Currency Mismatches in Chilean Nonfinancial Corporations

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The potential financial vulnerability that can occur when private sector or government agents acquire high levels of foreign currency debt has been at the center of discussion since the financial crises that affected the countries of Southeast Asia in the late 1990s. To the extent that a mismatch is generated in the denomination of assets and liabilities, foreign currency debt increases agents' vulnerability to fluctuations in the exchange rate. After a depreciation, the debt-asset ratios increase, interest rates rise in relation to income and access to new debt is limited. For firms in the private sector (especially those that operate in the nontradable sector), these balance sheet effects reduce output and investment and, in extreme cases, lead to the bankruptcy of firms and financial instability.

Measuring the empirical relevance of these negative effects of foreign currency debt is particularly important for the conduct of monetary and exchange rate policies in emerging markets. In conventional open-economy models à la Mundell-Fleming, exchange

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rate depreciations have an expansionary effect on domestic output. It follows that in the face of a contraction of foreign demand or a reduction of international liquidity, monetary authorities should reduce domestic interest rates and let the exchange rate depreciate in order to stabilize output. The expansionary effect of the depreciation of the peso may be reversed, however, if firms are highly indebted in dollars and the balance sheet effects are significant. Under these circumstances, the optimal policy response to a negative external shock would be a tight monetary policy and a strong defense of the peso.[1]

A growing literature, using aggregate data, finds empirical evidence that justifies this concern about the effects of the mismatches generated by the dollar debt. In particular, evidence shows that both dollarization of external liabilities and dollarization of the domestic financial system are correlated with increased volatility of output and capital flows and with greater financial vulnerability. Moreover, external dollarization reduces the expansionary effects of a depreciation and makes a sudden stop in capital flows more likely.[2]

In contrast to the macroeconomic literature, a second group of studies based on firm-level data obtains ambiguous results on the impact of a depreciation on investment and output of firms with dollar debt.[3]

1. Although they suffer problems of endogeneity, a couple of studies argue that the dollarization of liabilities leads to a "fear of floating" the domestic currency. Panizza, Hausmann, and Stein (2001) find that countries that are able to borrow externally in their own currencies allow greater fluctuations of the exchange rate relative to fluctuations of the interest rate and their reserves. Along a similar line of research, Levy Yeyati, Sturzenegger, and Reggio (2003), using de facto and de jure classifications of the exchange rate, find that the level of dollar liabilities (relative to the money supply) is positively correlated with the probability of fixing the exchange rate.

2. McKinnon and Pill (1998) document that many of the Asian economies that experienced financial crises in the second half of the 1990s maintained high levels of dollar debt. Calvo, Izquierdo, and Mejía (2004) find that domestic bank dollarization, measured by the sum of dollar deposits and foreign loans, increases the likelihood of a sudden stop in net capital inflows. Levy Yeyati (2003, 2005) shows that a banking crisis is more likely after a currency depreciation in countries in which domestic banks are highly dollarized, and these countries also have more volatile output growth rates. Céspedes (2004) provides evidence that exchange rate depreciations have a less expansionary effect when the level of dollar debt is higher. Eichengreen, Hausmann, and Panizza (2003) show that countries with a higher proportion of dollar-denominated foreign debt have more volatile growth of output and capital flows, and their sovereign debt obtains lower ratings from the rating agencies. Finally Arteta (2003) presents evidence in the opposite direction. This author does not find statistically significant evidence that dollarization in the domestic banking system makes a banking crisis more likely.

3. For a detailed summary of the literature on balance sheet effects from dollar debt, see Galindo, Panizza, and Schiantarelli (2003) and Bleakley and Cowan (2005).

This ambiguity has two possible explanations. The first is that currency mismatches are not quantitatively important, and the macroeconomic evidence is therefore likely to be capturing omitted variables, correlated with the level of dollarization, which are the true determinants of the financial volatility and vulnerability. The second explanation relates to the endogeneity of the currency composition of the debt. This explanation has two components. The first relates to the use that this literature makes of the dollar debt as a proxy for currency mismatches. If the firms that maintain dollar debt are also the firms whose income is highly correlated with the real exchange rate, then dollar debt will be a bad measure of the currency mismatch. The second component relates to the endogeneity of currency mismatch decisions. In particular, if firms with strong mismatches are precisely those for which the balance sheet effects are less important, depreciations could be expected to have a small effect on their output and investment levels.

In this study, we argue that the lack of conclusive empirical results at the firm level is due to the endogeneity of the debt choice, not to the absence of a balance sheet effect. To test this, we construct a new database of around 200 firms in the Chilean nonfinancial sector, which includes information on the currency composition of their liabilities, assets, and revenue and their net currency derivative positions. As far as we know, this is the first database that includes such detailed information on the currency mismatches on and off the balance sheet of firms in an emerging economy.

Our main result is that after we adequately control for differences in the composition of assets and revenue and for the net derivatives position, we find a significant balance sheet effect in the sample of Chilean firms. In other words, currency mismatch is important. We also find that currency derivatives play a role in isolating firms' investment decisions from currency shocks and that the balance sheet effect is smaller for firms that a priori we think have fewer constraints on access to credit.

On the choice of dollar debt, we find evidence of currency hedging among the Chilean firms. Firms in Chile hedge the currency composition of their liabilities, assets, and revenue, and they take derivative positions if they do not have a "real" hedge.[4] This is why dollar debt is higher in firms with dollar assets and in firms that export part of their sales. We

4. This result is consistent with the results obtained for Asia by Allayanis and Weston (2001).

also find that currency exposure is negatively correlated with measures of credit constraints and a measure of investment opportunities.[5] This suggests that the firms that are the most exposed to exchange rate risk are the best prepared for taking this risk.

A key question when considering the determinants of dollar debt is the role of exchange rate policy. By increasing the variance of the real exchange rate in the short and medium terms, a flexible exchange rate policy increases the relative risk of the dollar debt, inclining the balance in favor of the peso debt. In line with this hypothesis, we find significant changes in the level of currency exposure after the implementation of a floating exchange rate regime in Chile in 1999. This fall is significant, even after we control for interest rate differentials.

1. Effects and Determinants of Currency Mismatches: A Summary of the Literature

Several empirical studies use firm-level data to test the presence of a balance sheet effect generated by the increase in the peso value of dollar-denominated debt due to the depreciation of the exchange rate. At first sight, the results are not conclusive. Some studies find that, in the period immediately after a devaluation, dollar-indebted firms do not invest relatively less than firms with peso-denominated debt. Other articles conclude that the balance sheet effect is, in fact, important and statistically significant. The former group includes the work of Bleakley and Cowan (2005). In a sample of 450 nonfinancial firms from five Latin American countries, the authors do not find a negative and significant effect of dollar debt on investment following a depreciation. The authors argue that this result is due to the fact that firms hedge the composition of their liabilities with their assets and revenue, so a currency devaluation leads to an increase not only in the peso value of the debt, but also in the income received and the value of their assets. These results are confirmed by Bonomo, Martins, and Pinto (2003) using a sample of Brazilian firms; Benavente, Johnson, and Morandé (2003) using a sample of Chilean firms; and Echeverry and others (2003) using a large sample of Colombian firms (around 8,000). None of these studies finds a negative and significant coefficient for the interaction between dollar debt and exchange rate depreciation. Luengnaruemitchai (2004)

5. Measured as the deviations of dollar debt net of derivatives from the levels predicted by a simple regression between debt in dollars, assets in dollars, and exports.

studies the impact of depreciations on investment in nonfinancial firms in Asia, the region that brought the risks associated with currency mismatches to the forefront of the discussion following the financial crisis in the region in the late 1990s (see McKinnon and Pill, 1998). Again, it is not possible to identify a negative and significant effect of the interaction between dollar debt and the rate of currency depreciation.

There are several possible explanations for this lack of results. The first relates to the way in which currency exposure is measured. Although the firms with more dollar debt are affected by a contractionary balance sheet effect, this could be offset by a competitiveness effect derived from the fact that they have dollar-denominated assets or that their income is positively correlated with the currency depreciations. Consistent with this hypothesis, studies that control for the competitiveness effect find that the most dollar-indebted firms invest relatively less immediately after a depreciation—that is, after controlling for the competitiveness effect, there is a negative and significant balance sheet effect (Aguiar, 2002; Pratap, Lobato, and Somuano, 2003).

The second explanation relates to the endogeneity of currency exposure decisions. In particular, an extensive theoretical literature, as well as a growing empirical literature, maintains that firms determine their optimal level of risk exposure based on their vulnerability to situations of financial distress and their set of investment possibilities. Froot, Sharfstein, and Stein (1993) develop a model in which the cost of financial distress is the loss of investment opportunities. In this context, currency hedging reduces the cost of external financing and mitigates the problems of underinvestment described by Myers (1977). The implication is that firms will increase their currency hedging if they are vulnerable to critical financial situations or have better investment opportunities. In the context of the literature on balance sheet effects and currency exposure, this means that the investment decisions of firms with a high level of currency exposure could be less sensitive to balance sheet effects.

From the empirical point of view, firm-level studies that seek to explain firms' hedging decisions center mainly on the use of derivatives. Gezcy, Minton, and Schrand (1997), and Allayanis and Ofeck (2001), using data from 500 nonfinancial U.S. firms listed in Forbes, find that derivative use is positively correlated with investment opportunities, measured by expenditure on research and development, firm size, and the interaction between firm leverage and the market-to-book ratio (a measure of investment opportunities); and negatively correlated with the level of firm liquidity, measured by the

quick ratio. Bartram, Brown, and Fhele (2004) use data on currency, interest rate, and commodity derivatives on 7,000 nonfinancial firms in forty-eight countries; they find that the firms that use currency derivatives the most also have income generated by foreign sales, are listed on foreign stock exchanges, or have foreign-currency-denominated debt. Firms also use currency hedging more if they have higher leverage, lower quick ratios, and higher market-to-book ratios.

Finally, Allayanis, Brown, and Klapper (2001) study currency hedging in nonfinancial firms from eight Asian economies over the 1996–98 period. In contrast to the U.S. studies, the evidence reported does not support the hedging theories described above. The authors find that liquidity-constrained firms and firms with higher investment opportunities do not use derivatives more and that currency derivatives are substitutes for foreign-currency revenue generated by sales. They also find that firms in countries with sufficiently large interest rate differentials have a lower level of hedging, which suggests that in this case firms trade off the higher risks of currency hedging with the benefits of cheap foreign credit.

2. Currency Mismatches, Balance Sheet Effects, and Hedging in Nonfinancial Firms

The empirical strategy in our framework is based on the estimation of a hedging equation at the firm level. The estimation is derived from a simple mean-variance framework in which we assume that the firm's profit function is concave on the level of its net worth:

$$\beta^* = \alpha + \frac{\tau + \varepsilon}{\mu \sigma_z}, \tag{1}$$

where β^* is the ratio of dollar debt to assets; α is the share of firm assets that produce foreign currency operational income; $\tau + \varepsilon$ is the expected interest rate differential between domestic and foreign currency debt, which we assume has an aggregate component τ, and a firm level idiosyncratic component ε; μ is a measure of firm risk aversion; and σ_z is the variance of the real exchange rate.

In the absence of interest rate differentials ($\tau + \varepsilon = 0$), the firm will choose the currency composition of its debt to match that of its assets (net operational income). However, if there are differential costs between peso and dollar borrowing, they will choose to carry some foreign exchange exposure in their balance sheet in order to reduce their expected

borrowing costs. In other words, if there is a gap between domestic and foreign borrowing costs adjusted for expectations τ or if the firm has some idiosyncratic advantage that allows it cheaper access to foreign currency debt ε, then a currency mismatch will result. For a given interest rate differential, the size of this mismatch is decreasing in the expected volatility of the exchange rate, σ_z, and the degree of the firm's risk aversion, μ.

We start by measuring the size and significance of balance sheet effects on investment in Chilean firms in section 4. Our specific empirical strategy is to assess whether firms with more dollar debt invest relatively less in the aftermath of a depreciation. We do so by estimating reduced-form equations for fixed capital investment. The proposed mechanism centers on the interaction of alternative measures of currency mismatch with shifts in the exchange rate. Thus the key variable in our analysis in this section is for firm i in period t:

$$\text{FOREIGN DEBT}_{i,t-1} \times \Delta \ln \text{EXCHANGE RATE}_t .$$

If firms are behaving according to equation (1), foreign currency debt will be a poor measure of currency exposure in the balance sheet. If firms systematically match the currency composition of their assets and income α, with that of their liabilities β, then empirical estimates of the balance sheet effects based on dollar debt alone will be biased upwards, as firms holding high shares of dollarized debt see the largest increases in profits following a depreciation. We therefore augment this basic specification with a series of controls for α, using firm level data on exports, foreign assets, and net derivative positions.

In section 5, we examine the extent of matching between foreign currency assets, income, and liabilities directly within the cross-section of firms in our sample. First, we check the relation between foreign currency debt, net derivative usage, and the currency composition of assets and net income at the firm level. Next, we check whether variables that the corporate finance literature argues are correlated with firm risk aversion, μ, explain deviations in observed debt composition levels from the matching composition. Since we do not directly observe firm-level values of α, we look at the absolute value of deviations of β from the level predicted by the matching equations estimated in the previous subsection and correlate these deviations with proxies for μ.

Finally, in section 6, we analyze how the change in the macroeconomic policy regime in Chile in the late 1990s affected foreign currency hedging by firms. As is evident from equation (1), monetary

and exchange rate policy affects the extent of hedging in firms through its impact on the economywide interest rate differential τ, and the exchange rate volatility σ_z. A key component of the new policy regime was the adoption of a floating exchange rate regime. This caused both an increase in exchange rate volatility and a compression of interest rate differentials. Therefore, we expect the level of currency exposure of Chilean firms to decline after the shift to the floating exchange rate regime in the late 1990s. We further test whether the decline was larger for firms that are likely to be more risk averse because of capital market imperfections. In the final section, we attempt to separate the effects of changes in interest differential from changes in exchange rate volatility after 1999.

3. The Database

Our data consist of firm-level accounting information for nonfinancial corporations in Chile for the period 1995 to 2003. We also have data on firm exports, sectors in which the firms operate, and ownership. Our main source of information is the Chilean Superintendency of Securities and Insurance (the *Superintendencia de Valores y Seguros,* or SVS),which requires all firms categorized as corporations to disclose their accounting information using a standardized format (the *Ficha Estadística Codificada y Uniforme,* or FECU). We use nonconsolidated data, so that investments in subsidiaries are reported in a separate account and not as a part of the aggregate stock of fixed assets.

Data on the currency composition of liabilities and assets is not recorded directly in the FECUs, but is reported in the notes attached to each firm's annual financial statistics. These notes are not standardized and are not available in an electronic format. We therefore start with the data on foreign currency liabilities assembled by Benavente, Johnson, and Morandé (2003).[6] We then input data on foreign currency assets and derivatives collected from each of the notes mentioned above.

For our estimates, we use a sample restricted to the nonfinancial firms for which foreign-currency data are available. Table 1 shows the number of observations in the final sample per year, as well as descriptive statistics for the main variables we use. The size of the sample changes as new firms are incorporated into the SVS database.

6. This database is part of a broader effort by the IDB to put together data on firm-level currency composition of liabilities. For more details, see Galindo, Panizza, and Schiantarelli (2003).

Table 1. Descriptive Statistics

Variable	*Observations*	*Mean*	*Standard deviation*	*Minimum*	*Maximum*
Investment in fixed capital over lagged assets	1,326	0.038	0.149	–2.200	1.071
Dollar debt over lagged assets	1,183	0.093	0.139	0.000	1.013
I (firm has dollar debt)	1,179	0.651	0.476	0.000	1.000
Dollar assets over lagged assets	1,186	0.058	0.164	–0.029	1.008
Net foreign exchange derivatives position over lagged assets	1,325	0.007	0.043	–0.153	0.562
I (firm has derivatives)	1,326	0.141	0.348	0.000	1.000
Exposure (dollar debt – forwards – dollar assets) over lagged assets	1,181	0.027	0.169	–1.008	0.648
Cash flow over lagged assets	1,326	0.072	0.185	–1.584	3.209
Exports over lagged assets	1,309	0.053	0.156	0.000	1.379
Exports over sales	1,309	0.098	0.229	0.000	1.027
Lagged capital over assets	1,326	0.772	0.451	0.000	4.833

Source: See appendix.

Our main measure of firm performance is investment in fixed capital, measured as the change in gross fixed assets. Accounting standards in Chile only contemplate revaluations of fixed assets for consumer price index (CPI) inflation, making it possible to separate investment from changes in the accounting valuation of capital goods.

Our main measure of currency exposure is foreign currency debt (D^*), the book value of foreign currency liabilities converted into local currency. Chilean accounting standards dictate that conversion of debt from foreign to local currency values be carried out using the exchange rate at the time at which the balance sheet is reported. We augment this variable with a measure of foreign currency assets (A^*), which is the local currency value of fixed assets that are indexed to a foreign currency instead of the local CPI, and the nominal value of outstanding currency derivatives contracts with domestic banks. To our knowledge, this is the first comprehensive dataset of emerging market firms to include information on the currency composition of both sides of the balance sheet.

One of the main questions we seek to answer in this paper is whether firms match the currency composition of assets and liabilities. To answer this question, we construct additional variables that proxy for α. The first is a tradable dummy, that takes a value of one for firms in agriculture, manufacturing, and mining and zero otherwise. Data on the sector composition of output is reported in the FECU, and we also add firm-level data on FOB export shipments collected from the Chilean Customs Office. We convert the export data from dollars to pesos using the year-end exchange rate.

To explore the relation between investment and currency exposure, we control for additional determinants of investment. The first of these is earnings, defined as net operational earnings plus depreciation. Since we wish to identify the effects of leverage (in particular, leverage in dollars) on investment, we follow Lang, Ofek, and Stulz (1996) in using a measure of earnings that does not depend on the firm's debt choice. This measure of cash flow also excludes gains (or losses) from exchange rate changes, which allows us to isolate the effects of exchange rate fluctuations on revenues and costs from its effects on the valuation of assets and liabilities.

Some of our specifications include measures of the ratio of the book to market value of assets and average q ratios as control variables. Both of these require data on market capitalization. We obtain this data directly from the Chilean stock exchange. In all cases, the values we use correspond to closing prices and outstanding shares in December.

Data on the use of derivatives at the firm level is scarce in the literature in general, mostly because regulatory entities have only recently imposed the obligation to report this kind of transaction. Chile is no exception. Homogeneous data on derivative use from the notes to the financial statements is only available since 2001.[7] To overcome this limitation, we obtained access to an additional source of derivative data: the register of notional values of foreign currency derivatives outstanding with Chilean banks (F^*). The main advantage of this series is that it is available since 1993. On the other hand, derivative transactions that do not include a domestic bank are excluded. This seems to be a fairly minor problem in our sample. Differences in 2001 and 2002 between the nominal amounts reported by firms in the notes to their financial statements and the notional amounts reported by banks are minimal.

Although we use the longer derivatives series from the Central Bank of Chile in all of the regressions, the notes to the financial statements provide interesting additional information on the use of currency derivatives in Chile in. The notes provide contract-by-contract information for all derivative transactions, covering all derivative instruments and underlying assets. Based on the data for the period

7. In October 2000, the SVS modified the regulations that define how to report derivative transactions in the complementary notes to the balance sheet data. In the new norm, the SVS explicitly clarifies the obligation to report derivatives and identifies which information to disclose. Before 2000, the norm was not clear enough to ensure that every single transaction would be informed, leaving this decision up to the firm. The data that comes from the complementary notes is thus trustworthy only since 2001.

2001–02, we observe three important stylized facts. First, Chilean firms use derivatives contracts primarily to cover exchange rate exposure. In fact, 73 percent of the total number of contracts reported in the period (385) corresponds to foreign currency contracts. Second, the most common instrument used to cover exchange rate risk is the forward. If we restrict our sample to foreign currency contracts, 86 percent are forwards contracts. Third, derivatives contracts are established over relatively short periods, with an average duration of less than one year (ten months).

Finally, we build four indicator variables to control for differences in firm ownership. The variable ADR measures whether the firm's stock trades on a U.S. stock exchange in the form of American depositary receipts (ADRs) in any given year. The variable GRUPO is a dummy variable that indicates whether a firm was part of a conglomerate (as defined by the SVS) in 2003. AFP is dummy variable that takes the value of one if the Chilean pension fund administrators (AFPs) may hold stock from the firm without restrictions. We construct the variable using information provided by the Superintendcy of Pension Fund Administrators (the *Superintencia de Administradores de Fondos de Pension,* or SAFP). We exclude the stocks of financial intermediaries such as banks, pension funds, insurance companies, mutual fund administrators, and investment funds administrators on the stock exchange. The last of the ownership variables is FOREIGN, a dummy variable for firms controlled by foreign multinationals. This variable is constructed in two steps. First, we pooled the most recent information from the SVS, Economática, and Worldscope on shareholder composition. We then used Lexis Nexis, the corporate affiliations Database, and the Mergers and Acquisitions Database to cross-check the nationality of the main shareholder or parent company. Of these four variables, all but GRUPO are time varying.

We modify all accounting variables in the followings three ways. First, we inflate or deflate our data to 1996 values using December-to-December changes in the consumer price index. Second, we drop all firm-year observations if the accounting data are not self-consistent, because data on foreign currency liabilities and assets are inputted by hand. In particular, we drop observations if the ratios of dollar debt over total liabilities, dollar assets over total assets, exports over total sales, and short-term liabilities over total liabilities are outside the range (–0.1, 1.1). We also drop observations if the ratio of forward position over total assets is outside the range (–1.1, 1.1). Finally, we drop outliers of our key left-hand-side and right-hand-side variables. To do so, we

construct a z score using the sample mean and standard deviation, and we then drop firm-year observations that have $|z| > 2$.

Because we are interested in the effects of a devaluation on firms holding dollar debt, in the analysis below we interact D^*, A^*, and F^* with changes in the real exchange rate, Δe. Our definition of e (the nominal exchange rate against the U.S. dollar, scaled by the local CPI) is consistent with the inflation adjustments described above. In all the specifications we report, we measure Δe as the log change in the real exchange rate between Decembers of successive years. Using e on inflation-adjusted values of debt is equivalent to using the nominal exchange rate on current values. According to this definition, a devaluation leads to a higher value of e.

4. The Effects of Currency Exposure on Firm Performance

Our empirical specification in this section can be motivated with a simple framework in which the optimal stock of capital is a function of the real exchange rate (due to the competitiveness effect) and the real value of previous-period liabilities (due to a balance sheet effect). Specifically, assume that the log of the optimal capital stock, k_t^*, is given by

$$k_t^* = \alpha e_t - \theta P_t ,$$

where α measures the elasticity of k_t^* to the real exchange rate, θ represents the elasticity of the log of the optimal capital stock to leverage, and P_t is the real (inflation-adjusted) value of previous-period liabilities, which serves as a proxy for net worth. In the presence of quadratic adjustment costs, investment (I_t) will be a fraction (λ) of the gap between the frictionless capital stock and lagged capital, so that

$$I_t = \lambda(\alpha e_t - \theta P_t - k_{t-1}). \tag{2}$$

The key mechanism we wish to test is how a depreciation alters investment by inflating the domestic-currency value of debt. To incorporate this mechanism in the previous equation, consider that the real value of previous-period liabilities is given by

$$P_t \approx D_{t-1}^* \Delta e_t + P_{t-1} , \tag{3}$$

where D^*_{t-1} is lagged dollar debt and Δe_t the log change in the real exchange rate. The real value of the firm's debt rises if it holds foreign

currency debt and the exchange rate goes up faster than the domestic-price level. This is, of course, a purely mechanical effect.

Our basic empirical specification (for firm i in year t) follows directly from equations (2) and (3):

$$I_{i,t} = -\gamma\left(D^*_{i,t-1}\Delta e_t\right) + \delta P_{i,t-1} + \lambda\left(\alpha_i e_t\right) - \lambda k_{i,t-1} + \phi D^*_{i,t-1} + y_t + \omega_t + \upsilon_{i,t}\,, \quad (4)$$

We estimate versions of equation (4) on our sample of firms for the period 1995–2003. The key explanatory variable in our analysis is the interaction of lagged dollar debt, $D^*_{i,t-1}$, with the log change in the real exchange rate, Δe_t.

We can interpret the estimated coefficient on this interaction in two ways. The first, which follows directly from the framework presented in this section, is the effect of exogenous changes in the real value of total liabilities on firm investment. The second follows from a difference in difference approach, in which the estimated coefficient on the interaction between lagged dollar debt and the change in the real exchange rate ($D^*_{i,t-1} \cdot \Delta e_t$) indicates whether firms holding dollar liabilities invest significantly less than their counterparts in periods following a devaluation.

In addition to the ($D^*_{i,t-1} \cdot \Delta e_t$) interaction, we include lagged foreign-currency-denominated debt to absorb any preexisting differences among firms with different levels of dollar indebtedness. Such differences might have prevailed in the absence of movements in the real exchange rate(for example, if expanding firms were more likely to issue dollar debt than stagnant ones). We also include sets of year and firm-specific dummies, y_t and ω_i. The year dummies capture aggregate shocks common to all firms in our sample, including changes in the real exchange rate. The firm-level dummies capture time-invariant differences across firms in the optimal level of capital. Finally, we include a series of proxies for α_i, the elasticity of k^* to the real exchange rate. We discuss these proxies and additional controls below.

4.1 Main Results

Table 2 presents estimates of the reduced effect on investment of holding dollar debt during a depreciation. The key variable here is the interaction between lagged dollar debt and the change in the real exchange rate. This interaction will indicate whether firms holding dollar debt invest relatively less that those holding peso debt in periods following a depreciation.

Table 2. Effect of Exchange Rate Exposure on Investment, 1995–2003[a]

Explanatory variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Interaction						
Dollar debt x (Δ log real exchange rate)	0.009	–0.020	–0.049	–0.043	–0.428**	–0.453***
	(0.155)	(0.126)	(0.109)	(0.112)	(0.205)	(0.170)
Main effect						
Dollar debt	0.014	0.015	0.026	0.025	0.021	0.032
	(0.063)	(0.059)	(0.060)	(0.057)	(0.060)	(0.058)
Total debt	–0.097*	–0.095*	–0.100*	–0.099*	–0.098*	–0.101*
	(0.057)	(0.057)	(0.057)	(0.057)	(0.058)	(0.057)
Control						
Exports		–1.239		0.001		
		(1.191)		(1.229)		
Exports x (log real exchange rate)		0.205		0.004		
		(0.179)		(0.187)		
Tradable x (log real exchange rate)			0.169***	0.170***		0.152***
			(0.059)	(0.061)		(0.057)
Dollar assets					0.013	0.009
					(0.029)	(0.029)
Dollar assets x (Δ log real exchange rate)					0.847***	0.791***
					(0.210)	(0.231)
Summary statistic						
No. observations	1.326	1.326	1.326	1.326	1.326	1.326
R^2	0.26	0.26	0.26	0.26	0.26	0.27

Table 2. (continued)

Explanatory variable	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*	*(12)*
Interaction						
Dollar debt x (Δ log real exchange rate)	–0.451**	–0.494**	–0.492**	–0.353**		
	(0.201)	(0.206)	(0.208)	(0.164)		
Exposure x (Δ log real exchange rate)					–0.265**	–0.274***
					(0.117)	(0.097)
Main effect						
Dollar debt	0.011	0.009	0.009	0.010		
	(0.043)	(0.045)	(0.045)	(0.043)		
Exposure					–0.016	–0.018
					(0.020)	(0.023)
Total debt	–0.099*	–0.099*	–0.099*	–0.100*	–0.096*	–0.090*
	(0.057)	(0.057)	(0.057)	(0.056)	(0.055)	(0.049)
Control						
Tradable x (log real exchange rate)	0.113**	0.113**	0.113**	0.110***	0.106**	0.117**
	(0.044)	(0.044)	(0.044)	(0.042)	(0.042)	(0.046)
Dollar assets	0.013	0.013	0.013	0.030		
	(0.026)	(0.026)	(0.026)	(0.022)		
Dollar assets x (Δ log real exchange rate)	0.693***	0.711***	0.710***	0.224*		
	(0.203)	(0.202)	(0.203)	(0.117)		
Cash flow from operations	0.324**	0.324**	0.324**	0.321**	0.322**	0.307**
	(0.145)	(0.145)	(0.145)	(0.148)	(0.148)	(0.132)
Net long derivative position		0.016	0.018	0.015		
		(0.062)	(0.061)	(0.060)		
Net long derivative pos. x		0.404*		0.382		
(D log real exchange rate)		(0.236)		(0.256)		

Table 2. (continued)

Explanatory variable	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*	*(12)*
Net long derivative x (Δ log real exchange rate unexpected)			0.355*			
			(0.214)			
Lagged capital stock						–0.168**
						(0.071)
Lagged capital stock x (Δlog real exchange rate) x I (account US$)				0.609***	0.580***	0.561***
				(0.185)	(0.197)	(0.171)
Summary statistic						
No. observations	1.326	1.326	1.326	1.326	1.326	1.326
R^2	0.36	0.36	0.36	0.37	0.37	0.41

Source: Authors' calculations, based on accounting data from SVS and macroeconomic data from various sources.
* Statistically significant at the 10 percent level. ** Statistically significant at the 5 percent level. *** Statistically significant at the 1 percent level.
a. The dependent variable is the change in the CPI-adjusted stock of fixed capital. The regressions are variants of equation 4 in the text, using OLS and year fixed effects. All independent accounting variables (with the exception of cash flow from operations) are once lagged. All accounting variables are scaled by once-lagged total firm assets. I (account US$) is a dummy for firms that carry their accounting in dollars. Exposure is the dollar debt net of derivatives and dollar assets. The baseline real exchange rate is defined as the nominal peso-dollar exchange rate divided by the domestic CPI. Unexpected changes in the real exchange rate are built assuming uncovered interest rate parity, as described in the text. Net derivative positions are the notional values of currency derivative positions with domestic banks. For detailed sources and descriptions, see the appendix. Standard errors adjusted for clustering by year are reported in parentheses.

The sample covers the period 1995–2003. It includes two large depreciations in 1999 and 2001 (both approximately 10 percent in real terms) and a large appreciation in 2003. In addition, the levels of foreign currency debt exhibit substantial cross-firm variation, which allows us to identify differential responses of firms to a depreciation (or appreciation).

All specifications include firm fixed effects to control for time-invariant firm differences in the optimal capital stock, as well as year dummies to capture the shocks common to all firms. Following equation (4), we also include the lagged dollarization ratio to control for previous-period differences in firms with higher or lower dollar debt. Lagged total leverage is included as an additional control.

Column 1 includes only the interaction between dollar debt and the change in the real exchange rate ($D^* \cdot \Delta e$). As in previous studies for Chile, the estimated coefficient is not negative: firms with more dollar debt do not invest relatively less in periods following a depreciation. At the same time, the estimated coefficient on lagged leverage is negative as expected, suggesting a negative balance sheet effect from outstanding debt commitments.

As discussed above, the estimated coefficient on ($D^* \cdot \Delta e$) will be biased upwards if firms holding dollar debt also see their current and future profits expand following a depreciation. To control for this bias, columns 2 through 4 include interactions between changes in the real exchange rate and two proxies for the elasticity of income to the real exchange rate a: the ratio of exports over assets and a dummy for firms in the tradable sector. In both cases the estimated coefficient on the interaction term is positive—significantly so in the case of the tradable dummy interaction. The estimated coefficient on ($D^* \cdot \Delta e$) remains insignificant, although marginally more negative that in column 1.

The discussion so far in this section, and indeed in most of the empirical literature on firm-level currency balance sheet effects, focuses on dollar debt as the only mechanism through which a change in e can have balance sheet effects. By doing so, we are ignoring the fact that firms may also hold dollar-denominated assets, such as current assets in a foreign bank or offshore investments, and that the inflated value of these sources of income following a depreciation will offset the negative balance sheet effect of dollar liabilities. This is a necessary simplification in many cases given the absence of data on the currency composition of assets, but it can introduce substantial biases into the estimation of the balance sheet effects of a depreciation in a country such as Chile, where domestic firms hold significant foreign assets. In our sample,

the average ratio of dollar assets to total assets is 5.8 percent, which is very close to the 9.3 percent average of dollar liabilities.

With this in mind, we include an additional interaction between dollar assets and the change in the real exchange rate ($A^* \cdot \Delta e$) (see columns 5 and 6). As expected, the coefficient on the interaction is positive, since firms holding dollar assets see their fixed capital investment go up by relatively more than firms holding only peso assets. This, in itself, suggests a balance sheet effect: firms whose liabilities fall relative to total assets are perceived as less risky, face a lower cost of external finance, and consequently have a higher optimal capital level than do firms with a stable or rising ratio of liabilities to total assets.

Once the effect of ($A^* \cdot \Delta e$) is considered, the estimated coefficient on ($D^* \cdot \Delta e$) falls, becoming negative and significant. This confirms our prior: the insignificant coefficient on ($D^* \cdot \Delta e$) in column 1, and in many of the empirical papers so far, is due to omitted variables that are positively correlated with dollar debt. The reason is matching. Firms that hold dollar debt also have dollar assets (which offsets the balance sheet effect) and export a larger share of their output (which also offsets the negative balance sheet effect).

Finally, we control for differential effects of changes in the exchange rate on firm cash flow that are not captured by the interactions between tradable sectors and the exchange rate and exporting firms and the exchange rate. The specification reported in column 7 includes a measure of cash flow from operations. As expected, the cash flow variable is positive and highly significant, measuring relaxed credit constraints stemming from improved net worth and changes in the marginal product of capital.

Our results presented thus far suggest, first, that firms match the currency composition of their income and assets with that of their liabilities. As a result, those firms holding dollar debt during a depreciation see the value of their profits and assets expand in line with the value of their liabilities. The negative balance sheet effect of the exchange rate on debt is offset by the positive balance sheet effect of the exchange rate on assets and profits. Second, our results suggest substantial balance sheet effects: exogenous changes in leverage brought about by inflated peso values of debt have significant effects on investment. In our sample, the investment-to-asset ratio of firms holding 50 percent of their debt in foreign currency is 5 percent of assets lower that their peso-indebted counterparts following a 20 percent real depreciation (similar to the 2001 depreciation in Chile). This difference

is sizeable considering a sample mean of 4 percent. Third, from a measurement perspective, these result highlight the importance of having a measure of total balance sheet exposure to determine the effect of a depreciation in investment and output.

The Chilean derivatives market, in particular the market for currency derivatives, has expanded substantially in recent years. Although average net positions are still small in relation to total assets, they are no longer negligible, and in the case of some firms, they substantially alter the level of net (or uncovered) dollar debt. To explore the effects of these derivative positions on firm-level investment, column 8 includes an interaction between the real depreciation and net foreign exchange derivative position over assets in the previous period ($F^* \cdot e$). The estimated coefficient in positive and significant, meaning that in periods following a depreciation, firms holding long foreign exchange derivative positions invest relatively more than firms that do not.

Arguably, what matters for the effect of derivatives on output is not the total change in the real exchange rate, but the deviation from the change preestablished in the contract. We address this concern by using interest rate differentials to construct a measure of deviations of realized depreciation from the depreciation implicit in the forward contract, Δe^u. Assuming covered interest parity,

$$\Delta e_t^u = \Delta e_t - \left(r_{t-1} - r_{t-1}^*\right),$$

where r_{t-1} is the rate on UF-indexed debt for 90–365 days and r^*_{t-1} is the dollar lending rate in the domestic financial system for the same period.[8] According to this construction, most of the large depreciations were unexpected, even the 1999 depreciation. We therefore do not expect our results to vary substantially when we include an interaction of derivative positions with Δe_t^u. Indeed, the estimated coefficient (reported in column 9) is very similar to our previous result using total exchange rate movements.

A peculiarity of Chilean accounting norms is that certain firms are allowed to keep their accounts in dollars. Because these firms are allowed to revalue their fixed assets by changes in the nominal exchange rate, part of our measure of investment may simply be driven by changes in the prices of preinstalled assets. To correct for this, we introduce an

8. The *Unidad de Fomento* (UF) is an inflation-indexed unit of account that is commonly used in Chilean financial transactions.

interaction between the lagged capital stock and the change in the real exchange rate for those firms with dollar accounting (see column 10). This component controls for the effects of mechanical revaluations on investment. The estimated coefficient on the ($A^* \cdot \Delta e$) interaction falls considerably, but it is still significant. The estimated coefficient on the ($D^* \cdot \Delta e$) interaction remains negative and statistically significant.

The absolute value of the estimated coefficients on dollar debt, dollar assets, and currency derivatives are similar, and an F test fails to reject the hypothesis that all three coefficients are equal. We thus build an accounting measure of currency mismatch (E^*), equal to dollar debt net of assets and the net long position in foreign exchange derivatives $E^* = D^* - A^* - F^*$. In column 11, we repeat our baseline estimation of investment and include an interaction between exposure and changes in the real exchange rate ($E^* \cdot \Delta e$). As expected, the estimated coefficient on the interaction ($E^* \cdot \Delta e$) is negative and significant at conventional confidence level. The estimated coefficient implies that a difference in exposure of 50 percent of assets will lead (all things equal) to nearly 3 percent lower investment if the currency depreciates by 20 percent.

Finally, in column 12 we deviate from the difference-in-differences approach we have followed so far and estimate an empirical specification that follows directly from equation (4). To do so, we include the lagged capital stock. The main result remains unchanged: the estimated coefficient on ($E^* \cdot \Delta e$) is negative and significant. As expected, the estimated coefficient on lagged capital stock is negative and significant. We use the specification from column 12 as our baseline result in the tables that follow.

Summing up, we find evidence of sizeable balance sheet effects and of firm-level matching. These results are robust to a series of alternative specifications and firm level controls.[9]

4.2 Sensitivity Analysis

By focusing exclusively on exchange rate fluctuations, we have ignored the fact that many of the exchange rate changes in our sample occur simultaneously with changes in the supply (and cost) of foreign and domestic credit. For example, firms holding dollar debt might be

9. In addition to the specification reported here, we carried out the following additional robustness tests: estimates using lagged investment and interaction of Dln(real exchange rate) with exports and tradables; estimates using lagged investment and firm fixed effects based on the Arellano-Bond methodology; estimates that drop all observations in which E^* is zero, to control for right-hand-side variable censoring bias. In all cases, our main results remain qualitatively unchanged.

less sensitive to changes in domestic interest rates than firms holding peso liabilities. If domestic rates rise in periods of a depreciation because the Central Bank is defending the currency, then our coefficient on the ($E^* \cdot \Delta e$) interaction would be biased upward (toward zero). Alternatively, the large negative coefficient on the ($E^* \cdot \Delta e$) interaction could be the result of rising external capital costs and a tightening of foreign credit constraints that coincide with periods of depreciation.

Furthermore, exposure to exchange rate fluctuations is by no means the only aggregate shock that affects firm output and investment decisions. It is therefore informative to see how aggregate credit shocks (domestic and foreign) have differential effects on firms with different financial structures. To control for changing credit conditions, we estimate the investment regressions including an indicator of domestic credit conditions (namely, the domestic interest rate) and an indicator of external credit conditions (the return on the Emerging Market Bond Index, or EMBI, bond basket). In each case, we interact the macroeconomic variable with our measure of currency exposure and the ratio of dollar debt to total assets. We also interact the macroeconomic variables with a measure of the firm's maturity mismatch.[10] The risk of maturity mismatch for emerging market firms has received almost as much attention in recent years as the risk of currency mismatch. Although business assets are (stereotypically) installed for the long term and are therefore illiquid, capital market frictions and distortions may induce firms to issue debt with relatively short maturity. Should aggregate credit conditions shift suddenly, these firms would be unable to renew their debt and thus might have to curtail investment and perhaps liquidate.

Table 3 shows the results obtained for investment after including aggregate credit variables. The ($E^* \cdot \Delta e$) interaction is significant and negative even after we include this additional set of controls. Moreover, the point estimates change only slightly. Most of the additional coefficients estimated have the expected signs, but they are not significant at conventional confidence levels. We do, however, obtain interesting results for the interactions with the maturity mismatch variable. All things equal, firms with more short-term debt relative to short-term assets react more strongly to hikes in the domestic interest rates than do firms with a lower ratio.

10. We tested the robustness of our results to a series of additional interactions (not report in the table). At the firm level we used short term debt, log(assets), and total leverage. At the macroeconomic level, we used net capital inflows, changes in the stock of bank loans to the private sector, a dummy for sudden stops (as defined by Calvo, Izquierdo, and Mejía, 2004), and London interbank offered rates (LIBOR) on dollar loans. These results are available on request.

Table 3. Changes in Aggregate Credit Conditions[a]

Explanatory variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Interaction						
Exposure x (Δ log real exchange rate)	–0.253***	–0.292**	–0.248***	–0.267***	–0.283***	–0.291***
	(0.081)	(0.125)	(0.084)	(0.091)	(0.100)	(0.095)
Baseline control						
Exposure	0.005	–0.065**	–0.006	–0.007	–0.018	–0.019
	(0.041)	(0.033)	(0.025)	(0.024)	(0.023)	(0.023)
Cash flow from operations	0.307**	0.307**	0.308**	0.307**	0.307**	0.303**
	(0.132)	(0.132)	(0.132)	(0.132)	(0.132)	(0.133)
Tradable x (Δ log real exchange rate)	0.118**	0.113**	0.116**	0.117**	0.111**	0.137***
	(0.046)	(0.047)	(0.047)	(0.046)	(0.047)	(0.049)
Lagged capital stock	–0.168**	–0.168**	–0.169**	–0.169**	–0.171**	–0.171**
	(0.071)	(0.071)	(0.071)	(0.071)	(0.072)	(0.072)
Total debt	–0.09*	–0.09*	–0.087*	–0.087*	–0.106*	–0.108*
	(0.049)	(0.049)	(0.049)	(0.049)	(0.056)	(0.057)
Additional control						
Lagged capital stock x (Δ log real	0.558***	0.567***	0.56***	0.554***	0.569***	0.563***
exchange rate) x I (account US$)	(0.169)	(0.169)	(0.169)	(0.173)	(0.169)	(0.164)
Exposure x EMBI yield	–0.174					
	(0.296)					
Exposure x domestic interest rate		0.666				
		(0.494)				
Dollar debt			0.025	–0.04		
			(0.070)	(0.091)		
Dollar debt x EMBI yield			–0.406			
			(0.395)			

Table 3. (continued)

Explanatory variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Dollar debt x domestic interest rate				0.151		
				(0.931)		
Maturity mismatch					–0.007	0.136***
					(0.073)	(0.045)
Maturity mismatch x EMBI yield					0.291	
					(0.502)	
Maturity mismatch x domestic interest rate						–1.46***
						(0.552)
Summary statistic						
No. observations	1.326	1.326	1.326	1.326	1.326	1.326
R^2	0.41	0.41	0.41	0.41	0.41	0.41

Source: Authors' calculations, based on accounting data from SVS and macroeconomic data from various sources.
* Statistically significant at the 10 percent level. ** Statistically significant at the 5 percent level. *** Statistically significant at the 1 percent level.
Source: Authors' calculations, based on accounting data from SVS and macroeconomic data from various sources.
a. The dependent variable is the change in the CPI-adjusted stock of fixed capital. All regressions are estimated using OLS, with year fixed effects. All independent accounting variables (with the exception of cash flow from operations) are once lagged. All accounting variables are scaled by once-lagged total firm assets. Exposure is dollar debt net of derivatives and dollar assets. I (account US$) is a dummy for firms that carry their accounting in dollars. Maturity mismatch is defined as the difference between current liabilities and current assets, scaled by total assets. Macroeconomic variables (the real exchange rate and domestic and international interest rates) are from the current period (that is, concurrent with the left-hand-side investment variable). The real exchange rate is defined as the nominal exchange rate divided by the domestic CPI. The domestic interest rate is the three-month rate of return on 30- to 89-day UF-denominated loans in the domestic financial system. For detailed sources and descriptions, see the appendix. Standard errors adjusted for clustering by year are reported in parentheses.

Differential balance sheet effects across firms

The sample-average effect presented above was strongly negative, but this might mask differences in balance sheet effects across groups of firms. Indeed, we would expect the estimated coefficient on the ($E^* \cdot \Delta e$) interaction to be relatively smaller (in absolute terms) for firms that we would consider a priori less credit constrained or financially stronger.

Table 4 partitions the sample by predetermined firm characteristics. Column 1 replicates our baseline results, while columns 2 through 5 introduce an additional interaction between the ($E^* \cdot \Delta e$) variable and one of four indicator variables. The first of these is a dummy that takes a value of one for firms that are eligible to be included in the AFP portfolio. Two previous studies for Chilean firms have found that investment by firms in this category is less correlated with cash flow and less sensitive to leverage than is the investment of firms that are not in the AFP portfolios (Medina and Valdés, 1998; Gallego and Loayza, 2000). The additional three dummy variables were described above: a dummy for foreign ownership, a dummy for firms with ADRs, and a dummy for firms belonging to a financial conglomerate.[11] All the specifications also include the indicator variable, its interaction with total leverage, and its interaction with De, although only the coefficients on ($E^* \cdot \Delta e$) and the triple interaction are reported. Structuring the specification in this manner allows us to estimate how the effect of ($E^* \cdot \Delta e$) among the indicated set of firms differs from the rest of the sample.

When we interact our measure of exposure with the AFP dummy and the ADR dummy, the estimated coefficient is positive, suggesting that less credit constrained firms are less vulnerable to the balance sheet effects of currency exposure. The interaction has the opposite sign, however, in the case of the foreign and financial conglomerate dummies. These regressions have been estimated very imprecisely, so these findings must be taken with caution. We have no explanation for the results of either the foreign dummy or the financial conglomerate dummy.

5. Foreign Currency Hedging by Chilean Nonfinancial Firms

The previous section provides empirical support of a strong balance sheet effect arising from the interaction of foreign debt and exchange rate depreciations after controlling for differences in the composition of

11. We exclude those periods from the sample in which a firm changes categories. This explains the smaller sample than in previous specifications.

Table 4. Effect of Exposure across Firm Categories[a]

Explanatory variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*
Exposure x (Δ log real exchange rate)	–0.287***	–0.451	–0.293*	–0.310**	0.250
	(0.092)	(0.295)	(0.154)	(0.123)	(0.369)
Exposure	–0.023	–0.026	–0.025	–0.023	–0.025
	(0.023)	(0.033)	(0.023)	(0.024)	(0.024)
Total debt	–0.089*	–0.090	–0.091*	–0.093*	–0.091*
	(0.049)	(0.055)	(0.050)	(0.049)	(0.050)
Cash flow from operations	0.309**	0.275**	0.307**	0.308**	0.308**
	(0.131)	(0.135)	(0.132)	(0.132)	(0.131)
Lagged capital stock	–0.167**	–0.179**	–0.168**	–0.169**	–0.167**
	(0.071)	(0.091)	(0.071)	(0.072)	(0.071)
Lagged capital stock x (Δ log real exchange rate)	0.577***	0.542**	0.582***	0.553***	0.533*** x I
(account US$)	(0.179)	(0.211)	(0.186)	(0.188)	(0.182)
I (AFP) x exposure x (Δ log real exchange rate)		0.343			
		(0.394)			
I (foreign) x exposure x (Δ log real exchange rate)			–0.057		
			(0.606)		
I (ADR) x exposure x (Δ log real exchange rate)				0.185	
				(0.452)	
I (GRUPO) x exposure x (Δ log real exchange rate)					–0.750
					(0.559)
Summary statistic					
No. observations	1.326	1.102	1.323	1.308	1.326
R^2	0.41	0.4	0.41	0.41	0.41

Source: Authors' calculations, based on accounting data from SVS and macroeconomic data from various sources.
* Statistically significant at the 10 percent level. ** Statistically significant at the 5 percent level. *** Statistically significant at the 1 percent level.
a. The dependent variable is the change in the CPI-adjusted stock of fixed capital. All regressions are estimated using OLS, with year fixed effects. All independent accounting variables (with the exception of cash flow from operations) are once lagged. All accounting variables are scaled by once-lagged total firm assets. Exposure is dollar debt net of derivatives and dollar assets. I (account US$) is a dummy for firms that carry their accounting in dollars, I (AFP) is a dummy variable for firms eligible to be included in the portfolio of pension fund regulators, I (foreign) is a dummy for firms owned by foreign corporations, I (ADR) is a dummy for firms listing ADRs on the New York Stock Exchange, and I (GRUPO) is a dummy for firms belonging to a conglomerate in 2002 as defined by the SVS. The baseline real exchange rate is defined as the nominal peso-dollar exchange rate divided by the domestic CPI. The number of observations changes because periods in which firms change categories are excluded from the sample. Standard errors adjusted for clustering by year are reported in parentheses.

the balance sheet and net operational income. The evidence also suggests that Chilean nonfinancial corporations actively use foreign debt as a hedge for other sources of foreign currency exposure. This section studies the hedging behavior of Chilean firms during the sample period. We estimate a set of regressions to examine the extent of currency matching in our sample and the relation between hedging and those variables identified in the corporate finance literature to explain risk aversion in nonfinancial corporations.

5.1 Dollar Debt and Productive Structure

In this section, we evaluate the first prediction of the mean variance framework we presented in the previous section—namely, that firms match the currency composition of their liabilities with that of their assets and income. To do so, we estimate the following equation on pooled firm-level data for the period 1996–2002

$$\beta_{it} = \delta\alpha_{it} + \upsilon_{it}\,, \tag{5}$$

in which for firm i in period t, β_{it} is a measure of dollar debt to total assets and α_{it} is the set of variables introduced in the previous section that proxy for the elasticity of firm income to the real exchange rate (specifically, direct exports as a share of total sales; a dummy variable that takes a value of one if the firm is in the agriculture, mining, or manufacturing sector; and the ratio of dollar-denominated assets to total assets).

Table 5 reports the ordinary least squares (OLS) estimation for the ratio of dollar debt to assets. Column 1 includes the tradable dummy (agriculture, mining, or manufacturing), while column 2 includes a set of dummies for one-digit International Standard Industrial Classification (ISIC) sectors (not reported). Because β_{it} is left-hand censored at zero, we also estimate equation (5) using a Tobit method (see columns 3 and 4). In all four specifications, the estimated coefficients on exports and dollar assets are positive and highly significant. The coefficients are also sizeable. Using the estimated coefficients from column 1, we find that the fraction of dollar-denominated liabilities over assets is 6.5 percent higher in firms that export 50 percent of their output than in firms that sell their output domestically. Similarly, firms with a 50 percent share of dollar-denominated assets have, on average, ratios of dollar debt to assets that are 13 percent higher than firms with primarily peso- or UF-denominated debt. The tradable dummy is positive and

Table 5. Dollar Debt and Production Structure, 1996–2002[a]

	Dollar debt / total assets				Dollar debt / total debt				I (dollar debt)		Net dollar debt / total assets	
Explanatory variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*	*(12)*
Dollar assets / total assets	0.269*** (0.052)	0.264*** (0.051)	0.330*** (0.034)	0.344*** (0.034)	0.586*** (0.082)	0.629*** (0.079)	0.702*** (0.070)	0.788*** (0.069)	7.466*** (2.332)	8.127*** (2.393)	0.274*** (0.051)	0.269*** (0.050)
Exports / sales	0.128*** (0.033)	0.122*** (0.031)	0.174*** (0.026)	0.196*** (0.023)	0.356*** (0.069)	0.419*** (0.063)	0.441*** (0.052)	0.568*** (0.048)	1.894*** (0.466)	2.583*** (0.549)	0.149*** (0.033)	0.142*** (0.030)
Tradable	–0.008 (0.018)		0.027** (0.013)		0.077* (0.040)		0.157*** (0.027)		0.547*** (0.184)		–0.008 (0.017)	
Summary statistic												
No. observations	1.078	1.078	1.078	1.078	1.078	1.078	1.078	1.078	1.085	1.085	1.075	1.075
R^2	0.17	0.17			0.29	0.27					0.21	0.21
Sector dummies	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Cluster rut	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Estimator	OLS	OLS	Tobit	Tobit	OLS	OLS	Tobit	Tobit	Probit	Probit	OLS	OLS

Source: Authors' calculations.
* Statistically significant at the 10 percent level. ** Statistically significant at the 5 percent level. *** Statistically significant at the 1 percent level.
a. This table reports the estimates of equation 5 in the text. The estimation method for each regression is reported in the bottom row. The dependent variable is as detailed in each column. Net dollar debt is dollar debt net of derivative positions. The net derivative position is the notional value of the net long position of foreign exchange derivatives with domestic banks. Tradable firms are those in ISIC sectors 1 through 3 (agriculture, mining, and manufacturing). Standard errors are in parentheses.

significant in column 3: even after we control for dollar assets and exports, dollar liabilities are 3 percent higher (as a percent of total assets) than in nontradable sectors.

We obtain qualitatively identical results when we measure β as the ratio of dollar debt to total debt (in columns 5 through 8), when we replace β with an indicator variable for firms that hold dollar debt (column 9 and 10), and when we measure β as dollar debt over assets net of derivative positions (columns 11 and 12).

In sum, we find strong evidence that firms match the currency composition of their debt with that of their accounting assets and income streams. Effective foreign currency exposure is therefore substantially smaller than what foreign currency debt suggests, so that in periods of depreciation we expect the negative balance sheet effects of dollar debt to be offset (or reversed) by the positive balance sheet effects of dollar assets and income.

5.2 Structural Determinants of Derivative Use

What ultimately matters for firm performance is the net exposure to exchange rate shocks. Nevertheless, in our sample derivative positions are relatively small vis-à-vis total dollar debt, so the results for net dollar debt (dollar debt net of long foreign exchange derivative positions) are driven to a large extent by the debt component. We therefore present some additional results for the determinants of derivative use in table 6. In columns 1 and 2, the left-hand-side variable is the nominal value of net derivative positions over total assets; in columns 3 and 4, the left-hand-side variable is an indicator variable for firms holding any form of foreign exchange derivative.

The estimated coefficient on dollar debt is positive and significant at conventional confidence levels in all specifications. Firms holding dollar debt hold larger long positions in foreign exchange derivatives and are, in turn, more likely to hold any form of foreign exchange derivative than firms that do not hold dollar debt. On the other hand, the estimated coefficients on the ratio of exports to sales and the ratio of dollar assets to total assets are negative and significant only in columns 1 and 2. When we control for dollar debt, firms exporting a large share of their sales and firms with a large share of dollar-denominated assets hold significantly lower long derivative positions. The estimated coefficients on exports and dollar assets are not significant in columns 3 and 4 since long positions are treated identically to short positions in the dummy variable.

Table 6. Determinants of Derivative Use[a]

	Net derivatives/ total assets		I (dollar derivatives > 0)	
Explanatory variable	*(1)*	*(2)*	*(3)*	*(4)*
Dollar assets / total assets	–0.040	–0.039	–0.179	0.122
	(0.013)***	(0.015)***	(0.578)	(0.534)
Exports / sales	–0.037	–0.036	–0.426	–0.008
	(0.009)***	(0.010)***	(0.358)	(0.320)
Tradable	0.000		0.543	
	(0.005)		(0.209)***	
Dollar debt / total assets	0.129	0.129	2.613	2.428
	(0.039)***	(0.040)***	(0.495)***	(0.506)***
Summary statistic				
No. observations	1075	1075	1078	1078
R^2	0.13	0.13	—	—
Sector dummies	No	Yes	No	Yes

Source: Authors' calculations.
* Statistically significant at the 10 percent level. ** Statistically significant at the 5 percent level. *** Statistically significant at the 1 percent level.
a. The dependent variable is as detailed in each column. The estimation method is OLS in columns 1 and 2 and probit in columns 3 and 4. The net derivative position is the notional value of the net long position of foreign exchange derivatives with domestic banks. Tradable firms are those in ISIC sectors 1 through 3 (agriculture, mining, and manufacturing). Firm-clustered standard errors are reported in parentheses.3 and 4 since long positions are treated identically to short positions in the dummy variable.

Hence, firms in our sample use derivatives as a complement to real hedges. That is, firms use derivatives to offset the balance sheet risk of dollar debt when their income is not correlated with the real exchange rate.

5.3 Currency Exposure and Risk Aversion

If we control for a and the relative cost of domestic and foreign credit ($\tau + \varepsilon$), the level of exposure to currency shocks should be lower for more risk-averse firms than for risk-loving firms (that is, μ should be higher). To test this prediction empirically, we estimate a measure of excess currency exposure for firms over the period 2000–02. We do this in two stages. In the first, we estimate a regression of dollar debt against our proxies for α (exports, sector, and dollar assets) and against the measure of μ. The first terms capture matching; the second term captures possible correlations between μ and ε, the idiosyncratic component of expected interest. In the second stage, we calculate the absolute deviations between the fitted values from the first stage and observed net dollar debt (net of derivatives), and we then regress them on μ. Table 7 reports the estimated coefficients for the second stage of this estimation for data pooled over the period 2000–02. Each cell reports

the estimated coefficient and standard error of univariate regressions of excess net dollar debt against the respective measure of risk aversion or, in the case of the liquidity and investment opportunities variables, the coefficients from a regression that also includes the log of total assets.

Table 7. Corporate Determinants of Currency Exposure[a]

Explanatory variable	*(1)*	*Expected sign of the correlation*
Ownership		
Log (total assets)	0.018***	+
	(0.003)	
I (ADR)	0.081***	+
	(0.024)	
I (foreign)	0.043***	+
	(0.013)	
I (AFP)	0.020**	+
	(0.009)	
I (GRUPO)	0.026**	+
	(0.012)	
Liquidity risk		
Current assets / current liabilities	–0.001*	+
	(0.000)	
Accrued interest / earnings from operations	0.002	–
	(0.002)	
Investment opportunities		
Ratio of lagged investment to assets	0.023	–
	(0.031)	
ln (market-to-book ratio)	–0.004**	–
	(0.002)	

Source: Authors' calculations.
* Statistically significant at the 10 percent level. ** Statistically significant at the 5 percent level. *** Statistically significant at the 1 percent level.
a. The table reports estimated coefficients for univariate regressions between excess dollar debt and each of the variables reported in the table. Excess dollar debt is defined as the absolute value of the error term in a regression of dollar debt on firm productive structure, as detailed in column 2 of table 5. In the case of liquidity risk variables and investment opportunities variables, the regression also includes total assets as a control. All liquidity variables are once lagged. I (AFP) is a dummy variable for firms eligible to be included in the portfolio of pension fund regulators, I (foreign) is a dummy for firms owned by foreign corporations, I (ADR) is a dummy for firms listing ADRs on the New York Stock Exchange, and I (GRUPO) is a dummy for firms belonging to a conglomerate in 2002 as defined by the SVS. Liquidity and investment opportunity variables are as defined in text. Firm ownership data are from various sources. Robust standard errors are in parentheses.

The first section of table 7 reports the estimated coefficients for variables we believe a priori to be correlated with credit constraints. The first is firm size. A series of empirical studies argues that large

firms are less credit constrained than small firms because of fixed costs in information disclosure. The estimated coefficient is consistent with this hypothesis: large firms hold net foreign debt positions that are, on average, further from the matching composition than small firms, and these firms are therefore more exposed (in terms of their balance sheet, at least) than small firms. This result is also consistent with the effect of size limitations in the domestic market.

The next two variables measure foreign ownership, either via the U.S. stock market (in the case of firms issuing ADRs) or directly, as part of a foreign conglomerate (in the case of firms owned by foreign corporations). In both cases we estimate a positive and significant coefficient, which suggests that these firms are less credit constrained that their counterparts.

Several empirical papers for Chile group Chilean firms according to their eligibility for pension fund investment, the idea being that firms eligible for AFP portfolios will be less credit constrained than ineligible firms. For a start, firms eligible for AFP investment can access a larger pool of accumulated wealth. In addition, if there are fixed costs to monitoring, then AFP-eligible firms will be closely monitored by the investment managers in the AFPs, reducing the degree of information asymmetry. With this in mind, we include a dummy variable for firms classified by the SAFP as eligible for AFP investment as a proxy for μ.

Finally, we include the GRUPO dummy, for firms belonging to financial conglomerates. We find a positive and significant coefficient, as was the case for the ADR, foreign ownership, and AFP dummies.

The next section of table 7 includes variables that measure liquidity risk. As discussed above, we expect firms with high liquidity risk to minimize exposure to currency fluctuations. However, the estimated coefficients for the coverage ratio is not significant at conventional confidence levels, and the estimated coefficient of the current ratio is the opposite of what we expect. These results are robust to using alternative liquidity measures (not reported in the table), including the quick ratio, total leverage, short-term debt, and the maturity mismatch. Although the approach we follow here is relatively standard in the corporate finance literature, these puzzling results suggest that our specification suffers from endogeneity issues. Lagging the right-hand-side variable, as we do in this table, only addresses part of the problem. For example, an omitted firm-level variable that is negatively correlated with credit constraints would drive up leverage and at the same time lead to higher dollar exposure, as we find in the table.

Finally, the last part of table 7 shows the results for two variables that proxy for investment opportunities: a lagged moving average of investment over assets and the log of the market-to-book ratio. The sample drops significantly once the market-to-book variable is included because a substantial share of our firms are not listed. We fail to find a statistically significant effect of lagged investment, but the estimated coefficient on the market-to-book ratio is negative and significant, as expected.

6. Exchange Rate Regime, Net Exposures, and the Balance Sheet effect

In this section, we focus on the time dimension of our panel of firms to examine the impact of the adoption of a floating exchange rate regime in the late 1990s on currency mismatches and the size of the balance sheet effect among Chilean firms.

This shift in the policy regime affected the two macroeconomic variables that explain currency mismatches in the mean-variance framework: interest rate differentials and exchange rate volatility. The economywide differentials between domestic and foreign borrowing costs declined, while exchange rate volatility increased. In the period prior to 1998, the annualized standard deviation of monthly depreciations of the dollar-UF exchange rate was 2.4 percent. It doubled to 4.4 percent after the floating of the peso in September 1999 (see table 8).

Accordingly, we expect that the new policy regime created greater incentives for firms to hedge and reduce their currency risk exposures. We further expect the reduction to be sharper in firms that have relatively weak balance sheets and are likely to face capital market imperfections and financial constraints. Both predictions imply that the empirical relevance of the adverse effect of exchange rate depreciations on balance sheets should have declined in Chile after 1999.

6.1 Floating and Currency Risk Exposure in Chilean Firms

In this subsection, we review evidence on the evolution of currency risk exposure across firms in our sample. We begin with a look at different average measures of exposure to foreign exchange risk, and then we reestimate the matching regressions of the previous section to examine changes in the behavior of firms after the shift to the floating exchange rate regime.

Table 8. Average Three-Month Interest Rates and Exchange Rate Volatility[a]

Percent

		US$ (ex ante)				US$ (ex post)				Standard deviation
		EMBI		*LIBOR*		*EMBI*		*LIBOR*		
Period	*UF*	*No URR*	*URR*	*No URR*	*URR*	*No URR*	*URR*	*No URR*	*URR*	*Δ (UF / US$)*
1994–97	8.7	14.5	17.7	5.5	6.7	12.2	14.8	3.4	4.1	2.4
1998–99	9.8	14.8	18.0	5.5	6.7	17.6	21.3	8.0	9.7	2.5
2000–03	5.7	12.7	12.7	3.3	3.3	12.8	12.8	3.4	3.4	4.4
2000–04	5.3	12.0	12.0	3.0	3.0	12.3	12.3	3.2	3.2	4.4

Source: Authors' calculation based on Central Bank data.
a. UF corresponds to the average rate in the financial system on 30- to 89-day loans in CPI-indexed units of account (*Unidad de Fomento*, or UF). EMBI corresponds to the EMBI yield, and LIBOR corresponds to the three-month LIBO rate in U.S. dollars. Ex post U.S. dollar interest rates are calculated as the ex ante U.S. dollar rates adjusted by changes in the UF-US$ exchange rate. Interest rates labeled as URR have been adjusted by the *encaje* (or unremunerated reserve requirement) assuming a two-year loan period. Exchange rate volatility is calculated as the standard deviation of the three–month change in the UF-US$ exchange rate.

All aggregate measures of foreign exchange exposure show a similar pattern (see figure 1): an initial phase of rising currency mismatches from 1995 to 1998, a significant drop through 1999 and 2000, and relative stability in the following two years. Dollar debt increased between 1995 an 1998 from 20 percent of total liabilities to 27 percent, but in the following two years it fell back to 20 percent of total liabilities (18 percent when adjusted for the depreciation of the real exchange rate) and then stayed at that level. Similarly, hedging activity increased sharply during 1998 and 1999 and then stabilized. Firms net (and gross) positions on forward markets ere negligible until 1997, after which the net positions increased sharply, reaching around 4 percent of total liabilities or 10 percent of foreign currency debt.

Similarly, an alternative measure of net accounting exposure in the balance sheet of firms—namely, foreign currency debt adjusted for foreign currency assets and derivatives—increased gradually from 1995 to 1997. It then started to decline, quite sharply in the years 1999 and 2000, until becoming slightly negative in the final years of our sample. Overall, the evolution of aggregate measures of foreign exchange exposition in our sample of firms is consistent with a reduction of exposure after the shift in the macroeconomic policy regime.

The empirical evidence on the differential behavior of firms before and after the changes in the macroeconomic-policy regime is shown in table 9. We reestimate regressions on the hedging behavior of firms, this time including a time dummy for the period prior to the adoption of the floating exchange rate regime and other reforms. Although changes in macroeconomic policies were implemented in 1998 and 1999, we consider that some adjustment costs to the composition of the balance sheet could lead to a lagged response of firms. The dummy variable therefore covers 1995–98, and 1999 is excluded from the sample.

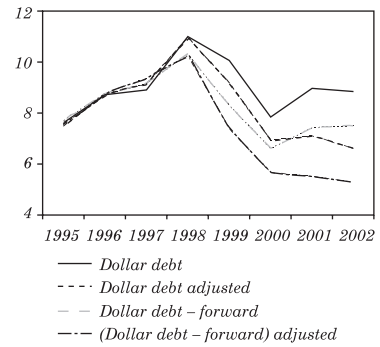
The results for all regressions indicate a significant drop in foreign currency exposure or a significant increase in foreign currency hedging after 1999. The ratio of dollar debt to total assets declines significantly for all firms, to around 20 percent of the pre-float exposure. The dollar debt ratio adjusted for derivatives declines further, to around 35 percent of the pre-float exposure, and the net accounting exposure disappears after 1999. Similarly, the net derivative position increases significantly after 1999. As shown in the graphs for the aggregate numbers, most of the action comes from the reduction of foreign currency debt, with a smaller effect from the increase in derivatives.

Because we have detected an increase in the volatility of the exchange rate in the period after 1999, we expect the drop in the

Figure 1. Exchange Rate Exposure and Derivatives Position in Chilean Firms

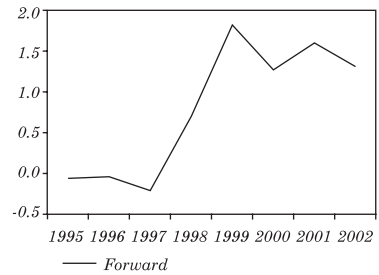
Dollar debt adjusted by forward position

Percent of total assets



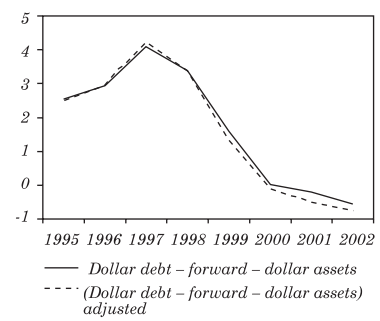
Derivatives position: US$ forwards

Percent of total assets



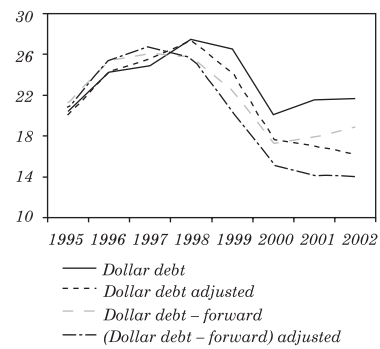
Dollar debt adjusted by forward position and dollar assets

Percent of total assets



Dollar debt adjusted by forward position

Percent of total liabilities



Sources: Authors' calculations, based on data from Superintendencia Valores y Seguros (SVS) and International Financial Statistics.

Table 9. Exposure before and after the Float, 1996–2002[a]

	Dollar debt (% total assets)		*Dollar debt net of derivative position (% total assets)*		*Dollar debt net of derivative position and dollar assets (% total assets)*		*Dollar debt (% total liabilities)*		*Dollar debt net of derivative position (% total liabilities)*		*Net derivative position (% total assets)*	
Explanatory variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*	*(12)*
Log (total assets)	0.025***	0.048***	0.019***	0.044***	0.008	0.004	0.061***	0.056**	0.050***	0.044*	0.003**	0.000
	(0.004)	(0.012)	(0.004)	(0.012)	(0.006)	(0.018)	(0.008)	(0.024)	(0.008)	(0.026)	(0.001)	(0.006)
Dollar assets /total assets	0.229***	0.133***	0.25***	0.133***			0.522***	0.31***	0.561***	0.304***	–0.045***	–0.012
	(0.057)	(0.028)	(0.056)	(0.029)			(0.071)	(0.056)	(0.069)	(0.059)	(0.014)	(0.013)
Exports/sales	0.117***	–0.017	0.136***	–0.033	0.031	0.138**	0.409***	0.113	0.474***	0.068	–0.031***	0.017
	(0.036)	(0.037)	(0.033)	(0.038)	(0.043)	(0.056)	(0.062)	(0.075)	(0.060)	(0.079)	(0.008)	(0.017)
Dollar debt /total assets											0.105***	0.086***
											(0.036)	(0.016)
Dummy (1996–98)	0.016**	0.019***	0.028***	0.031***	0.038***	0.039***	0.067***	0.064***	0.102***	0.095***	–0.014***	–0.014***
	(0.007)	(0.006)	(0.007)	(0.006)	(0.013)	(0.008)	(0.014)	(0.011)	(0.016)	(0.012)	(0.004)	(0.003)
Summary statistic												
No. observations	923	923	921	921	921	921	923	923	921	921	921	921
R^2	0.28	0.75	0.29	0.72	0.02	0.6	0.41	0.79	0.43	0.77	0.16	0.51
Fixed effects	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Firm-clustered standard errors	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Dummy (1996–98) as a percent of pre-float exposure	18	22	33	37	122	125	28	27	44	41		

Source: Authors' calculations.

* Statistically significant at the 10 percent level. ** Statistically significant at the 5 percent level. *** Statistically significant at the 1 percent level.

a. This table reports the estimates of equation 5 in the text. The dependent variable in regressions 1 through 6 is the ratio of exposure to total assets; in regressions 7 through 10 it is the ratio of exposure to total liabilities. The estimation method is OLS. Observations from 1999 are excluded from the regressions. Dummy 1996-98 takes the value of one in the pre-float period. The net derivative position is the notional value of the net long position of foreign exchange derivatives with domestic banks. Standard errors are reported in parentheses.

exposure to be larger for firms with a more vulnerable financial condition. Firms are sampled according to the variables identified in the previous section as measures of a firm's risk aversion. We then test for differences in the change of the foreign exchange exposure after 1999. To measure foreign exchange exposure, we replicate the methodology discussed in the previous section—that is, we estimate the matching portfolio using the dollar assets, exports, and tradable dummies, and we then estimate deviations from this portfolio. To allow for changes across periods in this matching relation, we estimate the first stage allowing for different coefficients across regimes. These coefficients will capture the differences in levels of exposure we discussed above. In the second stage, we interact the firm-level dummies we found to be positively correlated with higher mismatches in the float period with the pre-float dummy. We report these second stage results in table 10. The estimated coefficients on the interactions are negative in all cases except the AFP dummy, although only the interaction with the ADR dummy is significant. This is contrary to what we expect.

Thus far, we have attributed the fall in dollar debt or average exposure to the shift in the macroeconomic policy regime and its impact on compressing interest rate differentials and increasing exchange rate volatility. We have not attempted to disentangle the effects of each of these components. To begin decomposing these two macroeconomic effects, we reestimate our regressions of firm hedging, incorporating the return on the EMBI bond index as a measure of the cost of external finance and the average rate on one- to three-year UF-denominated loans in the Chilean banking system as a measure of the domestic interest rate.[12] We report the results of these estimates in table 11. The estimated signs on the interest rate coefficients are as expected, with dollar debt rising when domestic rates are high and falling with the cost of external financing. As reported in column 2, we also obtain a positive coefficient on the pre-float dummy, even after controlling for the interest rates individually or (as in column 3) by the spread between the two rates.

The interest rate differentials provide an alternative way to validate the a priori measures of credit constraints used in previous sections. One of the predictions of the framework presented above is that interest

12. We carried out these estimations with the LIBO and EMBI rates ex ante, with and without the unremunerated reserve requirement over a two-year entry period; we obtained similar results.

Table 10. Excess Dollar Debt[a]

Explanatory variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*
Pre-float	0.004	0.063	0.005	0.009**	0.003	0.007	0.003	0.000	0.003	0.007
	(0.005)	(0.049)	(0.004)	(0.004)	(0.005)	(0.005)	(0.005)	(0.006)	(0.005)	(0.006)
Log (assets)	0.016***	0.018***								
	(0.002)	(0.003)								
Pre-float x log (assets)		–0.003								
		(0.003)								
I (ADR)			0.049***	0.081***						
			(0.014)	(0.024)						
Pre-float x I (ADR)				–0.052**						
				(0.022)						
I (foreign)					0.033***	0.043***				
					(0.011)	(0.013)				
Pre-float x I (foreign)						–0.015				
						(0.012)				
I (AFP)							0.025***	0.020**		
							(0.008)	(0.009)		
Pre-float x I (AFP)								0.007		
								(0.009)		
I (GRUPO)									0.022**	0.026**
									(0.010)	(0.012)
Pre-float x I (GRUPO)										–0.006
										(0.009)
Summary statistic										
No. observations	1.221	1.221	1.221	1.221	1.211	1.211	1.221	1.221	1.221	1.221
R^2	0.14	0.14	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02

Source: Authors' calculations.

* Statistically significant at the 10 percent level. ** Statistically significant at the 5 percent level. *** Statistically significant at the 1 percent level.

a. The dependent variable is the absolute value of excess dollar debt (net). The estimation method is OLS. I (AFP) is a dummy variable for firms eligible to be included in the portfolio of pension fund regulators, I (foreign) is a dummy for firms owned by foreign corporations, I (ADR) is a dummy for firms listing ADRs on the New York Stock Exchange, and I (GRUPO) is a dummy for firms belonging to a conglomerate in 2002 as defined by the SVS. Firm-clustered standard errors are reported in parentheses.

Table 11. Macroeconomic Determinants of Net Dollar Debt[a]

	Macroeconomic determinants of net dollar debt			Macroeconomic determinants of net dollar debt *interacted* firm characteristics				
Explanatory variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
Exports / sales	0.043	0.043	0.043	0.017	0.049	0.045	0.048	0.043
	(0.077)	(0.077)	(0.077)	(0.070)	(0.079)	(0.078)	(0.078)	(0.077)
Dollar assets / total assets	0.135***	0.139***	0.139***	0.121***	0.139***	0.139***	0.135***	0.139***
	(0.034)	(0.036)	(0.036)	(0.032)	(0.036)	(0.036)	(0.033)	(0.036)
Domestic interest rate	0.484***	0.218						
	(0.110)	(0.172)						
Foreign interest rate	–0.165**	–0.215***						
	(0.074)	(0.045)						
Spread = (r – r*)			0.216***	0.191***	0.175**	0.078	0.134	0.208
			(0.056)	(0.061)	(0.075)	(0.128)	(0.086)	(0.135)
Dummy(1996–99) = pre-float		0.015***	0.015***	0.022***	0.014***	0.014***	0.016***	0.015***
		(0.005)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
log (assets) x spread				0.068*				
				(0.035)				
I (ADR) x spread					0.560			
					(0.722)			
I (AFP) x spread						0.277		
						(0.170)		
I (foreign) x spread							0.303	
							(0.277)	
I (GRUPO) x spread								0.012
								(0.133)
Summary statistic								
No. observations	1.221	1.221	1.221	1.198	1.221	1.221	1.211	1,221
R^2	0.68	0.68	0.68	0.69	0.68	0.68	0.69	0.68

Source: Authors' calculations.

* Statistically significant at the 10 percent level. ** Statistically significant at the 5 percent level. *** Statistically significant at the 1 percent level.

a. The dependent variable is dollar debt net of the notional derivative value with domestic banks. The estimation is OLS, firm fixed effects, and the main effects of those variables that proxy for risk aversion in the interactions are included but not reported. I (AFP) is a dummy variable for firms eligible to be included in the portfolio of pension fund regulators, I (foreign) is a dummy for firms owned by foreign corporations, I (ADR) is a dummy for firms listing ADRs on the New York Stock Exchange, and I (GRUPO) is a dummy for firms belonging to a conglomerate in 2002 as defined by the SVS. Domestic interest rate is the average three-month rate of return on 30- to 89-day loans in the domestic financial system in UF. The foreign interest rate is the annualized yield on the EMBI bond index. Standard errors adjusted by year clusters are reported in parentheses.

rate differentials have a large effect on currency exposure of firms that are less risk averse. To test this hypothesis, we estimate interactions between the interest rate differential and the measures of a priori credit constraints that we found to be significant in explaining excess net dollar debt (or exposure). In all cases, we obtain positive coefficients (as expected), although these are only significant for the size variable. We thus find some evidence that firms that are less risk averse respond the most to changes in interest rate differentials, as the cost (in terms of financial distress or missed investment opportunities) are lower.

A higher exchange rate volatility in the post-float period is a plausible explanation for the positive coefficient on the pre-float dummy. However, other economywide events occurring in the same period could also be driving our results. An alternative hypothesis to explain why firms closed their currency mismatches after 1998 would be that they faced an external liquidity crunch during this period that pushed them to the local market, independently of the shift in the policy regime and the measured interest rate spread. They had no option but to close the currency mismatches because they could not continue borrowing abroad.

We find no compelling evidence to argue that after 1998, either the Chilean economy was liquidity constrained in international markets or that firms were cut off from international credit. Indeed, in January 1999 the Government was able to fund its fiscal deficit by taping into international markets with spreads of 200 basis points, while risk premiums on private debt had returned to 300 basis points in early 1999. Also, total private foreign debt of nonfinancial firms continued to increase in 1998, 1999, and 2000, from US$21 billion to US$29.4 billion. After 2000, credit spreads continued to decline, although private foreign debt of nonfinancial firms stabilized at US$ 29 billion.

7. Conclusions

This paper contributes to the existing empirical literature on the balance sheet effects of currency mismatches in three ways. First, we assemble a new firm-level database that allows us to build more comprehensive measures of currency exposure. In addition to data on foreign currency debt, our dataset incorporates data on firm-level exports, foreign currency assets, and foreign currency derivative positions. This data should allow us to correct for the omitted variables present in many of the previous studies of balance sheet effects. Second, we explicitly look at differences in exposure across firm-level variables

that the corporate finance literature argues (or shows) to be correlated with firm-level risk aversion. Finally, by looking at firm-level data for Chile over the period 1995 to 2003, we are able to identify changes in the level and distribution of dollar debt across two distinct policy regimes. Before 1999, Chile had an exchange rate band and therefore an explicit commitment to exchange rate stability. After 1999, the Central Bank allowed the exchange rate to float freely.

As in previous studies for Chile by Benavente, Johnson, and Morandé (2003) and Fuentes (2003), we find that firms with higher dollar debt do not underperform their peso counterparts in periods following a depreciation. However, once we adequately control for differences in the currency composition of assets and income and in net derivative positions, we find a significant balance sheet effect. In other words, we find that currency mismatches matter when they are correctly measured. We also find that derivatives play a role in insulating firm-level investment from exchange rate shocks and that the balance sheet effects are slightly smaller for firms we categorize a priori as less credit constrained.

In line with previous firm-level studies, we find evidence of currency matching in Chilean corporations. Firms in Chile appear to actively minimize the risks associated with open currency positions and choose the currency composition of their debt and their derivative positions accordingly. They do this by matching the currency composition of their debt with that of their income and assets and by taking on derivatives if no real hedge is available. We also find that exposure—as measured by deviations of dollar-debt net of derivatives from the levels predicted by a simple regression between debt, assets, and exports—is negatively correlated with measures of credit constraints (or firm risk aversion) and investment opportunities. Our results on exposure suggest that the firms that are most exposed to currency risk are better prepared to take this risk.

Finally, we find significant changes in the level of exposure after the exchange rate was floated in 1999. This drop is significant even after we control for a crude measure of interest rate differentials. We argue that one possible interpretation of these results is that the higher exchange rate variance affects the relative risk of domestic and foreign debt. This being the case, the evidence suggests that floating exchange rate regimes would reduce exposure by eliminating an implicit exchange rate insurance and forcing firms to internalize exchange rate risk. More evidence from other emerging market economies is needed to generalize this assertion.

APPENDIX
Variables Definitions and Sources

Variable	*Definition (codes correspond to the FECU classification)*	*Source*
Main variables		
Investment in fixed capital	k(t) – k(t – 1) / total assets (t – 1)	FECU
Dollar debt over lagged assets	Book value of dollar debt (t) / total assets	Complementary note to FECU
Dollar assets over lagged assets	Book value of dollar assets (t) / total assets	Complementary note to FECU
Net long derivatives position over lagged assets	Nominal value of foreign exchange forward position / total assets	Central Bank of Chile and FECU
Exposure	dd2a – f2a – da2a	
Tradable[a]	1 if ISIC code (rev 2) is 1, 2 or 3	FECU
Exports over total assets	Exports / total assets	PROCHILE and FECU
Exports over sales	Exports / sales	PROCHILE and FECU
Secondary variables		
Total assets	5.10.00.00	FECU
Sales	5.31.11.11	FECU
Capital stock	5.12.10.00 + 5.12.20.00 + 5.12.30.00 + 5.12.40.00	FECU
Leverage (total debt) over total assets	(5.10.00.00 – 5.24.00.00) / total assets	FECU
Cash flow from operations (EBIT)	5.31.11.00 + depreciation	FECU
Cash flow from operations over assets	EBIT / total assets	
Depreciation	5.12.60.00 (t) – 5.12.60.00 (t–1)	FECU
Current ratio = current assets / current liabilities	5.11.00.00 / 5.21.00.00	FECU
Coverage ratio = accrued interest / cash flow from operations	5.31.12.60 / EBIT	FECU

(continued)

Variable	*Definition (codes correspond to the FECU classification)*	*Source*
Market capitalization = PQE	Market cap (December)	Bolsa de Comercio
Accounting equity	5.24.00.00	FECU
Log (market–to–book)	Log (PQE / accounting equity)	FECU and Bolsa de Comercio
Log (Tobin's q)	Log [(PQE + total debt) / total assets]	FECU and Bolsa de Comercio
Maturity mismatch = (current liab – current assets) / total assets	(5.21.00.00– 5.11.00.00) / total assets	FECU
Ownership variables		
ADR	1 if firm has ADR on New York Stock Exchange	J.P. Morgan
GRUPO	1 if firm is in a economic conglomerate	Superintendency of Securities and Insurance (SVS)
AFP	1 if firms is eligible for AFP portfolios	Superindentency of Pension Funds Administrators (SAFP)
Macroeconomic variables		
Log (real exchange rate)	Log (TC_DIC / CPI_DIC)	*International Financial Statistics*
EMBI yield	Annual EMBI return	Bloomberg
Domestic interest rate	Average annualized loan rate in financial system in UF (1 – 3 years)	Central Bank of Chile
CPI_DIC	Consumer price index (December)	*International Financial Statistics*
TC_DIC	Nominal exchange rate (December)	*International Financial Statistics*

There are two companies that we classified as tradable that do not follow this definition: LAN Chile (the privatized national airline) and Cia. Sudamericana de Vapores (the shipping company).

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