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Currency Mismatches, Balance-Sheet Effects and Hedging in Chilean Non-Financial Corporations

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Abstract

Using a new database on the currency composition of assets and liabilities, this paper explores the determinants and consequences of currency mismatches in Chilean non-financial firms. As in previous firm level studies for Chile, we find that in periods following a depreciation firms with higher dollar debt do not underperform their peso counterparts. However, once we adequately control for differences in the currency composition of assets, income and net derivative positions, we do find a significant balance sheet effect. In addition, we find that derivatives play a role in insulating firm level investment from exchange rate shocks. In line with previous studies, we also find evidence of currency matching in Chilean corporates. Firms in Chile actively reduce the risks associated with exchange rate exposure 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. Finally, we find significant changes in the level of net currency exposure after the exchange rate was floated in 1999. We argue that one possible interpretation of these results is due to the effect of higher exchange rate variance on the relative risk of domestic and foreign debt.

1. Introduction[1]

After the Tequila crisis in 1994-95 and the East Asian crisis in 1997, many observers have raised questions about the role of exchange rate and monetary policies in the context of crisis management in emerging market economies (Goldstein and Turner, 2004).

In conventional open economy models *à la* Mundell-Fleming, exchange rate depreciations are assumed to 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 and inflation. However, this conventional result may be reversed when domestic firms carry substantial amounts of un-hedged foreign currency (dollar) debt in their balance sheets and the cost of external funds decreases with net worth. A depreciation of the local currency (peso) inflates the value of debt, deteriorates net worth and increases the cost of external finance. Holding all else constant, the weakening of balance-sheet positions prevents firms from investing and expanding their production. Consequently, the expansionary effect of depreciation of the peso may be attenuated or even reversed because of the behavior of firms that are highly leveraged in dollars.[2] Under these circumstances, a tight monetary policy and dogged defense of the peso may be the recommended response to a negative external shock.

Given their potential implications for aggregate vulnerability and optimal monetary policy, measuring the size and effects of these mismatches should be a priority for policymakers in emerging market economies. A second priority should be to understand the micro and macroeconomic determinants of these mismatches. The respective roles of monetary and exchange rate policies are particularly relevant. On the one hand, by changing domestic interest rates, monetary policy alters the relative costs of domestic and foreign debt. On the other, by changing the perceived risk on foreign currency debt, exchange rate policy alters the relative risks of foreign currency borrowing.

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[1] This paper was originally prepared for the *Octava Conferencia Anual del Banco Central de Chile: Vulnerabilidad Externa y Políticas de Prevención.* The data used in this paper are largely drawn from an IDB database on firm-level currency mismatches compiled by Herman Kamil, to whom we are extremely grateful. We also thank J.M. Benavente, C. Johnson and F. Morandé for providing the IDB with their data on debt dollarization for Chilean firms. Valuable research assistance was provided by Eric Cárdenas. We thank Roberto Rigobón for useful comments. This paper represents the views of the authors only and not those of the Central Bank of Chile or the Inter-American Development Bank.

[2] Krugman (1999a) presents a stylized version of this effect, while Aghion, Bacchetta, and Banerjee (2001) and Céspedes, Chang, and Velasco (2000) incorporate this mechanism into more fully articulated models.

1.1. What Do We Know So Far About the Level and Effects of Currency Mismatches?

At the macro level, a substantial literature documents the high levels of foreign currency debt in those countries in East Asia that experienced a financial crisis in the late 1990s.[3] In addition, recent papers have attempted to identify the effects of aggregate measures of dollar debt on the likelihood of financial crisis or on the response of output and investment to currency depreciations. On the one hand, Arteta (2003) fails to find a significant correlation between dollarization in the domestic banking system and the likelihood of a banking crisis. On the other hand, Calvo, Izquierdo and Mejía (2004) find that domestic bank dollarization (as measured by the sum of dollar deposits and foreign loans) increases the likelihood of a Sudden Stop in capital inflows. Additional macro evidence of the implications of dollarization for aggregate vulnerability is provided by Céspedes (2004), who finds that depreciations become increasingly contractionary as the level of foreign debt increases, and Levy-Yeyati (2003), who argues that domestic financial dollarization is positively correlated with volatility of output growth.

There is also a growing empirical literature that focuses on the determinants and effects of currency mismatches using firm-level data. The evidence in this literature is mixed on the effects of holding foreign currency debt in a depreciation.[4] Although for some countries there is evidence that firms that hold more foreign currency debt suffer relatively more at times of devaluation, in many other countries the differential effect is mixed, non-significant or even positive.

Many authors have attributed these ambiguous results to an omitted variable bias. If firms holding dollar debt are also those whose income is positively correlated with the exchange rate, then there is no reason to believe that these firms will fare any worse in a depreciation than their counterparts. Indeed, most firm-level studies find that firms match the currency composition of their incomes with that of their liabilities. The main exceptions to this tendency are Argentina, Peru and Mexico prior to the 1995 crisis. In other countries, firms holding higher shares of dollar debt are also firms whose income we would expect *a priori* to be more positively correlated with

[3] See, for example, McKinnon and Pill (1998).
[4] See Bleakley and Cowan (2002), Galindo, Panizza and Schiantarelli (2003), Luengnaruemitchai (2004) and Table 1 below.

the real exchange rate—whether because they operate in a tradable sector, or because they directly export a share of their sales.[5]

If firms are actively hedging their currency exposures, balance sheet estimates obtained from dollar debt as a proxy for currency mismatches will be biased upwards, as this variable will be positively correlated with unobserved variables that explain the sensitivity of the firm's net revenues, assets or derivatives to the exchange rate. The size of the bias will depend on the extent of currency hedging across firms. Therefore, in those countries in which firms match, having detailed data on the currency composition of assets, liabilities, income streams and (potentially) derivative positions becomes crucial if we are to measure adequately either the level of currency mismatch or the effects of this exposure on output and investment.

We provide a complementary hypothesis based on the endogeneity of risk exposure decisions at the firm level. It is possible that firms that choose greater exposure to currency mismatches are, on average, less sensitive to balance-sheet effects because they are less credit constrained, or because their set of investment opportunities is smaller. This issue is addressed in the corporate finance literature on hedging financial risks. Absent financial market imperfections, the structure of corporate liabilities, including their currency composition, should have no effect on firm production decisions or valuation.[6] Research on corporate finance, however, suggests that several capital market imperfections can create incentives for firms to hedge their risk exposures, including foreign currency risk. Following the taxonomy by Geczy, Minton, and Schrand (1997), incentives for hedging come from some concavity in the profit function that can arise at the level of managers, equity-holders or debt-holders.[7] Froot,

[5] Several studies have also found that, even after controlling for export share and sector, the profits (or stock prices) of those firms holding dollar debt are more correlated with the real exchange rate.

[6] The theoretical corporate finance literature does not provide clear-cut answers on why and how much firms should hedge their foreign currency exposure. If the CAPM and Modigliani-Miller propositions hold, there would be no value for firms in reducing the variability of their net income or net worth. Under these conditions, the firm's choice of currency debt will only be driven by the differences in the cost of borrowing in domestic or foreign currency. If uncovered interest parity holds and macroeconomic interest rate differentials are fully compensated by market expectations on the exchange rate, the choice of foreign currency debt will be related only to firm-specific factors that determine the relative cost of borrowing at home or abroad: size relative to local banks and other intermediaries, foreign ownership, and availability of credit from suppliers.

[7] At the managerial level, risk-averse managers who allocate a significant portion of their wealth to holding a firm's shares will choose to hedge foreign currency risk or any other market risk at the firm level when it is less costly than doing so on their own account. If managers are paid through stock options, their expected utility may increase according to the variability of their firms' expected cash flows (Smith and Stulz, 1985). At the equity-holder level, tax credits may create a progressive tax schedule for corporations (i.e., a concavity on the expected profit function of the firm) and thus create incentives for hedging different types of risk (Smith and Stulz, 1985). Also, if managers

Sharfstein, and Stein (1993), for example, endogenize the cost of financial distress as lost investment opportunities. Consequently, firms that have either greater growth opportunities or are more likely to become financially distressed have more to gain from reducing the volatility of their cash flow. Therefore, all else equal, a firm's exposure to foreign currency risk should decrease with variables that proxy for investment opportunities (e.g., the market-to-book value ratio and lagged values of capital expenditures), and with variables positively correlated with liquidity risk (the debt leverage ratio, and the inverse of the interest coverage and liquidity ratios). This being the case, we would expect the effects of a currency mismatch in firm investment to be smaller for those firms holding more dollar debt, as those firms have "less to lose" from exchange rate exposure. On the whole, existing studies for firms in the US find evidence supporting the theories discussed above. However, the only empirical study that concentrates exclusively on hedging by emerging market firms finds very limited support for any of the above explanations.[8]

The relationship between hedging and the costs of financial distress implies that, even if we are able to measure correctly the level of currency exposure at the firm level, balance- sheet effects may remain hard to find empirically. The endogeneity of hedging behavior across firms creates an additional bias towards zero in the estimation of the size of balance-sheet effects across firms. Those firms that are relatively more exposed to a depreciation of the local currency will also be less vulnerable to financial distress, and therefore less likely to face negative balance-sheet effects at the time of a depreciation.

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have private information about an unobservable risk that affects the firm's payoffs, hedging may help to devise an optimal incentive structure (De Marzo and Duffie, 1991).

[8] Gezcy, Minton and Schrand (1997) and Allayanis and Ofek (2001) examine currency derivative use by Fortune 500 non-financial corporations. The results of these studies suggests that derivative use is positively correlated with investment opportunities (measured by R&D expenditure), firm size and the interaction between firm leverage and the market-to-book ratio (investment opportunities) and negatively related with firm liquidity (quick ratio). In addition, derivatives and foreign debt are substitutes for hedging income exposure. Bartram, Brown and Fhele (2004) use data on over 7,000 non-financial firms from 48 countries for currency, interest rate and commodity derivatives. In line with previous results, the authors find that a firm is more likely to use currency derivatives if the firm has forex exposure from foreign sales, is cross-listed or has foreign debt. Firms with higher leverage, lower quick ratios and higher market-to-book ratios are also more likely to use derivatives. Note, however, that most of the sample consists of OECD economies, and the results are mainly driven by those economies. The only cross-country study that focuses exclusively on emerging markets is Allayanis, Brown and Klapper (2001), which examines the currency hedging practices of non-financial firms from eight East Asian countries over the period 1996-1998. In contrast to the US studies, the authors find limited support for existing theories of derivative use: liquidity-constrained firms with higher investment opportunities do not hedge significantly more in their sample. They also document that firms in East Asia use foreign cash income as a substitute for derivative hedging. At the country level, they argue that firms hedge selectively. In countries with a large interest rate differential, hedging is lower, suggesting that firms trade off the risks of currency exposure with the benefits of cheap foreign credit.

The overall discussion so far suggests that, if firms in emerging markets internalize the risk of currency mismatches, then the empirical relevance of dollar debt may be smaller than expected. First of all, firms will match the currency composition of their liabilities with that of their income, effectively hedging a substantial component of their debt. Second, those firms choosing to carry higher currency mismatches on their balance sheet will be firms whose investment or output decisions are less vulnerable to fluctuations in their net worth.

1.2. What Do We Know So Far Regarding the Determinants of Currency Mismatches?

There is much less empirical work on the cross-country determinants of currency mismatches. At the micro level, there is only one paper that explicitly looks at the effects of macro policy (specifically exchange rate policy) on the level and distribution of dollar debt in emerging markets. Using firm-level data from Mexico, Martínez and Werner (2001) analyze how floating the exchange rate in 1995 impacted the debt composition decision of Mexican firms, and they find that post-float matching between exports and foreign currency debt increases significantly.

At the macro level, a series of recent papers have looked at the effect of domestic dollar debt on the exchange rate policy. The main finding of this literature is that financial dollarization leads to exchange rate rigidity.[9] Although this "fear of floating" literature argues that dollarized debt (and implicitly mismatches) conditions optimal exchange rate policy, the empirical results presented are correlations and therefore can equally well be interpreted as the effect of exchange rate regimes on dollar debt holdings. Considered this way, the literature finds that countries with more rigid exchange rate regimes have higher levels of dollarization in the domestic banking system. Finally, using data on bank loans and deposits for a broad sample of countries, Arteta (2003) finds that flexible exchange rate regimes are correlated with lower loan and deposit dollarization.

This paper contributes to the existing empirical literature in three ways. First of all, we assemble a database that allows us to build more comprehensive measures of currency exposure. In addition to data on foreign currency debt, our dataset also incorporates data on firm-level exports, foreign currency assets and foreign currency derivative positions. This data should allow

[9] There is a related literature on financial dollarization that examined determinants of domestic financial dollarization (Levy-Yeyati 2003, De Nicoló, Honohan and Ize, 2003). Broadly speaking, this literature concentrates on the impact of monetary policy credibility (via the relative variances of inflation and real exchange rates) on

us to correct for the omitted variables discussed above. Second, we explicitly look at differences in exposure across variables that the corporate finance literature has argued (or shown) to be correlated with firm-level risk aversion. Finally, by looking at firm-level data for Chile over the period 1995-2003, we identify changes in the level and distribution of dollar debt across two distinct policy regimes. Pre-1999 Chile had an exchange rate band and therefore an explicit commitment to exchange rate stability. Post-1999, the Central Bank has allowed the exchange rate to float freely.

1.3. What Do We Find?

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

In line with previous studies, we also find evidence of currency matching in Chilean corporations. The evidence indicates that firms in Chile actively reduce 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. This last result (that firms use derivatives as a substitute for real hedges) is in line with previous results for Asia by Allayanis and Weston (2001).

We also find that "exposure"—measured by deviations of dollar-debt net of derivatives from the levels predicted by a simple regression between debt, assets and exports—is positively correlated with measures of credit constraints (or firm risk aversion) and a measure of investment opportunities. We fail to find a positive correlation between exposure and liquidity risk. Our results on exposure suggest that those firms most exposed to currency risk are also those best prepared to take this risk.

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financial dollarization in the domestic banking system. In countries where inflation is volatile vis-à-vis the real exchange rate, contracts tend to be written in dollars to reduce ex-post price risk.

Finally, we find significant changes in the level of currency exposure after the exchange rate was floated in 1999. This drop is significant even after controlling for a measure of interest rate differentials. We argue that one possible explanation of these results is the effect of higher exchange rate variance on the relative risk of domestic and foreign debt. This being the case, floating exchange rate regimes would reduce exposure by eliminating implicit exchange rate insurance and forcing firms to correctly internalize exchange rate risk.

2. Empirical Strategy

The empirical strategy in our framework is based on the estimation of a hedging equation at the firm level, which is derived from a simple mean-variance framework assuming that the profit function of the firm 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, and $\tau + \varepsilon$ 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. Finally, 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, it will choose to carry some foreign exchange exposure in its balance sheet in order to reduce its 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 there will be a currency mismatch. For a given interest rate differential, the size of this mismatch decreases by the expected volatility of the exchange rate σ_z and the degree of risk aversion of the firm 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, and so the key variable in our analysis in this section is for firm i in period t

$$(\text{Foreign Debt})_{i,t\text{-}1} \text{ x } (\Delta \, ln \text{ Exchange Rate})_t$$

It is obvious that if firms are behaving according to (*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 balance-sheet effects based on dollar debt alone will be biased upwards, as firms holding higher shares of dollarized debt are also those firms that see the largest increases in profits following a depreciation. With this in mind, we 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 within the cross section of firms in our sample directly. First, we examine the relationship between foreign currency debt, net derivative usage and the currency composition of assets and net income at the firm level. We then determine whether variables that the corporate finance literature has argued are correlated with firm risk aversion (μ) explain deviations in observed debt compositions levels from the "matching" composition. Of course, we do not directly observe α at the firm level. We therefore 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 examine how the change in the macro policy regime that happened 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 their impact on the economy-wide interest rate differential τ and the exchange rate volatility σ_z. A key component of the new policy regime was the abandonment of the exchange rate band and the adoption of a floating regime for the exchange rate. Indeed, there was an increase in exchange rate volatility *and* a compression of interest rate differentials. We therefore 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 examine this issue in Section 6. We further test whether the decline was larger for those firms that are more likely to be 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. Database

This section describes our sample and main variables. Our data consist of firm-level accounting information for non-financial corporations in Chile for the period 1995-2003. In addition, we have data on firm exports, the sectors in which firms operate and firm ownership. Our main source of information is the FECU database of the *Superintendencia de Valores y Seguros* (SVS). The FECU database has standardized accounting data for all firms categorized as *Sociedades Anónimas Abiertas*. By law these firms must disclose their accounting information using a standardized format (the *Ficha Estadística Codificada y Uniforme* FECU). We use non-consolidated 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 neither standardized nor available in an electronic format. Because of this, we start with the data on foreign currency liabilities assembled by Benavente, Johnson and Morandé (2003).[10] 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 non-financial firms for which foreign-currency data are available. Table 2 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.

Our main measure of firm performance is *investment* in fixed capital, measured as the change in gross fixed assets. Accounting standards in Chile 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. In Chile, accounting standards dictate

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

that conversion of debt from foreign to local currency values must be carried out using the exchange rate at the end of the period in 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 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 time a comprehensive dataset has been compiled for emerging market firms with 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 variables that proxy for α. The first is a tradable dummy that takes the value of one for firms in agriculture, manufacturing and mining. Data on the sector composition of output is reported in the FECU. In addition, we add firm-level data on FOB export shipments collected from the Customs Office (*Dirección de Aduanas*). We convert the export data from dollars to pesos using the year-end exchange rate.

To explore the relationship 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 (and, in particular, leverage in dollars) on investment, we follow Lang, Ofek and Stulz (1996) and use 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, allowing us to isolate the effects of exchange rate fluctuations on revenues and costs from their effects on the valuation of assets and liabilities.

In some specifications we include measures 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 are scarce in the literature in general, mostly because regulatory entities have only recently imposed requirements on reporting such transactions. Chile is no exception. Homogenous data on derivative use from the notes to the Financial Statements are only available since 2001.[11] To overcome this limitation, we obtained

[11] 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 which information to disclose. Before 2000, the norm was not clear enough to ensure that every

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 from 1993 onward. On the other hand, derivative transactions that do not include a domestic bank are excluded, though 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.

Even though we use the longer derivatives series from the Central Bank of Chile in all of the regressions, there is interesting additional information on the use of currency derivatives in Chile in the notes to the financial statements. This is because the notes provide contract-by-contract information for all derivative transactions, covering all derivative instruments and underlying assets. On the basis of data for the period 2001-2002, we observe three stylized facts:

1. In Chile, derivatives contracts are used primarily to cover exchange rate exposure. In fact, 73 percent of the total number of contracts reported in the period (385) correspond to foreign currency contracts.
2. The most common instrument used to cover exchange rate risk is the forward contract. If we restrict our sample to foreign currency contracts, 86 percent of them are forwards.
3. Derivatives contracts are established over relatively short time periods. The average duration of contracts is less than one year (10 months).

Finally, we build four indicator variables to control for differences in firm ownership. The variable *ADR* measures whether the firm's stock trades in a US 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 is part of an economic conglomerate as defined by the SVS in 2003. *AFP* is a dummy variable that takes the value of 1 if pension funds may hold stock from the firm without restrictions. We construct the variable using information provided by *Superintencia de Administradores de Fondos de Pensión* (*SAFP*). We exclude the stocks of financial intermediaries such as banks, pension funds, insurance companies, mutual fund administrators, investment funds administrators and the stock exchange. The last ownership

single transaction would be informed, leaving this decision up to the firm. In this context, the data drawn from the complementary notes are trustworthy only as of 2001.

variable is *foreign*, a dummy variable for firms controlled by foreign multinationals. The variable is constructed in two steps. First, we pooled the most recent information from SVS, Economática and Worldscope on shareholder composition. We then used the LexisNexis 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 ways:

1. We inflate/deflate our data to 1996 values using December-to-December changes in the CPI.

2. We drop all firm/year observations if the accounting data are not internally consistent. We do this because data on foreign currency liabilities and assets are entered 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). Additionally, we drop observations if the ratio of forward positions over total assets is outside of (-1.1, 1.1).

3. 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 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 real exchange rate, Δe. Our definition of e (nominal exchange rate with the US 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. It is straightforward to show that using e on inflation-adjusted values of debt is equivalent to using the nominal exchange rate on current values. Note that, according to this definition, a devaluation leads to a higher value of e.

4. The Effects of Currency Exposure on Firm Performance

4.1 Empirical Specification

Our empirical specification in this section can be motivated by 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 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 optimal capital stock to leverage, and P_t is the real (inflation-adjusted) value of previous period liabilities, 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, by inflating the domestic currency value of debt, alters investment. To incorporate this mechanism into the previous equation, consider that the real value of previous period liabilities will be given by

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

where D^*_{t-1} is lagged dollar debt and Δe_t is 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 rises 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 (2) and (3) and is:

$$I_{it} = - \gamma (D_{i,t-1}^* \, x \, \Delta e_t) + \delta P_{i,t-1} + \lambda (\alpha_i e_t) - \lambda k_{i,t-1} + \phi D^*_{i,t-1} + y_t + \omega_i + \upsilon_{i,t} \tag{4}$$

We estimate versions of (4) for our sample of firms during 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 follows directly from the framework presented in this section and 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 ($D^*_{i,t-1} \; x \; \Delta e_t$) indicates whether firms holding dollar liabilities invest significantly less than their counterparts in periods following a devaluation.

In addition to the ($D^*_{i,t-1} \; x \; \Delta e_t$) interaction, we include lagged foreign currency-denominated debt to absorb any pre-existing differences among firms with different levels of dollar indebtedness. Such differences might have prevailed in the absence of movements in the real exchange rate (e.g., whether expanding firms were more likely than stagnant firms to issue dollar debt). 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.

4.2 Main Results

Table (3) 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 than those holding peso debt in periods following a depreciation.

The sample covers the period 1995-2003. The period was characterized by three events: two "large" depreciations, of approximately 10 percent in real terms, in 1999 and 2001, and a large appreciation in 2003. In addition, there is substantial cross-firm variation in the levels of foreign currency debt, 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, and year dummies to capture the shocks common to all firms. Following (4), we also include the lagged dollarization ratio to control for previous period differences in firms with higher/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 ($D^* \; x \; \Delta e$). 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, as expected, negative, suggesting a negative balance-sheet effect due to outstanding debt commitments.

As discussed above, the estimated coefficient on ($D^* \times \Delta e$) 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 α: 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, and significantly so in the case of the tradable dummy interaction. The estimated coefficient on ($D^* \times \Delta e$) remains insignificant, although marginally more negative than in column (1).

The discussion so far in this section, and indeed 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. This discussion does not, however, consider that firms may also hold dollar-denominated assets, whether 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. Although this is a necessary simplification in many cases, due to the absence of data on the currency composition of assets, it is a simplification that 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 a significant amount of foreign assets. In our sample, the average ratio of dollar assets to total assets is 5.8 percent, very close to the 9.3 percent average of dollar liabilities.

With this in mind, columns (5) and (6) include an additional interaction between dollar assets and the change in the real exchange rate ($A^* \times \Delta e$). As expected, the coefficient on the interaction is positive—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 seeing their liabilities go down relative to total assets are perceived as less risky. They consequently face a lower cost of external finance and in turn a higher optimal capital level.

Once the effect of ($A^* \times \Delta e$) is considered, the estimated coefficient on ($D^* \times \Delta e$) falls, becoming negative and significant. This confirms our prior: the insignificant coefficient on ($D^* \times \Delta e$) in column (1), and in many of the empirical papers so far, is due to omitted variables positively correlated with dollar debt. The reason is matching: firms that hold dollar debt are also

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

What are the implications of the results we have presented so far? In the first place, our results suggest 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. Hence, 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 than 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 results highlight the importance of having a measure of total balance-sheet exposure to determine the effect of a depreciation on investment and output.

Recent years have seen a substantial expansion of the Chilean derivatives market, in particular the market for currency derivatives. 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. What are the effects of these derivative positions on firm-level investment? To answer this question, Column (8) includes an interaction between the real depreciation and net forex derivative position over assets in the previous period ($F^* \times \Delta e$). The estimated coefficient is positive and significant: in periods following a depreciation, those firms holding long forex derivative positions invest relatively more than those 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 from the price previously established in the contract. We address this concern by using interest rate differentials, and assuming covered interest parity, to construct a measure of deviations of realized depreciation from the depreciation implicit in the forward contract, Δe^u.

$$\Delta e^u_t = \Delta e_t - (r_{t-1} - r^*_{t-1})$$

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.[12] Built in this way, most of the large depreciations were "unexpected," even the 1999 depreciation. Bearing this in mind, we should not expect our results to vary substantially when we include an interaction of derivative positions with Δe^u_t. 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. For our purposes this is relevant because these firms are allowed to revalue their fixed assets by changes in the nominal exchange rate so that part of our measure of investment may simply be due to changes in the prices of preinstalled assets. To correct for this, in column (10) we introduce an interaction between the lagged capital stock and the change in the real exchange rate for those firms with dollar accounting. This component controls for the effects of mechanical revaluations on investment. The estimated coefficient on the ($A^* \times \Delta e$) interaction falls considerably, but it is still significant. The estimated coefficient on the ($D^* \times \Delta e$) interaction remains negative and statistically significant.

Note that the absolute values of the estimated coefficients on dollar debt, dollar assets and currency derivatives are similar. Indeed, an F-test fails to reject the hypothesis that all three coefficients are equal. With this in mind, we build an "accounting" measure of currency mismatch (E^*), equal to dollar debt net of assets and the net long position in forex 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 ($E^* \times \Delta e$). As expected, the estimated coefficient on the interaction ($E^* \times \Delta e$) is negative and significant at conventional confidence

levels. The estimated coefficient implies that a difference in exposure of 50 percent of assets will lead, *ceteris paribus*, to investment almost 3 percent lower if the currency depreciates by 20 percent.

Finally, in column (12) we deviate from the difference-in-difference 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 ($E^* \times \Delta e$) is negative and significant. As expected, the estimated coefficient on lagged capital stock is negative and significant. In the tables that follow, we use the specification from column (12) as our baseline result.

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.[13]

4.3 Sensitivity Analysis

4.3.1 Exposure to Exchange Rate Shocks or Aggregate Credit Conditions?

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

Furthermore, although this paper concentrates on exposure to exchange rate fluctuations, this 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.

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[12] The Unidad de Fomento (UF) is an adjustable accounting unit based on variation in the Consumer Price Index.

[13] In addition to the specification reported here we carry out the following additional robustness tests: i) we estimate using lagged investment and interaction of $\Delta ln(rer)$ with exports and tradables, ii) we estimate using lagged

To control for changing credit conditions, we estimate the investment regressions including an indicator of domestic credit conditions, the domestic interest rate, and an indicator of external credit conditions, the return on the emerging market bond index (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. In addition we also interact the macro variables with a measure of the firm's maturity mismatch.[14] The risk of "maturity mismatch" for emerging-market firms has received almost as much attention as the risk of currency mismatch in recent years. Although business assets are (stereotypically) installed for the long term and therefore illiquid, capital-market frictions and distortions may induce firms to issue debt with relatively short maturity. Should aggregate credit conditions shift suddenly, these same firms, unable to renew their debt, might have to curtail investment and perhaps liquidate.

Table (4) shows the results obtained for investment after including aggregate credit variables. First and foremost, we find that the $(E^* \times \Delta e)$ interaction is significant and negative even after including this additional set of controls. Additionally, the point estimates change only slightly. Most of the additional coefficients estimated have the expected signs, but are not significant at conventional confidence levels. We do, however, obtain interesting results for the interactions with the maturity mismatch variable. *Ceteris paribus*, firms with more short-term debt relative to short-term assets react more to hikes in domestic interest rates.

4.3.2 Differential Balance-Sheet Effects Across Firms

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

With this in mind, we divide the sample by predetermined firm characteristics in Table (5). Column (1) replicates our baseline results, while columns (2) through (5) introduce an additional interaction between the $(E^* \times \Delta e)$ variable and one of four indicator variables. The

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investment and firm fixed effect using Arellano-Bond, and iii) to control for right-hand variable censoring bias, we drop all observations in which E^* is zero. In all cases our main results remain qualitatively unchanged.

[14] Although we do not report them in the table, we tested the robustness of our results to a series of additional interactions. At the firm level we used short-term debt, log (assets) and total leverage. At the macro 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 Libor rates on dollar loans. These results are available from the authors.

first of these is a dummy that takes on a value of 1 for firms that are eligible to be included in the AFP portfolio. Two previous studies for Chilean firms have found that the investment of firms in this category is less correlated with cash flow and less sensitive to leverage.[15] The additional three dummy variables were described above: i) a dummy for foreign ownership, ii) a dummy for firms with ADRs, and iii) a dummy for firms belonging to a *grupo financiero*.[16] We also include the indicator variable in all the specifications, its interaction with total leverage and its interaction with Δe, although only the coefficients on $(E^* \times \Delta e)$ and the triple interaction are reported. Structuring the specification in this manner allows us to estimate how the effect of $(E^* \times \Delta e)$ among the indicated set of firms differs from the rest of the sample.

The estimated coefficient is positive only when we interact our measure of exposure with the AFP dummy and the ADR dummy. This suggests that less credit-constrained firms are less vulnerable to the balance-sheet effects of currency exposure. However, in the case of the foreign and *grupo* dummies the interaction has the opposite sign. These regressions have been estimated very imprecisely, so these findings must be treated with caution. We have no explanation for the results of either the foreign dummy or the *grupo* dummy.

5. Foreign Currency Hedging by Chilean Non-Financial Firms

The previous section provides empirical support for a strong balance-sheet effect arising from the interaction of foreign debt and exchange rate depreciations after controlling for differences in the composition of the balance sheet and net operational income. The evidence also suggests that Chilean non-financial 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 relationship between hedging and those variables identified in the corporate finance literature to explain risk aversion in non-financial corporations.

[15] See Medina and Valdés (1998) and Gallego and Loayza (2000).
[16] We exclude those periods from the sample in which a firm changes categories. This explains the smaller sample than in previous specifications.

5.1 Determinants of Currency Exposure in Chilean Firms

5.1.1 Dollar Debt and Productive Structure

In this section we evaluate the first prediction of the mean variance framework presented in the previous section, 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: direct exports as a share of total sales, a dummy variable that takes a value of one if the firm is in a tradable sector (agriculture, mining, or manufacturing), and the ratio of dollar-denominated assets to total assets.

Columns (1) and (2) of Table 6 report the ordinary least squares (OLS) estimation for the ratio of dollar debt to assets. In column (1) we include the tradable dummy 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 0, in columns (3) and (4) we also estimate (5) using a Tobit method. 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 those firms that sell their output domestically. Similarly, firms with a 50 percent share of dollar-denominated assets on average have dollar debt over asset ratios that are 13 percent higher. The dummy for the tradable dummy is positive and significant in column (3) even after controlling for dollar assets, and exports dollar liabilities are 3 percent higher (as a percentage of total assets) than in non-tradable 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 by an indicator variable for firms that hold non-zero dollar debt (column 9 and 10) and when we measure β as dollar debt over assets net of derivative positions, in columns (11) and (12).

In summary, 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.

5.1.2 Structural Determinants of Derivative Use

What ultimately matters for firm performance is net exposure to exchange rate shocks. Nevertheless, because in our sample derivative positions are relatively small vis-à-vis total dollar debt, results for net dollar debt (dollar debt net of long forex derivative positions) are driven to a large extent by the debt component. Therefore, we believe it is informative to present some results for the determinants of derivative use.

We report the results of these estimates in Table (7). 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 LHS is an indicator variable for firms holding any form of forex derivative.

In all specifications the estimated coefficient on dollar debt is positive and significant at conventional confidence levels. Firms holding dollar debt hold larger long positions in forex derivatives and are in turn more likely to hold any form of forex derivative. 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). Controlling for dollar debt, firms exporting a larger share of their sales and firms with a larger share of dollar-denominated assets hold significantly lower long derivative positions. It is not surprising that the estimated coefficients on exports and dollar assets are not significant in columns (3) and (4), as long positions are treated the same as 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.

5.1.3 Currency Exposure and Risk Aversion

Controlling for α and the relative cost of domestic and foreign credit $\tau + \varepsilon$, the level of exposure to currency shocks will be lower for more risk-averse firms (higher μ). To test this prediction empirically we estimate a measure of "excess" currency exposure for firms over the period 2000-2002. 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 term captures matching, while the second term captures possible correlations between μ and ε, the idiosyncratic component of the 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 regress them on μ. Table 8 reports the estimated coefficients for the second stages of this estimation for data pooled over the period 2000-2002. 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 log (total assets).

The first section of Table 8 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 have argued that large firms are less credit-constrained 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 are therefore more exposed (at least in terms of their balance sheet) 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 indirectly via the US 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, suggesting that these firms are less credit-constrained than their counterparts.

A number of empirical papers for Chile have grouped Chilean firms according to their eligibility for pension fund investment, as firms eligible for AFP portfolios are expected to be less credit-constrained than others. 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 more closely monitored by AFP investment managers; this reduces 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. As was the case for the ADR, foreign ownership and AFP dummies, we find positive and significant coefficients.

The next section of Table 8 includes variables that measure liquidity risk. As discussed above, we expect firms with higher liquidity risk to minimize exposure to currency fluctuations. Nevertheless, the estimated coefficient 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: 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, negatively correlated with credit constraints, would drive up leverage and at the same time lead to higher dollar exposure, as indeed we find in the table.

Finally, the last panel of Table 8 shows the results for two variables that proxy for investment opportunities: a lagged moving average of investment over assets and the (log) 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. On the other hand, the estimated cofficient on market-to-book ratio is negative and significant, as expected.

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

The empirical evidence in the previous section indicated that Chilean firms in the sample actively hedged their balance-sheet exposure, matching foreign currency liabilities, assets and derivatives. Also, across firms in the sample, net exposures are smaller among those that are more likely to face financial constraints and suffer a negative balance-sheet effect from exchange rate fluctuations. In this section, we focus on the time dimension of our panel of firms in order 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 in Chilean firms.

Through most of the 1990s, Chilean authorities followed a monetary/exchange rate regime based on three main pillars: an active monetary policy that aimed to gradually reduce the inflation rate though year-end inflation targets, a crawling band for the nominal exchange rate, and regulatory restrictions on capital inflows.

Money market interest rates were actively managed to keep inflationary pressures under control and internal demand growth in line with potential output and fluctuations of the terms of trade. For most of the decade, domestic interest rates, adjusted for inflation differentials, were kept well above international levels, more in line with the economy's high growth rates. From 1994 to 1997, the average three-month interest rate for time deposits was 8.7 percent in UFs, while the ex-post average three-month Libor dollar rate was 3.4 percent in UFs.

The interest rate differential exerted pressure for the appreciation of the peso. However, the exchange rate policy was anchored by the commitment of the Central Bank of Chile (CBCh) to buy or sell dollars within a crawling band on the nominal exchange rate. The CBCh intervened in the foreign exchange market on a regular basis, buying dollars on a sterilized basis and accumulating international reserves. The width and the level of the band were adjusted on several occasions, always at times of pressure for further appreciation of the peso. The real exchange rate appreciated on a consistent basis at an average 4.7 percent a year between 1994 and 1997.

In order to cope with massive capital inflows, the authorities imposed an unremunerated reserve requirement (URR) on foreign debt inflows for a one-year period at a 30-percent rate. This restriction, known as the *encaje*, was very costly for short-term (arbitrage) inflows, distorting the uncovered interest parity condition for short-term interest rates, but less so for long-term debt inflows, allowing firms to borrow abroad at long maturities (Herrera and Valdés, 2001; De Gregorio, Edwards and Valdés, 2000). Adjusting international borrowing rates for the *encaje* reduced but did not eliminate the interest rate differential (see Table 9).

The combination of interest differentials and nominal exchange rate stability provided incentives for domestic firms to borrow abroad and for domestic investors to stay at home. For example, in 1997 pension funds were allowed to invest up to 16 percent of their portfolio abroad, but in fact chose to hold only 1 percent of their portfolios in foreign assets. On the liabilities side, Chilean blue-chip corporations had strong incentives to substitute domestic UF debt for international debt and small incentives to hedge the currency risk, as in the forward market the

peso traded constantly at a discount to compensate for interest rate differentials, while in the spot market the peso exchange rate remained stable with occasional discrete adjustments towards appreciation. From 1993 to 2000, the stock of foreign debt of Chilean non-financial private firms rose from US$5.8 billion to US$29.5 billion. The forward market did not develop significantly until 1998. By the end of 1997, Chilean firms had bought less than US$500 million in the forward market. The development of the local market for private bonds was minimal until 2000, and the only important issuer in the local market was the Central Bank, which did so in order to sterilize its intervention in the forex market.

The aftermath of the Asian crisis hit the Chilean economy severely through 1998 and 1999 and highlighted flaws in the prevailing policy regime. In early 1998 the CBCh stepped in to contain the depreciation of the peso, reduce cost pressures on inflation, and speed up the adjustment of the current account. The policy response during 1998 was a mix of restrictive monetary policy, non-sterilized intervention in the foreign exchange market, a narrowing of the exchange rate band, issuance of dollar-linked debt and a fiscal adjustment. The combination of negative external shocks and the contractionary policy mix moved the Chilean economy into a recession in 1999.

On the basis of this experience, fiscal and monetary authorities completely revamped macroeconomic policies between 1998 and 2001. First, the CBCh eliminated the *encaje* in September 1998. The CBCh subsequently adopted a floating exchange rate regime in September 1999 and a full-fledged inflation-targeting framework for monetary policy. In March 2000, the new Lagos administration committed itself to a fiscal policy rule intended to achieve a surplus of 1 percent of GDP for the full-employment budget. In April 2001, all capital account restrictions were eliminated.

The 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. Indeed, the economy-wide 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 US$/UF exchange rate was 2.4 percent. After the floating of the peso in September 1999 the annualized standard deviation nearly doubled to 4.4 percent. Accordingly, we expect that the new policy regime created greater incentives for firms to hedge and reduce their currency risk exposures. Further, we expect the

reduction to be more intense in those firms that have relatively weaker balance sheets and are more 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.

We examine these predictions in this section, and look for changes in both the level of exposure and the size of the balance-sheet effect in our sample of Chilean firms after the shift in the macroeconomic policy regime.

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. First, we review different average measures of exposure to foreign exchange risk, and then we re-estimate the matching regressions of the previous section to examine changes in the behavior of firms after the shift to the floating exchange regime.

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 during the following two years. Likewise, dollar debt increased from 20 percent of total liabilities in 1995 to 27 percent in 1998, but in the following two years fell back to 20 percent of total liabilities (18 percent when adjusted for the depreciation of the real exchange rate) and stayed at that level. Similarly, hedging activity increased sharply during 1998 and 1999 and then stabilized. Until 1997, firms' net (and gross) positions on forward markets were negligible, but afterwards the net position 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, foreign currency debt adjusted for foreign currency assets and derivatives, increased gradually from 1995 to 1997, and then started to decline quite sharply in 1999 and 2000, 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 macro policy regime.

The empirical evidence on the differential behavior of firms pre- and post-changes in the macro policy regime is shown in Table 10. We re-estimate regressions on the hedging behavior of firms, including a time dummy for the period prior to the adoption of the floating exchange

rate regime and other reforms. Although changes in macro policies were implemented during 1998 and 1999, we consider that there could be some adjustment costs to the composition of the balance sheet that may lead to a lagged response on the part of firms; therefore the dummy variable covers the years from 1995 to 1998, and only 1999 is excluded from the sample.

The results for all regressions indicate a significant drop of 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, after 1999 the net derivative position increases significantly. As shown in the graphs for the aggregate numbers, most of the action comes from the reduction of foreign currency debt and a smaller effect of the increase in derivatives.

As we have detected an increase in the volatility of the exchange rate in the period after 1999, we expect the drop in exposure to be larger for firms in more vulnerable financial condition. Firms are sampled according to those variables identified in the previous section as measures of firms' risk aversion, and then we test for differences in the change of the forex exposure after 1999. To measure forex exposure we replicate the methodology discussed in the previous section—that is, we estimate the "matching" portfolio using dollar assets, exports and tradable dummies, and we estimate deviations from this portfolio. To allow for changes across periods in this matching relationship 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 11. In all cases except the AFP dummy, the estimated coefficient on the interactions are negative, although only the interaction with the ADR dummy is significantly so. This is contrary to what we expect.

Until now we have attributed the fall in dollar debt or average exposure to the shift in the macro policy regime and its impact on compressing interest rate differentials and increased exchange rate volatility. Note that we have not attempted to disentangle the effects of each of these components. In Table 12 we take a first pass at decomposing these two macro effects. To do so, we re-estimate 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 1-3 year loans in UF in the Chilean banking system as a measure of the domestic interest rate.[17] We report the results of these estimates in Table 12. The estimated signs on the interest rate coefficients are as expected, with dollar debt rising when domestic rates are higher 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 interest rates individually or, as in column (3), by the spread between both 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 rate differentials have a large effect on the currency exposure of less risk-averse firms. 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. Hence, we find some evidence that firms that are less risk-averse respond most to changes in interest rate differentials, as the costs (in terms of financial distress or missed investment opportunities) are lower.

Higher exchange rate volatility in the post-float period is a plausible explanation for the positive coefficient on the pre-float dummy. However, other economy-wide events occurring during the same period could also be driving our results. An alternative hypothesis for explaining why firms closed their currency mismatches after 1998 would be to argue that during this period they faced an external liquidity crunch 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 their currency mismatches because they could not continue borrowing abroad.

The evidence on credit spreads is consistent with the observation that, in the aftermath of the Asian crisis, foreign borrowing by Chilean firms became more expensive and restrictive. Credit spreads increased to record levels in mid 1998, but local interest rates also increased to record levels during the same period, partly to compensate for increases in external rates and expectations of further depreciation of the exchange rate through the ceiling of the band.

[17] We carry out these estimations with the ex-ante Libor and EMBI rates, with and without the URR over a two-year entry period, and we obtain similar results.

Furthermore, we find no compelling evidence to argue that, after 1998, either the Chilean economy was liquidity-constrained in international markets or that firms had been cut off from international credit. Indeed, in January 1999 the government was able to fund its fiscal deficit, tapping 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, the total private foreign debt of non-financial firms continued increasing in 1998, 1999 and 2000, growing from US$21 billion to US$29.4 billion. Credit spreads have continued to decline since 2000, although the private foreign debt of non-financial firms has stabilized at US$29 billion. However, despite the reduction in the cost of international borrowing, we have not witnessed a surge in capital inflows, even after 2002 when international liquidity conditions improved.

Another candidate for the positive pre-float dummy could be changes in micro-prudential regulations on credit risk. In 1999, regulatory caps for banks were introduced on market risk, including currency risk. At the time, however, foreign currency exposure was limited, and foreign currency lending by local banks to domestic firms was very limited as well, with the exception of trade-related credits.

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. These data should allow us to correct for the omitted variables bias 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 has argued (or shown) to be correlated with firm-level risk aversion. Finally, by looking at firm-level data for Chile over the period 1995-2003, we are able to identify changes in the level and distribution of dollar debt across two distinct policy regimes. Pre-1999 Chile had an exchange rate band and therefore an explicit commitment to exchange rate stability. Post-1999, the Central Bank has allowed the exchange rate to float freely.

As in previous studies of Chile by Benavente, Johnson and Morandé (2003) and Fuentes (2003), we find that in periods following a depreciation firms with higher dollar debt do not

underperform their peso counterparts. 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, when correctly measured, currency mismatches matter. In addition, we find that derivatives play a role in insulating firm-level investment from exchange rate shocks, and that the balance sheet effects are (weakly) smaller for firms we categorize *a priori* as less credit-constrained.

In line with previous firm-level studies, we also 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 positively correlated with measures of credit constraints (or firm risk aversion) and investment opportunities. Our results on exposure suggest that those firms most exposed to currency risk are those best 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 controlling for a (crude) measure of interest rate differentials. We argue that one possible explanation of these results is the effect of higher exchange rate variance on 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 implicit exchange rate insurance and forcing firms to internalize exchange rate risk. However, more evidence for other emerging market economies would be needed to generalize this assertion.

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Table 1. Balance Sheet Literature

Author	Countries Covered	Firms Covered	Measure of fx exposure	Performance Variables	Measures of Income Elast.	Derivatives	Dollar Assets?	Evidence of Matching	Balance Sheet Effect?
Aguiar (2002)	Mexico	Large listed	Short and long term dollar debt	Fixed capital investment, profits, net worth and working capital	Exports and ADR	No	No	Yes	Negative and significant
Allayanis et al. (2001)	S. Korea, Hong-Kong, Indonesia, Phillipines, Malasya, Taiwan, Thailand	Large listed	Dollar Debt and derivatives	Excess return, Beta and Exchange rate sensitivity	Foreign EBIT, foreign cash	Yes	No	Yes	Negative and significant
Benavente et al. (2003)	Chile	Large listed	Dollar Debt	Fixed capital investment	Tradable sectors dummy	No	No	Yes	Positive or not significant
Bleakley and Cowan (2002)	Argentina, Brazil, Chile, Colombia, Mexico	Large listed	Dollar Debt	Fixed capital investment, inventory accumulation	Tradable sectors dummy	No	No	Yes	Positive or not significant
Bonomo et al. (2003)	Brazil	Large listed	Dollar Debt	Fixed capital investment	Tradable sectors dummy	No	No	Yes (not signicant)	Negative, not significant
Carranza et al. (2003)	Peru	Large listed	Dollar Debt	Fixed capital investment	Tradable sectors dummy and export ratio by sector	No	No	Yes	Negative and significant
Echeverry et al. (2003)	Colombia	Listed and unlisted firms	Dollar Debt	Fixed capital investment and profits	Exports, Imports, Sectoral GDP growth	No	No	Yes	Not significant for inv., negative and significant for profits
Fuentes (2003)	Chile	Large listed	Short and long term dollar debt	Fixed capital investment		No	No	N/A	Positive for long-term debt, negative for short-term debt
Galiani et al. (2003)	Argentina	Large listed, large unlisted and privatized	Dollar Debt	Fixed capital investment, Sales and Earnings	Exports	No	No	Yes (not signicant)	Negative and significant
Luengnaruemitchai (2003)	South Korea, Indonesia, Phillipines, Malasya, Taiwan, Thailand	Large listed	Dollar Debt	Fixed capital investment	Share of earnings before income tax from foreign currency (FEBIT)	No	No	Yes	Positive or not significant
Martinez and Werner (2002)	Mexico	Large listed	Dollar Debt	--	Exports	No	No	Yes, post 1995	--
Pratap et al. (2003)	Mexico	Large listed	Dollar Debt	Fixed capital investment and earnings	Exports and tradable sectors dummy	No	No	Yes, post 1994	Negative and significant

Table 2. Descriptive Statistics

Variable	*Observations*	*Mean*	*Standard Deviation*	*Minimun*	*Maximun*
Investment in Fixed Capital over Lagged Assets	1326	0.038	0.149	-2.200	1.071
Dollar Debt over Lagged Assets	1183	0.093	0.139	0.000	1.013
I (Firm has Dollar Debt)	1179	0.651	0.476	0.000	1.000
Dollar Assets over Lagged Assets	1186	0.058	0.164	-0.029	1.008
Net Forex Derivatives Position over Lagged Assets	1325	0.007	0.043	-0.153	0.562
I (Firm has derivatives)	1326	0.141	0.348	0.000	1.000
Exposure (Dollar Debt - Forwards - Dollar Assets) over Lagged Assets	1181	0.027	0.169	-1.008	0.648
Cash Flow over Lagged Assets	1326	0.072	0.185	-1.584	3.209
Exports over Lagged Assets	1309	0.053	0.156	0.000	1.379
Exports over Sales	1309	0.098	0.229	0.000	1.027
Lagged Capital over Assets	1326	0.772	0.451	0.000	4.833

Table 3. Effect of Exchange Rate Exposure on Investment, 1995-2003

RHS variables:	Dependent Variable: Investment in Fixed Capital											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Interactions												
Dollar Debt x (D log Real Exchange Rate)	0.009	-0.020	-0.049	-0.043	-0.428	-0.453	-0.451	-0.494	-0.492	-0.353		
	[0.155]	[0.126]	[0.109]	[0.112]	[0.205]**	[0.170]***	[0.201]**	[0.206]**	[0.208]**	[0.164]**		
Exposure x (D log Real Exchange Rate)											-0.265	-0.274
											[0.117]**	[0.097]***
Main Effects												
Dollar Debt	0.014	0.015	0.026	0.025	0.021	0.032	0.011	0.009	0.009	0.010		
	[0.063]	[0.059]	[0.060]	[0.057]	[0.060]	[0.058]	[0.043]	[0.045]	[0.045]	[0.043]		
Exposure											-0.016	-0.018
											[0.020]	[0.023]
Total Debt	-0.097	-0.095	-0.100	-0.099	-0.098	-0.101	-0.099	-0.099	-0.099	-0.100	-0.096	-0.090
	[0.057]*	[0.057]*	[0.057]*	[0.057]*	[0.058]*	[0.057]*	[0.057]*	[0.057]*	[0.057]*	[0.056]*	[0.055]*	[0.049]*
Controls												
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	0.113	0.113	0.113	0.110	0.106	0.117
			[0.059]***	[0.061]***		[0.057]***	[0.044]**	[0.044]**	[0.044]**	[0.042]***	[0.042]**	[0.046]**
Dollar Assets					0.013	0.009	0.013	0.013	0.013	0.030		
					[0.029]	[0.029]	[0.026]	[0.026]	[0.026]	[0.022]		
Dollar Assets x (D log Real Exchange Rate)					0.847	0.791	0.693	0.711	0.710	0.224		
					[0.210]***	[0.231]***	[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 pos.								0.016	0.018	0.015		
								[0.062]	[0.061]	[0.060]		
Net long derivative pos. x (D log Real Exchange Rate)								0.404		0.382		
								[0.236]*		[0.256]		
Net long derivative x (D log Real Exchange Rate Unexpected)									0.355			
									[0.214]*			
Lagged Capital Stock												-0.168
												[0.071]**
Lagged Capital Stock x (D log Real Exchange Rate) x I(account usd)										0.609	0.580	0.561
										[0.185]***	[0.197]***	[0.171]***
Regression Information												
N	1326	1326	1326	1326	1326	1326	1326	1326	1326	1326	1326	1326
R^2	0.26	0.26	0.26	0.26	0.26	0.27	0.36	0.36	0.36	0.37	0.37	0.41
Estimator	OLS/FE	OLS/FE	OLS/FE	OLS/FE	OLS/FE	OLS/FE	OLS/FE	OLS/FE	OLS/FE	OLS/FE	OLS/FE	OLS/FE
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cluster Year SE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

This table reports the OLS estimates of variants of equation (4) in the text. The dependent variable is the change in the CPI-adjusted stock of fixed capital. All independent accouting variables with the exceptior cash flow from operations are once lagged. All accounting variables are scaled by once lagged total firm assets. Standard errors adjusted for clustering by year are reported in parentheses. A single aste denotes statistical significance at the 90% level of confidence; double, 95%; triple, 99%. I(account usd) is a dummy for firms that carry their accounting in dollars. Exposure is the dollar debt net of derivatives a 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 rates are built assuming uncove interest rate parity, as described in the text. Net derivative positions are the notional values of currency derivative positions with domestic banks. The accounting data are from the SVS sample, as described in text. Macro data are drawn from various sources. For detailed sources and descriptions, see Section 3 and Appendix.

Effect 20% depreciations with 50% dollar debt	0.05
Effect 20% depreciations with 50% exposure	0.03

Table 4. Changes in Aggregate Credit Conditions

	Dependent Variable: Investment in Fixed Capital					
	(1)	(2)	(3)	(4)	(5)	(6)
Interactions						
Exposure x (D 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 Controls						
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 (D 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 Controls						
Lagged Capital Stock x (D log Real Exchange Rate) x I(account usd)	0.558	0.567	0.56	0.554	0.569	0.563
	[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]			
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]***
Regression Statistics						
N	1326	1326	1326	1326	1326	1326
R^2	0.41	0.41	0.41	0.41	0.41	0.41
Estimator	OLS/FE	OLS/FE	OLS/FE	OLS/FE	OLS/FE	OLS/FE
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Cluster Year SE	Yes	Yes	Yes	Yes	Yes	Yes

The dependent variable is the change in the CPI-adjusted stock of fixed capital. All independent accouting variables with the exception of cash flow from operations are once lagged. All accounting variables are scaled by once-lagged total firm assets. Standard errors adjusted for clustering by year are reported in parentheses. A single asterisk denotes statistical significance at the 90% level of confidence; double, 95%; triple, 99%. I(account usd) is a dummy for firms that carry their accounting in dollars. Exposure is the dollar debt net of derivatives and dollar assets. Maturity mismatch is defined as the difference between current liabilities and current assets, scaled by total assets. Macroeconomic variables (real exchange rates, domestic and international interest rates) are from the current period (i.e., concurrent with the LHS 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 30-89 days loans in the domestic financial system in UF. The accounting data are from the SVS sample, as described in the text. Macro data are drawn from various sourc

Table 5. Effect of Exposure Across Firm Categories

	Dependent Variable: Investment in Fixed Capital				
	(1)	(2)	(3)	(4)	(5)
Exposure	-0.287	-0.451	-0.293	-0.310	0.250
x (D log Real Exchange Rate)	[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 (D log Real Exchange Rate) x I(account usd)	0.577	0.542	0.582	0.553	0.533
	[0.179]***	[0.211]**	[0.186]***	[0.188]***	[0.182]***
I(AFP) x Exposure x (D log Real Exchange Rate)		0.343			
		[0.394]			
I(foreign) x Exposure x (D log Real Exchange Rate)			-0.057		
			[0.606]		
I(ADR) x Exposure x (D log Real Exchange Rate)				0.185	
				[0.452]	
I(grupo) x Exposure x (D log Real Exchange Rate)					-0.750
					[0.559]
Regression Information					
N	1326	1102	1323	1308	1326
R2	0.41	0.4	0.41	0.41	0.41
Estimator	OLS	OLS	OLS	OLS	OLS
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Cluster Year SE	Yes	Yes	Yes	Yes	Yes

The dependent variable is the change in the CPI adjusted stock of fixed capital. All independent accouting variables with the exception of cash flow from operations are once lagged. All accounting variables are scaled by once-lagged total firm assets. Standard errors adjusted for clustering by year are reported in parentheses. A single asterisk denotes statistical significance at the 90% level of confidence; double, 95%; triple, 99%. Exposure is the dollar debt net of derivatives and dollar assets. I(account usd) 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 in the NYSE, 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 accounting data are from the SVS sample, as described in the text. The number of observations changes because periods in which firms change categories are excluded from the sample.

Table 6. Dollar Debt and Production Structure 1996-2002

	Dollar Debt / Total Assets				Dollar Debt / Total Debt				I(dollar debt)		Net Dollar Debt / Total Assets	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Dollar Assets / Total Assets	0.269	0.264	0.330	0.344	0.586	0.629	0.702	0.788	7.466	8.127	0.274	0.269
	[0.052]***	[0.051]***	[0.034]***	[0.034]***	[0.082]***	[0.079]***	[0.070]***	[0.069]***	[2.332]***	[2.393]***	[0.051]***	[0.050]***
Exports / Sales	0.128	0.122	0.174	0.196	0.356	0.419	0.441	0.568	1.894	2.583	0.149	0.142
	[0.033]***	[0.031]***	[0.026]***	[0.023]***	[0.069]***	[0.063]***	[0.052]***	[0.048]***	[0.466]***	[0.549]***	[0.033]***	[0.030]***
Tradeable	-0.008		0.027		0.077		0.157		0.547		-0.008	
	[0.018]		[0.013]**		[0.040]*		[0.027]***		[0.184]***		[0.017]	
Regression Information												
N	1078	1078	1078	1078	1078	1078	1078	1078	1085	1085	1075	1075
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

This table reports the estimates of equation (5) in the text. The estimation method is reported under each column. Standard errors are reported in parentheses. A single asterisk denotes statistical significance at the 90% level of confidence; double, 95%; triple, 99%. 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 forex derivatives with domestic banks. Tradable firms are those from ISIC sectors 1 to 3 (agriculture, mining and manufacturing). For detailed sources and descriptions, see Section 3.

Table 7. Determinants of Derivative Use

	Net Derivatives/ Total Assets		I(dollar derivatives>0)	
	(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]***
Regression Information				
N	1075	1075	1078	1078
R^2	0.13	0.13	--	--
Sector Dummies	No	Yes	No	Yes
Cluster RUT	Yes	Yes	Yes	Yes
Estimator	OLS	OLS	Probit	Probit

The estimation method is reported under each column. Standard errors are reported in parentheses. A single asterisk denotes statistical significance at the 90% level of confidence; double, 95%; triple, 99%. The dependent variable is as detailed in each column. The net derivative position is the notional value of the net long position of forex derivatives with domestic banks. Tradable firms are those from ISIC sectors 1 to 3 (agriculture, mining and manufacturing). For detailed sources and descriptions, see Section 3.

Table 8. Corporate Determinants of Currency Exposure

LHS: Absolute "Excess" Dollar Debt (Net of derivatives)		
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		
lagged investment to asset ratio	0.023	-
	[0.031]	
ln (market to book)	-0.004	-
	[0.002]**	

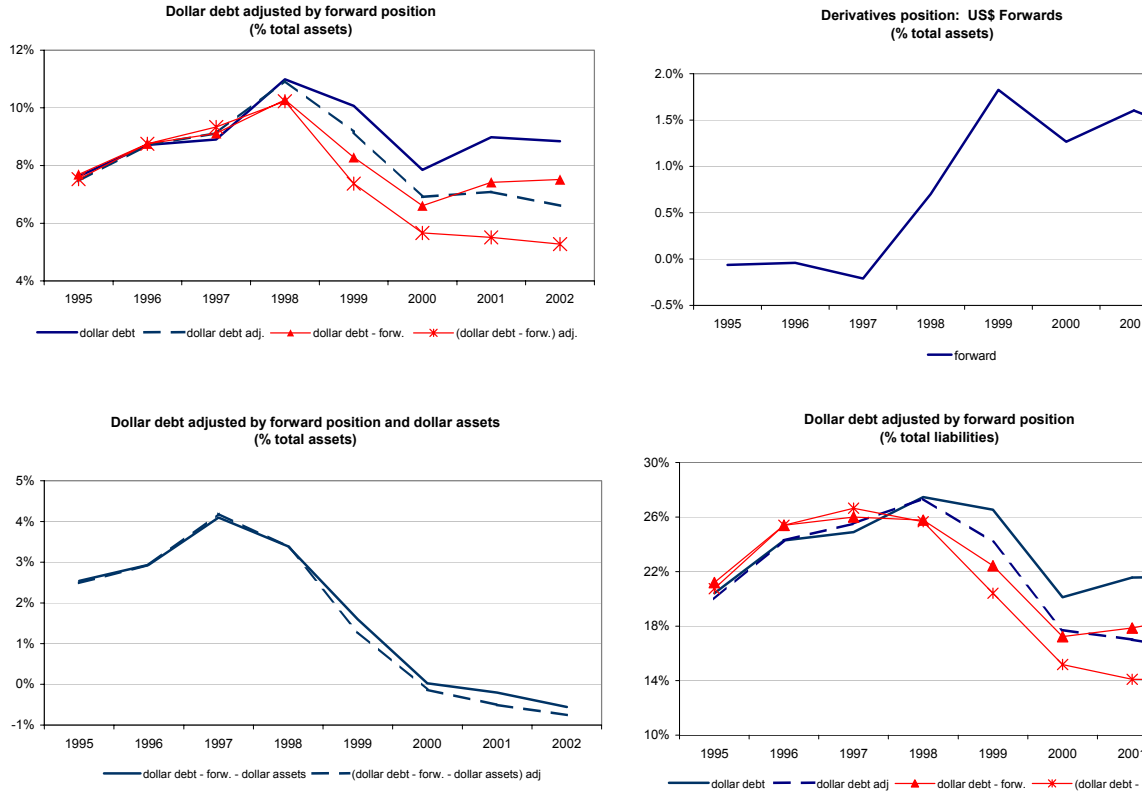
The table reports estimated coefficients and robust standard errors for univariate regressions between "excess" dollar debt and each of the variables reported in the table. The final column shows the expected sign of the correlation. In the case of liquidity risk variables and investment opportunities variables, the regression also includes total assets as a control. 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 6. 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 in the NYSE 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. All liquidity variables are lagged once. A single asterisk denotes statistical significance at the 90% level of confidence; double, 95%; triple, 99%.

Table 9. Average Three-Month Interest Rates and Exchange Rate Volatility (%)

	UF	*USD (ex-ante)*				*USD (ex-post)*				*Std. Dev.*
		EMBI		*Libor*		*EMBI*		*Libor*		*D(UF/USD)*
		no URR	URR	no URR	URR	no URR	URR	no URR	URR	
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

Each cell contains average three-month rates of return for an instrument denominated in the currency mentioned above each column. UF corresponds to the average rate in the financial system on 30-89 days loans in CPI-indexed units of account, UF (*Unidad de Fomento*). EMBI corresponds to the EMBI yield, and Libor corresponds to the 3-month Libor rate in US dollars. Ex-post US$ interest rates are calculated as the ex-ante USD rates adjusted by changes in the UF/USD exchange rate. Those interest rates labeled as URR have been adjusted by the "encaje" (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/USD exchange rate.

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



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

Table 10. Exposure Pre and Post Float 1996-2002

RHS variables:	LHS: Ratio of exposure to total assets:						LHS: Ratio of exposure to total liabilities							
	Dollar Debt		Dollar Debt Net of Derivative Position		Dollar Debt Net of Derivative Position and Dollar Assets		Dollar Debt		Dollar Debt Net of Derivative Position		**Net Derivative Position**		**Dollar Assets / Total Assets**	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
log (total assets)	0.025	0.048	0.019	0.044	0.008	0.004	0.061	0.056	0.05	0.044	0.003	0		
	[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(1996-1998)	0.016	0.019	0.028	0.031	0.038	0.039	0.067	0.064	0.102	0.095	-0.014	-0.014	-0.015	-0.018
	[0.007]**	[0.006]***	[0.007]***	[0.006]***	[0.013]***	[0.008]***	[0.014]***	[0.011]***	[0.016]***	[0.012]***	[0.004]***	[0.003]***	[0.014]	[0.007]***
Regression Information														
N	923	923	921	921	921	921	923	923	921	921	921	921	921	921
R2	0.28	0.75	0.29	0.72	0.02	0.6	0.41	0.79	0.43	0.77	0.16	0.51	0	0.7
Estimator	OLS	OLS/FE	OLS	OLS/FE	OLS	OLS/FE	OLS	OLS/FE	OLS	OLS/FE	OLS	OLS/FE	OLS	OLS/FE
Cluster RUT	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
dummy (1996-1998) as a % of pre-float exposure	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!				

This table reports the estimates of equation (5) in the text. Observations from 1999 are excluded from the regresion. The estimation method is reported under each column. Standard errors are reported in parentheses. A single asterisk denotes statistical significance at the 90% level of confidence; double, 95%; triple, 99%. The dependent variable is as detailed in each column. The dummy 1996-98 takes a value of one in the pre-float period. The net derivative position is the notional value of the net long position of forex derivatives with domestic banks. For detailed sources and descriptions, see Section 3.

Pre average	0.088047	0.088047	0.084815	0.084815	0.0311518	0.0311518	0.2363123	0.2363123	0.2326951	0.2326951

Table 11. Excess Dollar Debt

	LHS: Absolute Value of Excess Dollar Debt (Net)									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
pre	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 x log(assets)		-0.003								
		[0.003]								
I(ADR)			0.049	0.081						
			[0.014]***	[0.024]***						
pre x I(ADR)				-0.052						
				[0.022]**						
I(Foreign)					0.033	0.043				
					[0.011]***	[0.013]***				
pre x I(Foreign)						-0.015				
						[0.012]				
I (AFP)							0.025	0.020		
							[0.008]***	[0.009]**		
pre x I(AFP)								0.007		
								[0.009]		
I(Grupo)									0.022	0.026
									[0.010]**	[0.012]**
pre x I(Grupo)										-0.006
										[0.009]
Regression Information										
N	1221	1221	1221	1221	1211	1211	1221	1221	1221	1221
R2	0.14	0.14	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02
Estimator	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
Cluster RUT	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Firm-clustered standard errors are reported in parentheses. A single asterisk denotes statistical significance at the 90% level of confidence; double, 95%; triple, 99%. 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 in the NYSE and I(grupo) is a dummy for firms belonging to a conglomerate in 2002 as defined by the SVS. For detailed sources and descriptions, see Section 3.

Table 12. Macroeconomic Determinants of Net Dollar Debt

	Dependent variable: Dollar debt net of derivative positions							
	Macro determinants of net dollar debt			Macro determinants of net dollar debt interacted with firm characteristics				
RHS variables:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
a								
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]***
(r-r*)								
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]
s^2								
dummy(1996-1999) = pre		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]***
interactions with m								
log(assets)				0.052				
				[0.011]***				
log(assets) x spread				0.068				
				[0.035]*				
I(ADR)					0.021			
					[0.061]			
I(ADR) x spread					0.560			
					[0.722]			
I(AFP)						0.009		
						[0.014]		
I(AFP) x spread						0.277		
						[0.170]		
I(Foreign)							0.165	
							[0.067]**	
I(Foreign) x spread							0.303	
							[0.277]	
I(grupo)								0.000
								[0.000]
I(grupo) x spread								0.012
								[0.133]
Regression Information								
N	1221	1221	1221	1198	1221	1221	1211	1221
R^2	0.68	0.68	0.68	0.69	0.68	0.68	0.69	0.68
Estimator	OLS/FE	OLS/FE	OLS/FE	OLS/FE	OLS/FE	OLS/FE	OLS/FE	OLS/FE
Cluster Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Firm fixed effects included but not reported. Standard errors adjusted by year clusters are reported in parentheses. A single asterisk denotes statistical significance at the 90% level of confidence; double, 95%; triple, 99%. The dependent variable is dollar debt net of the notional derivative value with domestic banks. 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 in the NYSE 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 30-89 days loans in the domestic financial system in UF.The foreign interest rate is the annualized yield on the EMBI bond index. For detailed sources and descriptions, see Section 3.

APPENDIX : Variables Definitions and Sources

Name	*Definition (codes correpond to FECUS classification)*	*Source*	*Code*
Main variables			
investment in fixed capital	k(t) - k(t-1) / total assets (t-1)	FECU	i2a
dollar debt over lagged assets	book value of dollar debt (t) / total assets	complementary note to FECU	dd2a
dollar assets over lagged assets	book value of dollar assets (t) / total assets	complementary note to FECU	da2a
net long derivatives position over lagged assets	nominal valule of forex forward position / total assets	Central Bank of Chile and FECU	f2a
exposure	dd2a - f2a - da2a		ddfa2a
tradable	1 if isic code (rev 2) is 1, 2 or 3. **(1)**	FECU	trad
exports over total assets	exports / total assets	PROCHILE and FECU	x2a
exports over sales	exports / sales	PROCHILE and FECU	x2s
Secondary variables			
total assets	5.10.00.00	FECU	a
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	k
leverage (total debt) over total assets	(5.10.00.00 - 5.24.00.00) / total assets	FECU	l2a
cash flow from operations (EBIT)	5.31.11.00 + depreciation	FECU	
cash flow from operations over assets	EBIT / total assets		cf2a
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	current
coverage ratio = accrued interest / cash flow from operations	5.31.12.60 / EBIT	FECU	coverage
market capitalization = pqe	Market cap (December)	Bolsa de Comercio	pqe
accounting equity	5.24.00.00	FECU	
log(market-to-book)	log(pqe / accounting equity)	FECU + Bolsa de Comercio	lnmkt2book
log(tobin q)	log ((pqe + total debt) / total assets)	FECU + Bolsa de Comercio	lntobinq
maturity mismatch = (current liab - current assets) / total assets	(5.21.00.00- 5.11.00.00) / total assets	FECU	mmis2a
Ownership			
ADR	1 if firm has ADR	JP Morgan	
grupo	1 if firm is in a economic conglomerate	SVS	
AFP	1 if firms is AFP-able	SAFP	
Macro			
log (real exchange rate)	log(tc_dic / cpi_dic)	International Financial Statistics, IFS.	lrer
embi yield	annual embi return	Bloomberg	embir
domestic interest rate	average annualized loan rate in financial system in UF (1 - 3 years)	Central Bank of Chile	iuf
cpi_dic	consumer price index (december)	International Financial Statistics, IFS.	cpi_dic
tc_dic	nominal exchange rate (december)	International Financial Statistics, IFS.	tc_dic

There are two companies that we classified as tradable that do not follow this definition: LAN CHILE (the national airline) and CIA SUD AMERICANA DE VAPORES (the shipping company).