural implication of this line of thought is that the adoption of floating exchange rate regimes would provide incentives for a more cautious management of currency exposure, thereby reducing financial vulnerabilities associated to currency mismatches in the private sector.

Other authors, however, have claimed that the problem of unhedged foreign currency liabilities in the corporate sector has deeper roots than the exchange rate regime (Eichengreen and Hausmann (1999) and Eichengreen, Hausmann, and Panizza (2005)). According to this view, currency choice is not the result of a market equilibrium but of financial market incompleteness, and thus monetary or exchange rate policies are ineffective in reducing vulnerabilities related to foreign exchange exposures. [1]

[1] This phenomenon is known in the literature as "original sin" (see Eichengreen and Hausmann (1999)).

Fueling this theoretical debate is the mixed empirical evidence on whether pegged regimes contribute to higher debt dollarization and currency mismatches in firms' balance sheets.[2] Martinez and Werner (2002) conclude that the exposure of Mexican firms to devaluation risk lessened after Mexico switched to a flexible regime. Using firm level data for Chile, Cowan and De Gregorio (2007) also find that currency exposure of Chilean corporates fell after 1999 when Chile moved to a floating regime. In the case of Asia, Parley and Popper (2006) find that firms in East Asia were less hedged under pegged exchange rates, while Patnaik and Shah (2010) find that low currency flexibility encouraged Indian companies to hold larger unhedged currency exposures than during periods of greater currency flexibility.

On the contrary, firm level evidence from Brazil over the period of 1996 to 2001 suggests that the collapse of the fixed exchange rate regime in Brazil, in early 1999, did not cause a major change in the currency composition of debt and the hedging behavior of the corporate sector (Berrospide, Purnanandam, and Rajan (2008)). Using bank-level data, Arteta (2005) finds that floating exchange rate regimes have been, if anything, consistently associated with greater currency mismatches in a sample of developing and transition economies from the early 1990s to 2000. Thus, whether exchange rate regimes reduce or exacerbate financial fragility by encouraging excessive foreign currency borrowing is far from settled.

Against this background, the goal of this paper is to investigate whether the choice of exchange rate regime, and the degree of exchange rate flexibility, affects firms' foreign currency borrowing decisions and the associated currency mismatches in their balance sheets. For these purposes, I use a new hand-collected dataset with information on the foreign-currency share of firms' assets and liabilities, and the breakdown of sales into domestic and export revenues, for a large sample of firms in six Latin American countries between 1992 and 2005. To my knowledge, this is the first cross-country dataset of emerging market firms to include information on the currency composition of both sides of companies' balance sheet.[3]

Estimating the effect of exchange rate flexibility on firms' foreign currency debt choices (and currency mismatches) is problematic due to the possible two-way causality.[4] As noted, authorities' commitment with exchange rate stability may encourage foreign currency borrowing if the central bank is perceived as effectively providing free currency risk insurance to the private sector. In turn, high levels of liability dollarization may make authorities more reluctant to allow the exchange rate to float fearing the balance sheet impacts of real exchange

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[2] As its standard in the literature, I use the term "debt dollarization" to refer to debt denominated in a foreign currency.

[3] The most widely used firm-level dataset in cross-country studies, Worldscope, has no information on the currency denomination of either assets or debt, and very sparse coverage of firm's foreign currency revenues (see, for example, Desai, Foley, and Forbes (2008)).

[4] Berkmen and Cavallo (2010) and Iannariello (2005) examine the two-way causality between exchange rate regimes and dollarization using macro data. Chang and Velasco (2006) and Chamon and Haussmann (2005) model the endogenous determination of liability dollarization and exchange rate policy.

rate movements—giving rise to a spurious negative association between exchange rate flexibility and financial dollarization.[5]

To identify the causal effect of exchange rate regimes, I compare the cross-sectional changes in firms' foreign currency debt holdings after the adoption of floating exchange rate regimes, across companies with differing abilities to generate foreign currency revenues. If floating exchange rate regimes lead to better currency risk management, firms with lower foreign currency buffers (that is, with little foreign currency earnings or assets denominated in foreign currency) should experience larger declines in dollar debt relative to those firms selling mostly to international markets or holding larger amounts of foreign currency assets.

The empirical evidence yields three key results. First, I find strong evidence of a persistent decline in firms' foreign currency borrowing in response to the adoption of a flexible exchange rate regime. The switch to a floating regime is associated with a statistically and economically significant reduction of 7 percent on corporate debt dollarization, on average, compared with pegged regimes. Second, consistent with a causal effect of flexible regimes in reducing currency mismatches, I find that after countries switch to flexible exchange rate regimes, firms with lower natural currency buffers experienced larger declines in dollar debt relative to firms that rely principally on export revenues or have large dollar asset holding. That is, beyond reducing the share of debt denominated in dollars, flexible exchange rate regimes seem to provide incentives for firms to match more strongly the currency composition of liabilities with the currency denomination of assets and cash flows, in a way that effectively reduces the balance-sheet effects of large devaluations.

To explore the robustness of these findings, I verify that these results hold up under a wide variety of conditions and econometric specifications. Within a panel framework, I demonstrate that the results are robust to different methods for classifying exchange rate regimes and measuring exchange rate flexibility, potentially confounding macroeconomic influences, and are not driven by changes to regulations on banks' foreign currency lending. In addition, I also use an event study approach around exchange rate regime changes, and compare cross-sectionally the changes in firms' foreign currency debt holdings for firms with differing levels of foreign currency buffers. Again, I find that after the adoption of flexible exchange rate regimes, firms reduce their unhedged foreign currency exposures by using more systematically their assets in foreign currency to offset their dollar debt risk.

The effects of exchange rate regimes on firms' foreign currency hedging—if present—should be particularly manifest in firms that are significantly exposed to currency risk. To test this hypothesis, I use a censored quantile regression approach to look at the effects of the exchange regime at various points of the cross-sectional distribution of firms' dollar debt ratios. My third finding is flexible exchange rate regimes have a larger impact in reducing currency mismatches

[5] This is the so-called "fear of floating" phenomenon (Calvo and Reinhart (2002)).

in firms in the upper tail of the conditional distribution of dollar debt ratios, i.e., those more exposed to exchange rate risk.[6]

The findings in the paper are consistent with, and complementary to, several strands of literature. First, results in this paper are related to previous studies of the determinants of capital structure financial decisions and risk exposures for companies in emerging markets (Allayannis, Brown, and Klapper (2003), Schmukler and Vesperoni (2006), and Desai, Foley, and Hines (2008), among others). The empirical findings are novel because I examine emerging market firms' financing patterns simultaneously across a number of countries and years with a broad coverage of firms and detailed information of the currency and maturity composition on both sides of their balance sheets. Second, the study contributes new evidence on the impact of exchange rate regimes on the level of unhedged foreign currency debt in the corporate sector and thus on aggregate financial stability (Céspedes, Chang, and Velasco (2004)). My results support the view that fixed or pegged regimes bias corporate borrowing towards foreign currency denominated debt, and is in line with previous country-level evidence for Mexico from Martinez and Werner (2002) and for Chile from Cowan, Hansen, and Herrera (2005).[7] In addition, I provide evidence of a significant change in the way firms match the currency structure of assets and liabilities after the adoption of flexible regimes, such that they reduce their level of unhedged foreign currency borrowing and become less exposed to exchange rate depreciations. Taken together, the preponderance of evidence presented in the paper supports the notion that higher exchange rate flexibility provides stronger incentives for firms to reduce their balance sheet currency exposure and take-on less risky financing structures.[8]

The remainder of the paper is organized as follows. Section II provides a brief overview of the literature. Section III describes the data and provides a first glance at the evolution of firms' foreign currency borrowing and foreign currency exposures around exchange rate regime switches. Section IV discusses the empirical strategy and presents the baseline panel regression results. Section V shows that the baseline results are robust, while Section VI discusses competing or alternative explanations. Section VII uses a quantile regression approach to provide a more nuanced picture of the extent to which the exchange rate regime affects firms' incentives to hedge their exposure to currency risk. The last section concludes.

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[6] Previous studies' focus on the impact at the mean of the conditional distribution may obscure this policy-relevant heterogeneity.

[7] This evidence is also consistent with recent theoretical work by Shi and Xu (2010) demonstrating that exchange rate policy is a key factor in determining firms' currency-financing choices.

[8] This result is also in line with the evidence reported by Tong and Wei (2010) and Sengupta (2010), who find that governments' higher international reserve buffers (to cushion the impact of a sudden stop in capital inflows) is associated with higher risk-taking in the corporate sector.

II. THEORETICAL LITERATURE REVIEW

How does the exchange rate regime affect firms' incentives to hedge their exposure to currency risk? This question has been at the center of the debate over optimal exchange rate regimes in emerging markets since the financial crises of the 1990s exposed the perils of unhedged foreign currency debt. [9] Yet there is no clear consensus among economists on whether the type (or degree of flexibility) of the exchange rate regime affects the corporate sector's incentives to take on foreign currency denominated liabilities or to insure against depreciation risk.

Two basic views exist in this respect. On the one hand, several authors have argued that pegged exchange rate regimes biases corporate borrowing towards foreign currency, due to an implicit exchange rate guarantee given by the government (see, among others, Mishkin (1996) and Goldstein and Turner (2004)). Under fixed or pegged regimes, the central bank keeps currency volatility within a pre-announced range, effectively underwriting currency risk (Dooley (2000)).[10] Thus, firms borrow in dollars to benefit from the lower ex ante dollar interest rates, and expect the government to insure them from any potential loss in the event of a large devaluation.[11] A second variant of this argument suggests that because of limited exchange rate volatility under fixed or tightly managed exchange rate regimes, borrowers appear to consider a steep devaluation a low-probability event, and therefore neglect or underestimate the exchange rate risk associated with borrowing in foreign currency.[12] The fact that fixed/pegged exchange rates have played a role in every recent financial crisis since 1994, and that firms relied extensively on unhedged foreign currency financing in the years leading up to the crisis, is often used as strong evidence for these views.[13]

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[9] The analytical literature on balance sheet effects and output contractions in emerging markets includes, but is not limited to, Aghion, Bacchetta, and Banerjee (2004); Caballero and Krishnamurthy (2003); Calvo, Izquierdo, and Mejía (2004); Céspedes, Chang, and Velasco (2004), Christiano, Gust, and Roldos (2004), Krugman (1999), Magud (2010) and Mendoza (2002). For firms with a large net debt positions in foreign currency, a sharp depreciation decreases firms' net worth and borrowing capacity and increases financial costs, with contractionary effects on investment and output. Caranza, Cayo and Galdon-Sanchez (2003), Harvey and Roper (1999), Galindo, Panizza, and Schiantarelli (2003), Aguiar (2005), Bleakley and Cowan (2008), and Kalemli-Ozcan, Kamil, and Villegas-Sanchez (2010) use firm-level data to estimate the effect of foreign currency indebtedness and currency mismatches on investment during emerging-market crises. For a detailed summary of the empirical literature on balance sheet effects from dollar debt, see Bleakley and Cowan (2008).

[10] An influential early statement of the connection between floating rates and hedging by the private sector is Goldstein (1998)..

[11] Private firms (and banks) may have interpreted relatively stable or fixed exchange rate regimes as a government's promise to protect private borrowers from currency risk. Ex-post, these expectations have usually been proven right, as in the case of preferential exchange rate deals in Chile in the 1980s, or more recently, through the *pesification* in Argentina in 2002. In the words of Corden (2002), unhedged foreign currency denominated borrowing is directly caused by pegged regimes which are "an invitation to gamble at the government's expense."

[12] Along these lines, other authors have stressed that an exchange rate pre-commitment prevents banking regulation from explicitly addressing exchange rate risk or the development of currency derivatives markets to hedge currency risk.

[13] Other authors have modeled the way pegged regimes lead to higher financial dollarization without recourse to moral hazard considerations or myopic behavior. Ize and Levy Yeyati (2003) use a portfolio theory of asset

(continued…)

On the other hand, Eichengreen and Hausmann (1999) and Eichengreen, Hausmann, and Panizza (2005) dispute this view. The authors suggest that at the root of currency mismatches lies the fundamental inability of emerging markets to borrow abroad in their own currency. Inevitably, this leads to an accumulation of foreign-currency denominated debt which firms are simply unable to hedge, even if they have the foresight or prudence to match the currency structure of their assets and liabilities.[14] In addition, McKinnon and Pill (1999) argue that adopting a floating rate regime will actually exacerbate currency mismatches. Because the domestic interest rate risk premium is a direct function of the stability of the currency, exchange rate volatility associated with floating rates will increase domestic interest rates (and thus the incentives to borrow in foreign currency) and make financial hedging more expensive.[15]

III. Data Set and Basic Stylized Facts

This section describes the data used and documents a new set of stylized facts on the evolution of firms' share of foreign currency debt and associated balance sheet currency exposures around exchange rate regime switches.

A. The Firm-Level Dataset

The empirical analysis in this paper draws on a new database with annual accounting information for over 1,800 non-financial companies in six Latin American countries, spanning the period 1992 to 2005.[16] The countries covered are: Argentina, Brazil, Chile, Colombia, Mexico, and Peru. A distinct feature of this dataset is that it contains detailed information on the currency and maturity structure of firms' liabilities and assets, firms' access to foreign currency revenues, and their ability to tap international capital markets. To my knowledge, this is the first

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substitution and show that, when uncovered interest parity holds, financial dollarization is explained by the relative volatilities of inflation (domestic assets) and real exchange rates changes (foreign currency-denominated assets). Since pegs tend to reduce real exchange rate volatility, they also increase dollarization. Jeanne (2005) shows that decreasing monetary credibility can induce firms to dollarize their liabilities, even though this makes them vulnerable to a depreciation of the domestic currency. Pegged or quasi-pegged regimes typically lead to lingering overvaluations and a high peso premium. When the peso premium is large enough, firms would prefer to denominate their loans in dollars (i.e., a dollar loan is "safer" than a peso loan) because the interest rate-induced default risk on peso loans in the event of no devaluation is higher than the currency-induced default risk on dollar loans in the event of a steep devaluation. See Levy Yeyati (2006) and Ize (2010) for comprehensive reviews of the literature.

[14] In more recent work (Eichengreen and Razo-Garcia (2006)), Eichengreen takes a different view and argues that a free float would discourage the policy-induced moral hazard thought to be at play in the 1990s.

[15] In a similar vein, Eichengreen and Hausmann (1999) argue that higher currency volatility would increase the costs of financial hedging of foreign currency risk, and could actually lead to more currency mismatches in firms' balance sheets. Calvo (2001) also suggests that the policy of allowing the exchange rate to undergo large fluctuations to discourage foreign-exchange-denominated borrowing is likely to result in a highly volatile *real* exchange rate, which may have negative effects on trade and output.

[16] Given that currency mismatches are limited by banking regulation, the capital structure of banks and other financial companies is not comparable with that of non-financial firms, and thus were not included in the analysis.

cross-country dataset of emerging market firms to include information on the currency composition of both sides of companies' balance sheet.[17]

The data were assembled from different sources. Financial statement data were drawn from local stock markets or regulatory agencies in each country.[18] Data on foreign currency liabilities and assets were hand-collected from the financial explanatory notes of firms' balance sheets. These include all assets or liabilities outstanding which are denominated in—or indexed to—foreign currency, issued domestically or abroad.[19] Information on firms' export revenues was obtained from income statement data. When this was not available, I used countries' customs office records or Central Bank's Balance of Payments trade registries. Together with information on firms' dollar assets, the export to sales ratio captures the degree to which a company is well-positioned to capitalize on exchange-rate depreciation.[20] This is a substantial improvement over previous studies in the literature that have typically used aggregate variables to proxy for firms' access to foreign currency revenues, i.e., binary tradable/non-tradable classification or sectoral export shares. Finally, I merge the balance sheet information with firm-level issuance data on external bonds, loans and equity from Dealogic to capture firms' access to international capital markets.

All firms in the sample are non-financial, publicly-traded companies, except for the case of Argentina, where roughly half of the firms are not publicly traded. Focusing mostly on publicly listed firms was dictated by data availability, and has the drawback 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 are typically more accurate and comprehensive.

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[17] See Kamil (2007) for a more detailed description. I have been especially careful in making sure that variable definitions are comparable across economies and consistent across time. Further information on the data construction and variable definitions is provided in Appendix A.

[18] As discussed in Kamil (2007), I have been especially careful in making sure that variable definitions are comparable across economies and consistent across time. In particular, while firms in many cases report both consolidated and unconsolidated financial statements, we use un-consolidated figures whenever possible, to reduce variations arising from changes in subsidiaries' ownership and to avoid double counting. Further details on the data construction and variable definitions are provided in Appendix A.

[19] Information on the exact currency composition of foreign-currency denominated debt or assets for all countries is not available. For countries for which I do have a detailed breakdown of currency denomination (Chile and Peru), I find that, on average, 95 percent is denominated in dollars. Thus, I assume throughout that all foreign currency debt is denominated in, or indexed to, the U.S. dollar. In what follows, when I refer to the term dollarization, I specifically mean the degree to which debts or assets are denominated in foreign currency.

[20] A comprehensive measure of the exchange rate sensitivity of net income flows to the exchange rate should also allow for the fraction of intermediate inputs or capital goods imported by the firm, as well as the extent to which sales in domestic markets are denominated or indexed to foreign currency. Unfortunately, data to construct these measures at the firm-level were unavailable.

Moreover, relative to other available databases, such as Worldscope, the coverage of small and medium-sized publicly traded firms is significantly wider.[21]

Most of the variables are expressed as ratios; where this is not the case (firm size), I deflate the nominal magnitudes with 2000 values using December-to-December changes in the consumer price index and convert them to U.S. dollars using December 2000 market exchange rates. To ensure that results are not driven by outliers, I treat the data following common procedures in the literature. I dropped all firm/year observations for explanatory variables that exceeded the sample mean by more than five standard deviations.[22] These exclusions leave us with complete information for an unbalanced panel of 12,223 firm-year observations, which consist of 1470 firms with an average of around 8 years each.

Table 1 shows the number of firm observations per country and year that have non-missing data on foreign-currency debt and export sales. The size of the sample changes as new firms enter and exit the sample. Attrition is mostly due to the fact that some public firms that are privatized, merged, or acquired are subsequently delisted. Few firms drop from the sample because of bankruptcy.

Table 2 and Figure 1 report descriptive statistics for the variables used in the analysis. Inspection of Table 2 reveals significant cross-country variation in the currency denomination of corporate borrowing. The average share of foreign currency debt during this period ranged from 6 percent in the case of Colombia, to close to 60 percent in the cases of Argentina and Peru. Figure 1, in turn, shows the cross-sectional distribution of foreign currency debt ratios within each country for the whole sample. Again, differences across countries are striking. The data for Argentina and Peru are consistent with the fact that debt dollarization has been pervasive in all productive sectors. For several countries in the sample, however, the cross-sectional distribution of dollar debt ratios is highly skewed—clustered around zero and decidedly non-normal. In addition, and as shown in Table 2, a common pattern in firm capital structures across Latin America is the relatively low dollarization of assets (compared to liabilities). Finally, the average share of exports over sales for firms in the sample show less variation across countries.

[21] 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 cross-country studies (see, for example, Allayanis, Brown, and Klapper (2003)).

[22] These controls for outliers arising from inadequate accounting, typing errors, or extreme values associated to mergers and acquisitions, for example.

Table 1. Number of Observations used in Empirical Analysis

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	**Total**
Panel A. Number of Firms by Country															
Argentina		124	143	164	175	194	206	205	205	188	66	65	67	64	**1866**
Brazil		30	57	112	208	233	259	288	274	270	236	219	207	188	**2581**
Chile			204	217	228	227	228	226	223	222	218	211	200	196	**2600**
Colombia			132	168	179	172	127	135	106	123	128	120	115	92	**1597**
Mexico	234	231	208	191	182	174	159	143	119	138	124	116	109	93	**2221**
Peru			116	125	138	144	131	119	115	112	91	96	90	81	**1358**
Total	**234**	**385**	**860**	**977**	**1110**	**1144**	**1110**	**1116**	**1042**	**1053**	**863**	**827**	**788**	**714**	**12,223**
Panel B. Number of Firms by Economic Sector															
Agriculture	6	8	46	46	50	52	47	45	44	43	42	38	36	27	**530**
Mining	5	10	36	42	47	48	44	40	37	41	33	33	32	30	**478**
Manufacturing	146	225	428	463	537	531	507	497	466	470	379	360	344	307	**5660**
Utilities		23	79	98	110	131	136	143	144	142	98	100	95	88	**1387**
Construction	11	24	30	40	43	42	41	44	40	39	32	34	33	29	**482**
Commerce	38	49	77	81	86	94	86	91	81	80	67	59	53	52	**994**
Transport & Comm.	7	19	47	69	87	96	112	111	99	102	75	69	66	64	**1023**
Services	4	7	58	71	74	73	71	77	71	75	82	81	77	69	**890**
Miscellaneous	17	20	59	67	76	77	66	68	60	61	55	53	52	48	**779**
Total	**234**	**385**	**860**	**977**	**1110**	**1144**	**1110**	**1116**	**1042**	**1053**	**863**	**827**	**788**	**714**	**12,223**

Source: Author's calculations based on data described in Appendix 1.

Note: The first panel depicts the number of firms in the sample for each country containing consistent balance sheet and income statement data, and information on the currency composition of debt and sales. The second panel breaks down the firms in the sample by economic sector.

Table 2. Descriptive Statistics for Full Sample

Variable	Argentina	Brazil	Chile	Colombia	Mexico	Peru
Share of foreign currency liabilities	57.6	17.4	22.4	6.9	37.8	62.1
Share of foreign currency assets	4.7	1.4	7.7	1.1	7.5	15.8
Total assets (in millions of dollars)	180	536	78	10	204	40
Share of exports in total sales	9.5	11.7	8.8	6.1	14.3	17.9
Fraction of firms with access to international capital markets	30.1	22.8	13.9	4.5	31.1	7.3

Source: Author's calculations.

Note: The table shows firm-level averages for each country for the variables used in the paper. The detailed information about variable definition is contained in the appendix. All variables expressed in percent, except where noted.

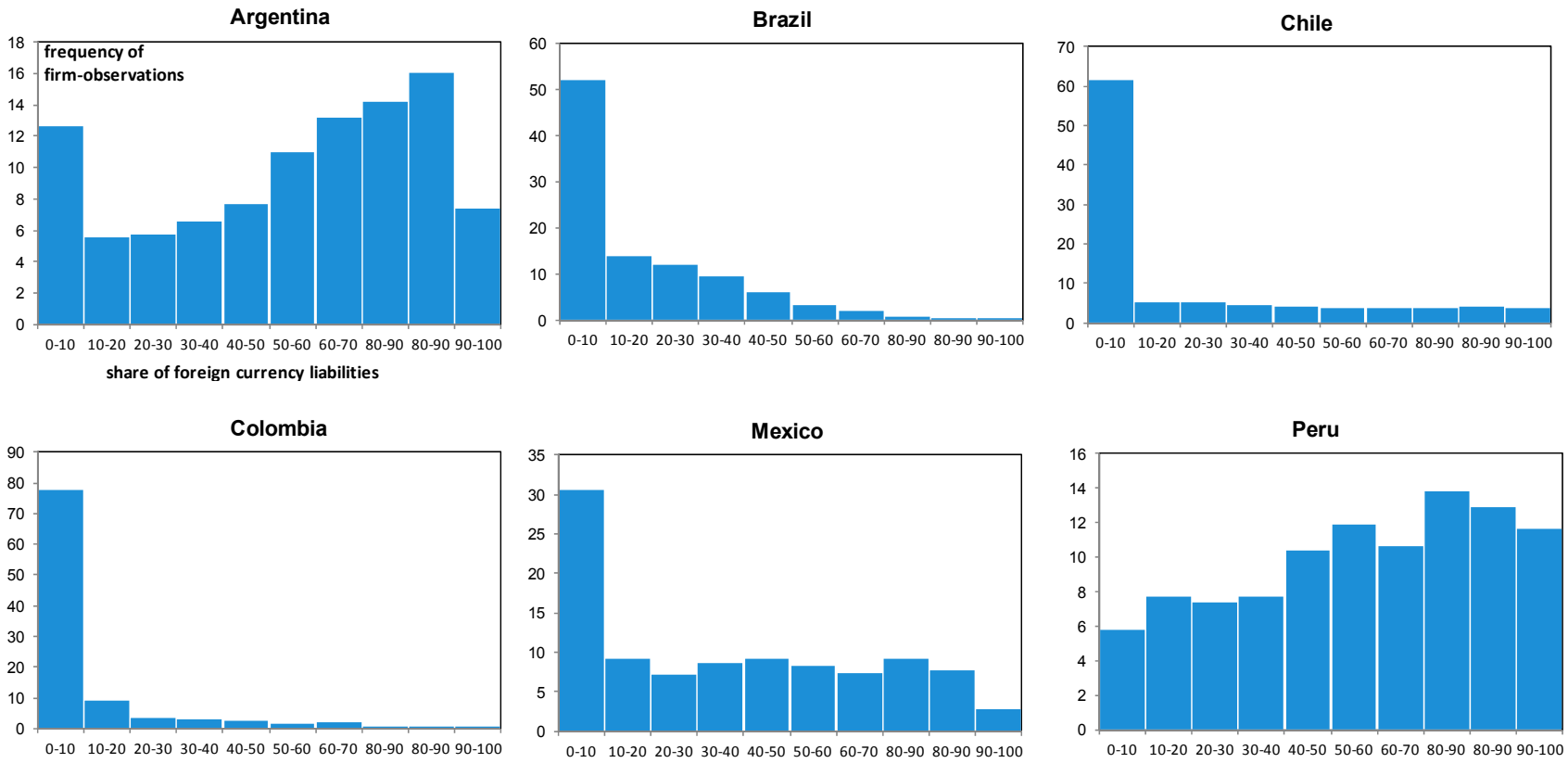
B. Exchange Rate Regimes

To measure the choice of exchange rate regime I rely on the de facto annual classification produced by the International Monetary Fund (IMF). As described by Bubula and Otker-Robe (2002), this classification combines market exchange rates, reserves data, and other quantitative information with the existence of formal or informal commitments to exchange rate paths assessed by IMF staff. Based on this classification, I construct a binary variable that takes the value of 0 for fixed, pegged, or crawling exchange rate regimes, and 1 for independently floating regimes.[23] During the sample period, we observe six regime switches from fixed or pegged to floating regimes: Mexico in 1994, Brazil, Chile, Colombia, and Peru in 1999, and Argentina in 2002.[24]

[23] In their paper, Bubula and Otker-Robe (2002) classify regimes into 13 categories. I code as 0 the following regimes: hard pegs (1-3), adjustable parities (4-6), crawls (7-10), and tightly managed floats (11).

[24] Ideally, one would like to analyze instead what happens with firms' currency mismatches when countries switch from flexible to fixed regimes. Argentina and Brazil adopted pegged regimes in 1991 and 1994, respectively. Firm-level data on the currency composition of debt is not available for Argentina before 1991. In the case of Brazil, I decided not to use data before 1994 given that the preceding years were marked by hyperinflation and severe distortions in accounting information.

Figure 1. Cross-Sectional Distribution of Dollar Debt Ratios Within Countries



Source: Author's calculations.

Note: For each country, the figure plots the histogram of the foreign currency debt ratios for the pooled sample of firm-year observations. The y-axis shows the frequency of firm-year observations for each interval of foreign currency debt share (expressed in percentage in the x-axis).

Because this binary variable may mask the heterogeneity of exchange rate policies across countries and time, I also construct a "Freedom to Float" index as in Calvo and Reinhart (2002). The index measures the variability of the rate of depreciation of the nominal exchange rate, relative to the sum of the variability of net international reserves and the variability of short term interest rates. It quantifies the extent to which the central bank chooses not to intervene to stabilize the exchange rate for a given level of pressure on its currency: a higher number indicates that the exchange rate is relatively more volatile than the policy instruments, thus indicating a more flexible exchange rate policy. Table 3 provides a description of the different exchange rate arrangements for each country during the sample period, and calculates measures of effective exchange rate flexibility as in Calvo and Reinhart (2002).

Table 3. Exchange Rate Regimes and Measures of Exchange Rate Flexibility Within Regimes

Country	Period	De Facto Regime (Coarse Classification, IMF)	Freedom to Float Indicator
Argentina	1994-2001	Currency Board Arrangement	0.00
	2002-2005	Managed Floating	0.28
Brazil 1/	1994-1998	Crawling Peg	0.01
	1999-2005	Independently Floating	0.97
Chile	1994-1998	Crawling Band	0.12
	1999-2005	Independently Floating	0.45
Colombia	1994-1998	Crawling Band	0.18
	1999-2003	Independently Floating	0.14
	2004-2005	Managed Floating	0.24
Mexico 2/	1990-1994	Crawling Band / Crawling Peg	0.00
	1995-2005	Independently Floating	0.08
Peru	1994-1998	Managed Floating	0.02
	1999-2001	Independently Floating	0.05
	2002-2005	Managed Floating	0.07

Source: Author's calculations.

1/ Crawling peg for Brazil starting from July 1994.

2/ Crawling band/crawling peg for Mexico ends in November 1994. Independent floating beginning in December 1994.

Note: This table reports the de-facto exchange rate regime for each country and period based on the classification described in Bubula and Otker-Robe (2002). The Freedom to Float indicator is calculated using Calvo and Reinhart (2002) measure of fear of floating. A higher value denotes more flexibility.

C. A First Glance at the Data

As a first step in assessing the relationship between exchange rate regimes and currency mismatches, Figure 2 plots the average share of firm's dollar liabilities in total liabilities for each country in the sample.[25] In each panel, the vertical line represents the year each country switched to more flexible exchange rate regimes.

Several important trends are visible in the data. Foreign currency debt as a share of total debt of nonfinancial firms rose sharply during the 1990s and then began to fall rapidly, typically when countries introduced flexible exchange rate regimes. This general pattern is observed both in countries with relatively low foreign currency borrowing as in Brazil and Colombia (which actively discouraged financial dollarization), as well as in the highly dollarized countries in the sample, Argentina and Peru. As a result, corporations in Latin America have become significantly less dependent on foreign currency financing: the average share of foreign-currency denominated liabilities in Latin America dropped from 35 percent 1998 to 19 percent in 2005.[26] Excluding the special case of Argentina, Mexico and Peru are the countries where dollarization of corporate liabilities have decreased the fastest, compared with their peak levels during the 1990s.[27]

Figure 3 depicts a more precise measure of currency exposure, defined as dollar debt as a percentage of exports plus dollar assets.[28] Overall, the data suggests that—accompanying the sustained decrease in dollarization levels—firms built up considerable foreign exchange buffers, by matching more strongly their dollar liabilities with export revenues and assets denominated in foreign currency, especially since the on-set of more flexible regimes. As the graphs illustrate, in the cases of Brazil, Chile, and Colombia, the sum of firm-level exports and dollarized assets is, on average, larger than foreign currency liabilities in the most recent period.[29]

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[25] To control for changes in sample composition and missing observations, we regress firm-level dollarization ratios on a complete set of firm and year intercepts. The graphs plot the estimated time dummies from these country-level regressions.

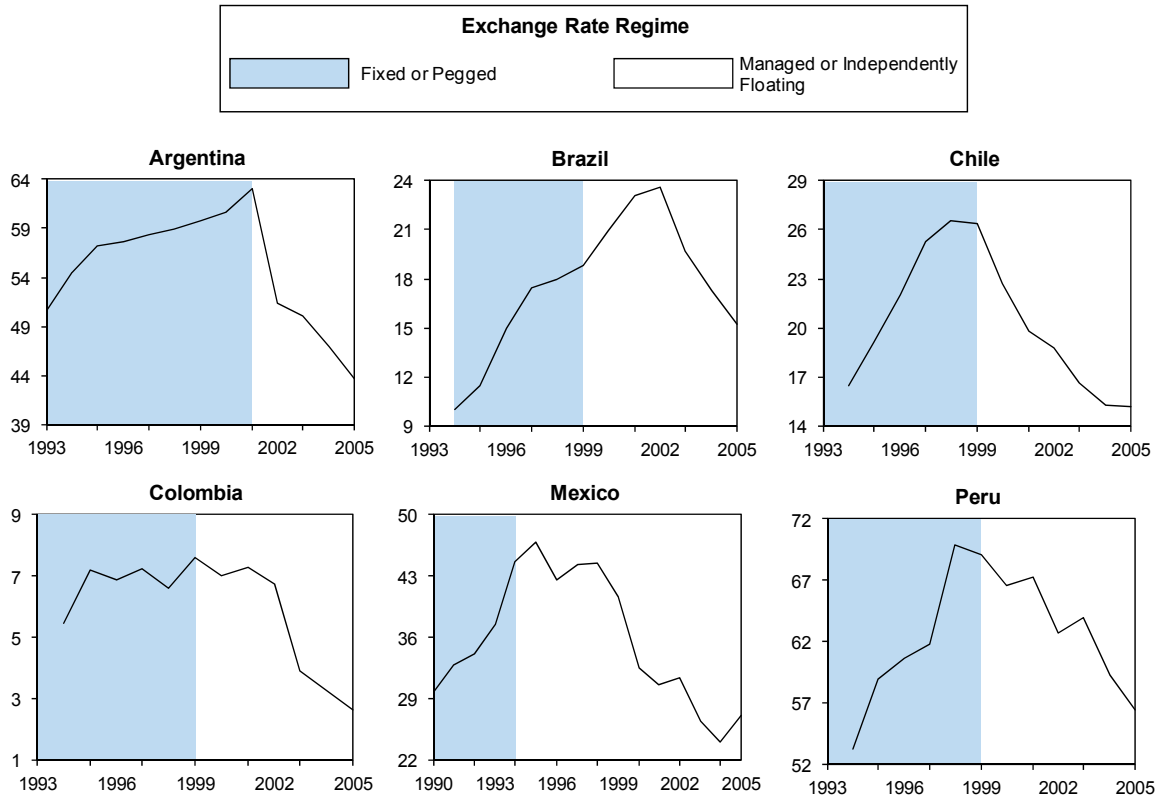
[26] In the case of Argentina, the sharp decrease in average dollarization is mostly explained by the mandatory redenomination of domestic dollar debt contracts to pesos (*pesification*) that occurred in 2002, at the time of the crises (see Calomiris (2007)). I discuss the implications for the estimation results in the next section.

[27] Rennhack and Nozaki (2006) review trends in financial dollarization in Latin America's banking system during the last two decades. A similar reduction in financial dollarization is observed in household deposits in the banking sectors of Argentina, Chile, Mexico, and Peru.

[28] Changes in this ratio are not driven by mechanical valuation effects arising from changes in the nominal exchange rate, which affect dollar debt ratios even in the absence of new net flows of dollar credit. This can be relevant, for example, in the case of Brazil, where the currency crisis of 2002 resulted in a 53 percent depreciation of the *real* vis-a-vis the dollar.

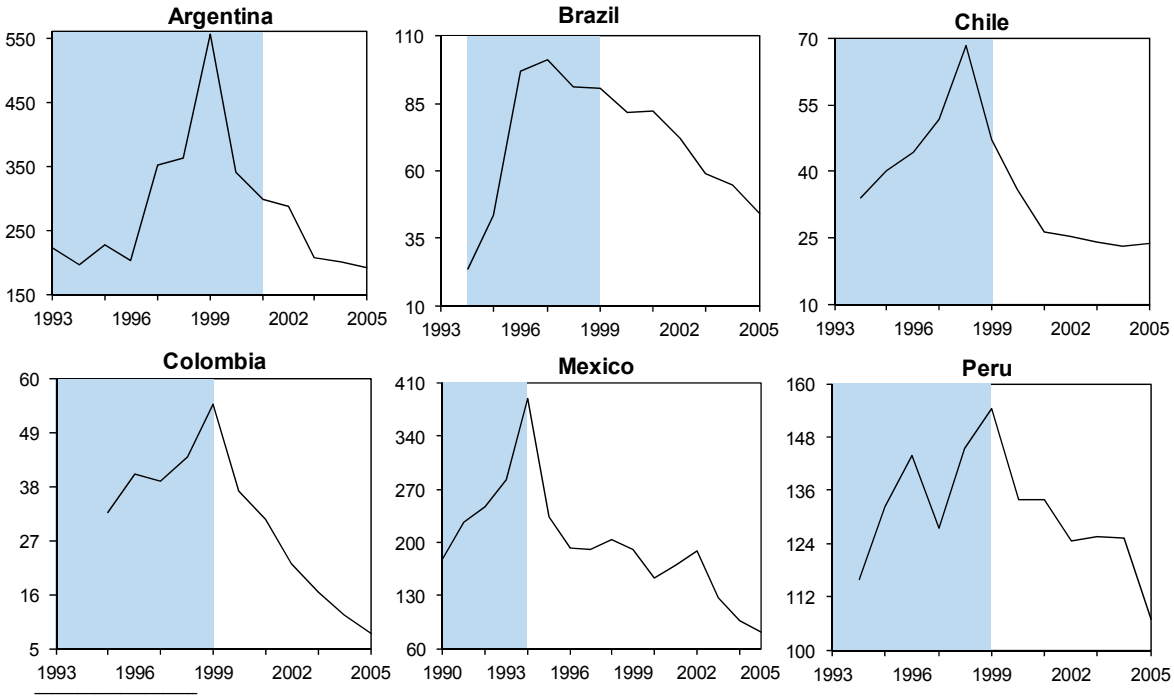
[29] Some countries exhibit trends prior to the regime change (e.g., Peru), but even in those cases there is a pronounced downward movement in the aftermath of the regime change.

Figure 2. Dollarization of Liabilities of the Corporate Sector in Latin America
(average across firms, in percent)



Source: Author's calculations based on data described in Appendix I.
Note: To control for changes in sample composition, we regress firm-level dollarization ratios on a complete set of firm and year fixed effects. The graphs plot the estimated time dummies from these country level regressions.

Figure 3. Dollar Debt as a Share of Natural Currency Hedges
(median across firms, in percent)



Source: Author's calculations based on data described in Appendix I.

While these raw facts are indicative of a significant economic effect of flexible exchange rate regimes on firms' balance sheet currency mismatches, one must be cautious in interpreting this as a causal link, due to the possible presence of omitted factors correlated both with currency exposure at the firm level and exchange rate regime switching. The rest of the paper is devoted to exploiting the panel structure of the dataset, which helps eliminate the potential confounding effects that unmeasured firm characteristics and common shocks across Latin American countries may have.

IV. BASELINE RESULTS

In this section, I describe the empirical strategy and present the baseline results from the panel data regressions.

A. Dollarization Levels in Flexible versus Pegged Regimes

The empirical strategy is based on estimating a pooled cross-section model of the main determinants of firms' foreign currency borrowing in Argentina, Brazil, Chile, Colombia, Mexico, and Peru between 1992 and 2005. I begin the analysis by looking at whether dollar debt ratios were lower after countries switched to more flexible regimes. I estimate the following panel regression.

$$DOLL_{ijct} = \beta_0 + \beta_1\ FLEXDate_{ct} + \beta_2 PostFLEX_{ct} + \beta_3\ EXPtoS_{ijct} + \beta_4\ DOLA_{ijct-1} + \gamma' \mathbf{X}_{ijct-1} + \phi_j + \chi_c + \lambda_t + \varepsilon_{ijct} \quad (1)$$

Equation (1) represents a reduced form equation which models $DOLL_{ijct}$, the share of total liabilities denominated or indexed to a foreign currency (typically the dollar) of firm *i* in sector *j*, in country *c* in year *t*. Thus, $DOLL_{ijct}$ is between 0 and 1. $FLEXDate$ is a binary dummy variable that takes the value of 1 the year a country switches to a flexible regime and 0 otherwise. $PostFLEX$ is a binary variable that also varies across countries and time, and takes on the value of 1 after the year the country switched to floating exchange rates. $EXPtoS$ is the ratio of exports (foreign currency revenues) to sales of each firm in the sample. $DOLA$ is the share of a firm's assets denominated in foreign currency, lagged one period. These two variables measure a firms' ability to generate dollar revenue for repayment of their foreign currency debt obligations. The estimated equation also controls for a vector of other firm-specific, time-varying covariates lagged one period, $\mathbf{X}_{ijt-1}$, as described below.[30] Standard errors are clustered by country and year to take into account the level of aggregation of the exchange rate regime indicator (Bertrand, Duflo, and Mullainathan (2004)).

The specification includes an extensive set of fixed effects. First, I allow for time fixed effects, λ_t, to account for regional changes that affect all countries and firms equally (for example, world business cycles or other events, such as the Asian and Russian crises that have

[30]Stock variables are lagged one year to minimize any possible reverse causality.

affected world financial markets). The high degree of commonality observed in the time series behavior of dollarization levels across countries described in the previous section suggests that global or regional factors may be partially driving the behavior of dollarization. Further, I also control for time-invariant country-specific factors (χ_c) which may drive cross-country differences in foreign currency borrowing—such as restrictions on dollar intermediation in the domestic banking systems in Brazil and Colombia.[31] In addition, I group firms into eight categories based on their primary industry classification, and include industry dummies, ϕ_j , in the empirical model. Industry fixed effects control for systematic differences across economic sectors that might determine dollarization levels—like competition structure, openness, or liquidity needs.

Finally, I also include a set of additional variables that have been shown in the literature to be important determinants of debt dollarization.[32] To capture firm size, I sort firms in each country and year into thirds based on total assets. Separate dummies are used for large-sized (top-third) and medium-sized (middle-third) firms (small-sized firms being the excluded category). [33] To account for firms' ability to raise funds in international capital markets, I construct two binary dummy variables: one that takes the value of 1 starting in the year a firm issues bonds or syndicated loans in international markets (and 0 otherwise), and a second one that takes the value of 1 starting in the year a firm issues equity abroad in the form of ADRs (and 0 otherwise).

Overall, this specification captures most of the factors that are likely to affect a firm's share of debt denominated in foreign currency and greatly attenuate problems of omitted variable bias. In particular, this differences-in-differences approach allows estimating the effect of the exchange rate regime while holding constant fixed characteristics of a country that affect dollarization and might also be correlated with the timing of flexible regimes introduction.

Table 4 presents the main results.[34] Given that observations for the dependent variable are censored by 0 and 1, I use Tobit regressions to estimate the model. I find that the introduction of more flexible exchange rate regimes leads to a sharp decline in firm-level liability dollarization. Column (1) shows that the switch to a flex regime is associated with a statistically significant decrease of 7 percent on the share of debt denominated in foreign

[31] In Brazil and Colombia, on-shore financial dollarization is severely restricted: foreign currency deposits are banned and, in the case of Brazil, private banks cannot lend in dollars. In Brazil, firms that want to borrow in foreign currency domestically can only do so through the state development bank under stringent conditions. As a result, most of Brazilian companies' foreign currency borrowing is obtained abroad (whether bond issuances, bank loans, or suppliers' credit).

[32] A number of recent papers model the firms' choice of currency denomination of borrowing (see Allayannis, Brown, and Klapper (2003), Gelos (2003) and Rossi (2009)).

[33]Thus, we do not restrict a given firm to maintain the same status during the whole sample. I obtain very similar results (not reported) when size is defined as the logarithm of total assets.

[34] To conserve space, I do not tabulate the coefficients on the industry and year dummies.

Table 4. The Effects of Exchange Rate Regimes on Firm-Level Dollarization

	(1)	(2)	(3)	(4)
Exchange Rate Regime				
Pre2FLEX		0.02 **	0.02 **	0.04 ***
		(0.01)	(0.01)	(0.01)
Pre1FLEX		0.04 ***	0.03 ***	0.06 ***
		(0.01)	(0.01)	(0.01)
PostFLEX	-0.07 ***	-0.05 ***		
	(0.01)	(0.01)		
Post1FLEX			-0.01	0.02
			(0.01)	(0.01)
Post2FLEX			-0.03 **	0.01
			(0.01)	(0.01)
AFTER			-0.08 ***	-0.05 ***
			(0.01)	(0.01)
Firm-Level Controls				
Exports to Sales ratio	0.31 ***	0.31 ***	0.31 ***	0.30 ***
	(0.03)	(0.03)	(0.03)	(0.03)
Dollar Assets ratio	0.55 ***	0.55 ***	0.55 ***	0.59 ***
	(0.05)	(0.05)	(0.05)	(0.06)
Medium Size dummy	0.13 ***	0.13 ***	0.13 ***	0.13 ***
	(0.02)	(0.02)	(0.02)	(0.02)
Big Size Dummy	0.17 ***	0.17 ***	0.17 ***	0.18 ***
	(0.02)	(0.02)	(0.02)	(0.02)
Access to Intl. Bond and Loan Markets	0.14 ***	0.13 ***	0.14 ***	0.12 ***
	(0.02)	(0.02)	(0.02)	(0.02)
Access to Intl. Equity Markets	0.06 ***	0.06 ***	0.06 ***	0.06 ***
	(0.02)	(0.02)	(0.02)	(0.02)
Country-Level Control				
Dummy for Year of Regime Switch (FLEXDate)	0.00	0.01	0.01	0.04 ***
	(0.01)	(0.01)	(0.01)	(0.01)
Fixed Effects				
Country	Yes	Yes	Yes	Yes
Sector	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
	Diagnostics			
Number of Observations	9378	9378	9378	7726
Pseudo R2	0.62	0.63	0.63	0.61
Non-Corner Observations (in %)	76.7	76.7	76.7	72.8

Source: Author's calculations.

Note: 'This table reports the pooled Tobit estimates of equations (1), (2) and (3) in the text, for the period 1992-2005. Coefficient estimates denote marginal effects on dependent variable, evaluated at mean values of independent variables. For dummy variables, they represent the effect of discrete changes from 0 to 1. A constant is also included but not reported. Standard errors adjusted for clustering by country-year are reported in parentheses. Asterisks denote significance of coefficients, with ***, ** and * indicating significance at the 1%, 5% and 10% level, respectively.

currency, on average, compared with pegged regimes. The results confirm the negative relationship illustrated in Figure 2 in section III.C.

Estimates of the other covariates in the regression appear generally reasonable and consistent with past research. First, the results suggest that, on average during the 1992 to 2005 period, firms whose income and assets were positively correlated with the exchange rate had a higher fraction of foreign currency-denominated liabilities, given everything else constant (and are positive and statistically significant). This result confirms the findings in Bleakley and Cowan (2008), who studied firm's investment response to exchange rate changes using a sample of 450 companies in five Latin American countries between 1991 and 1999. The authors found that the fraction of debt denominated in foreign currency was highest among firms whose earnings would typically increase in the event of a depreciation.[35] These results are also consistent with Brown, Ongena, and Yesin (2011), who study the currency denomination of individual bank loans in a large cross section of firms in 26 transition countries in 2005. The authors find that firms with foreign currency income and assets are more likely to borrow in a foreign currency.

Second, the results of the model also point to the theoretically sensible finding that bigger firms and firms with access to international capital markets hold more foreign currency debt as a fraction of their liabilities. These coefficients have the predicted signs and are statistically significant at standard confidence levels. The relation between firm size and the use of dollar debt is monotonic, increasing from smaller to medium and to larger firms, consistent with evidence for East Asian firms by Allayannis, Brown, and Klapper (2003). Overall, the model explains 63 percent of the variance in the dispersion of foreign currency borrowing ratios across countries and years.[36]

As with any identification strategy using variation in macroeconomic policies across countries, one must be concerned with the exogeneity of the shift in exchange rate regimes. The empirical analysis thus far rests on the assumption that the cross-country timing of regime changes was not affected by the average level of financial dollarization in the corporate sector. Yet it could be the case that declining corporate debt dollarization in a country over time reduces the financial stability concerns of a steep devaluation, making authorities more inclined to let the exchange rate float. Conversely, authorities' commitment to exchange rate stability may create perverse incentives to increase liability dollarization by artificially lowering the cost of borrowing in foreign currency. This could reinforce authorities' tendency

[35] There are three main differences between the analysis in this paper and that performed by Bleakley and Cowan. First, I use a more comprehensive dataset, covering a broader sample of firms and including companies from Peru, which is a highly dollarized country. Second, my period extends to 2005 and thus I am able to see how firms' debt currency choices varied when flexible exchange rate regimes were adopted in the late 1990s. Finally, Bleakley and Cowan use a sectoral variable to proxy for firms' access to foreign currency earnings (a binary dummy with a tradable/non-tradable classification). In this paper, I use a direct, firm-level measure of the sensitivity of income and assets to the exchange rate.

[36] Although not reported, country dummies are individually significant at conventional confidence intervals in all specifications, with firms in Argentina, Uruguay, and Peru holding the highest levels of dollar debt, and firms in Colombia and Brazil holding the lowest levels of dollar debt.

to stabilize the exchange rate because they fear the contractionary effects of currency depreciations (Hausmann, Panizza, and Stein (2001)).

To check whether results above are driven by reverse causality, I augment the specification in (1) by including two binary dummies that take the value of 1, one year and two years before a country adopts a flexible regime, respectively—and 0 otherwise. I thus estimate the following specification:

$$DOLL_{ijct} = \alpha_0 + \alpha_1 \Pr e2FLEX_{ct} + \alpha_2 \Pr e1FLEX_{ct} + \alpha_3 FLEXDate_{ct} + \alpha_4 PostFLEX_{ct} + \\ + \boldsymbol{\beta}' \mathbf{Y}_{ijct-1} + \varepsilon_{ijct} \quad (2)$$

where $\Pr e1FLEX$ and $\Pr e2FLEX$ take the value of 1 respectively in the first and second year before country *c* switched to a flexible regime, and 0 otherwise; $FLEXDate$ takes the value of 1 in the year in which country *c* liberalized the exchange rate regime and 0 in every other year. Finally, $PostFLEX$ takes on the value of 1 after the year the country switched to a floating exchange rate and 0 otherwise. The estimating equation also controls for the same set of country, sector, year, and firm-specific effects, $\mathbf{Y}_{ijt-1}$, as described above.

If changes in the exchange rate regime are driven by pre-existing declines in dollarization, then this "early" regime change dummies would be negative and significant, and/or would attenuate the observed negative average effect of the exchange rate regime change on the share of foreign currency debt documented above.[37] Column 2 in Table 4, however, shows a significant increase in dollarization in the years immediately preceding the regime change, and still a significant decrease in the years after countries switch to floating.[38] Thus, the results show that dollarization declined after floating regimes were introduced, but not before.

Finally, I estimate a specification similar as (2), but allowing for dynamic effects in the post-floating period:

$$DOLL_{ijct} = \alpha_0 + \alpha_1 \Pr e2FLEX_{ct} + \alpha_2 \Pr e1FLEX_{ct} + \alpha_3 FLEXDate_{ct} + \alpha_4 Post1FLEX_{ct} + \\ + \alpha_5 Post2FLEX_{ct} + \alpha_6 After_{ct} + \boldsymbol{\beta}' \mathbf{Y}_{ijct-1} + \varepsilon_{ijct} \quad (3)$$

where $Post1LEX$, and $Post2FLEX$ take the value of 1 respectively in the first and second year after the regime change and 0 otherwise; and $After_{ct}$ takes the value of 1 beginning the third year after the flexible regime was adopted. $\mathbf{Y}_{ijct-1}$ captures all firm-level controls and fixed effects described in (1). Results in Column 3 do not suggest a shift in the currency

[37] On the other hand, the results may understate the full negative impact of regime changes on dollar debt levels, because firms may anticipate the move away from the pegged regime, and adjust their balance sheet structures prior to the devaluation of the domestic currency.

[38] A test that the post-float dummies are equal to the pre-float dummies rejects the null at standard significance levels.

composition of firms' liabilities immediately following the regime change; rather, it appears that the significant negative effect of flexible regimes on dollar debt begins to take place in the second and third year after liberalization. I next investigate whether the results are robust to excluding Argentinean firms from the sample, as the forced de-dollarization of domestic financial contracts in Argentina after the crisis may be distorting estimations. Column 4 confirms that the central results remain unaffected: a switch to a flexible regime is associated with lower corporate debt dollarization.

Overall, I find that the adoption of floating regimes led to a statistically and economically significant decline in firms' foreign currency borrowing. These findings are not explained by pre-existing trends in dollarization or the mandatory pesification of domestic financial contracts in Argentina after 2001. The more significant effect of flexible regimes on dollar debt begins to take place in the third year after the regime change.

B. Currency Matching in Flexible versus Pegged Regimes

The stock of foreign currency debt may not be a good indicator of the potential for exchange-rate induced financial distress of a firm. A firm may have natural hedges in the form of foreign currency cash flows or assets that buffer the dollar risk arising from its debt portfolio. Thus, what should matter for financial vulnerability is not the level of dollarization per se, but the way firms match the exchange rate exposures on both sides of their balance sheet.

Therefore, in what follows I test whether the sensitivity of dollar debt holdings to the availability of foreign currency revenues and/or dollar assets increased (or decreased) under floating exchange rate regimes. For these purposes, I use a generalized difference-in-difference-in-difference (DDD) approach, interacting a country-level measure of exchange rate flexibility with firm-level measures of export orientation and dollarization of assets, and estimate the following specification:

$$\begin{aligned} DOLL_{ijct} = {} & \beta_0 + \beta_1\, FLEXDate_{ct} + \beta_2 PostFLEX_{ct} + \beta_3\, EXPtoS_{ijct} + \beta_4\, DOLA_{ijct-1} + \\ & \beta_5\, [EXPtoS_{ijct} * PostFLEX_{ct}] + \beta_6\, [DOLA_{ijct-1} * PostFLEX_{ct}] + \\ & \gamma' \mathbf{X}_{ijct-1} + \phi_j + \chi_c + \lambda_t + \varepsilon_{ijct} \end{aligned} \tag{4}$$

The main variables of interest are the interaction terms associated with parameters β_5 and β_6. The estimated values measure how much (or less) tighter is the match between the currency denomination of income streams and assets with the currency composition of liabilities under floating regimes. If, following the introduction of flexible regimes, firms' dollar debt holdings become more sensitive to the availability of foreign currency revenues and/or dollar assets (compared to countries that keep their exchange rate pegged during the same period), then

β_5 and/or β_6 should be positive.[39] This would provide evidence that firms reduce currency mismatches in their balance sheets, thus insulating themselves more strongly from financial risks arising from exchange rate fluctuations.[40]

The effects of the exchange rate regime are identified from the variation in dollar debt ratios across firms with different reliance on foreign currency earnings or assets *within* a given industry and country.[41] Thus, the estimation would suffer from reverse causality only if the relative foreign currency debt ratios of firms with high foreign currency income compared to those that mostly rely on domestic-market revenues had a causal effect on the probability that a country switched to a flexible regime. This seems very unlikely to be the case.

Table 5 reports estimates of various specifications of equation (4). Column 1 shows results for the case of export revenues as the only proxy for natural currency buffers. The interaction term on exports to sales is positive and statistically significant. That is, under flexible exchange rate regimes, there is evidence that firms significantly reduce the impact of exchange rate movements on the company's net cash flows and corporate value by using more systematically their operating income in foreign currency to offset their dollar debt exposure. Put differently, following the adoption of floating regimes, firms with lower real hedges (foreign currency revenues) experienced larger declines in dollar debt relative to firms selling mostly to international markets. In terms of economic magnitude, the point estimates in Column 1 imply that under floating exchange rate regimes, the foreign currency debt ratio of firms that sell primarily to the domestic market (in the bottom 5th percentile by exports to sales ratio) dropped 5 percentage points relative to the highly export-oriented firms in the 95th percentile of the distribution—compared to the same relative change across firms under pegged regimes.[42]

Column 2 shows the results for the full specification in equation (3), which includes foreign assets as another potential source of foreign currency cash flows. The results show that under floating regimes, firms have tended to limit the impact of exchange rate movements on the company's financial position by correlating more strongly the currency denomination of liabilities and assets. Evaluated at the sample means of the data, the point estimate in Column 2 indicates that firms on average increase the degree of currency matching between the stock of foreign currency assets and liabilities by more than 30 percent, compared with

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[39] Conceptually, β_5 , for example, reports the difference between the change in dollar debt ratios of firms with high export revenues vis-à-vis those with low export income in a country with exchange rate flexibility, and compares that to the same difference for a country with pegged regimes.

[40] Exporters with foreign currency debt are naturally hedged against exchange rate fluctuations to the extent that both their earnings and their liabilities are denominated in foreign currency. However, it should be noted that even loans to borrowers with foreign currency income may not be serviced during a crisis if their foreign income declines, for example, due to a drop in exports if foreign demand were to drop sharply.

[41] In this approach, the control group in each year includes the countries in the sample that had not yet liberalized their exchange rate regimes during the sample period.

[42] -.052=0.08*(0.0)-0.08*0.65.

Table 5. The Effects of Exchange Rate Regimes on Balance Sheet Currency Mismatches

	Dummy Indicator		Continous Indicator	
	(1)	(2)	(3)	(4)
Main Effects				
Flexible Regime Indicator	-0.03	-0.04 ***	-0.01	-0.02 **
	(0.02)	(0.02)	(0.01)	(0.01)
Exports to Sales ratio	0.31 ***	0.31 ***	0.35 ***	0.29 ***
	(0.03)	(0.03)	(0.03)	(0.03)
Share of Dollar Assets		0.47 ***		0.49 ***
		(0.06)		(0.06)
Interaction Effects				
Exports to Sales x Flex Indicator	**0.08 ** **	**0.00**	**0.06 ***	**0.04**
	(0.03)	**(0.03)**	**(0.03)**	**(0.03)**
Share of Dollar Assets x Flex Indicator		**0.15 ** **		**0.11 ** **
		(0.06)		**(0.05)**
Firm-Level Controls				
Medium Size dummy	0.11 ***	0.13 ***	0.12 ***	0.13 ***
	(0.02)	(0.02)	(0.02)	(0.02)
Big Size Dummy	0.17 ***	0.17 ***	0.18 ***	0.17 ***
	(0.02)	(0.02)	(0.02)	(0.02)
Access to International Bond and Loan Markets	0.17 ***	0.14 ***	0.14 ***	0.14 ***
	(0.02)	(0.02)	(0.02)	(0.02)
Access to International Equity Markets	0.10 *	0.06 ***	0.07 ***	0.06 ***
	(0.06)	(0.02)	(0.02)	(0.02)
Country-Level Control				
Dummy for Year of Regime Switch	0.00	0.00	0.02 *	0.02
	(0.03)	(0.02)	(0.01)	(0.01)
Fixed Effects				
Country	Yes	Yes	Yes	Yes
Sector	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
	Diagnostics			
Number of Observations	10823	9378	10823	9378
McFadden's Adjusted R2	0.61	0.63	0.62	0.62
Non-Corner Observations (in %)	77	77	76.5	76.5

Source: Author's calculations.

Note: This table reports the pooled Tobit estimates of augmented versions of equation (4) in the text, for the period 1992-2005. Coefficient estimates denote marginal effects on dependent variable, evaluated at mean values of independent variables. For dummy variables, they represent the effect of discrete changes from 0 to 1. Variables based on balance sheet stock values are measured at the beginning of the period. A constant is also included but not reported. Standard errors adjusted for clustering by firm are reported in parentheses. Asterisks denote significance of coefficients, with ***, ** and * indicating significance at the 1%, 5% and 10% level, respectively.

pegged regimes. When taken together, these results also indicate that the increase in currency matching is observed both in stocks and in flows.

I next investigate whether the previous results hold when using a continuous measure of exchange rate flexibility. I estimate the following specification:

$$DOLL_{ijct} = \beta_0 + \beta_1\ FLEXDate_{ct} + \beta_2 FtoF_{ct} + \beta_3\ EXPtoS_{ijct} + \beta_4\ DOLA_{ijct-1} + \beta_5\ [EXPtoS_{ijct} * FtoF_{ct}] + \beta_6\ [DOLA_{ijct-1} * FtoF_{ct}] + \gamma' \mathbf{X}_{ijct-1} + \phi_j + \chi_c + \lambda_t + \varepsilon_{ijct} \quad (5)$$

where *FtoF* is the Freedom to Float index, with higher values denoting more exchange rate flexibility $FLEXDate$ takes the value of 1 in the year in which country *c* liberalized the exchange rate regime and 0 in every other year. Again, the results show that the degree of *currency matching* in firms' balance sheets is—economically and statistically—higher during periods of higher exchange rate volatility.

In macroeconomic terms, the results suggest that flexible regimes lead to a reallocation of dollar liabilities towards firms with better natural currency hedges.[43] One can use the estimates of Column 4 in Table 5 to quantify the effect of exchange rate flexibility in redistributing dollar debt across firms with differing abilities to bear exchange rate risk. On the basis of the estimated coefficients, I compute the difference in dollarization levels between firms with high dollar asset holdings (95th percentile of the distribution in the sample) and firms with low dollarization of assets (5th percentile) in a country with the highest average index of flexibility compared to the country with the lowest index, as follows:

$$\hat{\beta}_6\ [\ (DOLA_{95th} - DOLA_{5th})(FtoF_{95th} - FtoF_{5th})\ ] \quad (6)$$

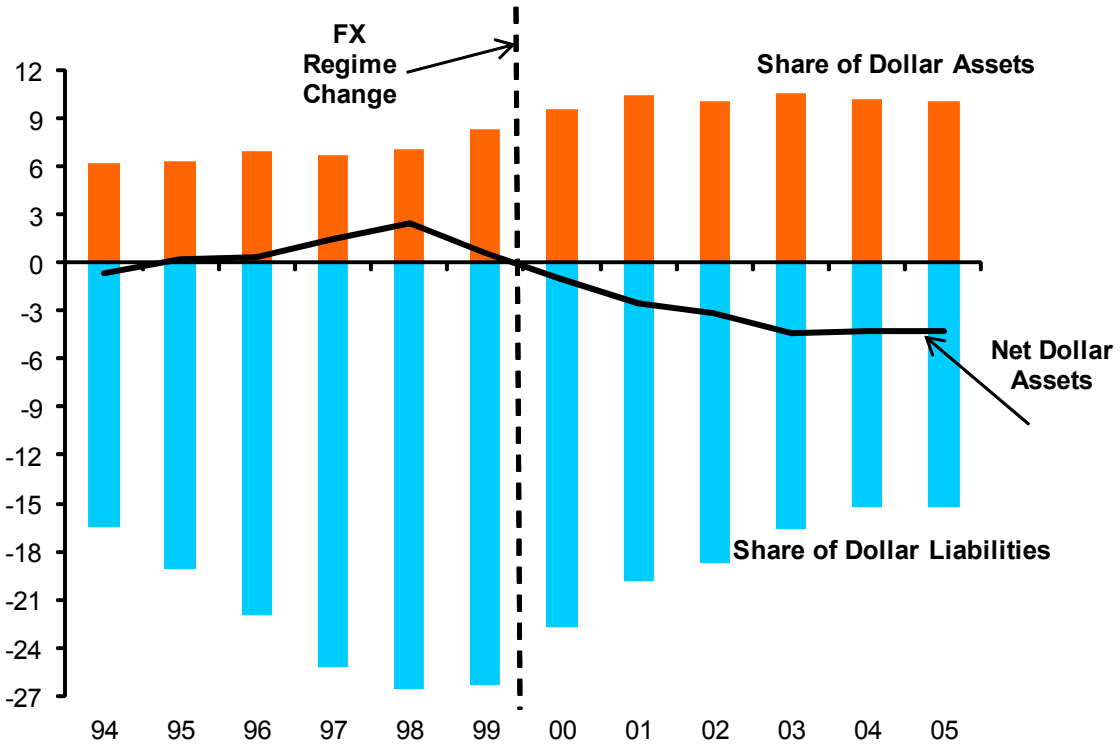
The coefficient estimate on the interaction term for the asset dollarization ratio in column 4 suggests that the difference in debt dollarization levels between firms with very high and very low dollarization of assets in Chile (the country that attains the maximum level of exchange rate flexibility in the sample) is 14 percent higher than the difference in average dollar debt shares between the same type of firms in Argentina (in the bottom 5th percentile in terms of flexibility over the whole sample). As a comparison, the difference across countries in the average dollarization among firms in these two extremes of the distribution is approximately 28.6 percent. This suggests that the effect of currency regime flexibility accounts for approximately 50 percent of the mean difference.

[43] Although the evidence suggests a strong relationship between exchange rate regimes and corporate exchange rate exposures, other dimensions of a firm's exchange rate risk-management practices still require further scrutiny. In particular, a complete analysis of the financial vulnerability to exchange rate fluctuations at the corporate level will require information on firms' incentives to use currency derivatives.

The evolution of Chilean firms' foreign exchange exposure over the sample period—presented in Figure 4—clearly illustrates this general result. Before 1999, Chile had an exchange rate band and an explicit commitment to exchange rate stability. Since 1999, the exchange rate was allowed to float freely. As shown in the figure, in the years following the switch to a flexible regime firms significantly reduced the negative exposure to a local currency depreciation by reducing their reliance on foreign currency borrowing, and by ramping up the accumulation of dollar assets. For the average firm in the sample, the net dollar asset position (as a percentage of total assets) jumped from -2.4 percent in 1998 (in the eve of the exchange rate regime change) to 4.2 percent in 2005.[44]

Figure 4. Chile: Strong Accumulation of Net Dollar Assets since Onset of Flexible Regime in 1999

(Annual averages across firms, except where noted) 1/



Source: Author's calculations.

1/ Net dollar assets are defined as the difference between dollar assets and dollar liabilities, as a fraction of total assets (median across firms).

[44] Cowan, Micco and Yáñez (2007) obtain similar results for Chile using a broader data set of both listed and non-listed companies.

V. ROBUSTNESS TESTS

In this section, I perform several robustness tests on the main results to address concerns with potential empirical biases in our estimations. I also consider competing explanations for the negative relation between the flexibility of exchange rate regimes and currency mismatches in firms' balance sheets. Results are presented in Table 6.

A. Firms with No Foreign Currency Debt

One concern with the baseline specification is that an important fraction of the firms had zero dollar debt in every year, suggesting that the dynamics governing their financial decisions could be very different from the rest of the firms in the sample. To allay concerns about sample selectivity, we excluded firms that showed zero dollar indebtedness throughout the sample.[45] As shown in the first two columns of Table 6, dropping these firms had minor qualitative impacts on the basic result of firms' lower foreign currency exposure under floating regimes.

B. Sample Selection Bias

Another concern is that non-random exit may be biasing the results. For example, it may be the case that those firms that went bankrupt or were merged or acquired (and subsequently delisted) after regime switches were those with higher currency exposure and thus a higher level of financial vulnerability. In this case, we would tend to observe a reduction in the average foreign currency exposure post-floating due to changes in the composition of the sample. To diminish concerns about survivorship bias, I re-estimate the model by including only those firms in the sample that had at least two year-observations in both fixed (and/or pegged) and flexible regimes. Results in columns 3 and 4 in Table 6 confirm the central finding in the paper that exchange rate regimes affect firm's incentives to hold foreign currency denominated debt and manage currency risk.

C. Importance of Interest Rate Differentials and Exchange Rate Appreciation

A firms' decision to borrow in foreign currency may be positively related to slow moving country-level determinants, such as interest rate differentials or the strengthening of the domestic currency in real terms.[46] Therefore, I allow country fixed effects to vary by year, to control for all time-varying, country-specific observed and unobserved factors that might affect the dollarization of firms' liabilities. This specification reduces concerns that the

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[45] This sample selection criteria also ensures that I can treat the lack of matching as a firms' choice variable rather than an absence of exposure to exchange rate risk.

[46] For example, a failure of uncovered interest parity (leading to lower ex-ante dollar financing expressed in the same currency) would tilt corporate borrowing towards foreign currency (Calvo (2001)). Allayannis, Brown, and Klapper (2003) find that interest differentials play a significant role in foreign currency debt issuance by East Asian corporations. In addition, the real exchange appreciation that typically occurred during the crawling peg regimes reduced the real burden of the outstanding foreign currency debt, providing firms with additional incentives to take on foreign currency debt (Roubini and Setser (2004)).

positive interaction term might be picking up time-varying country effects that are due to factors other than the regime change, like changes in the interest advantage on foreign currency funds or the appreciation of the domestic currency. As shown in columns 5 and 6 of Table 6, the central result is not sensitive to this specification: under floating regimes, firms match more systematically the currency denomination of their liabilities with the exchange-rate sensitivity of their assets and revenues, suggesting that flexible exchange rate regimes may have encouraged firms to insulate themselves more from balance sheet risks arising from exchange rate fluctuations. If anything, this specification suggests that the increase in balance sheet currency matching was almost 50 percent compared with pegged regimes for these subset of firms.

Table 6. The Effects of Exchange Rate Regimes on Currency Mismatches: Robustness Tests

	Firms with Dollar Debt		Balanced Panel		Country-Year fixed effects	
	(1)	(2)	(3)	(4)	(5)	(6)
Main Effects						
PostFLEX	-0.01	-0.06 ***	-0.03	-0.09 ***	-0.03	-0.06 ***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)
Exports to Sales ratio	0.27 ***	0.25 ***	0.30 ***	0.30 ***	0.34 ***	0.31 ***
	(0.03)	(0.03)	(0.04)	(0.04)	(0.03)	(0.03)
Share of Dollar Assets		0.38 ***		0.43 ***		0.45 ***
		(0.06)		(0.07)		(0.06)
Differential Effects						
Exports to Sales x PostFLEX	**0.10** ***	**0.02**	**0.06** *	**0.00**	**0.07** **	**-0.01**
	(0.03)	**(0.03)**	**(0.03)**	**(0.03)**	**(0.03)**	**(0.03)**
Share of Dollar Assets x PostFLEX		**0.18** ***		**0.15** **		**0.21** **
		(0.06)		**(0.06)**		**(0.06)**
Fixed Effects						
Country	Yes	Yes	Yes	Yes	Yes	Yes
Sector	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Country x Year					Yes	Yes
		Diagnostics				
Number of Observations	9423	8071	6438	6149	10825	9377
McFadden's Adjusted R2	0.64	0.65	0.62	0.62	0.63	0.64
Non-Corner Observations (in %)	76.5	77	75.2	76	76.5	75.5

Source: Author's calculations.

Note: This table reports the pooled Tobit estimates of augmented versions of equation (4) in the text, for the period 1992-2005. Coefficient estimates denote marginal effects on dependent variable, evaluated at mean values of independent variables. For dummy variables, they represent the effect of discrete changes from 0 to 1. The key independent variable is the interaction term, and the marginal effect is calculated as in Appendix 1. Variables based on balance sheet stock values are measured at the beginning of the period. A constant, a dummy for the year of the regime switch and firm-level controls are included but not reported. Standard errors adjusted for clustering at the country-year are reported in parentheses. Asterisks denote significance of coefficients, with ***, ** and * indicating significance at the 1%, 5% and 10% level, respectively. For detailed sources and descriptions, see Section 2.

D. Additional Statistical Checks

While not reported to conserve space, I performed a battery of additional robustness checks. I confirmed that my findings are not driven by individual countries by sequentially excluding one country at a time from the sample and re-estimating the same specification. In each case, I was unable to reject the null hypothesis that the estimated coefficient on the interaction terms equaled the value estimated for the full sample at the 5 percent level. Although statistical significance varies somewhat across specifications, the magnitude of the estimated effects and their economic significance remain fairly stable.

The results are also robust to alternative sample selection rules. I considered: (1) excluding firms with negative net worth or in financial distress, (2) excluding country-years during regime transitions, and (3) winsorizing all variables in both tails at the 1 percent level to control for outliers. Dropping these firms did little to alter the main result in the paper: under floating regimes, firms have tended to limit the impact of exchange rate movements on the company's financial position by correlating more strongly the currency denomination of assets and liabilities. That is, those firms relying more heavily on dollarized debt are also those firms that see the largest offsetting increases in current earnings and future investment opportunities following a depreciation of the domestic currency.

VI. Alternative Explanations

A. Changes in Regulations to Banks' Foreign Currency Lending

In response to the financial crises at the end of the 1990s and early 2000s, several Latin American countries sought to limit banks' exchange rate-induced credit risk arising from foreign currency lending to unhedged borrowers. Within our sample period, Argentina and Chile introduced prudential regulations to discourage lending in foreign currency, including tighter limits on dollar lending based on borrowers' ability to repay in the event of unexpected exchange rate movements.[47] Thus, the estimated negative effect of floating regimes on corporate currency mismatches documented above could be also capturing changes in domestic banks' lending practices as a result of new regulations—and not only changes in the behavior of non-financial firms themselves. To check this possibility, I re-estimated equation (4) but excluding firm-year observations for Argentina and Chile in the period after the regulations were adopted.[48] As shown in column 1 in Table 7, the baseline results still hold, although the degree of significance declines to the 10 percent confidence level.

[47] In the case of Argentina, since 2003 banks can only use foreign currency deposits to grant lending in foreign currency, and only to firms with international trade activity. In Chile, currency mismatch regulations were adopted in 2000 to prepare for the flexible exchange rate regime environment, as banks were required to assign a higher risk rating (and higher provisioning requirements) to debtors whose capacity to repay was sensitive to exchange rate movements. In 2006, Peru introduced regulations requiring banks set aside higher provisions for foreign currency loans relative to domestic currency ones. See Cayazzo et al. (2006) for a detailed discussion.

[48] For Argentina, I excluded observations after 2002 and for Chile after 2000.

Table 7. The Effects of Exchange Rate Regimes on Currency Mismatches: Alternative Explanations

	(1)	(2)	(3)
Main Effects			
PostFLEX	-0.06	-0.04	-0.03
	(0.05)	(0.03)	(0.02)
Exports to Sales ratio	0.32 ***	0.31 ***	0.31 ***
	(0.03)	(0.03)	(0.03)
Share of Dollar Assets	0.45 ***	0.47 ***	0.47 ***
	(0.06)	(0.06)	(0.06)
Differential Effects			
Exports to Sales x PostFLEX	**-0.03**	**-0.01**	**-0.01**
	(0.04)	**(0.02)**	**(0.02)**
Share of Dollar Assets x PostFLEX	**0.13 ***	**0.15 ***	**0.15 ***
	(0.08)	**(0.06)**	**(0.06)**
Other Interaction Effects			
Medium Size dummy x Flex Regime		0.00	
		(0.02)	
Big Size dummy x Flex Regime		0.00	
		(0.02)	
Access to Int. Debt Markets x PostFLEX			-0.03
			(0.02)
Access to Int. Equity Markets x PostFLEX			-0.01
			(0.03)
Fixed Effects			
Country	Yes	Yes	Yes
Sector	Yes	Yes	Yes
Year	Yes	Yes	Yes
Diagnostics			
Number of Observations	8155	9374	8071
McFadden's Adjusted R2	0.65	0.67	0.67
Non-Corner Observations (in %)	77	76.5	76.5

Source: Author's calculations.

Note: This table reports the pooled Tobit estimates of augmented versions of equation (4) in the text, for the period 1992-2005. Coefficient estimates denote marginal effects on dependent variable, evaluated at mean values of independent variables. For dummy variables, they represent the effect of discrete changes from 0 to 1. Variables based on balance sheet stock values are measured at the beginning of the period. A constant, a dummy for the year of the regime switch and firm-level controls are included but not reported. Standard errors adjusted for clustering at the country-year are reported in parentheses. Asterisks denote significance of coefficients, with ***, ** and * indicating significance at the 1%, 5% and 10% level, respectively.

B. Differential Access to Credit and Ability to Expand Production During Crisis

A concern with the interpretation of the basic regression result is that the sharper decline in dollar debt ratios observed for firms with no foreign currency earnings (compared with firms that rely principally on export revenues or have large dollar asset holdings) could be reflecting different abilities to overcome financial constraints across these two types of firms. Large currency depreciations that typically occur during regime changes often coincide with banking crises (the "twin crises") in which banks (even healthy ones) cut back on lending.[49] Firms that generate foreign currency revenues or hold dollar assets may have better ability to raise funds in international markets, as they can pledge export receivables or hard-currency assets as collateral—allowing them to better cope with domestic credit crunches.[50] Thus, if firms have also better access to international capital markets, and if large currency depreciations occur in association with banking crises, then the differential effect found may be more related to differences in the ability to access alternative sources of financing (especially foreign finance) when domestic credit is depressed, than changes in currency risk management.

Likewise, larger firms could have more available resources that enable them to take better advantage of the improved terms of trade that occur after large exchange rate depreciations.[51] If exporter firms and firms with foreign currency asset holdings are, on average, larger, then scale effects could be confounding the estimated impact of the exchange rate regime on currency mismatches documented above.

To investigate the access-to-credit and the scale-effect hypothesis, I include in the specification interacted terms of the dummies for access to international capital markets and size with the exchange rate regime indicator. Results in columns 2 and 3 in Table 7 indicate that the *only* interaction terms that remain significant are the export intensity and dollarization of assets, respectively—providing yet additional confirmation of our basic result. Overall, the evidence of an omitted-variable bias stemming from differential access to credit or ability to expand production is not compelling.

VII. A Closer Look at the Data: Exploiting Changes in Entire Distribution of Firms' Dollar Debt Ratios

A. Conditional Quantile Estimates: Basic Framework

In Sections IV and V, I investigated the effects of exchange rate regimes in foreign currency borrowing solely on the *conditional mean* of firm-level dollarization. While the central effects

[49] As argued by Kaminsky and Reinhart (1999), Mexico (in 1994), Colombia (in 1998), and Argentina (in 2001) suffered twin crises: prior to the currency crash, the local banking system collapsed and halted domestic credit provision. For example, in 1995, during the tequila crisis, Mexico suffered more-or-less simultaneous depreciation, capital flight, and collapse of the domestic banking system.

[50] Tornell and Westermann (2005) have argued that firms in the traded sector have better access to alternatives to domestic bank finance, especially foreign finance, and thus suffer less than firms in non-traded sectors during financial crises.

[51] For example, larger firms might be more capable of ramping-up expanding production and distribution networks to sell the expanded production.

are useful summary statistics of the impact of the exchange rate regime and other covariates, they may mask the heterogeneous impact at the various quantiles of the distribution of firms' foreign currency borrowing.[52]

In this section, I apply Quantile Regression (QR) techniques to study the determinants of firms' debt currency choices. Perhaps the most appealing feature of QR methods is that they allow estimation of the effect of explanatory variables on different points of the outcome's conditional distribution, including the upper and lower tails as well as the center of the distribution.[53] An additional advantage of quantile regression estimates is that the method is robust to departures from normality and homoscedasticity, thus alleviating some of the concerns regarding results obtained with Tobit models (Powell (1986)).[54]

In a linear setting, the quantile regression model can be written as:

$$y_i = \mathbf{x}_i'\boldsymbol{\beta}_\theta + u_{\theta_i}, \qquad Quant_\theta(y_i \mid \mathbf{x}_i) = \mathbf{x}_i'\boldsymbol{\beta}_\theta \tag{7}$$

where $Q_\theta(y_i \mid \mathbf{x}_i)$ denotes the θ-th quantile of y_i conditional on the regressor vector $\mathbf{x}_i$, with $0 < \theta < 1$. The distribution of the error term u_{τ_i} is left unspecified, so the estimation method is basically semi-parametric. The QR estimator of $\boldsymbol{\beta}_\theta$ is obtained as a solution to the problem:

$$\hat{\beta}_\theta = \arg\min \frac{1}{N}\left\{ \sum_{i:y \geq \mathbf{x}_i'\boldsymbol{\beta}} \theta \left| y_i - \mathbf{x}_i'\boldsymbol{\beta}_\theta \right| + \sum_{:y < \mathbf{x}_i'\boldsymbol{\beta}} (1-\theta) \left| y_i - \mathbf{x}_i'\boldsymbol{\beta}_\theta \right| \right\} \tag{8}$$

where unique slope parameters are estimated for each θ quantile of interest. The objective function above is a weighted sum of absolute deviations, which can be interpreted as an asymmetric linear penalty function. An important special case of the quantile regression estimator is the least absolute deviation estimator (LAD), which is obtained by setting θ=0.5 (the median regression). The first quartile is obtained by setting θ=0.25 and so on. When increasing θ from 0 to 1, it is possible to trace the effects at different points of the conditional distribution of y on x.[55]

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[52] The effect on the conditional mean will not capture the full distributional impact of a covariate unless it affects all quantiles of the outcome distribution in the same way (that is, the marginal effect is a "location shift").

[53] Economic relationships that are insignificant at the mean may be highly significant over other parts of the conditional distribution of the liability dollarization ratio. Taken together, the ensemble of estimated conditional quantile functions offers a much more complete view of the effect of covariates on the location, scale and shape of the distribution of the response variable (see Koenker and Bassett (1978)).

[54] The quantile regression estimator is "robust" to outliers and "long tails" in the distribution of the residuals. Since the quantile regression estimator is derived from the minimization of a weighted sum of absolute deviations, the parameter estimates are less sensitive to a few small or large observations at the tails of the distribution.

[55] Note that quantile regression is not the same as applying OLS to subsets of the data produced by dividing the complete data set into different percentiles of the dependent variable. Rather, quantile regression uses information from the entire sample to generate the estimate at each quantile. However, some observations get more weight than others, specifically those observations that lie above the conditional quantile plane.

When the dependent variable is censored or has corner solutions, the Censored Quantile Regression (CQR) estimator as derived by Powell (1986) is found by solving:

$\hat{\beta}_\theta = \arg\min \sum_{i=1}^{n} \rho_\theta \left(y_i - \max\left\{0, \mathbf{x}_i' \boldsymbol{\beta}_\theta\right\}\right)$ where $\rho_\theta(u_{\theta i})$ is an indicator function defined as:

$$\rho_\theta(u_{\theta i}) = \begin{cases} \theta\, u_{\theta i} & if\ u_{\theta i} \geq 0 \\ (\theta - 1)\, u_{\theta i} & if\ u_{\theta i} < 0 \end{cases} \tag{9}$$

and

$$\begin{aligned} \mathbf{x}_i'\boldsymbol{\beta}_\theta = {} & \beta_{0,\theta} + \beta_{1,\theta}\ FLEXDate_{ct} + \beta_{2,\theta} FtoF_{ct} + \beta_{3,\theta}\ EXPtoS_{ijct} + \beta_{4,\theta}\ DOLA_{ijct-1} + \\ & \beta_{5,\theta}\ [EXPtoS_{ijct} * FtoF_{ct}] + \beta_{6,\theta}\ [DOLA_{ijct-1} * FtoF_{ct}] + \\ & \gamma_\theta' \mathbf{X}_{ijct-1} + \phi_{j,\theta} + \chi_{c,\theta} + \lambda_{t,\theta} + \varepsilon_{ijct} \end{aligned} \tag{10}$$

Chernozhukov and Hong (2002) devised a tractable CQR algorithm that is robust and performs well near the censoring point. It also handles censoring non-parametrically, i.e., without any distributional assumptions. Given that in the sample 40 percent of firm-observations have zero dollar debt, this is an important econometric issue. The algorithm is a three-step procedure that predicts which observations are least likely to be censored and estimates the coefficients based on those observations using linear quantile regression methods. In Appendix 3, I provide the intuition for this CQR estimator and the practical implementation details of the programming in STATA.

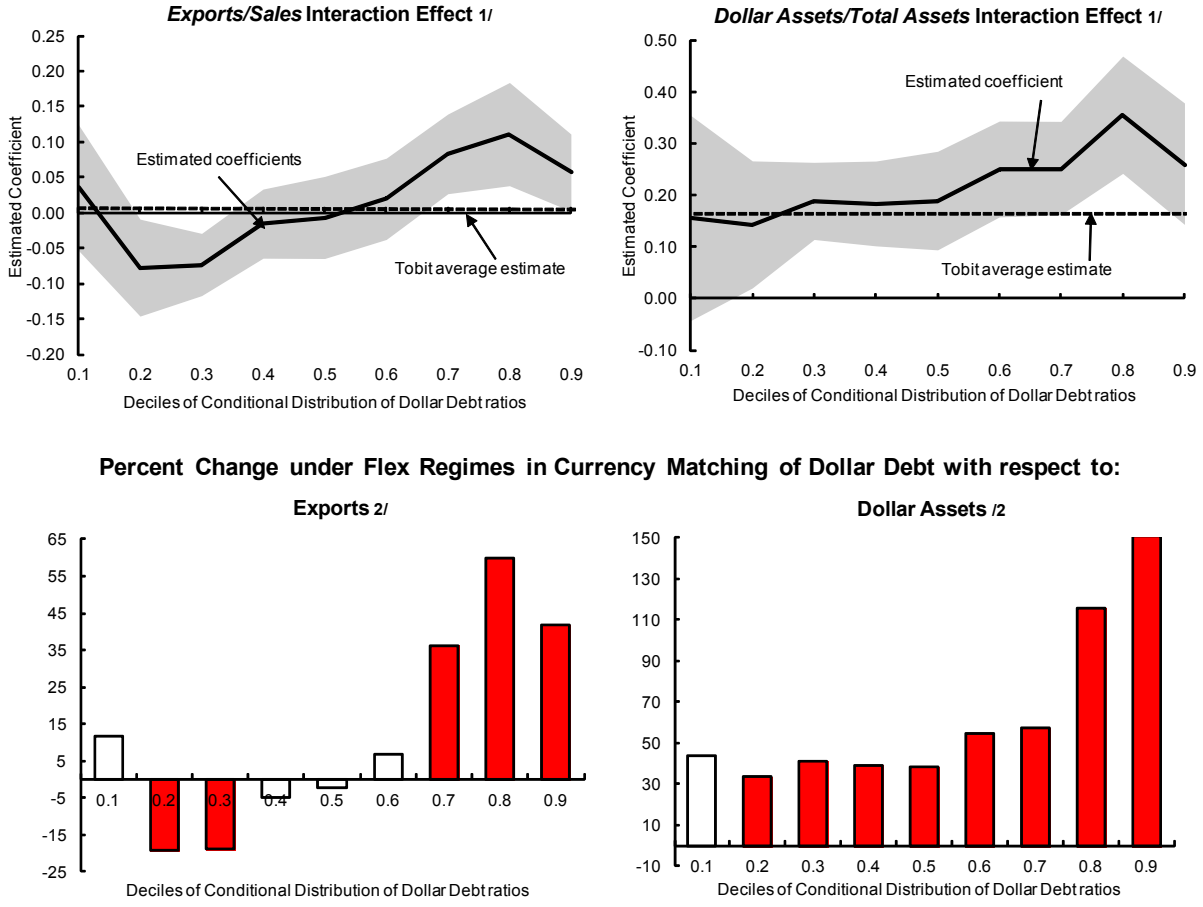
B. Results

Figure 5 presents a concise visual summary of the censored quantile regression results of the model in equations (9) and (10). The solid line in each of the top two charts plots the quantile regression estimates for the interaction coefficients (β_5 and β_6) for each of the nine percentiles (10th, 20th, up to 90th). The shaded grey area depicts a 95 percent point-wise confidence interval. The dashed line in each figure shows the Tobit estimate of the conditional mean effect.

In the case of the interaction term on the export to sales ratio, quantile regression estimates are positive and significant only for the upper conditional quantiles. That is, a switch to flexible exchange rate regimes leads on average to higher currency matching between dollar debt ratio and export to sales ratio at the upper tail of the distribution (seventh to ninth decile). Interestingly, while I do not find a significant average effect on Tobit estimates, we do observe significant positive impacts on specific parts of the relevant distribution. For the case

of the interaction on asset dollarization, all quantile estimates (except the lower decile tail) are positive and significant, and the effect increases monotonically as we move to the upper deciles, reaching the strongest impact in the eighth decile.[56]

Figure 5. Effect of Switch to Flexible Regimes at Different Points of the Cross-Sectional Distribution of Dollar Debt Ratios



Source: Author's calculations.

1/ Shaded area denotes 95 percent confidence interval.
2/ Red bars denote changes that are statistically different from zero.

The bottom two charts in Figure 5 show the percentage increase in the degree of currency matching at each decile of the conditional distribution for the case of exports (bottom left) and dollar assets (bottom right). For each decile, I take the ratio between the estimated interaction effects and the corresponding value for the estimated parameter on the level effect ($\beta_{5,\theta} / \beta_{3,\theta}$ for exports to sales and $\beta_{4,\theta} / \beta_{6,\theta}$ for the dollar asset ratio). The figure suggests that the percentage increase in the degree of currency matching in firms' balance sheets under flexible regimes increases monotonically as we move up the conditional distribution of dollarization,

[56] Results from the inter-quantile tests indicate that the coefficients are indeed significantly different from each other at the 10 percent and 90 percent quantiles.

with a much steeper increase in the upper tails. This last result implies a very interesting observation: as countries switch to flexible regimes, the reduction in the degree of foreign exchange rate exposure in firms' balance sheet becomes more important for firms in the highest deciles of the dollarization distribution. That is, the differential effect is stronger where the theory plausibly suggests the costs of exposure to devaluation risk are likely to be larger. These heterogeneous effects lend additional credibility to the hypothesis that following the adoption of a floating exchange rate regime firms match up more strongly the currency structure of assets and liabilities, effectively reducing currency risk.

VIII. CONCLUSIONS

This paper provides cross-country, firm-level evidence of the distinctive role of the exchange rate regime in shaping the behavior of firms towards exchange rate risk. I present robust evidence that exchange rate flexibility encourages firms to reduce currency mismatches in their balance sheets, thus insulating themselves more strongly from financial risks arising from exchange rate fluctuations. Specifically, I show that after countries switch from a pegged to a flexible regime, firms significantly cut their unhedged foreign currency exposures by reducing the share of debt contracted in foreign currency, while using more systematically export revenues and assets denominated in foreign currency to offset their dollar debt risk.

Confirming the logic of the baseline results, I find that a switch to more flexible regimes reduces the degree of currency exposure by significantly more for those firms at the higher conditional quantiles of the dollar debt distribution. These results are consistent with theories proposing that switching to flexible regimes will reduce the corporate sector's vulnerability to exchange rate fluctuations, as high-frequency volatility discourages foreign-exchange-denominated borrowing and increases incentives for firms to hedge currency risk.

From a macroeconomic point of view, the results imply that flexible regimes lead to a reallocation of dollar debt towards firms that are in a stronger position to absorb the impact of a large exchange-rate change on their balance sheets. This reduces the risks associated with the increasing domestic burden of debts of a country's non financial sectors (and those of their bank creditors) after exchange rate devaluations, which were devastating during past crises.

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Appendix I. Data Construction

In this appendix, I describe the firm-level data used in more detail, and the sources employed to construct them.

I use data reported on a calendar year basis, rather than fiscal year. While firms in many cases report both consolidated and unconsolidated financial statements, I use unconsolidated figures to the extent possible, to reduce variations arising from changes in subsidiaries' ownership and to work with comparable accounting data. For the purpose of the empirical implementation, I modified the original accounting data in three ways:

(i) Convert all data to real 2000 U.S. dollars using December-to-December changes in the country's consumer price index and the exchange rate for December 31, 1999.

(ii) Drop all firm/year observations if the accounting data are not self-consistent. In particular, we drop observations if dollar liabilities (assets) exceed total liabilities (assets) or if accounting variables do not accord with sign conventions.

(iii) Compute the change in total assets 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 $Z>5$. These controls for outliers (either because of inadequate accounting, typing errors, or extreme values).

Definition of Variables

Total assets. Sum of total current assets, long-term receivables, investment in unconsolidated subsidiaries, other investments, net property, plant and equipment, and other assets (Balance Sheet).

Total liabilities. Book value of total liabilities (Balance Sheet).

Foreign currency liabilities. Liabilities denominated or indexed to a foreign currency (in dollars or in other non-domestic currencies), issued domestically or abroad. These include bank loans, borrowing from non-bank financial institutions, securities issuance, commercial debt, and trade credit. Consistent with accounting standards in each country, items that are in foreign currency at the end of the year are converted to domestic currency at the contemporaneous exchange rate. (Balance Sheet Notes).

Short-term foreign currency liabilities. Foreign currency liabilities coming due in the upcoming fiscal year. Includes foreign currency denominated debt issued at short maturities as well as long term issues whose terminal date falls in the next year (Balance Sheet Notes).

Foreign currency assets. Assets denominated or indexed to a foreign currency. These include cash, government issues indexed to the dollar, bank deposits abroad, and overseas client credits. Converted into local currency using end of period exchange rate (Balance Sheet Notes).

Exports. Total sales in foreign markets. (Income Statement, when available or Customs data in each country). Dollar export values were converted into domestic currency using the year's average exchange rate.

Sales. Gross sales and other operating revenues from main activities (Income Statement).

Leverage. Total liabilities as a share of total assets in the balance sheet.

Industry Dummies. Is the industry in which the firm has its main operations. I code firms according to the one-digit ISIC 2 classification.

International Access. A dummy variable that takes on a value of one starting the year the firms accessed international equity markets (by cross-listing shares in foreign stock markets) and/or tapped foreign credit markets (by issuing bonds or taking loans abroad).

The third major source of firm-level data captures firms' access to international capital markets. I obtained firm-level issuance data on private bonds and syndicated loans from Dealogic Bondware and Loanware. For access to equity markets, I used Bank of New York data to identify those firms whose shares listed in a foreign stock exchange in the form of American Depositary Receipts (ADRs).

Sources

Balance sheet information was mostly collected from annual reports and corporate filings obtained from local stock markets, regulatory agencies, and/or trade chambers in each country.[57] Where appropriate, I complemented and cross-checked these sources with data obtained from Economática and Bloomberg. For access to equity markets, we used Bank of New York data to identify those firms whose shares listed in a foreign stock exchange in the form of American Depositary Receipts (ADRs). Firm-level issuance data on private bonds and syndicated loans were extracted from Dealogic Bondware and Loanware. Firms' main sector of operations was identified using Economatica and Lexis Nexis.

The country-specific sources are as follows:

Argentina. Balance sheet information up to 2001 comes from Galiani, Levy-Yeyati, and Schargrodsky (2003), and from financial statements compiled from the Buenos Aires Stock Exchange. From 2002 onwards, data is from Economática. Data on exports are matched using customs data from ExiNet (NOSIS).

Brazil. Data are compiled from corporate filings submitted to the Securities and Exchanges Commission of Brazil (CVM), and complemented with data from Economática and Bloomberg for 2003 to 2005. Export data come from Notes to Financial Statements and LAFIS.

[57] Data for Argentina and Peru builds upon a firm-level dataset compiled by the Research Department of the Inter-American Development Bank (2002).

Chile. Balance sheet information is obtained from the *Ficha Estadística Codificada Uniforme* (FECUS) database and notes to financial statements obtained from the SuperValores of Chile. Data on exports come from Pro-Chile.

Colombia. Balance sheet information and export data obtained from *Super Intendencia Financiera de Colombia*.

Mexico. Balance sheet information and export data obtained from Mexican Stock Exchange.

Peru. Balance sheet information come from *Comisión Nacional de Valores* (CONASEV). Data on exports comes from COMEXPERU.

Appendix II. Results Based on Event Study Techniques

Specification

In this section, I try a different approach to identifying the effect of exchange rate regimes on firm's balance sheet currency exposures: examining the variation in firm-level dollarization immediately before and after a country's switch to a flexible exchange rate regime. To do so, I estimate the following specification:

$$DOLL_{ijct} = \beta_0 + \eta_i + \beta_1\ FLEXDate_{ct} + \beta_2 PostFLEX_{ct} + \beta_3\ EXPtoS_{ijct} + \beta_4\ DOLA_{ijct-1} + \beta_5\ [EXPtoS_{iict} * PostFLEX_{ct}] + \beta_6\ [DOLA_{ijct-1} * PostFLEX_{ct}] + \gamma' \mathbf{X}_{ijct-1} + + \phi_j + \chi_c + \varepsilon_{ijct} \quad \text{(B1)}$$

This specification is more flexible than (4) in that it accommodates a firm-specific term η_i, which also captures any variation in initial conditions at the firm-level at the time of the switch to a floating regime.[58] Letting T=0 (T=1) denotes before (after) the exchange rate switch, then we can first difference (B1) and estimate the following specification:

$$\Delta DOLL_{ijct} = DOLL_{ijc1} - DOLL_{ijc0} = \beta_2\ \Delta PostFLEX_{ct} + \beta_3 \Delta\ EXPtoS_{ijct} + \beta_4 \Delta\ DOLA_{ijct-1} + \beta_5\ \Delta[EXPtoS_{ijct} * PostFLEX_{ct}] + \beta_6\ \Delta[DOLA_{ijct-1} * PostFLEX_{ct}] + \gamma' \Delta\mathbf{X}_{ijct-1} + \Delta\varepsilon_{ijct} \quad \text{(B2)}$$

This event study approach isolates the independent effect of a move to flexible exchange rate regimes purely from the within-firm changes in dollarization.[59] Note that the β_0 term has dropped out of the regression, as well as country and sector fixed effects. First differencing also removes unobserved heterogeneity across firms, such as differences in technologies, market power, and/or managerial behavior.[60] By eliminating these important sources of omitted variable bias, one may obtain coefficients that come closer to representing a causal impact.

I estimate the specification in (B2) with the post-flexible regime dummy, so that:

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[58] Note that is not possible to include fixed effects in a Tobit specification, as there does not exist a sufficient statistic allowing the fixed effects to be conditioned out of the likelihood.

[59] Note that the cross-section dimension is not entirely removed because countries switched at different times during this period. I included a dummy for Mexico (which switched in 1995) and Argentina (which did so in 2002). The rest of the countries in the sample moved to a floating regime in 1999.

[60] The fixed effect estimator will thus exclude the possibility that the results presented so far are a consequence of an omitted endogenous time-invariant characteristic of the firm.

$\Delta PostFLEX_{ct} = PostFLEX_{c1} - PostFLEX_{c0} = 1 - 0 = 1$ for all countries and (B2) reduces to:

$$\Delta DOLL_{ijct} = \beta_2 + \beta_3 \Delta\, EXPtoS_{ijct} + \beta_4 \Delta\, DOLA_{ijct} + \beta_5\, EXPtoS_{ijcT1} + \beta_6\, DOLA_{ijcT1} + \gamma' \Delta \mathbf{X}_{ijct} + u_{ijct} \quad \text{(B3)}$$

This way, the differential impact of exchange rate regimes across firms with different export to sales and asset dollarization ratios is estimated by the coefficients β_5 and β_6, respectively.

Unlike the panel analysis, the event study approach uses only one observation per country-firm: the change in foreign currency debt (and its determinants) around the regime change event. It thus requires defining the horizon over which the effects are expected to be realized. Based on results reported in the previous section, I measure $\Delta DOLL_{ijct}$ as the difference in average dollarization between (t–3,t–1) and (t+1,t+3) around the exchange rate regime switch in year t. Likewise, $\Delta\, EXPtoS$ ($\Delta\, DOLA$) is computed in each case as the difference between the average export ratio (average dollar asset ratio) between $t - 3$ and $t - 1$, and the corresponding average ratio between $t + 1$ and $t + 3$. Averaging ensures that the results are not influence by temporary movements in dollar debt, dollar asset, and export intensity ratios.

Results

The first column in Table A-1 reports results from the estimation of equation (B3). The effects of moving to flexible exchange rate regimes appear even in this econometrically stringent model.[61] Cross-sectional changes in firms' debt dollarization ratios after countries switch to flexible regimes are significantly correlated with the firms' holdings of foreign currency assets. That is, firms alter their balance sheet structures to provide a more effective buffer against exchange rate shocks and reduce their insolvency risk. These differences are statistically significant, or too large to have easily occurred by chance. The point estimates from the event study specifications are approximately half of the magnitudes from the earlier panel results.

One potential concern with the analysis is that export intensity can be itself endogenous to the exchange rate regime, as currency reforms are typically accompanied by steep increases in the nominal exchange rate which lead to gains in competitiveness. In this case, we would be violating the identification restriction that the exchange rate regimes can only have an

[61] Differencing will typically raise the noise-to-signal ratio and tend to reduce the significance of a number of independent variables because standard errors become larger.

Table A-1. The Effects of Exchange Rate Regimes on Currency Matching: Event Study

	(1)	(2)	(3)
Constant	-0.02 ***	-0.02 ***	-0.02 ***
	(0.01)	(0.00)	(0.00)
Change in Export to Sales ratio	0.16 ***		
	(0.06)		
Change in Dollar Asset ratio	0.17 **	0.21 ***	0.23 ***
	(0.07)	(0.07)	(0.07)
Change in Medium Size Dummy	0.00	-0.01	0.00
	(0.03)	(0.03)	(0.03)
Change in Big Size Dummy	-0.03	-0.03	-0.01
	(0.04)	(0.03)	(0.04)
Change in Access to International Debt Markets	0.09 ***	0.09 ***	0.09 ***
	(0.03)	(0.03)	(0.03)
Change in Access to International Equity Markets	0.07 **	0.06 **	0.06 **
	(0.03)	(0.03)	(0.03)
Differential FX Regime Effects			
Export to sales ratio in Post-Period	**0.00**		
	(0.03)		
Dollar Assets ratio in Post-Period	**0.12** **	**0.14** ***	**0.10** **
	(0.06)	**(0.05)**	**(0.05)**
Dummy for Mexico	0.01	0.02	0.03
	(0.02)	(0.02)	(0.02)
Dummy for Argentina	-0.20 ***	-0.19 ***	
	(0.03)	(0.03)	
Including Argentinean Firms?	Yes	Yes	No
Diagnostics			
Number of Observations	832	875	803
Adjusted R2	0.14	0.13	0.07

Source: Author's calculations.

Note: This table reports the pooled OLS estimates of equation (B3) in the text. The dependent variable is the difference in a foreign currency debt ratios between (t-1 to t-3) and (t+1 to t+3) where t is the year of the change in exchange rate regime. Robust standard errors are reported in parentheses. Asterisks denote significance of coefficients, with ***, ** and * indicating significance at the 1%, 5% and 10% level, respectively.

independent effect on the dependent variable.[62] However, changes in export status from non-exporter to exporter at the time of the crisis where relatively limited in our sample (5 percent of the observations at the time of the regime changes for the whole sample) and therefore, limit the potential sample selection concerns (see Table A-2).

In countries where domestic sales are conducted exclusively in local currency, exports are a good indicator of whether a firm has foreign currency income. But several countries in our sample display real dollarization, i.e., many domestic transactions are conducted in—or indexed to—foreign currency (typically the dollar). Thus, export earnings could be a noisy measure of the exchange rate-sensitivity of a firm's earnings. To address this concern, Columns 2 and 3 show the estimated results when using dollar assets as the only proxy for natural currency buffers. Again, results confirm the central finding in the paper that under flexible regimes, firms match more systematically the currency denomination of their liabilities and assets, that is, a higher share of foreign currency debt is backed by foreign currency assets. This would tend to cushion the effect of depreciation shocks on firms' balance sheets.[63]

[62] This issue becomes even more relevant if we consider that the signing of the North American Free Trade Agreement (NAFTA) in 1994 might have changed the financing opportunities for exporting firms as it was perceived that they had a higher growth potential (see Martinez and Werner (2002)).

[63] The last column in Table B1 shows that the key finding in the paper is robust to excluding Argentinean firms from the sample.

Table A-2. Changes in Export Status After Exchange Rate Regime Changes

Brazil

PRE-FLOAT REGIME	POST-FLOAT REGIME: Non-Exporter	POST-FLOAT REGIME: Exporter
Non-Exporter	49%	0%
Exporter	12%	39%

Chile

PRE-FLOAT REGIME	POST-FLOAT REGIME: Non-Exporter	POST-FLOAT REGIME: Exporter
Non-Exporter	47%	5%
Exporter	10%	38%

Colombia

PRE-FLOAT REGIME	POST-FLOAT REGIME: Non-Exporter	POST-FLOAT REGIME: Exporter
Non-Exporter	59%	3%
Exporter	8%	30%

Mexico

PRE-FLOAT REGIME	POST-FLOAT REGIME: Non-Exporter	POST-FLOAT REGIME: Exporter
Non-Exporter	27%	9%
Exporter	2%	63%

Source: Author's calculations.

Note: This table reports transition matrices for changes in export and non-export status after switches to flexible exchange rate regimes.

Appendix III. Censored Quantile Regression

In this section, I provide more intuition for the Censored Quantile Regression (CQR) estimates, and provide practical implementation details.

Basic Model and Interpretation of the Quantile Regression

A least square estimator of the mean regression model would be concerned with the dependence of the conditional mean of *Y* on the covariates *X*. The quantile regression estimator tackles this issue at each quantile of the conditional distribution, providing thus a more complete description of how the conditional distribution of *Y* given *X*=*x* depends on *x*. Instead of assuming that the covariates shift only the location and scale of the conditional distribution, quantile regression looks at the potential effects on the shape of the distribution as well.

More formally, for any variable *Y* whose distribution is continuous and monotone and for any $\theta \in (0,1)$, the θth unconditional quantile of *Y* is a number $Q_Y(\theta)$ such that:

$$F(Q_Y(\theta)) = \theta \tag{C1}$$

where *F*(.) is the distribution function of *Y*. Equivalently:

$$Q(\theta) = \inf\{y : F(y) \geq \theta\} \tag{C2}$$

Let $(y_i, \mathbf{x}_i)$, $i = 1,...,n$ be a sample from some population, where $\mathbf{x}_i$ is a *K*x1 vector of regressors. Assuming that the θth quantile of the conditional distribution of y_i is linear in $\mathbf{x}_i$, we can write the conditional quantile regression model as:

$$y_i = \mathbf{x}_i'\boldsymbol{\beta}_\theta + u_{\theta_i},$$

$$Q_\theta(y_i \mid \mathbf{x}_i) \equiv \inf\{y : F(y_i \mid \mathbf{x}_i) \geq \theta\} = \mathbf{x}_i'\boldsymbol{\beta}_\theta \tag{C3}$$

Where $\boldsymbol{\beta}_\theta$ is the unknown vector of parameters to be estimated for different values of $\theta \in (0,1)$. If $F_\theta(.)$ was known then various techniques could be used to estimate $\boldsymbol{\beta}_\theta$. However, here the distribution of the error term u_{θ_i} is left unspecified. The only constraint is that the conditional quantile of the error term is zero:

$$Q_\theta(u_{\theta i} \mid x_i) = 0 \tag{C4}$$

The QR estimator of $\boldsymbol{\beta}_\theta$ is obtained by minimizing its sample counterpart, i.e., the average of the asymmetrically weighted sum of the absolute errors, with weight θ on positive errors and weight on negative errors:

$$\hat{\beta}_\theta = \arg\min \frac{1}{N}\left\{ \sum_{i:y \geq \mathbf{x}_i'\boldsymbol{\beta}} \theta \left| y_i - \mathbf{x}_i'\boldsymbol{\beta}_\theta \right| + \sum_{:y < \mathbf{x}_i'\boldsymbol{\beta}} (1-\theta) \left| y_i - \mathbf{x}_i'\boldsymbol{\beta}_\theta \right| \right\} = \arg\min \sum_{i=1}^{n} \rho_\theta (u_{\theta i}) \quad \text{(C5)}$$

For example, when estimating the 75th percentile, negative residuals are weighted by 0.25 and positive residuals by 0.75. The criterion is minimized when 75 percent of the residuals are negative. In the specific case of the median regression, all residuals receive equal weight. This minimization problem can be solved by linear programming techniques for the different quantiles of the dependent variable as described in, for example, Koenker and Hallock (2001). It can be shown that the estimator for β_θ is consistent and asymptotically normal (Koenker and Bassett (1978)).

When the conditional quantile of the error term is zero, a CQR model can be written as:

$$Q_\theta (y_i \mid \mathbf{x}_i) = \max\left\{0, Q_\theta \left(\mathbf{x}_i'\boldsymbol{\beta}_\theta + u_{\theta_i} \mid \mathbf{x}_i\right)\right\} = \max\left\{0, \mathbf{x}_i'\boldsymbol{\beta}_\theta\right\} \quad \text{(C6)}$$

Censoring induces attenuation bias in quantile regression much in the same way it induces bias in mean regression: when a zero is observed in the place of a value that should be much smaller, a line that fits the observed values will be biased toward zero. Since quantile regression uses information from the entire sample to generate the estimate at each quantile, if some observations on the dependent variable are censored, the quantile regression lines can be biased toward zero at all quantiles. The Powell (1986) estimator overcomes this difficulty by incorporating censoring directly into the estimator as follows:

$$\hat{\beta}_\theta = \arg\min \sum_{i=1}^{n} \rho_\theta \left(y_i - \max\left\{0, \mathbf{x}_i'\boldsymbol{\beta}_\theta\right\}\right)$$

where

$$\rho_\theta (u_{\theta i}) = \left\{(1-\theta)\, I(u_{\theta i} < 0) + (\theta)\, I(u_{\theta i} > 0)\right\} \left| u_{\theta i} \right| \quad \text{(C7)}$$

and *I* is an indicator function taking the value of unity when the expression holds and zero otherwise.

Chernozhukov and Hong (2002) devised a tractable computational censored quantile regression (CQR) algorithm for Powell's estimator based on the idea that Powell's censored regression model estimates the coefficients using observations that are not likely to be censored. The algorithm is a three-step procedure that predicts which observations are least likely to be censored and estimates the coefficients based on those observations. The algorithm is simple, robust, and performs well near the censoring point.

This procedure selects a sub sample by a separation restriction that is put on the censoring probability (first step), and estimates the model twice by quantile regression. The goal of the first estimation (second step) is to find an appropriate sub sample, and the purpose of the

second estimation (third step) is to make the estimator efficient. In the first step, a set fraction of observations that are unlikely to be censored are retained for estimation via quantile regression in the second step. After the second step, a larger set of observations is retained based on the predicted values of the dependent variable. This sample gets asymptotically close to the ideal sample of non-censored observations, and consistent estimates are obtained through a third step of quantile regression on this sample.

Below I describe in more detail the algorithm that was programmed in STATA:

Step 1: The first step involves a parametric prediction of the probability of censoring based on a Probit or Logit model. I estimate a probability model on the sample: $\Pr(y_i > 0 \mid x_i) = F(\mathbf{x}_i'\gamma) + \varepsilon_i$. Use the probability model to select the subsample $J_0 = \{i : \mathbf{x}_i'\hat{\gamma} > 1 - \theta + c\}$ where *c* is a trimming constant between 0 and 1. To choose the trimming constant, *c*, Chernozhukov and Hong (2002) suggest using the minimum value of the Powell objective function in (C7). The goal of Step 1 is to choose a subset of the observations where $\Pr(y_i > 0 \mid x_i) > 1 - \theta$, that is, where the quantile line $\mathbf{x}_i'\boldsymbol{\beta}_\theta$ is above the censoring point.

Step 2: Obtain the initial estimator, $\boldsymbol{\beta}_\theta^0$ by ordinary QR on the sample J_0. It is shown by Chernozhukov and Hong (2002) that this step gives a consistent but inefficient estimator. Use the initial estimator to select the sample $J_1 = \{i : \mathbf{x}_i'\boldsymbol{\beta}_\theta^0 > 0\}$ to be used in Step 3.

Step 3: Estimate the model by ordinary QR on the sample J_1. Chernozhukov and Hong (2002) show that this step gives a consistent and efficient estimate of $\hat{\boldsymbol{\beta}}_\theta$.