Corporate Hedging, Investment and Value*

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Abstract

Following a severe currency crisis in 1998, the Brazilian economy switched from a fixed to a floating exchange rate regime in 1999. Brazilian firms that had accumulated foreign currency liabilities in the fixed exchange rate regime suddenly found themselves exposed to significant currency risk. The temporary disequilibrium created by this shock allows us to trace the causal effect of currency hedging on corporate performance and firm value. We find that hedging allows a firm to insulate its capital expenditure from variation in operating cash flow. That is, it mitigates the underinvestment friction of Froot, Scharfstein and Stein (1993). Hedging also increases the foreign debt capacity of a firm at a time when domestic capital is scarce, allowing the firm to increase the level of investment. Both these channels lead to an improvement in the value of the firm.

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1 Introduction

It is well-understood that corporate financial policy cannot increase the value of a firm in a frictionless world. In the presence of market imperfections, financial policy can be value-enhancing if it mitigates the effects of frictions such as informational problems or agency costs. Understanding the links between a firm’s financial policy, the frictions that it overcomes, and the resulting value effect is central to corporate finance research. Despite the importance of this issue, it has remained an extremely difficult task to empirically establish these links in a world in which all firms are making optimal decisions. In such a world, each firm chooses its financial policy based on the net benefits of different actions that, in turn, depend on several firm characteristics. Since many of these characteristics remain unobserved to the econometrician, it is not easy to determine the correct counterfactual, i.e., what would a firm’s value be under an alternative financial policy?

In this paper we study the effect of a specific financial policy, i.e., hedging foreign currency risk, on corporate performance and value. While there have been several worthy studies relating corporate hedging to firm value, the causal effect remains contentious due to the reasons mentioned above. If firms are heterogeneous along unobservable dimensions, any effect of hedging on firm value in equilibrium faces the challenge of isolating the effect of these unobservable factors from the effect of hedging. In an industry with identical firms, as Adam, Dasgupta and Titman (2007) demonstrate, in equilibrium each firm should be indifferent between hedging and not, and hedgers and non-hedgers should have identical values.

Our innovation is to study an emerging economy, Brazil, at a time when it switched from a fixed to a floating exchange rate regime. Following a severe currency crisis, in January 1999, Brazil abandoned its currency peg and adopted a floating exchange rate policy. The Brazilian currency, the real, depreciated by about 66% in two weeks following the switch, and remained volatile for many years thereafter. Several Brazilian firms had foreign currency denominated liabilities before the regime switch. These firms were now suddenly exposed to exchange rate risk. Further, due to the broader economic turmoil, capital in the domestic economy was scarce at this time. Given the scale of the upheaval in the economy, it is natural that it would take firms some time to learn their
optimal policies in the new regime.

Indeed, we find that while many firms in our sample start to use foreign currency derivatives, the change from being unhedged to hedging is not instantaneous. Rather, there is a gradual increase in the number of firms that hedge after the regime switch. The proportion of firms that use currency derivatives increases from a modest level of 14% at the end of 1999 to about 40% by the end of 2001, and remains stable thereafter. This pattern is consistent with firms gradually learning and adjusting to their new optimal policy in the floating exchange rate regime. We analyze the determinants of the time-to-switch for firms that begin to use currency derivatives, and find that firms with a higher benefit or lower cost to hedging do so more quickly. In particular, the size of a firm and the extent of its foreign debt as of 1998, the last year of fixed exchange rates, are critical in determining the likelihood that a firm will begin to hedge sooner.

The staggered change from a state of no hedging to hedging across the hedger firms in the economy offers an attractive empirical setting to assess the causal effect of hedging on firm performance and value. Immediately after the shock, there are two groups of non-hedgers: (a) firms for whom it is optimal to remain unhedged in the new exchange rate regime and (b) firms for whom it would be optimal to hedge. Many firms in the latter group find themselves temporarily adopting a sub-optimal policy as they adjust to the new regime. In this interim period, these firms are learning about the costs and benefits of hedging, setting up a hedging program, and searching for the supply of derivative products from financial intermediaries. Thus, by comparing the outcomes for such a firm after it begins to use derivatives with its own corresponding performance during the interim sub-optimal period, we are able to trace the effect of hedging on firm performance and value.

Motivated by the theoretical model of Froot, Scharfstein and Stein (FSS, 1993), we first examine the effect of hedging on capital expenditure plans. Using a firm fixed effect specification, we show that a firm that starts using currency derivatives increases its capital expenditures. To directly investigate the predictions of FSS, we estimate the investment-to-cash flow sensitivity of our sample firms across hedgers and non-hedgers. The investment of non-hedgers is highly sensitive to their cash flows, while hedger firms have investment that is insensitive to operating cash flow. In other
words, hedging allows firms to undertake investment even when their internal cash flow is low. These findings are in line with the FSS model and provide direct evidence on the role of hedging in mitigating financial frictions. Since the decision to hedge is a choice variable, it is important to show that our results are not driven by a precise simultaneous change in the firm’s investment opportunity set or managerial characteristics. To address this issue, we show that our results are not explained away by changes in time varying industry-specific investment opportunity sets or changes in the management at hedger firms.

We next show that the increase in capital expenditure is partly financed by a contemporaneous increase in the foreign currency debt of the firm. Thus, as predicted by Leland (1998), hedging increases the debt capacity of a firm in our sample. In our context, hedging not only increases the pledgeable income of a firm, but it allows the firm to overcome a supply-side friction in the capital market. In the floating exchange rate regime, the spread between deposit rates and interest rates on domestic loans is very high, and the banking sector is in turmoil.\(^1\) Currency hedging allows firms to access a source of capital that remains available at a reasonable cost.\(^2\) The additional capital is then invested at a time when the marginal value of investment is high, in part because many other firms in the economy cannot invest.

After establishing the role of hedging in smoothing investment and increasing debt capacity, we investigate its effect on a firm’s value. Comparing the value of a firm before and after it begins to hedge, we find that derivative usage results in a value gain of about 10%. The magnitude of the effect is large compared to that found by studies based on U.S. firms (for example, see Allayannis and Weston (2002)). It is important to note that our estimates come from a period of massive upheaval in the Brazilian economy. The possibility of under-investment due to the lack of external capital is likely to be very high during these periods. An increase in investment with the promise of smooth future investment is akin to an improvement in the growth rate of the hedgers, which can result in substantial improvement in firm value. Our evidence supports this view.

Our study relates to a large literature on hedging and firm value. Allayannis and Weston (2002)

1See Sobrinho (2007) for example.
2Berrospide (2010) extends the Holmstrom and Tirole (1997) model of external financing to an open economy, and demonstrates theoretically that hedging can increase foreign debt capacity.
examine the effect of currency derivatives on U.S. firms, and find a value premium of 4.87%. Guay and Kothari (2003) provide a critique of this result in which they uncover the actual derivative positions of firms in their sample, and show that the size of the positions is too small to justify such a large value premium. Indeed, they find that a simultaneous three-standard deviation adverse movement in interest rates, exchange rates, and commodity prices will only have a value effect of 1.3% on the typical hedged firm. Jin and Jorion (2006) do not find evidence in support of positive valuation effect of hedging in a sample of U.S. oil and gas producers.

Work on the mechanism through which hedging can influence firm value includes Graham and Rogers (2002), who show that hedging does increase the debt capacity of a firm, and that the increased interest tax shields add about 1.1% to firm value. Campello, et al. (2010) consider a sample of US firms and use an instrumental variables approach to show that hedging leads to lower spreads on syndicated loans and reduces the chances of covenants that restricts investments. While our study also considers the effect of hedging on investments, we focus on access to capital and the smoothing of investment across different cash flow states.

Our paper also contributes to the literature on the effect of supply shocks to banks on the performance of their borrowers (for example, see Khwaja and Mian (2008), Paravisini (2008), and Chava and Purnanandam (2011)). This literature shows that borrowing firms face significant adverse consequences when their lenders face adverse capital or liquidity shocks. Our study shows that hedging allows firms to substitute between domestic and international sources of capital, which in turn can insulate a firm’s performance from the financial health of its domestic lenders. Thus, at a broader level, we contribute to the literature on financial constraints and show that firms in an emerging market face significant frictions in raising external capital. Access to currency derivatives can help alleviate these frictions.

The rest of the paper is organized as follows. We discuss our theoretical and empirical framework in Section 2. In this section, we first provide some background information on the Brazilian economy and the currency crisis. We then discuss the theoretical motivation behind our tests and the identification strategy. Section 3 briefly describes our sample and data sources. In this section, we also discuss the determinants of hedging policy. Our empirical results are contained in Section 4, in
which we demonstrate the effect of derivative usage on capital expenditure, foreign currency debt, and value. Section 5 concludes the paper.

2 Theoretical and Empirical Framework

Our main theoretical motivation comes from the work by Froot, Scharfstein and Stein (1993; henceforth FSS) and Leland (1998). FSS argue that hedging is valuable when external financing is costly because it allows the firm to maintain its investment in states with low cash flow. Leland (1998) shows that hedging increases the debt capacity of a firm. We argue that foreign currency hedging by some firms in our sample increases the foreign debt capacity of these firms, at a time when capital in the domestic economy was scarce. The access to foreign capital then allows these firms to maintain a smooth investment policy, thereby increasing value.

On the empirical side, we argue that the scale of disruption in the Brazilian economy was sufficiently large that firms would take some time to determine their optimal policies in the new regime. As a result, for some time after the switch from fixed to floating exchange rates, some firms would have had sub-optimal hedging policies. By comparing outcomes for the same firm before and after it starts hedging, we can therefore obtain an estimate of the effect of hedging on firm performance and value.

Both our theoretical and empirical arguments rely on the Brazilian economy having suffered a large shock at the start of the sample period. We therefore begin by describing the macro-economic environment in Brazil immediately following the switch to a floating exchange rate regime.

2.1 Brazil: Macro-economic Environment

In late 1998 and early 1999, Brazil suffered from a financial crisis that led to its currency, the real, being fully floated on January 15, 1999. The real (denoted as R$; plural reais) was introduced in July 1994, as part of a stabilization package known as the Real Plan (see Averbug, 2002). As part of the plan, important regulatory changes were introduced in the financial markets to reduce controls on capital flows and improve the access of corporations to foreign currency debt from international
capital markets. A crawling peg exchange rate regime was adopted for the real, with preannounced narrow bands within which the exchange rate was maintained. In this paper, we refer to the period before January 1999 as the “fixed” exchange rate regime.

The years leading up to 1999 saw financial crises affect Mexico (1994), East Asia (1997), and Russia (1998). The Brazilian economy was severely affected by the Russian crisis of August, 1998, and suffered substantial capital outflows. External aid from the IMF and the G-7 provided a breather, but capital outflows increased again in January, 1999, leading to the fixed exchange rate regime being abandoned in favor of a floating regime. There were continued shocks to the economy in the floating exchange rate period, with the Argentinian crisis of 2001-02 having a ripple effect throughout Latin America, and a presidential election in 2002 contributing to political uncertainty.

2.1.1 Exchange rate, GDP growth, and inflation

Figure 1(a) displays the exchange rate (in reais/US dollar) of Brazil over the period 1996 through 2005. As seen from the figure, the exchange rate surged immediately after the real was floated in January, 1999, with the value of the real falling by about 65% within two weeks. The real/US dollar rate increased sharply again in 2001 and 2002. Further, compared to the orderly change in the value of the real in the fixed exchange rate regime, in the floating era the real was significantly more volatile. Figure 1(b) displays Brazil’s annual GDP growth and the inflation rate, as measured by the CPI, from 1996 to 2005. As seen from the figure, GDP growth was very low immediately before and after the decision to float the real (1998 and 1999, respectively) as well as in the period 2001-03, recovering somewhat in 2000 and 2004. Conversely, inflation was high throughout the period, averaging over 8% per year in the floating exchange rate years.

2.1.2 Domestic banking sector

The intermediation efficiency of the domestic banking sector in Brazil has typically been poor, compared both to developed markets as well as other comparable developing economies. The spread between the lending and deposit rates, a measure of efficiency and competition in the
Figure (a) shows the exchange rate (in reais per US dollar) from 1994 to 2005. Figure (b) shows the percentage GDP growth and inflation in Brazil for each year from 1995 to 2005.

Figure 1: Exchange rate, GDP growth and inflation

banking market, averaged about 30% in Brazil over the period of our study (see Sobrinho, 2007). The magnitude of the spread was about ten times higher than the average spread in developed countries and about three times higher than the average spread in Latin American countries. As a consequence, the nominal interest rate charged to commercial borrowers remained high as compared to other countries. Inflation-adjusted short-term interest rates in Brazil were also high. For example, based on IMF data, Rogoff (2005) shows that the inflation-adjusted short-term interest rate in Brazil was 9.6% in 2004, significantly higher than many other developed and developing countries.

Several reasons have been proposed for the inefficiency of banking sector in Brazil. Nakane, Afanasieff and Lhacer (2002) and Gelos (2006) point to a government subsidy to poorly performing sectors of the economy, high default rates on corporate loans, high operating costs of banks, and onerous reserve requirements in addition to overall macroeconomic instability. Sobrinho (2007) shows that a government policy requiring banks to make unprofitable loans to selected riskier borrowers leads to disproportionately higher rates on the other loans. Belaisch (2003) finds some
evidence of oligopolistic behavior in the Brazilian banking sector. Arida, Bacha, and Lara-Resende (2005) suggest that high credit spreads for Brazilian firms are a result of a crowding-out effect due to rising government debt in the aftermath of the currency crisis.

Inefficiencies in the banking sector resulted in limited access to bank credit as well as a high cost of bank loans. Gelos (2006) shows that on average the bank credit-to-GDP ratio was less than 30% in Brazil in 2003, compared to about 60% for Chile and the U.S. Figure 2 displays the evolution of the “Selic,” the Brazilian Central Bank’s overnight lending rate, from the period 1996 through 2005. For much of this period, the Selic hovered around 18-25%, with a few spikes corresponding to the East Asian (1997) and Russian (1998) currency crises.

This figure shows the central bank’s domestic overnight borrowing rate, the Selic, from 1996 to 2005.

Figure 2: Domestic interest rate (Selic)

Overall, during the period of our study, the Brazilian economy passed through an extremely turbulent phase. Exchange rate volatility was very high and the rapid depreciation of the real was associated with very high capital outflows. In addition, the inefficiencies in the domestic banking sector made it harder for corporate borrowers to raise external capital from domestic sources.
2.2 Theoretical Motivation

Derivatives allow firms to transfer cash flows across states and time. Since such transfers by themselves cannot add value in a frictionless world, theoretical models of corporate hedging rely on market frictions to explain the use of derivatives. We consider the specific frictions modeled by two theoretical papers, Froot, Scharfstein and Stein (1993) and Leland (1998), to motivate our empirical work. We argue that our empirical setting closely resembles the underlying set-up in these papers.

FSS develop a theory of hedging under the assumption that external financing is costly for firms as compared to internally generated funds. The paper argues that firm-level frictions such as bankruptcy costs or information asymmetries can lead to convex costs of raising outside capital. With costly external financing, a firm’s investment in low cash-flow states will necessarily be smaller than its investment in high cash-flow states. If the production function is concave, the marginal value of an extra dollar of investment is greater in low cash-flow states. Thus, a fairly priced hedge that allows the firm to transfer cash flows from high cash-flow to low cash-flow states can be value enhancing. In this model, hedging alleviates the friction in raising external capital. In extreme cases, when external capital is really scarce, the value of hedging can be especially high. There are two immediate implications of this model. First, holding fixed the investment opportunity set of a firm, hedging allows the firm to increase its investment in low cash flow states. Second, a hedged firm’s investment will be less sensitive to its operating cash flow (i.e., its cash flow before accounting for the effects of derivative usage) than the investment of an otherwise identical unhedged firm.

Leland (1998) considers a model in which debt creates an interest tax shield and therefore adds value. The tradeoff is that debt also increases the likelihood of bankruptcy, and bankruptcy has a deadweight cost. Hedging allows a firm to reduce the deadweight cost of bankruptcy, which increases the debt capacity of the firm. This in turn increases corporate value due to the additional interest tax shield.

In our setting, Brazilian firms have two potential sources of external finance: domestic and foreign. As discussed earlier, domestic external finance is scarce because of the economy-wide
frictions. The scale of the disruption in the Brazilian economy in 1998 and 1999 generates a large negative supply shock in the domestic banking sector and capital markets. As a result, firms wishing to raise external capital have to approach foreign investors. However, in a floating exchange rate regime with a high volatility in the exchange rate, foreign currency debt entails high exchange rate risk. As pointed out by Berrospide (2010), it creates the possibility that a firm may go bankrupt simply due to an adverse change in the exchange rate. Hedging against a depreciation in the real reduces the probability of exchange-rate-related bankruptcy, increasing the expected payout to foreign lenders and hence increasing the pledgeable income of the firm.

Overall, our empirical setting has ingredients from both the FSS and Leland models. As in the FSS model, firms face large costs in raising external financing. Further, our firms start out in a low cash flow state, so that benefits to increasing investment are likely to be high. International sources of capital are available, but the associated volatility in the exchange rate exposes firms to additional deadweight costs if bankruptcy arises as a result of currency fluctuations. As in the Leland model, firms can hedge away a source of risk (in our case, exchange rate risk) to increase their debt capacity (in our case, the capacity to take on foreign currency debt). Motivated by these papers, our empirical tests are designed to uncover the effect of hedging on capital expenditure, debt capacity, and consequently on corporate value.

2.3 Identification strategy

To estimate the effect of hedging on a firm’s value or corporate policies such as capital expenditure, one should compare the outcome variable for a hedged firm with the outcome variable for the same firm when it remains unhedged. In other words, the ideal counterfactual for a firm that chooses to hedge is the hypothetical outcome for the same firm had it chosen to remain unhedged. Of course, if each firm chooses an optimal hedging policy, the counterfactual must remain unobserved. The unobservability creates an important identification problem in any study that tries to empirically establish the causal effect of corporate hedging on firm value or corporate policies.

In the absence of an observable counterfactual, a general approach in the literature has been to
estimate a regression model of the following form:

\[ y_{it} = \alpha + \beta x_{it} + \theta \text{hedging}_{it} + \epsilon_{it}, \]  

(1)

where \( y_{it} \) is an outcome for firm \( i \) at time \( t \) (such as capital expenditure or firm value), \( x_{it} \) a set of firm-specific observables (including, say, size and a proxy for investment opportunities) for firm \( i \) at time \( t \), \( \text{hedging}_{it} \) a variable that captures the hedging decision of firm \( i \) and time \( t \), and \( \epsilon_{it} \) an error term. This model implicitly assumes that, after including the control variables \( x \), an unhedged firm \( i' \) serves as the correct counterfactual for a hedged firm \( i \).

As stated above, if each firm adopts an optimal hedging policy, this method is problematic. Self-selection implies that each firm, hedged or unhedged, maximizes its value under its own policy. In equilibrium, after we account for all costs and benefits of hedging, there should be no difference between the value of a hedged and an unhedged firm. Therefore, if one finds a positive coefficient \( \theta \) on estimating equation (1), it must be that there are unobservable differences in firm characteristics or in the costs and benefits of hedging across hedged and unhedged firms that have not been accounted for. For example, an important unobserved difference between the two groups of firms may be managerial quality. Firms that hedge tend to be larger than unhedged firms, and may therefore be able to outbid unhedged firms to obtain better quality managers. In such a case, a value premium for superior managerial quality may be falsely attributed to a firm’s hedging policy.

Our setting allows us to alleviate these concerns to a large extent. Our key argument is as follows. In the pre-crisis period, Brazil had a fixed exchange rate regime, as a result of which corporations did not face any meaningful exchange rate risk. Not surprisingly, almost all firms in our sample in this period are classified as non-hedgers. Many of these firms had borrowed in foreign currency (mainly in US dollars), but had no need to hedge currency risk; in a managed exchange rate regime, currency risk has essentially been hedged at the country level by government policy. Figure 3 shows the kernel density of foreign leverage at the end of 1998 for firms in our sample. Here, foreign leverage is measured as the ratio of foreign currency debt to total assets. It is evident from the figure that the firms in our sample had large quantities of foreign currency debt before the
onset of the crisis. Hence, the change in exchange rate regime exposed them to significant foreign currency risk.

This figure shows the kernel density of the ratio of foreign currency debt to total assets at the end of 1998 for firms in our sample. As may be observed from the figure, the mean foreign leverage ratio is approximately 20% at this time.

Figure 3: Foreign currency leverage in 1998

The move to a floating exchange rate regime dramatically affected the benefit of hedging currency risk for Brazilian firms. Consequently, the optimal hedging decision would also have changed for many firms, depending on their characteristics. Some firms would still have found it optimal to remain unhedged, whereas other firms would have benefited from switching to a policy which entailed hedging currency risk.

Our key identifying assumption is that, in the face of such a large disruption, firms do not instantaneously change corporate policies such as hedging. Rather, it takes firms some time to understand the implications of currency risk, which they have not been exposed to before. They also have to understand that hedging is feasible, and what the benefits to hedging are. Further, setting up a hedging program in the firm’s treasury office will take some time, as personnel are trained in managing and evaluating new financial contracts. Simultaneously, nascent markets in
currency swaps and futures (which would necessarily have remained under-developed in a fixed exchange rate era) begin to emerge. The banks that offer such contracts also have to learn what the volatility in the exchange rate will be going forward.

For all these reasons, one can expect inertia at firms with respect to their hedging decisions in the immediate aftermath of the switch to a floating exchange rate regime. That is, even firms that should optimally be hedging will take some time to start a hedging program. Consider a firm that switches from not hedging to hedging within a few years of the regime change. One can treat outcomes of the same firm before it started to hedge, but after the regime has changed, as a counterfactual for the same outcomes after the firm started to hedge. The identification strategy is schematically represented in Figure 4.
This figure depicts our identification strategy. In the pre-crisis period (period 1), firms are largely unhedged (represented as NH$_1$ in the figure). Very few firms hedge currency risk in this period (H$_1$). Period 2 is the floating exchange rate regime, delineated by the solid vertical line. Some firms in the set NH$_2$ sub-optimally remain unhedged; other firms are optimally unhedged. In long-run equilibrium (period 3), some of these firms have switched to hedging (H$_3$), whereas others remain optimally unhedged (NH$_3$). Our identification comes from comparing outcomes for switcher firms in period 3 to outcomes for the same firms when they were sub-optimally unhedged in period 2.

Figure 4: Identification Strategy

To make this idea concrete, suppose the outcome variable we are looking at is firm value. We see that a firm switched from not hedging to hedging in year 3 after the crisis. We argue that in years 1 and 2 of the crisis, the firm is behaving sub-optimally. Therefore, by comparing its value in years 3 and beyond (after it optimally hedges) to its value in years 1 and 2 (when it was sub-optimal), we can estimate the value of hedging to this firm. Of course, in doing this, one has to control for other observables such as size and operating cash flow that will affect the firm’s value as well as for macro-economic effects such as the level of exchange rates and aggregate economic activity. Since firms change their policies in a staggered manner in our data set, we are able to isolate the effect of macro-economic shocks by simply using year fixed effects. After controlling for these effects and
other observable differences, a firm fixed effect regression model allows us to estimate the causal effect of hedging on firm value.

It is worth noting the difference between a fixed effects model in our analysis and such a model estimated when firms are all in equilibrium. If firms are always in a long-run equilibrium, even a fixed effects model will not capture any causal effect of hedging. In long-run equilibrium, if a firm switches from not hedging to hedging, there must have been an underlying change in the cost and benefit of hedging for that firm. We argue that in our framework, firms are temporarily in disequilibrium due to the nature of the exogenous shock represented by the switch to the floating exchange rate regime. Therefore, we can interpret the coefficient in a fixed-effects regression model as capturing the causal effect of hedging on firm outcomes.

One concern with our identification strategy may be the possibility of a concomitant change in managers at a firm in the same period that it starts to hedge. If this happens, the effect on the outcome variable may be due to the superior quality of new management rather than to the hedging decision. To alleviate this concern, we collect data on CEO changes for all hedger firms in our sample, and directly include the effect of managerial changes in the regression model.

3 Data and Hedging Determinants

We collect data from two sources. First, we obtain financial statement and market value information for all Brazilian firms listed in the *Economática* database as of August, 2006. This comprises a list of more than 350 firms. The database over-represents large firms and potentially suffers from a survivorship bias: we have no data on firms that may have gone bankrupt or been acquired. If non-hedgers are more likely to fail, the bias works against our finding any positive effects of hedging. We exclude financial firms, which may use currency derivatives to hedge operational rather than financial risk. We also exclude state-owned and foreign-owned firms, both of which have potential access to capital from owners with deep pockets. For each of the firms listed in the database, we obtain annual financial statements and end-of-year equity market values for the period 1997 through 2005 from *Economática*. 

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While *Economatica* computes equity market values for many firms, there are several missing values. As a second way of determining equity values, we also determine for each firm and each class of share it has issued, the average daily closing price for the last five trading days of each year. We then determine the value of each class of share for each firm by multiplying the average price with the number of shares outstanding, and add across the classes to determine the overall market value of equity for the firm. As a cross-check, we find a very high correlation between the market values from the two methods, when both are available.

Our second source of data is BOVESPA, the São Paulo stock exchange. The BOVESPA web site provides the footnotes to the annual financial statements over our period of study. Since the sets of firms listed in *Economatica* and BOVESPA are different, our overall dataset is the intersection of these two sources of information. We obtain the following items of information for each firm-year from the footnotes to the balance sheet: whether a firm uses foreign exchange derivatives, whether it is an exporter, whether it has dollar assets, and the amount of foreign debt outstanding.

Following regulation CVM No. 235, introduced on March 23, 1995, a publicly-traded company in Brazil is required to disclose whether it uses derivative contracts, and also the nature and face value of the contracts in the footnotes to the balance sheet. Most of the non-users explicitly mention that they do not use derivatives, whereas many firms do not mention derivatives at all. The latter are treated as missing values. Since we only know the kinds of derivative contracts used (e.g., exchange rate or currency derivatives, and swaps, options, or forward contracts) and their notional value, but not the terms of the contracts themselves, we create a dummy variable $dderv$ set to 1 if firms use foreign exchange derivatives, and zero otherwise. The most common hedge contracts among firms in our sample are currency swaps and forward contracts. In both cases, firms buy the foreign currency (typically US dollars, and sometimes euro or yen) and pay reais, and are therefore hedging against a fall in value of the real.

Similarly, we create a dummy variable $export$ set to 1 if a firm is an exporter, and zero otherwise. Some firms disclose data on exports as part of their annual reports. In other cases, firms mention

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3 The CVM is the Brazilian equivalent of the SEC in the US. We provide an example of our data collection process in the Appendix.
that they are exporters but do not disclose information about foreign sales. The export dummy is set to 1 in each case. We also create a dummy variable dol set to 1 if a firm holds assets denominated in or indexed to US dollars. Such assets include cash and deposits in foreign currency and government bonds (treasury notes and central bank bonds indexed to the dollar). Finally, in many cases, firms report the currency composition of their debt, from which we determine the foreign to total debt ratio for each firm.

Our basic measure of value is Tobin’s q, or the ratio of a firm’s market value to its book value, where market value is determined as the sum of book value of debt and market value of equity, and book value is the sum of book value of debt and book value of equity. We remove observations with missing values for market value of equity, book equity, cash holdings, and derivative usage. Our final data set is an unbalanced panel containing 167 firms, 9 years, and 1,268 observations (firm-year pairs). We winsorize all variables in both tails at the 1% level to control for outliers.

Table 1 presents the key descriptive statistics for our sample. Panels A and B provide the mean, median and standard deviation of firm characteristics for hedgers and non-hedgers respectively, and Panel C provides the corresponding statistics for all firms. Hedgers are much larger than non-hedgers, both in terms of their revenue and market capitalization. The median hedger firm’s revenue (R$ 1,534 million) is about six times higher than that of the median non-hedger firm (R$ 250 million). The hedger firm’s book leverage (33.16%) is about 12% higher than that of the median non-hedger firm (20.67%). Noticeably, while the domestic leverage (i.e., the ratio of local currency debt to book value of assets) is similar at about 10% for the median firm across the two groups, hedgers have a substantially higher foreign currency leverage, defined as the ratio of foreign currency debt to book value of assets (19.13% for hedgers versus 3.59% for non-hedgers). The differences in firm size, book leverage and foreign leverage across the two groups are all significant at the 1% level. Further, we find that hedgers keep significantly higher cash-balances as compared to non-hedgers.

We find that hedgers have a net income to assets ratio approximately double that of non-hedgers, and a capital expenditure to assets ratio almost 50% higher than non-hedgers. Finally, we find that the median market-to-book ratio for hedgers is 1.09 as against 0.72 for the median
non-hedger firm. This difference is significant at the 1% level.

Overall, our univariate results show that hedgers are large firms with high leverage, in particular with large quantities of foreign currency debt. They are able to invest larger amounts in capital expenditure. In addition, their market value is significantly higher compared to their non-hedger counterparts.

3.1 Determinants of Hedging Policy

For our empirical exercise to be meaningful, it is important that there is some evidence of inertia in firms’ hedging policies. In particular, it is important to provide evidence consistent with the presence of fixed costs in learning about hedging policies or in starting a hedging program. While it is difficult to provide direct evidence for such costs, we offer several pieces of background information and empirical evidence to support our underlying assumption.

We start by documenting that there is a gradual move toward hedging activities in the years following the change in exchange rate regime. In other words, despite the large shock to the exchange rate environment, most firms that switched to hedging by the end of the sample did not do so instantaneously. Figure 5 shows the number of firms in each year of our sample. The number of derivative users grows for the first four years and levels out to between 53 and 58 over the last five years. The total number of firms grows for the first three years, and is between 133 and 141 over the last five years.

It is evident from the figure that at the aggregate level the hedging policy changes in a gradual manner. Only 20 firms are using foreign currency derivatives at the end of 1999, a year after the change to a floating exchange rate. For many firms, we observe derivative usage only two to three years after the regime change. Just as importantly, after a gradual increase till 2000, the fraction of hedgers stabilizes around 40% of the entire sample in subsequent years. Therefore, after 2000, it is reasonable to infer that firms are now optimally hedged. The pattern of a slow increase in the number of hedged firms followed by a stable number for the remaining years, while not conclusive, suggests a slow convergence toward a new equilibrium in the floating exchange rate regime.
This figure shows the number of firms in the sample in each year. The number of currency derivative users increases gradually until 2001, and then levels off for the remaining years in the sample.

Figure 5: Number of firms in sample

For each firm, its decision to hedge currency risk must be based on its own costs and benefits of hedging. A firm that faces a relatively minor cost or has a relatively high benefit from hedging is likely to begin hedging more quickly than other firms. We now present evidence consistent with the view that firms with higher net benefits, measured as of the beginning of the crisis, started their hedging programs early. However, the switch was not instantaneous. The intensity of switching was high in initial years, reaching a peak around 2001 after which it declined.

We consider four proxy variables for the costs and benefits of hedging. For each proxy, we divide firms into two groups, high and low, depending on whether they fall above or below the sample median. The variables are all measured as of December, 1998; i.e., before the real is floated, and so before the full effect of the crisis is felt by sample firms. We compute the estimated hazard rate for currency derivative use for the two groups based on each proxy using the Nelson-Aalen estimator for hazard function. The hazard rate function provides the probability of using derivatives in the next period conditional on remaining unhedged till that point. We expect to observe a steeper hazard function (i.e., a higher probability of using derivatives in earlier years) for firms that face below median costs to hedging and obtain above median benefits from hedging.
Our first proxy for the cost of hedging is simply a firm’s size in 1998 (as measured by total assets). To the extent that there are fixed costs to establishing a hedging program, larger firms should find it advantageous to start hedging earlier. Second, we consider the amount of foreign currency debt (scaled by total assets) on a firm’s balance sheet in 1998. A firm with substantial foreign currency debt has greater benefits from currency hedging. In addition, it is more likely to have an institutional knowledge and manpower in the area of foreign currency management. Third, we consider the reliance on foreign currency debt for capital expenditure. Specifically, we consider the ratio of capital expenditure in 1998 to new foreign currency debt in 1998. A firm that relies extensively on foreign currency debt to fund capital expenditure has greater benefits to hedging. Finally, we compute the ratio of capital expenditure to total assets in 1998. This ratio proxies for the investment needs of the firm. A firm with high investment needs will have a greater benefit from hedging.

We plot the four sets of hazard functions in Figure 6. On the X-axis, time is measured in years since 1997. For each of our four measures, there is a clear distinction between the two sets of hazard rate functions. The probability of starting a hedging program is unambiguously higher for firms that are likely to face lower costs and/or higher benefits from hedging. Further, in each case the hazard rate function is steeper for firms with lower costs or higher benefits to hedging. This suggests that the rate at which firms learn about the net benefits of hedging depends on the size of those benefits.

We re-emphasize that most of our hedged firms do not instantaneously switch from an unhedged to a hedge state. In all our plots, the hazard rate peaks around year four; i.e., in 2001. After that, it declines across all four measures. Thus, after the real is floated, many firms begin to hedge in the subsequent years. The rate at which firms switch from not hedging to hedging increases over time. Further, this rate is clearly faster for firms with a higher net benefit to hedging.

Overall, our non-parametric results provide support for the key identifying assumption that it takes firms some time to learn the optimal policy in the new exchange rate regime. We supplement this exercise with a parametric regression. We model a firm’s decision to start hedging as a function of its characteristics measured as of the beginning of the year, as well as relevant characteristics.
These figures show the hazard rate function for currency derivative usage, conditional on not having used derivatives to that point, as a function of different contemporaneous financial variables.

Figure 6: Hazard Function Across Different Measures of Costs and Benefits

measured in 1998. We estimate a Cox-proportional hazard model (see Cox (1972)) to understand the dynamics of the decision to start hedging. This framework is often used in the bankruptcy prediction literature (see Shumway (1997)). We use it to estimate the probability of hedging by a firm conditional on the fact that it has not hedged as yet. The hazard rate for firm $j$ at time
The probability that firm \( j \) at time \( t \) will use currency derivatives conditional on it being a non-user so far is modeled as:

\[
h(t|x_j) = h_0(t)exp\left(x_{j,t-1}\beta_j + x_{j,1998}\beta_{j,1998}\right).
\]

Here, \( x_{j,t-1} \) refers to a vector of firm characteristics at the end of year \( t-1 \) that are likely to be associated with the decision to hedge in year \( t \). \( h_0 \), called the baseline hazard function, represents the hazard ratio for a hypothetical firm that assumes a value of zero uniformly for all \( x_j \). The model is estimated via maximum likelihood to obtain the \( \beta \) coefficients.

Here, \( x_{i,1998} \) is a vector of firm characteristics measured as of 1998. The characteristics include a firm’s size (measured as the natural logarithm of total assets) as a proxy for the economies of scale in hedging. In other words, this variable is inversely related to the likely cost of starting a hedging program after the shock. In addition, we include a measure of the firm’s exposure to foreign currency risk in the floating exchange rate regime. Specifically, we consider each firm’s foreign currency debt to total asset ratio as of 1998 to proxy for the potential exposure to risk once the real is floated. This variable proxies for the likely benefits of hedging in the floating exchange rate regime.

In the model, we include several other firm characteristics measured as of the beginning of the current year \( t \). The control variables are motivated by prior empirical work on hedging by non-financial firms.\(^4\) The variables include the leverage ratio (i.e., the ratio of debt to firm value), as firms with greater leverage may be exposed to greater financial distress, and hence have a stronger motive to hedge. The decision to hedge may be concave in leverage: firms with very high leverage may have no incentive to hedge even when faced with higher expected bankruptcy costs (see Purnanandam, 2008). We therefore include the square of the leverage ratio as an explanatory variable. Among other variables, the firm’s annual capital expenditure captures the effects of growth opportunities in the spirit of FSS (1993). Finally, we include a dummy variable based on whether the firm has dollar assets, and a dummy variable based on whether the firm has exports.

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\(^4\)See, for example, Geczy, Minton and Schrand (1997), Purnanandam (2008), or Bartram, Brown, and Fehle (2007). Rossi (2007) studies the determinants of hedging policies of Brazilian firms in a similar time period as ours.
to account for natural hedges the firm may have. For this estimation, all variables in levels (such as firm size and leverage) are measured as of the beginning of the year. Thus, the results can be interpreted to be predictive.

Table 2 presents the estimation results. In Model 1, we confirm our key results from the non-parametric analyses. Considering 1998 values, larger firms and firms with a higher foreign leverage ratio are more likely to begin hedging. In Model 2, we predict the hedging decision based solely on contemporaneous changes in a firm’s financial conditions and find that larger firms and firms with a high capital expenditure are more likely to use derivatives. We find a strong non-monotonic relation between leverage and derivative usage. Overall, the relationship between contemporaneous firm characteristics and a Brazilian firm’s decision to hedge is similar to what other authors have found for US firms. In Model 3, we include both the 1998 characteristics of size and foreign leverage and the contemporaneous variables included in Model 2. Strikingly, we find that even after controlling for time-varying firm-specific covariates, the size and foreign leverage of the firm in 1998 predict the hazard rate. In fact in this model, a firm’s 1998 size and foreign leverage are the only variables other than leverage that are statistically significant in predicting the likelihood that a firm will start hedging.

Of course, the 1998 values of these variables are likely to be correlated with time-varying financial characteristics. However, it is clear that a firm’s decision to hedge even a few years after the regime change is strongly predicted by the relative costs and benefits of hedging as of December 1998. That is, initial conditions just before the switch to floating exchange rates have a lasting impact, so that a significant part of the motivation to hedge comes from a perturbation in the net cost of remaining unhedged as a result of the switch to a floating exchange rate. Changes in this net cost beyond 1998 have very little explanatory power in the hazard rate model. This evidence is consistent with the presence of set-up or fixed costs to starting a hedging program. The likely sub-optimality of hedger firms before they begin to hedge then allows us to draw a causal link between hedging and firm-level outcomes.
4 Results on Capital Expenditure, Foreign Currency Debt and Firm Value

We now turn to a more formal analysis to study the effect of derivative usage on capital expenditure, foreign currency debt, and firm value.

4.1 Effect of derivatives on capital expenditures

In line with the theoretical arguments of FSS, we estimate the following model to study the effect of derivatives on capital expenditure:

\[
\log(capex)_{it} = \alpha + \beta \times \log(ta)_{i,t-1} + \mu \times \text{indmtb}_{-it} + \gamma \times \text{dderiv}_{it} + \\
\xi \times \log(cashflow)_{it} + \phi \times \log(cashflow)_{it} \times \text{dderiv}_{it} + \theta \times \text{newceo}_{it} + \delta_t + \epsilon_{it}
\] (2)

Here, the dependent variable \(\log(capex)_{it}\) is the natural logarithm of capital expenditure by firm \(i\) in year \(t\). The explanatory variables are the log of total assets of firm \(i\) at the beginning of year \(t\) \((\log(ta)_{i,t-1})\), the average market-to-book value of all other firms in the same industry except firm \(i\) at the end of year \(t\) \((\text{indmtb}_{-it})\), a dummy variable that takes value 1 if firm \(i\) used foreign currency derivatives in year \(t\) \((\text{dderiv}_{it})\), the cash flow generated by firm \(i\) in year \(t\) \((\text{cashflow}_{it})\) and the interaction of cash flow at time \(t\) with the derivative dummy. We also include year fixed effects to control for the effect of macro-economic conditions such as the GDP growth rate and inflation levels. While our main focus is on the firm fixed effect estimation results, for completeness we also estimate this model without the inclusion of firm fixed effects.

We use the log of capital expenditure as our dependent variable, and the log of total assets as a measure of firm size. This specification allows for variable returns to scale. A coefficient of less than one on log total assets, for example, indicates decreasing returns to scale. An alternative regression specification would be to use the ratio of capital expenditure to total assets as the dependent variable, which implicitly assumes constant returns to scale in the production function. Our results remain qualitatively similar, though weaker, under this alternative specification.
The investment of a firm depends on its investment opportunities. As a proxy for the investment opportunity set of firm $i$, we use the average market-to-book ratio of all firms in the industry at the end of the year, excluding the market-to-book ratio of firm $i$ itself. The market-to-book ratio at the industry level changes across years, so allows us to control for variation in the industry’s investment opportunity set across time.$^5$

The hedging variable of interest, $dderiv_{it}$, is an indicator variable that equals one if firm $i$ used foreign currency derivatives in year $t$, and zero otherwise. We include an indicator variable $newceo_{it}$ that equals one if hedged firm $i$ hired a new CEO in year $t$, and zero otherwise. We do so to ensure that our results are not driven by a change in the CEO precisely at the time when the firm starts to hedge.

The cash flow variable takes the firm’s profits before taxes and adds back depreciation and amortization and net financial expenses. This measure captures the effect of all operating cash flows, but omits the cash flows from derivatives. We use the natural logarithm of annual cash flows to reduce skewness in the data. Several firms have negative cash flows in our sample. We scale all annual cash flows up by adding one plus the negative value of the minimum cash flows across the entire sample. This transformation allows us to estimate regression model using $\log(\text{cash flow})$ for all firms. We also estimate the model using raw cash flow numbers, and show that our results remain unchanged.

Table 3 presents the estimation results. Models 1 through 3 are estimated without firm fixed effects, whereas Models 4 through 6 include these effects. In line with our univariate results, we find that derivative usage allows firms to invest more (Models 1 through 3). Given our identification strategy, in the rest of this section we discuss the fixed effect estimation results.

In Model 4, which does not include the cash flow as a dependent variable, we find a positive coefficient of 0.15 on the $dderiv$ dummy. However, the coefficient is statistically insignificant at the 10% level, with a p-value of approximately 16%. Other results suggest that larger firms and firms with better investment opportunities invest more. As expected, the coefficient on log total assets

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$^5$Our results remain unchanged using other proxies for the firm’s investment opportunity set, including the market-to-book ratio of firm $i$ itself, the sales growth rate of firm $i$, and an industry market-to-book ratio that does not exclude firm $i$. 

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is less than one, and is approximately 0.75 across models 4 through 6.

Model 5 presents our base result on derivative usage and capital expenditure. We include both the logcashflow variable and its interaction with dderiv on the right hand side. There are three main results based on this estimation. First, we find a positive and statistically significant coefficient on the derivative dummy: thus, absent any cash flow effects, hedged firms are able to invest more. Second, we find that firms with higher operating cash flows invest larger amounts. The elasticity of capital expenditure to internal cash flow is directly given by the coefficient on the log of cash flow, which is about 0.15 in Model 5. This finding is consistent with a number of studies based on U.S. data that show that a firm’s investment responds positively to its internal cash flow. Third, the coefficient on the interaction of cash flow and derivative usage is negative and significant. That is, the investment of a derivative user is less sensitive to its operating cash flow than the investment of a non-user, as predicted by the FSS model. In terms of the economic magnitude, we find that the elasticity of investment to operating cash flow drops by about 0.11 for derivative users. The sum of the coefficients on the log cash flow variable and its interaction with dderiv is statistically zero. That is, in our sample hedgers are able to completely insulate their investment from variability in operating cash flow.

As a robustness exercise, in Model 6 we estimate the firm fixed effect model using the level of operating cash flow without taking a log transform. Our results remain the same. The estimated coefficients now measure the percentage increase in capital expenditure for a one-million reais increase in operating cash flow. We find that if operating cash flow is higher by one million reais, the log of capital expenditure at a firm increases by about 0.47. That is, capital expenditure itself increases by a factor of 1.6 (that is, \( e^{0.47} \)), or 60%. However, derivative usage completely offsets this effect as evident by a coefficient of -0.44 on the interaction term. Again, the sum of the coefficients on cash flow and its interaction with derivative usage is statistically indistinguishable from zero.

There are at least two channels (not mutually exclusive) through which hedging can decrease the investment-to-cash-flow sensitivity of a firm. First, hedging decreases the variability in a firm’s overall (operating plus financial) cash flows, which in turn allows the firm to invest smoothly over time. Second, in part due to the decline in cash flow volatility, hedgers can boost their debt capacity
and borrow more from their lenders. We provide direct evidence in support of the increased debt capacity channel in the next section. Here, we explore the first channel, i.e., whether a firm’s cash flows become less variable after it starts using currency derivatives.

We measure the variability of net cash flow by its coefficient of variation (COV), i.e., as the ratio of the standard deviation of net cash flow to the mean net cash flow of the firm. For every firm that began using foreign currency derivatives in our sample, we compute this number separately for non-hedger and hedger years. We require a firm to be present for at least six years in our sample to be included in this exercise. Given the relatively short panel we have, our estimates of volatility in cash flow are not very precise. Therefore, we consider this exercise to be a supporting piece of evidence rather than a direct test of volatility reduction. We are able to compute the coefficient of variation of net cash flow before and after the firm begins hedging for 48 firms. Figure 7 presents the distribution of their COV during the pre- and post-hedging periods. The COV for the average firm declines from 1.78 to 1.27 after it starts to hedge. The difference is significant at the 1% significance level (t-stat=3.11).

It is important to note that the Brazilian economy stabilizes considerably during the latter half of our sample period. This stability in turn leads to an overall decline in volatility of output and prices. By construction, the observations in which a firm uses derivatives fall in the latter half of the sample period. Therefore, the decline in COV documented above need not be caused by derivative usage.

To account for the overall reduction in volatility, we compute the COV for all firms that remained unhedged throughout the sample period. Figure 7 also presents the distribution of COV for this control sample, before and after 2001. It is evident that unhedged firms also experienced a decline in volatility of net cash flow in the second half of the sample period. However, the rate of decline is much steeper for derivative users. The decline in COV is 0.50 (or 28% from the pre-hedging value) for hedged firms, as compared to a decline of 0.08 (or 6% from pre-2001 values) for non-hedgers. After a test of the difference in these two differences, we reject the null hypothesis that there was an equal decline in COV across the two samples. Our results are unchanged if we use either 2000 or 2002 as a cutoff year for unhedged firms. Overall, the results on reduced variability of cash flows

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These figures show the coefficient of variation (i.e., the standard deviation scaled by the mean) in net cash flow for hedger firms (left figure) and firms that remain unhedged by the end of the sample period (right figure). The figure on the left shows that the volatility in net cash flow is lower for hedgers after they begin to hedge. The figure on the right shows that the volatility in cash flow is lower for non-hedgers as well after 2001. However, the decline is steeper for hedged firms.

Figure 7: Coefficient of variation in net cash flow for hedger and non-hedger firms

are consistent with the theoretical predictions of FSS and with our results relating investment to cash flow. The results also confirm that in our sample, firms that use derivatives do so to hedge their cash flow risk, rather than simply to speculate.

4.2 Foreign currency debt

As discussed in Section 2.2, Leland (1998) shows that hedging can add value by increasing the debt capacity of a firm. Recall from Section 2.1 that, at the macroeconomic level there is evidence that (a) domestic credit was scarce in Brazil during the period of study, and (b) domestic interest rates were very high during this period. Thus, if hedging increases the access to foreign debt, firms can benefit both via greater quantity and reduced cost of debt financing.

We first test whether derivative usage allows firms to raise more debt financing by estimating
the following model:

\[
\log(\text{debt})_{it} = \alpha_i + \delta_t + \beta * \log(\text{ta})_{i,t-1} + \theta * \text{dderiv}_{it} + \sum_{k=1}^{K} \beta_{ki} * X_{kit} + \epsilon_{it}.
\] (3)

Here, \( \log(\text{debt})_{it} \) is the natural logarithm of one plus the debt value of firm \( i \) at the end of year \( t \), \( \log(\text{ta})_{i,t-1} \) is the natural logarithm of total assets at the end of year \( t - 1 \), \( \text{dderiv}_{it} \) is as defined earlier, \( X_{it} \) is a vector of other control variables for firm \( i \) at time \( t \), \( \alpha_i \) denotes firm fixed effects, and \( \delta_t \) year fixed effects.

We add one to the debt value before taking the log transform of the dependent variable to ensure that firms with zero debt in any year are not excluded from the estimation exercise. We are interested in the estimate of \( \theta \), which represents the increase in debt level consequent to the adoption of a hedging program. Observationally, we cannot distinguish whether the managers of a firm wish to hedge currency risk or a lender demands that the firm be hedged. For our exercise, such a distinction is immaterial: even if a firm starts to hedge based on its lender’s initiative, our interpretation that hedging allows firms to borrow more remains unchanged.

We include several variables in the \( X_{it} \) vector to control for some well-documented drivers of debt capacity. The set of controls is motivated by previous studies on the determinants of leverage (see Titman and Wessels (1988) and Graham, Lemmon and Schallheim (1998) for example). The variables in this set capture the effects of firm size, growth options, profitability, asset tangibility and non-debt tax shields on the debt level of the firm. As a proxy for growth options, we include sales growth, measured as the year-by-year percentage growth in sales revenue. Asset tangibility is captured by the ratio of property, plant and equipment (PPE) to total assets. We include depreciation and amortization scaled by total assets as a measure of non-debt tax shields.

A firm with a natural hedge in the form of foreign currency cash inflows has less incentive to use derivatives to hedge currency risk. In the regression, we therefore include a dummy variable \( \text{export} \) that equals one if a firm reports export income in its footnotes and zero otherwise. Several Brazilian firms also hold financial assets linked to the US dollar. These include foreign currency accounts as well as domestic bonds indexed to the US dollar. We include a dummy variable \( \text{dol} \)
that equals one for firms with dollar assets and zero otherwise.

In our first exercise we estimate this model with foreign currency debt as the dependent variable. Model 1 of Table 4 provides the regression estimates. The coefficient $\theta$ on the $dderiv$ variable is 0.8951. Therefore, the firm’s total foreign debt increases by about 145% (i.e., approximately $e^{0.8951} - 1$) after it starts using currency derivatives. The result is significant at 1% level. Consistent with the notion that the extra debt is used to fund capital expenditure, we find a positive and statistically significant coefficient on the depreciation expense variable.

In Model 2 of the table, we replace foreign debt with domestic debt as the dependent variable, and show that the adoption of a hedging program has no meaningful effect of domestic borrowing. Thus, the increase in foreign debt is not merely a replacement of domestic currency debt. Recall that univariate results in Table 1 also confirm this result: while hedgers have significantly higher foreign leverage as compared to non-hedgers, both the groups have similar levels of domestic leverage. In unreported tests we also regresses total debt of the firm on $dderiv$ and find a positive and significant coefficient. In Models 3 and 4 of Table 4, we regress the ratio of foreign currency debt to total debt on the explanatory variables. In both models, we find that larger firms have a greater proportion of foreign debt. The coefficient on derivative usage is also positive and significant in both models.

Taken together these results suggest that using currency derivatives allows firms to increase their foreign currency debt. The access to foreign capital is especially important at a time when capital in the domestic economy is scarce. Overall, derivative usage allows a firm to invest both by decreasing the volatility of internal cash flows and by allowing it to raise more capital in the external market. We conclude our analysis by investigating the effect of these factors on the overall value of the firm.

### 4.3 Valuation effects

We estimate the following model of the effect of hedging on a firm’s value:

$$ value_{it} = \alpha_i + \delta_{it} + \theta * dderiv_{it} + \sum_{k=1}^{K} \beta_{ki} * X_{kit} + \epsilon_{it} $$

(4)
The dependent variable, $value_{it}$, is the Tobin’s $q$ of firm $i$ at time $t$. The explanatory variables include firm fixed effects ($\alpha_i$), year fixed effects ($\delta_t$), a derivative usage dummy set to 1 if firm $i$ uses foreign currency derivatives in year $t$ ($dderv_{it}$), and a vector of control variables for firm $i$ at time $t$ ($X_{it}$).

$X_{it}$ includes the following control variables. We use the log of total revenue to proxy for firm size. A dummy variable $newceo_{it}$ is set to 1 if firm $i$ changed its CEO in year $t$. The growth in sales revenue from time $t - 1$ to $t$ is used as a measure of growth rate. We include a proxy for the firm’s profitability, $margin$, measured as the ratio of earnings before interest and taxes (EBIT) to total assets. The ratio of capital expenditures to total assets proxies for current investment opportunities. We also include the ratios of financial income to total assets and financial expenses to total assets as measures of financial cash flow variables that may affect value. As access to foreign debt is likely to be valuable for Brazilian firms in these crisis years, we include the ratio of foreign currency debt to total debt. Finally, we include dummy variables for firms that have dollar assets and firms that have export income. Needless to say, many of these variables are likely to be correlated with each other as well as correlated with the use of derivatives itself. For example, we have already shown that derivatives correlate with the foreign currency leverage of firms. Therefore, to carefully separate their effects on firm value, we include additional regressors in a step-wise manner in the regression model.

The results are reported in Table 5. As discussed earlier, all models include firm fixed effects and exploit the variation in firm value as a firm moves from the state of temporary sub-optimality as a non-hedger to the state of optimal hedger. We find a positive and significant coefficient on $dderv$ across all four model specifications in the Table. In terms of economic magnitudes, derivative usage increases the value of a firm by approximately 10–12%. Statistically, the coefficient is significant at the 5% level or better in Models 1, 2, and 3, and at the 10% level in Model 4.

In Models 2 and 3, the coefficient on the CEO turnover dummy is significant and negative. While it is beyond the scope of our investigation, it seems that CEOs are fired in anticipation

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6Since our dependent variable, Tobin’s Q, includes book value of asset in the denominator, we use revenue as a proxy for firm size in this model to ensure that our results are not contaminated by any mechanical relationship between the two variables.
of poor performance due to their decisions. Size is positively related to value in Model 3, but in Model 4 it’s effect is dominated by the effects of operating margin and capital expenditure. The profitability margin of a firm is the most important determinant of its value in our sample as evidenced by statistically and economically large coefficient on \( \text{margin} \) in Model 4 of the Table.

Our estimate of the effect of derivative usage on value is approximately twice as high as that found by Allayannis and Weston (2002), who find that US users of foreign currency derivatives have a approximately 4.87% higher value than non-users. We emphasize that, given the scale of the crisis in Brazil during our sample period and the scarcity of domestic capital, currency derivatives are especially important in our sample because of the access to foreign capital. Guay and Kothari (2003) suggest that the extent of derivative usage by US firms is too small to justify a value premium of about 5%. They show via simulation that a simultaneous three standard deviation adverse change in exchange rates, interest rates, and commodity prices will generate enough cash flow via derivatives holdings to add only 1.3% to the the equity value of the median US firm. Indeed, when it is relatively easy for firms to raise external capital, our arguments do not apply and we should expect to see low value premia. However, when external financing is costly or difficult, the FSS model implies that hedging will have high value and our empirical exercise confirms this prediction.

5 Conclusion

The Brazilian currency crisis of 1999 represents a natural setting to study the effects of corporate financial policy on firm outcomes. The switch to a floating exchange rate in January 1999 was followed by periods of high volatility and rapid depreciation of the real. We analyze the effect of risk-management policies in a panel of Brazilian firms from 1998 to 2005. By focusing on an economy in disequilibrium, we are more likely to establish a causal effect of hedging on firm value. That is, in a firm-fixed effect specification, we compare a firm that hedges with the same firm when it was not hedging. If the firm was behaving sub-optimally in the latter case, the difference in outcomes is attributable to the use of derivatives.
We find that foreign currency hedging allows firms to both increase their capital expenditures and to smooth their investment policies. In particular, hedger firms’ investment is less sensitive to their operating cash flows as compared to their non-hedger counterparts. Since external financing is indeed costly for firms in Brazil during our study, our results provide support for the Froot, Scharfstein and Stein (1993) model. The result that the foreign debt capacity of a firm increases when it uses derivatives ties into the predictions of Leland (1998).

We find that foreign currency hedging is positively correlated with the value of a firm. In particular, we estimate a valuation premium in the range of 10–12% for currency hedging by Brazilian firms in the period of our study. Overall, therefore, we provide evidence that risk-management policies add significant value to firms during a period of economic turmoil. More broadly, we show that when there is a supply shock to one source of capital, financial policies that make it easier to access other sources of capital lead to better real outcomes and increased value for firms.
References


A Appendix

A.1 Description of Variables

The following variables are defined for each firm and each year.

logsize: natural logarithm of sales revenues.
salesgrowth: growth rate of revenues from year $t - 1$ to year $t$.
margin: ratio of EBIT to total assets.
ebitda: ratio of EBITDA to total assets.
dep/TA: ratio of depreciation and amortization to total assets.
ppe/TA: ratio of permanent assets (the bulk of which are plant, property, and equipment) to total assets.
leverage: ratio of total debt to total assets.
forlev: ratio of foreign currency debt to total assets.
domlev: ratio of domestic currency debt to total assets.
cash: ratio of cash and short-term investments to total assets.
cashflow: operating profit before taxes plus depreciation and amortization plus net financial expenses.
invinc: income from equity investments in other firms.
dderiv: dummy variable set to 1 if firm uses foreign currency derivatives, and zero otherwise.
export: dummy variable set to 1 if firm reports export sales, and zero otherwise.
dol: dummy variable set to 1 if firm reports foreign currency asset holdings, and zero otherwise.

A.2 Example Firm

To illustrate the data collection process, we consider the firm Acesita S.A. in the year 2001. Financial information (i.e., the balance sheet and income statement) is obtained from Economatica, as is the market value of equity. Most of the variables we need (including, for example, book value of debt, revenues, net profit) are thus easily obtained.

Data on hedging and the extent of foreign currency debt are in the explanatory notes to the financial statements (the “Notas Explicativas”) maintained on the Bovespa (the São Paolo stock exchange) web site at www.bovespa.br.
From the Notas Explicativas for Acesita S.A. in 2001, we extract the following information:

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<td>330,411</td>
</tr>
<tr>
<td>21.</td>
<td>24–26</td>
<td>Instrumentos Financeiros</td>
<td>Financial Instruments</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Operacoes de Swap</td>
<td>Swap operations</td>
<td>995,404</td>
</tr>
</tbody>
</table>

Table A: **Information obtained from financial statement notes for Acesita S.A. in 2001**

The text on Item 21 (page 25), Instrumentos Financeiros, explains that the firm engages in currency swap operations to reduce the effects of exchange rate variation. Similarly, the text on page 5 (Item 4, Disponibilidades or Short-term assets) explains that a specified amount of the short-term assets are indexed to the US dollar.

Based on this information, we set $deriv = 1$ (since it has a foreign currency derivative position) and $dol = 1$ (since it holds foreign currency assets) for Acesita in 2001.
Table 1: Firm characteristics Across Derivative Users and Non-Users
This table provides the descriptive statistics for the sample firms. Panels A and B provide the descriptive statistics for the non-users and users of derivatives, respectively. Panel C provides the corresponding number for all firms pooled across the two groups. All the summary statistics are pooled across sample years starting in year 1998 and ending in 2005. Revenue is the sales of a firm represented in millions of R$. MarketCap denotes the market capitalization of the firm’s equity in millions of R$ computed by multiplying the number of shares by year end share price. Leverage is the ratio of book value of debt to book value of assets. Domestic and Foreign leverage represent the ratio of local currency borrowings and foreign currency borrowings to the book value of total assets, respectively. Market/Book ratio of assets is computed as the ratio of (book value of debt + market value of equity) to (book value of debt + book value of equity). Margin denotes the ratio of earnings before interest, taxes, and depreciation to the book value of total assets. Net Income/TA denotes the ratio of net income to book value of total assets. Cash/TA measures the cash-holdings as a fraction of book value of total assets. Capex/TA represents the ratio of capital expenditure to the one-year lagged value of total assets. Cashflow/TA is the ratio of internally generated cash flow scaled by beginning of the year total assets. Internally generated cash flow is computed as the sum of profits before taxes (excluding extraordinary items) plus depreciation & amortization plus net financial expenses. Columns labeled as N, Median and Mean represent the number of observations, median and mean, respectively. Std.Dev. represents the standard deviation.
## Firm characteristics Across Derivative Users and Non-Users

<table>
<thead>
<tr>
<th>Variable</th>
<th>Panel A: Non-Users</th>
<th>Panel B: Users</th>
<th>Panel C: All firms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Median</td>
<td>Mean</td>
</tr>
<tr>
<td>Revenue (R$ million)</td>
<td>739</td>
<td>250.3540</td>
<td>547.7564</td>
</tr>
<tr>
<td>MarketCap (R$ million)</td>
<td>739</td>
<td>73.9195</td>
<td>358.4563</td>
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<tr>
<td>Leverage</td>
<td>739</td>
<td>0.2067</td>
<td>0.2291</td>
</tr>
<tr>
<td>Domestic Leverage</td>
<td>739</td>
<td>0.1048</td>
<td>0.1424</td>
</tr>
<tr>
<td>Foreign Leverage</td>
<td>739</td>
<td>0.0359</td>
<td>0.0867</td>
</tr>
<tr>
<td>Market/Book</td>
<td>739</td>
<td>0.7235</td>
<td>0.8546</td>
</tr>
<tr>
<td>Margin</td>
<td>709</td>
<td>0.1112</td>
<td>0.1185</td>
</tr>
<tr>
<td>Net Income/TA</td>
<td>739</td>
<td>0.0208</td>
<td>0.0209</td>
</tr>
<tr>
<td>Cash/TA</td>
<td>739</td>
<td>0.0312</td>
<td>0.0681</td>
</tr>
<tr>
<td>Capex/TA_{-1}</td>
<td>658</td>
<td>0.0387</td>
<td>0.0534</td>
</tr>
<tr>
<td>Cashflows/TA_{-1}</td>
<td>709</td>
<td>0.1090</td>
<td>0.1152</td>
</tr>
<tr>
<td>Revenue (R$ million)</td>
<td>431</td>
<td>1534.7070</td>
<td>3268.7159</td>
</tr>
<tr>
<td>MarketCap (R$ million)</td>
<td>431</td>
<td>900.4713</td>
<td>2985.3811</td>
</tr>
<tr>
<td>Leverage</td>
<td>431</td>
<td>0.3316</td>
<td>0.3340</td>
</tr>
<tr>
<td>Domestic Leverage</td>
<td>431</td>
<td>0.1076</td>
<td>0.1270</td>
</tr>
<tr>
<td>Foreign Leverage</td>
<td>431</td>
<td>0.1913</td>
<td>0.2069</td>
</tr>
<tr>
<td>Market/Book</td>
<td>431</td>
<td>1.0938</td>
<td>1.2665</td>
</tr>
<tr>
<td>Margin</td>
<td>421</td>
<td>0.1754</td>
<td>0.1861</td>
</tr>
<tr>
<td>Net Income/TA</td>
<td>431</td>
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<td>0.0428</td>
</tr>
<tr>
<td>Cash/TA</td>
<td>431</td>
<td>0.0622</td>
<td>0.1049</td>
</tr>
<tr>
<td>Capex/TA_{-1}</td>
<td>402</td>
<td>0.0644</td>
<td>0.0830</td>
</tr>
<tr>
<td>Cashflow/TA_{-1}</td>
<td>421</td>
<td>0.1671</td>
<td>0.1777</td>
</tr>
<tr>
<td>Revenue (R$ million)</td>
<td>1170</td>
<td>512.1240</td>
<td>1550.0928</td>
</tr>
<tr>
<td>MarketCap (R$ million)</td>
<td>1170</td>
<td>184.0293</td>
<td>1326.1525</td>
</tr>
<tr>
<td>Leverage</td>
<td>1170</td>
<td>0.2712</td>
<td>0.2678</td>
</tr>
<tr>
<td>Domestic Leverage</td>
<td>1170</td>
<td>0.1065</td>
<td>0.1367</td>
</tr>
<tr>
<td>Foreign Leverage</td>
<td>1170</td>
<td>0.0952</td>
<td>0.1310</td>
</tr>
<tr>
<td>Market/Book</td>
<td>1170</td>
<td>0.8663</td>
<td>1.0063</td>
</tr>
<tr>
<td>Margin</td>
<td>1130</td>
<td>0.1371</td>
<td>0.1437</td>
</tr>
<tr>
<td>Net Income/TA</td>
<td>1170</td>
<td>0.0297</td>
<td>0.0290</td>
</tr>
<tr>
<td>Cash/TA</td>
<td>1170</td>
<td>0.0395</td>
<td>0.0817</td>
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<tr>
<td>Capex/TA_{-1}</td>
<td>1060</td>
<td>0.0477</td>
<td>0.0646</td>
</tr>
<tr>
<td>Cashflow/TA_{-1}</td>
<td>1130</td>
<td>0.1334</td>
<td>0.1385</td>
</tr>
</tbody>
</table>
Table 2: Cox Proportional Hazard Model for Derivative Usage

This table presents the regression coefficients of a Cox Proportional Hazard Model for the first time use of derivatives by sample firms. In particular we estimate the following model: \( h(t|x_{jt}) = h_0(t)\exp(x_{jt}\beta) \); where \( h \) stands for the hazard rate of derivative usage, i.e., the probability of using derivatives next year conditional on not having used derivatives in the past. \( h_0 \) is the baseline hazard rate and \( h_t \) denotes hazard rate conditional on set of covariates given by \( x_{jt} \) at time \( t \). We report the estimated beta coefficients in this table. \( \logta98 \) is the natural logarithm of the firm’s total assets in 1998. \( \forlev98 \) measures the ratio of dollar denominated debt to total asset as of 1998. \( \logta \) and \( \forlev \) are constructed similarly using the most recent fiscal year end data. \( \capexta \) measures the ratio of capital expenditure to total asset; \( \leverage \) is computed as the ratio of total debt to total assets. \( \export \) is a dummy variable that equals one for the exporters, zero otherwise. \( \dol \) is a dummy variable that equals one for firms that hold dollar assets, zero otherwise. The number of observations used in each regression is reported in the bottom row.

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th></th>
<th>Model 2</th>
<th></th>
<th>Model 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Estimate</td>
<td>t-stat</td>
<td>Estimate</td>
<td>t-stat</td>
<td>Estimate</td>
</tr>
<tr>
<td>( \logta98 )</td>
<td>0.4606**</td>
<td>(4.96)</td>
<td>0.4874*</td>
<td>(1.76)</td>
<td></td>
</tr>
<tr>
<td>( \forlev98 )</td>
<td>3.4503**</td>
<td>(3.53)</td>
<td></td>
<td></td>
<td>3.0757**</td>
</tr>
<tr>
<td>( \capexta )</td>
<td>4.0461**</td>
<td>(3.79)</td>
<td>-1.6089</td>
<td>(-0.57)</td>
<td>-11.9789**</td>
</tr>
<tr>
<td>( \logta )</td>
<td>0.5098**</td>
<td>(6.69)</td>
<td>-0.0709</td>
<td>(-0.25)</td>
<td></td>
</tr>
<tr>
<td>( \leverage )</td>
<td>7.8101**</td>
<td>(3.68)</td>
<td>8.0798**</td>
<td>(2.59)</td>
<td></td>
</tr>
<tr>
<td>( \leverage^2 )</td>
<td>-11.9789**</td>
<td>(-3.52)</td>
<td>-13.8399**</td>
<td>(-2.95)</td>
<td></td>
</tr>
<tr>
<td>( \dol )</td>
<td>0.7167**</td>
<td>(2.78)</td>
<td>0.4320</td>
<td>(1.19)</td>
<td>0.0205</td>
</tr>
<tr>
<td>( \export )</td>
<td></td>
<td></td>
<td>0.1263</td>
<td>(0.39)</td>
<td></td>
</tr>
<tr>
<td>( N )</td>
<td>491</td>
<td>645</td>
<td>423</td>
<td></td>
<td></td>
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</tbody>
</table>
Table 3: Derivatives and Capital Expenditure

This table presents regression estimates from a regression of firm’s capital expenditure on derivative usage and control variables. The dependent variable in the regression is the natural logarithm of the firm’s annual capital expenditure. \( \text{logta} \) is the natural logarithm of the beginning of the year value of total assets; \( \text{dderiv} \) is a binary variable that equals one for years after a firm starts using derivatives, zero otherwise; \( \text{newceo} \) is a binary variable that equals one for years after a new CEO is appointed by the derivative user firm, zero otherwise. \( \text{indmtb} \) is average market-to-book ratio of all other firms in the same industry in the given year. \( \text{cashflow} \) is the dollar value of a firm’s operating cash flows; \( \text{logcashflow} \) is constructed as the natural logarithm of cash flows after scaling it up. We add the one plus the negative of sample minimum to all observations before taking the logarithm to ensure that all available sample firm-year pairs are present in the regression analysis. We report the adjusted \( R^2 \) and the number of observations toward the bottom, and provide other estimation details in the last three rows. ** denotes significance at the 5% level and * at the 10% level.

<table>
<thead>
<tr>
<th>Model</th>
<th>dderiv</th>
<th>logta</th>
<th>newceo</th>
<th>indmtb</th>
<th>logcashflow * dyes</th>
<th>cashflow * dyes</th>
</tr>
</thead>
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<tr>
<td></td>
<td>Est. t-stat</td>
<td>Est. t-stat</td>
<td>Est. t-stat</td>
<td>Est. t-stat</td>
<td>Est. t-stat</td>
<td>Est. t-stat</td>
</tr>
<tr>
<td>Model 1</td>
<td>0.4927** (3.67)</td>
<td>1.1602** (24.19)</td>
<td>0.1233 (0.90)</td>
<td>1.2607** (4.10)</td>
<td>-0.3248** (-3.41)</td>
<td>-1.0786** (-2.75)</td>
</tr>
<tr>
<td>Model 2</td>
<td>4.3255** (3.71)</td>
<td>1.0210** (14.73)</td>
<td>0.0984 (0.76)</td>
<td>1.1827** (4.09)</td>
<td>0.4034** (3.66)</td>
<td>1.1016** (2.63)</td>
</tr>
<tr>
<td>Model 3</td>
<td>0.7368** (4.02)</td>
<td>1.0833** (15.07)</td>
<td>0.1268 (0.95)</td>
<td>1.2546** (4.19)</td>
<td>-0.1128** (-1.99)</td>
<td>0.4703* (1.70)</td>
</tr>
<tr>
<td>Model 4</td>
<td>0.1475 (1.40)</td>
<td>0.7620** (2.52)</td>
<td>-0.1543 (-0.71)</td>
<td>0.4266** (2.40)</td>
<td>0.1476** (2.51)</td>
<td>0.4703* (1.70)</td>
</tr>
<tr>
<td>Model 5</td>
<td>1.5071** (2.07)</td>
<td>0.7319** (2.38)</td>
<td>-0.1503 (-0.67)</td>
<td>0.3930** (2.20)</td>
<td>-0.4393** (-2.01)</td>
<td>0.4703* (1.70)</td>
</tr>
<tr>
<td>Model 6</td>
<td>0.2575* (1.92)</td>
<td>0.7446** (2.29)</td>
<td>-0.1229 (-0.55)</td>
<td>0.4171** (2.37)</td>
<td>0.4703* (1.70)</td>
<td>0.4703* (1.70)</td>
</tr>
</tbody>
</table>

** denotes significance at the 5% level and * at the 10% level.

### Model Details

<table>
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<tr>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
<th>Model 5</th>
<th>Model 6</th>
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</thead>
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<td>Est. t-stat</td>
<td>Est. t-stat</td>
<td>Est. t-stat</td>
<td>Est. t-stat</td>
<td>Est. t-stat</td>
</tr>
<tr>
<td>( R^2 )</td>
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<td>0.731</td>
<td>0.700</td>
<td>0.873</td>
<td>0.875</td>
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<tr>
<td>( N )</td>
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<td>1034</td>
<td>1034</td>
<td>1036</td>
<td>1034</td>
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<td>Year Fixed Effects</td>
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<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Clustering unit</td>
<td>firm</td>
<td>firm</td>
<td>firm</td>
<td>firm</td>
<td>firm</td>
</tr>
<tr>
<td>Firm Fixed Effects</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
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</table>
Table 4: Foreign Currency Debt-Mix and Derivative Usage

This table presents firm fixed effect regression estimates from a regression of firm’s foreign currency and domestic debt on derivative usage and control variables. The dependent variable is the natural logarithm of one plus total amount of foreign currency debt in Model 1. In Model 2, the dependent variable is the natural logarithm of one plus total local currency or domestic debt of the firm. Models 3 and 4 use the ratio of foreign currency debt to the total debt of the firm as the dependent variable. dderiv is a binary variable that equals one for years after a firms starts using derivatives, zero otherwise; logta is the natural logarithm of the firm’s total assets at the beginning of the year; margin measures the operating profit of the firm and is constructed as the ratio of earnings before interest and taxes to the book value of total assets; export is a dummy variable that equals one for the exporters, zero otherwise; dol is a dummy variable that equals one for firms that hold dollar assets, zero otherwise; ppe/TA is the ratio of plant, property and equipment to the total assets; dep/TA measure the depreciation-to-total asset ratio. We report the adjusted $R^2$ and the number of observations toward the bottom, and provide other estimation details in the last three rows. ** denotes significance at the 5% level and * at the 10% level.

<table>
<thead>
<tr>
<th></th>
<th>Foreign Debt</th>
<th>Domestic Debt</th>
<th>Fx Debt/Total Debt</th>
<th>Fx Debt/Total Debt</th>
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</thead>
<tbody>
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<td></td>
<td>Estimate</td>
<td>t-stat</td>
<td>Estimate</td>
<td>t-stat</td>
</tr>
<tr>
<td>logta</td>
<td>1.6452**</td>
<td>(4.74)</td>
<td>0.8460**</td>
<td>(2.61)</td>
</tr>
<tr>
<td>margin</td>
<td>0.0501</td>
<td>(0.04)</td>
<td>2.4880*</td>
<td>(1.96)</td>
</tr>
<tr>
<td>dderiv</td>
<td>0.8951**</td>
<td>(3.55)</td>
<td>-0.1619</td>
<td>(-0.89)</td>
</tr>
<tr>
<td>dol</td>
<td>0.2861</td>
<td>(0.86)</td>
<td>0.5958**</td>
<td>(2.12)</td>
</tr>
<tr>
<td>export</td>
<td>0.4000</td>
<td>(0.87)</td>
<td>-0.1824</td>
<td>(-0.71)</td>
</tr>
<tr>
<td>ppe/TA</td>
<td>-0.2877</td>
<td>(-0.22)</td>
<td>1.0464</td>
<td>(1.02)</td>
</tr>
<tr>
<td>dep/TA</td>
<td>15.3953*</td>
<td>(-0.22)</td>
<td>5.3586</td>
<td>(1.10)</td>
</tr>
<tr>
<td>$R^2$</td>
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<td>Clustering unit</td>
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<td>firm</td>
<td></td>
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<tr>
<td>Firm fixed-effects</td>
<td>yes</td>
<td></td>
<td>yes</td>
<td></td>
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Table 5: Firm Value and Derivative Usage

This table presents the firm fixed effect regression estimates from a regression of firm value on derivative usage and other firm-level control variables. The dependent variable is the firm’s market-to-book ratio defined as the ratio of the (book value of total debt plus market value of equity) to the (book value of debt plus book value of equity). \( \alpha_i \) and \( \alpha_t \) represent firm and year fixed effects, respectively. \( \text{dderiv} \) is a binary variable that equals one for if firm \( i \) has begun using currency derivatives by year \( t \), zero otherwise. \( \text{newceo} \) is a binary variable that equals one for years after a new CEO is appointed by the derivative user firm, zero otherwise. \( \text{x}_{it} \) represents a set of control variables: \( \text{logsize} \) is the natural logarithm of the firm’s total revenue; \( \text{margin} \) measures the operating profit of the firm and is constructed as the ratio of earnings before interest and taxes to the book value of total assets; \( \text{salesgrowth} \) represents the percentage growth in year-by-year revenue of the firm; \( \text{capex/TA} \) is measured as the ratio of firm’s capital expenditure to the book value of total assets; \( \text{fininc/TA} \) is the ratio of the firm’s financial income to total assets; \( \text{finexp/TA} \) is the ratio of firm’s financial expenses (such as interest expense, bank fees, and losses on derivative transactions) to the book value of total assets; \( \text{export} \) is a dummy variable that equals one for the exporters, zero otherwise; \( \text{dol} \) is a dummy variable that equals one for firms that hold dollar assets, zero otherwise; \( \text{fordebt/total} \) measures the ratio of foreign debt to total debt of the firm. All standard errors are clustered at the firm level. We report the adjusted \( R^2 \) and the number of observations toward the bottom, and provide other estimation details in the last three rows. ** denotes significance at the 5% level and * at the 10% level.

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th></th>
<th>Model 2</th>
<th></th>
<th>Model 3</th>
<th></th>
<th>Model 4</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Estimate</td>
<td>t-stat</td>
<td>Estimate</td>
<td>t-stat</td>
<td>Estimate</td>
<td>t-stat</td>
<td>Estimate</td>
<td>t-stat</td>
</tr>
<tr>
<td>( \text{dderiv} )</td>
<td>0.1079**</td>
<td>(2.06)</td>
<td>0.1276**</td>
<td>(2.31)</td>
<td>0.1149**</td>
<td>(2.12)</td>
<td>0.1068*</td>
<td>(1.74)</td>
</tr>
<tr>
<td>( \text{newceo} )</td>
<td>-0.1465*</td>
<td>(-1.94)</td>
<td>-0.1485**</td>
<td>(-1.99)</td>
<td>-0.0927</td>
<td>(-1.06)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \text{logsize} )</td>
<td></td>
<td></td>
<td>0.1392**</td>
<td>(1.97)</td>
<td>0.0984</td>
<td>(1.37)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \text{fininc/TA} )</td>
<td>-0.1211</td>
<td>(-0.22)</td>
<td></td>
<td></td>
<td>0.0986</td>
<td>(0.17)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \text{finexp/TA} )</td>
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<td>(-0.45)</td>
<td></td>
<td></td>
<td>0.0716</td>
<td>(0.15)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \text{salesgrowth} )</td>
<td>0.0739</td>
<td>(1.37)</td>
<td></td>
<td></td>
<td>-0.0923</td>
<td>(-1.39)</td>
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