Exchange Rate Exposure, Foreign Currency Debt, and the Use of Derivatives: Evidence from Brazil

José Luiz Rossi Júnior

ABSTRACT: This paper studies the exchange rate exposure and its determinants for a sample of nonfinancial Brazilian companies from 1996 to 2006. The results indicate that the number of firms exposed to exchange rate fluctuations is higher in periods of crisis and under a fixed exchange rate regime. In addition, the results point out that, although companies' international activities, operational hedging, and financial policies are important determinants of firms' exposure, the changes in companies' exposure that took place when Brazil moved from a fixed to a floating exchange rate regime were mainly driven by changes in companies' foreign currency borrowing and the use of derivatives that occurred in that period.

KEY WORDS: debt composition, exchange rate regime, exposure, hedging.

Several episodes of crisis and economic downturns in developing countries are associated with depreciations of the home currency. Unlike what happens in their developed counterparts, in these countries, depreciations are usually viewed as an important source of risk. Following a sequence of financial crises in the 1990s, a new generation of models of currency crises has placed corporate financial policies, especially foreign currency borrowing and the use of derivatives, at the center of the debate about the relationship between movements in the exchange rate and economic activity.

In these models, negative balance sheet effects caused by depreciations of the home currency would offset the textbook-positive expenditure-switching effect, leading to a fall in economic activity, especially in private investment; therefore, because both the public and the private sector hold a considerable amount of unhedged foreign currency–denominated debt, depreciations would be more problematic for developing countries than for developed ones.

The empirical literature that tries to ascertain the importance of these balance sheet effects has obtained mixed results. Analyzing the impact of exchange rate fluctuations on private investment by using a sample of Latin American firms, Bleakley and Cowan (2008) find no evidence of the significance of the balance sheet effects. In a survey of six studies for different countries using a similar methodology, Galindo et al. (2003) find that four out of six countries show a negative balance sheet effect. This paper departs from the previous literature to analyze the role of foreign currency borrowing and the use of derivatives in explaining the impact of exchange rate fluctuations on the corporate sector and, consequently, on economic activity.

The paper takes a systematic look at companies' exchange rate exposure and its determinants for a sample of nonfinancial Brazilian companies from 1996 to 2006. The analysis employs a unique database constructed directly from companies' annual reports

José Luiz Rossi Júnior (joselrj1@insper.edu.br) is an associate professor in the Insper Institute of Education and Research, São Paulo, Brazil.

containing information about their international activities, the currency composition of their debt, and their use of derivatives.

The paper contributes to the literature by analyzing whether corporate financial policies play a role in determining companies' exchange rate exposure. Most of the previous studies about the determinants of companies' exchange rate exposure have focused on developed countries, with the exception of Muller and Verschoor (2007) for East Asian countries and Dominguez and Tesar (2006) for Chile and Thailand. However, none of the papers for developing economies study whether corporate international activities together with financial policies, especially foreign currency borrowing and use of derivatives, have an impact on companies' exchange rate exposure.

Moreover, during the period of this study, Brazil adopted two different exchange rate regimes—a (quasi-) fixed exchange rate regime from 1996 to 1999 and a flexible exchange rate regime from 1999 to 2006—which allows us to test not only the impact of the adoption of each regime on companies' exchange rate exposure but also whether changes in companies' exchange rate exposure that took place when the country moved from a fixed to a floating exchange rate regime may be associated with changes in their financial policies.[1]

First, this study analyzes the extent to which Brazilian companies are exposed to exchange rate fluctuations using different methods proposed in the literature. The study finds that, on average, Brazilian companies—unlike their counterparts in the United States—do not benefit from depreciations of the home currency, and a significant number of companies are exposed to fluctuations in the exchange rate.[2] In fact, this study confirms that a depreciation of the Brazilian real led to a fall in the average company's stock market returns, providing evidence that exchange rate fluctuations are indeed troublesome for developing economies like Brazil. Moreover, this study shows that, depending on the method of estimation, from 25 percent to 38 percent of the companies in the sample were exposed to exchange rate fluctuations in the period from 1996 to 2006, indicating that Brazilian companies are significantly affected by movements in the exchange rate.

Second, this study investigates whether these results depend on the time period used in the analysis. The results show that there is substantial time variation in companies' exchange rate exposure. The number of companies exposed to exchange rate fluctuations is higher during the fixed exchange rate regime period than under the flexible one and during periods of crisis. In addition, the results show that when the country moved from a fixed to a floating exchange rate regime, aside from the decrease in the number of companies with a significant exchange rate exposure, there was a change in the distribution of companies' exchange rate exposure with a reduction in the number of companies that do not benefit from depreciations of the home currency, implying that depreciations become less problematic after the adoption of a flexible exchange rate regime.

Finally, this analysis provides evidence that companies' exchange rate exposure is determined not only by their international activities but also by their financial policies, especially foreign currency borrowing and use of derivatives. In addition, the study shows that the documented changes in companies' exchange rate exposure that took place when moving from a fixed to a floating exchange rate regime were mainly determined by changes in the companies' financial policies. The improvement in companies' prudential measures led to a reduction in their exchange rate risk. This study shows that the reduction in companies' foreign currency–denominated debt and the increase in their use of foreign currency derivatives have an impact on their exchange rate exposure.

Macroeconomic Background and Data

Background

In the period between the stabilization plan in 1994 and January 1999, Brazil adopted a "crawling band" exchange rate regime.[3] During this period, Brazil suffered from several speculative attacks, especially during the Asian and Russian crises. Banco Central do Brasil (Central Bank of Brazil) promptly reacted to those attacks by raising interest rates to maintain the regime, clearly demonstrating its commitment to the exchange rate regime even at the cost of maintaining high interest rates, increasing the public debt, and causing an economic recession. After a speculative attack in January 1999, the home currency was allowed to float, and an inflation-targeting regime was adopted. By tightening its monetary and fiscal policies, Brazil succeeded in stabilizing inflation, and the economy quickly recovered from the crisis. In 2002, due to the possibility that a new president who was against the current policies would be elected, a reversal of capital flows took place, and the real depreciated more than 50 percent during the year with a consequent rise in inflation. After 2003, the home currency began to appreciate because the new government opted to reinforce the orthodox macroeconomic policy, and a positive external shock, represented by an increase in the price of the main exported commodities, struck the country.

Data

Data for this analysis were collected from both companies' annual reports and Econo-mática, a database that contains stock market and financial data for all Latin American publicly traded companies. A sample of Brazilian nonfinancial publicly traded companies from 1996 to 2006 is used. The description of all variables used throughout the text is shown in the Appendix. The choice to use the period 1996–2006 was made because the use of derivatives was required to be reported only after 1995.[4] The sample contains information for all companies that were in the database in 1996 and stayed until 2006, a total of 173 companies.[5] This procedure was followed to give a better comparison of companies' behavior under different time periods. All information was obtained from the consolidated balance sheet in case a company has subsidiaries that are also publicly traded. The final sample comprises more than 50 percent of all publicly traded companies in Brazil and 67.9 percent of all market capitalization.

The São Paulo stock exchange index (IBOVESPA) was adopted as the domestic stock market return. This index was used because the São Paulo stock exchange is the most important and liquid stock market in Brazil. The savings account interest rate was used as the risk-free interest rate.

Because most of Brazilian trade is in American dollars and almost all foreign currency debt is issued in this currency, the analysis of companies' exchange rate exposure is developed by using the real/dollar exchange rate. The convention adopted here is that companies with positive (negative) exposure benefit (suffer) from depreciations of the home currency. This definition holds throughout the text.

Data about foreign sales, the currency composition of the debt, and the use of derivatives were collected directly from companies' annual reports. Unfortunately, Brazilian companies do not have a systematic procedure to register information about their foreign sales. Sometimes it is reported together with their total gross sales, sometimes it is reported

under the comments from managers to shareholders, and sometimes it is found in the explanatory notes. In some cases, companies mention being exporters but do not report the amount of foreign sales; in this case, the companies were contacted directly through e-mail. In the end, seven companies mentioned as exporters had to be discarded because they did not report the amount of their foreign sales or answer the e-mails.

Data about companies' import inputs are reported by the secretary of trade. The secretary of trade reports the value of imports in U.S. dollars only for the 250 largest importers; for all others, the secretary of trade reports only the interval of the value of imports. For this study a variable is created that assumes discrete values for all intervals reported by the secretary of trade, starting from zero for nonimporters.

Information about corporate foreign currency borrowing and use of currency derivatives is available in the annual reports under the explanatory notes. The amount of foreign currency–denominated debt is located under the item loans and financing, and use of derivatives is registered under the item financial instruments.

The total gross notional value of currency derivatives is used as a proxy for the extension of use of currency derivatives. Graham and Rogers (2002) argue that, ideally, to identify a more precise picture of companies' risk management practices, one should compute the net position of the companies in the derivatives markets. However, because this information is made available for only a small number of firms, this study uses the total gross notional value, which is available for a larger number of companies.[6]

Sample Characteristics

A summary of the statistics for the main variables in this paper can be found in Table 1. Table 1 shows that, although the number of exporters and importers is reported to be stable during the period, the ratio of foreign sales to total sales follows a different pattern. From 1996 to 1998, during the fixed exchange rate regime, the ratio remained stable; however, after the currency was allowed to float until 2002, the ratio increased steadily. After 2002, with the appreciation of the home currency, there was a slight reduction in the ratio of foreign sales to total sales, but this ratio was still higher than the fraction observed before 1999. This fact corroborates the idea that the traditional expenditure-switching effect took place with exports rising after the depreciation of the domestic currency, and falling after the appreciation. In addition, the results using the Wilcoxon two-sample rank-sum test confirm that there was a change in the distribution of the firms' ratio of foreign sales to total sales between the period 1996–98 under the fixed exchange rate regime and 1999–2006 under a flexible regime.[7]

Table 1 displays the behavior of corporate foreign currency borrowing during the period. It reports that the proportion of companies in the sample that hold foreign currency–denominated debt reached a peak in 1998 right before the currency crisis. This proportion decreased after the crisis, especially after 2004, reaching its minimum value in 2006. A similar pattern was followed by the ratio of foreign debt to total debt, which reached its peak in 1999 and suffered a significant fall after 2002. Again, use of the Wilcoxon nonparametric test results in rejection of the hypothesis that the distribution of the ratio of total foreign debt to total debt is equal for the periods before and after 1999. Table 1 also shows that the proportion of companies that keep subsidiaries abroad was stable until 2003, increasing only after 2004, although its level is still very close to what it was in 1996.

In Table 1, use of currency derivatives is reported to have considerable variation from 1996 to 2006. This table shows that the number of users of derivatives increased

Table 1. Summary statistics (in percent)

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Total number of firms	173	173	173	173	173	173	173	173	173	173	173
Exporters	56.6	56.0	57.8	58.3	58.3	58.3	58.3	58.3	57.8	55.6	55.0
Foreign Sales/Total Sales	12.3	12.3	12.3	14.0	14.1	14.9	16.1	15.8	16.0	15.3	15.3
Importers	66.4	66.4	67.0	64.7	64.7	67.0	68.2	68.2	68.2	69.3	69.3
Debtors	76.9	77.4	82.1	78.6	76.8	76.3	76.8	72.8	73.4	72.1	64.6
Total Foreign Debt/Total Debt	44.4	46.5	46.6	49.7	48.8	48.8	49.1	42.4	41.5	36.1	31.7
Foreign Subsidiaries	17.9	17.3	17.3	17.3	17.3	17.3	17.3	17.3	17.9	18.1	18.1
Users—currency derivatives	6.93	8.67	13.8	16.2	24.9	33.5	38.7	34.7	32.3	34.3	26.5
Derivatives/Total Assets	0.53	0.63	1.06	1.29	1.84	3.15	3.90	3.13	2.10	2.34	1.76
Derivatives/Total Foreign Debt	5.91	3.83	7.21	7.38	15.4	19.7	25.1	23.1	34.5	54.3	48.3
(Net) Foreign Debt/Total Debt	42.6	44.6	42.9	45.8	42.9	38.5	37.1	33.2	32.9	27.4	23.9

Notes: Exporters represents the percentage of exporters in the sample. *Debtors* represents the percentage of companies in the sample that hold foreign currency–denominated debt. *Foreign subsidiaries* represents the percentage of companies in the sample that have foreign affiliates. *Users* represents the percentage of companies that use foreign currency derivatives. All other variables are described in the Appendix.

from 1996 to 2002. Likewise, the extent of hedging activities represented by the ratio of the total notional amount of derivatives to total assets and the total notional amount of derivatives to total foreign debt also increased during the same time frame. An interesting pattern arises after 2002 with respect to the use of currency derivatives; there is a reduction in the ratio of derivatives to total assets, indicating that firms used derivatives less intensively. This reduction occurs because, as discussed by Rossi (2007), Brazilian firms use derivatives to protect themselves from fluctuations in the exchange rate on the liability side of their balance sheets; with the reduction of the ratio of foreign debt to total debt, firms reduce the total amount of currency derivatives used.

However, data from Table 1 also show that the ratio of derivatives to total foreign debt increased until 2005, and even after a reduction in 2006, the level of this ratio is much higher than before; the ratio of (net) foreign debt to total debt, defined as the total amount of foreign debt to total debt minus the total amount of currency derivatives used by the firm—a better proxy for the exposure of the liability side of the companies—decreased steadily after 1999. These results are consistent with the theory that a flexible exchange rate regime would have an impact on companies' currency mismatches. The data indicate that the floating exchange rate regime reduces currency mismatches on companies' balance sheets. Cowan et al. (2005) show a similar pattern for Chilean companies.

Corroborating the possibility that most Brazilian firms use derivatives to avoid the negative impact of exchange rate fluctuations on the liability side of their balance sheet, Table 2 data show the choices among currency derivatives. The data indicate that currency swaps are the most preferred among all possible derivatives. This can be viewed as evidence that the hedging activities of Brazilian companies are linked to their attempt to reduce their foreign currency exposure and are not for speculative purposes, because swaps are usually preferred when the sources of exposure extend for multiple periods but are predetermined. This is the case when liabilities are denominated in foreign currency. By contrast, forward contracts are preferred when the main source of exposure is related to short-term transactions that are characterized by uncertainty. This is the case with foreign revenues derived from exports.

The hedging practices reported in Table 2 are completely different from those found in previous studies for developed countries. Geczy et al. (1997), for example, show that for a sample of U.S. companies, forward contracts, or a combination of forward and option contracts, were the most preferred instruments. The preference for swaps is stable across periods and is therefore independent of the exchange rate regime. It might be evidence that Brazilian firms use derivatives for hedge purpose and not for speculation reasons. The use of currency swaps indicates that the main concern of Brazilian users of derivatives is the negative impact of fluctuations in the exchange in the liability side of their balance sheet.[8]

Summarizing, the data show that although Brazilian companies' international activities changed during the period of the study, corporate financial policies, especially the amount of foreign currency–denominated debt and the use of currency derivatives, suffered from more substantial changes within the period. Companies took the exposure of the liability side of their balance sheets more seriously, reduced the amount of their debt expressed in foreign currency, and increased use of derivatives, which resulted in reducing currency mismatches on their balance sheets. All results are robust if we compare the sample under the fixed and flexible exchange rate regimes using a parametric *t*-test and a nonparametric Wilcoxon test considering a 5 percent level of significance. In the next sections, we test whether these changes have an impact on foreign exposure.

Table 2. Choice of currency derivatives

Year/Type	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Only swap	8	8	17	24	27	39	49	41	38	38	32
Combination swap and forward	2	3	2	4	7	10	10	11	11	11	8
Combination swap and options	0	0	0	0	0	0	0	1	1	1	1
Combination swap, options, and forward	0	0	0	0	2	3	3	4	3	3	2
Only forward	2	3	3	2	4	4	3	3	2	4	2
Only options	0	1	1	1	1	1	1	0	1	2	1
Combination forward and options	0	1	1	1	0	0	0	0	0	0	0
Total	12	15	24	28	43	58	67	60	56	59	46

Notes: This table displays the choice of different currency derivatives by Brazilian firms. Combination means that the company used both currency derivatives.

Exchange Rate Exposure

Methodology

Initially, following the standard specification used in the literature to estimate companies' exchange rate exposure, we estimate the following equation:

$$R_{it} = \alpha_i + \theta_i \cdot R_{mt} + \beta_i \cdot \Delta S_t + \varepsilon_{it}, \tag{1}$$

where R_{it} is the stock return of firm i in period t, R_{mt} is the market portfolio return in period t, ΔS_t is the change in exchange rate, and β_i represents firm i's exchange rate exposure—that is, the sensitivity of firm i's stock returns to movements in the exchange rate. This approach has been used extensively in the corporate finance literature, so this specification is used here as the baseline result for estimating companies' exchange rate exposure.

Since the studies of Jorion (1990) and Amihud (1994) found that exchange rate fluctuations matter only for a small number of companies in the United States, researchers have focused on different methods to verify the robustness of the results.[9]

According to Bodnar and Wong (2003), lack of significance of the exchange rate coefficient is a result of the market portfolio's being a value-weighted market portfolio, which induces a bias in the estimation of companies' exchange rate exposure, because large firms have more weight in value-weighted portfolios and these firms are more likely to be exposed to fluctuations in the exchange rate (as they are usually multinational corporations). In this case, the coefficient of the changes in the exchange rate cannot be interpreted as "total" exposure; rather, it should be interpreted as the difference between the firm's total exposure elasticity and the market exposure adjusted by the firm's market beta. Therefore, if the market portfolio is exposed to the exchange rate, the distribution of the firms' exposure will be shifted. Using an equally weighted portfolio, Bodnar and Wong found a larger number of companies with significant exchange rate exposure. Equation (1) is also estimated here by use of an equally weighted market portfolio return encompassing all firms in the sample.

Another procedure to control for multicollinearity problems has been used by Bris et al. (2004) and Kiymaz (2003). Companies' exchange rate exposure is estimated by following a two-step procedure. In the first step, the market portfolio is regressed on the changes in the exchange rate as shown by Equation (2):

$$R_{market,t} = \gamma_0 + \gamma_1 \cdot \Delta s_t + \varepsilon_t. \tag{2}$$

Then, the component of the market portfolio return that is orthogonal to the changes in the exchange rate is obtained by calculating $F_{market,t} = R_{market,t} - (\hat{\gamma}_0 - \hat{\gamma}_1 \cdot \Delta s_t)$. Finally, companies' exchange rate exposure is estimated by regressing companies' excess stock market return on the orthogonal component of the market portfolio and on changes in the exchange rate, as illustrated by Equation (3):

$$R_{i,t} = \alpha_i + \beta_{i,market} \cdot F_{market,t} + \beta_{i,exposure} \cdot \Delta s_t + v_{i,t}, \tag{3}$$

where $R_{i,t}$ is the stock return of firm i, $F_{market,t}$ is the estimated orthogonal component of the market portfolio (IBOVESPA), and Δs_t is the percentage change in the exchange rate over the same period.[10] Companies' exchange rate exposure is also estimated using Equation (3) to analyze the robustness of the results.

Dominguez and Tesar (2006) find that in a world of perfectly integrated financial markets, the market portfolio might be better represented by a global portfolio. To control for this, we also add a global portfolio—the world index reported by Datastream expressed in Brazilian home currency—to the estimation of Equation (1).

Finally, Chow et al. (1997) argue that because market participants make errors in forecasting the long-term effects of exchange rate fluctuations, the estimation of Equation (1) using short-term horizon returns would fail to detect companies' exposure to exchange rate fluctuations. The authors confirm this finding, showing that a large number of firms have significant exchange rate exposure when long-horizon returns are used in the estimation of Equation (1). Similar results were found by Dominguez and Tesar (2006) and Bodnar and Wong (2003), among others. In addition to our baseline estimation using monthly returns, we also estimate Equation (1) using weekly returns to analyze the dependence of the results with respect to the horizon of the returns.

Results

Table 3 indicates that some interesting results arise from the estimation of companies' exchange rate exposure from 1996 to 2006. First, the data reveal the destabilizing potential of exchange rate fluctuations. On average, Brazilian companies do not benefit from a depreciation of the domestic currency. According to our baseline specification, a 1 percent depreciation of home currency leads to a 0.11 percent fall in stock market returns. This result is consistent with the hypothesis that in relatively closed and highly indebted emerging countries like Brazil, depreciations of home currency are more likely to cause a fall in asset prices due to presence of negative balance sheet effects.[11] This result contradicts the findings of Bleakley and Cowan (2008), who report that for a sample of Latin American companies, the negative balance sheet effects generated by depreciations of the home currency are completely offset by the positive expenditure-switching effects. Results of the present study show that, with respect to Brazil, this is not true. Instead, the negative effect, on average, surpasses the positive effect of depreciations, leading to a fall in stock market returns. This result is robust across the different methods presented in Table 3.

Table 3 also shows that, independently of the method used, about 25 percent of the companies are exposed to fluctuations in the exchange rate. This proportion of exposed companies is higher than in most studies for U.S. companies, indicating that exchange rate fluctuations, besides having negative effects, affect a large number of Brazilian companies.

The results in Table 3 also confirm previous results that the significance of companies' exchange rate exposure depends on horizon returns considered in its estimation. Once we use one-week returns instead of monthly returns, the number of companies with significant exchange rate exposure falls from 44 in our baseline estimation to 27, indicating that, as argued by Chow et al. (1997) in the short term, investors make errors about the role of exchange rate fluctuations on the firms' cash flow, reducing its impact on firm value. Finally, the results in Table 3 indicate that the inclusion of a world index does not have any influence on the results. As discussed by Dominguez and Tesar (2006), the global portfolio does a poor job of explaining returns; therefore, adding the world index to the estimation of Equation (1) does not change the results significantly.[12]

Exchange Rate Exposure, Time Variation, and the Exchange Rate Regime

Several studies show that companies' exchange rate exposure is not stable across different time periods.[13] As argued by Dominguez and Tesar (2006), the assumption that companies' exposure does not vary with time is too strong, because companies are likely to change to adapt to exchange rate risk.

Table 3. Exchange rate exposure for Brazilian companies, 1996–2006

Model	Baseline OLS	OLS with equally weighted market index	Orthogonal	OLS including MSCI World index	OLS using weekly data
Panel A: Summary statistics of companies' exchange rate exposure					
Mean exposure coefficients	−0.109	−0.117	−0.196	−0.118	−0.0581
Median exposure coefficients	−0.0681	−0.0546	−0.1534	−0.0896	−0.0363
Maximum exposure coefficients	0.948	0.842	0.742	0.915	0.780
Minimum exposure coefficients	−1.977	−1.716	−1.971	−2.020	−1.398
Panel B: Statistical significance of companies' exchange rate exposure					
Total number of firms with statistically significant exchange rate exposure	44	42	65	47	27
Total number of firms with negative and significant exchange rate exposure	27	31	52	32	17
Total number of firms with positive and significant exchange rate exposure	17	11	13	15	10
Total number of companies	173	173	173	173	173

Notes: The *Baseline* is an ordinary least squares (OLS) estimate with robust standard errors. *Equally weighted* uses an equally weighted market portfolio index instead of a value-weighted portfolio index. *Orthogonal* represents the estimation in two steps to control for multicollinearity. *MSCI* adds the MSCI World index in the estimation of Equation (1). *Weekly* shows the results of estimation of Equation (1) using one-week returns instead of monthly returns. The results for companies' exchange rate exposure considered a 5 percent level of significance.

Following Ihrig and Prior (2005), this study tests whether the exchange rate exposure varies in periods of crisis and noncrisis. Results indicate that the number of companies with a significant exchange rate exposure is higher under periods of crisis and that some firms have significant exposure only in crisis periods, whereas others have significant exposure only during normal exchange rate fluctuations.

The events that took place in the Brazilian economy also allow us to test whether the change from a fixed to a floating exchange rate regime has an impact on companies' exchange rate exposure. Parsley and Popper (2006) find that for a sample of East Asian countries, foreign exchange exposure was much more widespread under a peg than under a floating exchange rate regime.

The following equation is estimated:

$$R_{it} = \alpha_i + \beta_i \cdot R_{mt} + \sum_j D_j \cdot \theta_i \cdot \Delta S_t + \varepsilon_{it},$$ (4)

where D_j are dummy variables that assume the value of one during the subperiods in which the sample is divided and zero otherwise. First, we divide the sample into two different subperiods: one, denominated fixed, from January 1996 to December 1998, in which the country adopted a fixed exchange rate regime, and the second, between January 1999 and December 2006, covering the period of a floating exchange rate regime. To study the impact of the crises on companies' exchange rate exposure, the sample is also divided into five subperiods: the first, from January 1996 to August 1998, covers the period of the fixed exchange rate regime; the second subperiod is from September 1998 to April 1999 and represents the period of the currency crisis and the change in the exchange rate regime; the third, from April 1999 to March 2002, is a tranquil time under the floating exchange rate regime; the fourth covers the period before the presidential election, from April 2002 to December 2002; and the last encompasses the period after January 2003 up until December 2006.

The data in Table 4 indicate that the floating exchange rate regime indeed helps to alleviate the problem of companies' exposure to fluctuations in the exchange rate. Under the floating exchange rate regime, 14 percent of the companies are exposed to fluctuations in the exchange rate; however, under the fixed exchange rate regime, more than 20 percent of the companies are exposed to fluctuations in the exchange rate. Therefore, one can reject the hypothesis that the fixed exchange rate regime would give a more stable environment for business, leading companies' value to be less volatile. Indeed, the opposite is observed. Under the fixed regime, companies' value is much more sensitive to changes in the exchange rate, leading to a more unstable environment. The results are robust with respect to the method used for estimation of Equation (1).

The results in Table 4 also show that when the country moves from a fixed to a floating exchange rate regime, there is not only a change in the number of companies with statistically significant exchange rate exposure but also a shift in the distribution of companies' exposure. Under the floating exchange rate regime, the median exposure is positive, and it is the opposite under the fixed regime. This fact reflects the increase in the number of companies with positive exchange rate exposure and the decrease in companies with negative exposure under the floating regime.

The results presented in Table 4 confirm the results of Ihrig and Prior (2005). The number of companies with a statistically significant exchange rate exposure increases in periods of crisis. In the currency crisis of 1999 (September 1998 to April 1999), 52 percent of the firms in the sample were exposed to exchange rate fluctuations. However,

Table 4. Time variation of Brazilian companies' exchange rate exposure

Panel A: Distribution of companies' exchange rate exposure under different exchange rate regimes

	Fixed exchange rate regime January 1996 to December 1998	Floating exchange rate regime January 1999 to December 2006
Mean exposure coefficients	-4.772	-0.043
Median exposure coefficients	-4.195	+0.001
Maximum exposure coefficients	4.502	1.281
Minimum exposure coefficients	-6.460	-1.607
Total number of firms with statistically significant exchange rate exposure	36	25
Total number of firms with negative and significant exchange rate exposure	30	13
Total number of firms with positive and significant exchange rate exposure	6	12
Total number of companies	173	173

Panel B: Distribution of companies' exchange rate exposure under different periods

	January 1996 to August 1998	September 1998 to April 1999	May 1999 to March 2002	April 2002 to December 2002	January 2003 to December 2006
Mean exposure coefficients	−4.399	−0.263	−0.148	−0.035	−0.031
Median exposure coefficients	−4.221	−0.154	−0.091	−0.050	+0.002
Maximum exposure coefficients	6.267	1.590	1.867	1.833	2.678
Minimum exposure coefficients	−6.732	−5.445	−3.430	−2.333	−2.076
Total number of firms with statistically significant exchange rate exposure	33	90	28	52	19
Total number of firms with negative and significant exchange rate exposure	26	63	18	33	10
Total number of firms with positive and significant exchange rate exposure	7	27	10	19	9
Total number of companies	173	173	173	173	173

Notes: In Panel A the sample is divided into two periods, from January 1996 to December 1998, during which the country adopted a fixed exchange rate regime, and from January 1999 to December 2006, covering the period of a floating exchange rate regime. Panel B shows the results of the estimation of Equation (4), splitting the sample into five periods. The period January 1996 to August 1998 marks the period of the fixed exchange rate regime. The second subperiod covers September 1998 to April 1999 and represents the period of the currency crisis and the change of the exchange rate regime. The third, from May 1999 to March 2002, was a tranquil time under the floating exchange rate regime. The fourth subperiod represents the period before the presidential election, from April 2002 to December 2002. And the last is from January 2003 to December 2006. All results are from the baseline procedure. The results for companies' exchange rate exposure considered a 5 percent level of significance.

during the 2002 crisis (April to December 2002), 30 percent show a significant exchange rate exposure. Interesting to note is that although this proportion is higher than during the noncrisis period, it is lower than the proportion of firms exposed during the crisis in 1999.

The results in Table 4 also show a steady change in the distribution of companies' exchange rate exposure across different periods. The median of companies' exchange rate exposure moved from –0.154 during the first crisis to +0.002 in the final subsample. At the same time, there was also an increase in the maximum positive exposure and a reduction in the minimum negative exposure. When we compare noncrisis periods in Table 4, we observe that, again, the fixed exchange rate regime presents the highest number of companies with significant exchange rate exposure (33), and consistent with our previous results, during the floating period there is an increase in the number of companies with positive exchange rate exposure and a decrease in the number of those with negative exchange rate exposure.

The data in Table 5 reveal more about the dynamics of companies' exchange rate exposure across different subsamples. The results confirm the instability of companies' exchange rate exposure, showing that when we split the sample into fixed and floating periods, only 7 companies show a statistically significant exchange rate exposure in both periods, 47 are exposed to exchange rate fluctuations only in one period, and 119 were never exposed. In addition, when we split the sample into crisis and noncrisis periods, none of the companies in the sample was exposed for all periods, and most of the companies were exposed for fewer than two periods.

The results in Table 5 also indicate that the change in the distribution of companies' exchange rate exposure observed when the country moved from a fixed to a floating exchange rate regime took place mainly because of the Brazilian companies' shift toward a positive exchange rate exposure. A total of 26 firms in the sample changed from a negative statistically significant exposure to a nonsignificant exposure, 4 changed directly from a negative to a positive exchange rate exposure, and 7 changed from a nonsignificant exposure to a positive exposure. None of the firms changed from a positive to a negative or nonsignificant exposure, and 10 changed from a nonsignificant exposure to a negative exchange rate exposure.

Determinants of Companies' Exchange Rate Exposure

The results in the previous section showing that companies' exchange rate exposure varies across different time periods might be driven by changes in different factors. International activities (exports, import inputs), the industry's competitive structure, operational hedging, and corporate financial policies, especially foreign currency borrowing and use of derivatives, are among the factors identified in the literature as exerting an impact on companies' exchange rate exposure.[14] In this section, the role of these different factors that have an impact on companies' exchange rate exposure is discussed, as well as which factors were important in causing the time variation in the exposure observed in the last section.

Methodology and Results

To perform a formal analysis of the main determinants of companies' exchange rate exposure, the following equation is estimated:

Table 5. Changes in the exchange rate exposure of Brazilian companies across time

Panel A: Stability of companies' exchange rate exposure across different periods

Pegged exchange rate regime (January 1996 to December 1998) → Floating exchange rate regime (January 1999 to December 2006)

Statistically significant in both periods	Statistically significant only in 1 period	Never statistically significant
7	47	119

January 1996 to August 1998 → September 1998 to April 1999 → May 1999 to March 2002 → April 2002 to December 2002 → January 2003 to December 2006

Statistically significant in all periods	Statistically significant in 4 periods	Statistically significant in 3 periods	Statistically significant in 2 periods	Statistically significant in 1 period	Never statistically significant
0	6	15	48	57	47

Panel B: Changes in the distribution of companies' exchange rate exposure from a fixed to a floating exchange rate regime

Positive and statistically significant → Negative and statistically significant	Positive and statistically significant → Nonsignificant	Negative and statistically significant → Positive and statistically significant	Negative and statistically significant → Nonsignificant	Nonsignificant → Positive and statistically significant	Nonsignificant → Negative and statistically significant
0	0	4	26	7	10

Notes: Panel A shows the number of companies that have a statistically significant exchange rate exposure in different periods. Panel B shows the change in the distribution of companies' exchange rate exposure from the fixed to the floating exchange rate regime period.

$$\beta_i = \alpha_0 + \alpha_1 \log(\text{Total Sales}) + \alpha_2 \cdot (\text{Foreign Sales / Total Sales}) + \alpha_3 \cdot (\text{Imports})$$
$$+ \alpha_4 \cdot (\text{Foreign Operations Dummy}) + \alpha_5 \cdot (\text{Foreign Debt / Total Debt}) \qquad (5)$$
$$+ \alpha_6 \cdot (\text{Derivatives / Total Assets}) + \alpha_7' \cdot \text{Sectoral Dummies} + \varepsilon_i,$$

where β_i are the exchange rate exposures estimated in Table 3. The independent variables are the average of the variables during the whole period of the estimation for all firms.

Larger firms might be able to manage fluctuations of the exchange rate better, leading to a positive relationship between exposure and the size of the company; we thus expect α_1 to be positive. The ratio of foreign sales to total sales is expected to be positively correlated with companies' exchange exposure, because exporters benefit from depreciations of the home currency. The opposite is true for importers; we thus expect α_2 to be positive and α_3 to be negative.

Companies can reduce their exposure to exchange rate fluctuations by making use of hedging instruments. The literature identifies two types of hedges: operational hedges and financial hedges. Operational hedges pertain to companies with foreign subsidiaries; these companies will be protected from fluctuations in the home currency by having a fraction of their revenue coming from abroad. In this case, we expect $\alpha_4 > 0$.

Financial hedges stand for the use of currency derivatives—swaps, futures, forwards, and options—to mitigate companies' foreign exposure. Previous literature has mainly focused on developed countries and included foreign currency–denominated debt as a hedging instrument, because the companies in these countries would use foreign debt as a way to offset the exchange rate fluctuations on their revenue side. In this paper, given the destabilizing effect of foreign currency liabilities on the companies' balance sheet in developing countries, these two variables are disentangled. The coefficient of the ratio of derivatives to total assets is expected to be positive, confirming the efficiency of hedging activities, and the coefficient of the ratio of foreign currency debt to total debt is expected to be negative, indicating the risk of keeping currency mismatches on companies' balance sheets. Sectoral dummies were included in the estimation of Equation (5) to control for the competitive structure of each industry.[15]

One problem usually disregarded in the literature is that the results of the estimation of Equation (5) by ordinary least squares (OLS) may suffer from endogeneity problems. Foreign borrowing and the use of derivatives may be able to boost or mitigate, respectively, companies' exchange rate exposure, but the causation may run in the opposite direction. Companies whose exchange rate exposure is higher for reasons other than dollarized liabilities may have restricted their access to international capital markets by reducing their foreign borrowing. These companies will be more likely to use currency derivatives to reduce their exposure. Therefore, a higher level of exposure may cause low levels of foreign borrowing and a more extensive use of currency derivatives, leading to a negative correlation between exchange rate exposure and the ratio of foreign debt to total debt and a positive correlation between exposure and use of currency derivatives, biasing the results. In the results presented in Table 6, we move one step further in the literature and try to solve this endogeneity problem by estimating Equation (5) using an instrumental variables estimation. First, it is necessary to find instrumental variables to solve the problem. The optimal capital structure and hedging literature shed light on possible instruments for estimating Equation (5).

In a survey of the empirical literature, Harris and Raviv (1991) find that, among other factors, leverage is negatively related to growth opportunities and profitability. Companies with greater growth opportunities are expected to use less debt to avoid underinvestment

Table 6. Determinants of foreign currency exposure

| | Dependent variable: Exchange rate exposure | | | | Dependent variable: Change in exchange rate exposure (Fixed → Floating exchange rate regime) | |
| | Instrumental variables estimation – 2SLS | | | OLS | | |
Variable	Coefficients	First-stage foreign debt/ Total debt	First-stage derivatives/ Total assets	Coefficients	Variable	Coefficients
Size	0.758	0.081	0.276	0.672	Δ(Size)	0.294
(log Total Sales)	(0.13)	(8.23)*	(2.44)*	(1.18)		(2.80)*
Foreign Sales/Total Sales	0.547	0.233	−0.034	0.082	Δ(Foreign Sales/Total Sales)	0.221
	(1.97)**	(2.56)*	(−1.70)**	(0.29)		(0.14)
Imports	−0.015	0.081	0.078	−0.070	Δ(Imports)	−0.010
	(−1.96)**	(3.89)*	(1.53)	(−1.99)*		(−0.72)
Foreign Operations Dummy	0.377	0.026	0.041	0.486	Δ(Foreign Operations dummy)	−0.699
	(2.67)*	(0.64)	(0.041)	(2.70)*		(−0.13)
Derivatives/Total Assets	1.29	—	—	0.042	Δ(Derivatives/Total Assets)	1.21
	(1.92)**			(2.03)*		(3.77)*
Foreign Debt/Total Debt	−0.938	—	—	−0.767	Δ(Foreign Debt/Total Debt)	−1.51
	(−2.18)*			(−3.72)*		(−3.21)*
Industry dummies	Yes	Yes	Yes	Yes	Industry dummies	Yes
Capital expenses to sales	—	−0.624	0.130	—	—	—
		(−5.97)*	(5.76)*			
Gross margin	—	−0.060	0.482	—	—	—
		(−5.40)*	(2.00)*			
F-instruments	—	25.4	10.89	—	—	—
R^2	0.354	0.485	0.285	0.400	R^2	0.324
Number of companies	173	173	173	173	Number of companies	173

Notes: Results are for the exposures obtained using the baseline procedure for the estimation of Equation (1). Columns 2 and 3 show the results of the estimation of the first step of the procedure with the ratio of total foreign debt to total debt and the ratio of derivatives to total assets as dependent variables. For the changes in the exchange rate exposure, the results for the estimation of Equation (4) when the sample was split into two periods—fixed and floating exchange rate regimes—were used. All independent variables except industry dummies are the differences between their means in these two periods. *t*-statistics are in parentheses. * and ** significant at the 5 percent and the 10 percent levels, respectively.

costs related to debt overhang problems (Jensen and Meckling 1976). Moreover, Froot et al. (1993) argue that given capital market imperfections, firms would hedge to mitigate their underinvestment problem; therefore, firms with higher growth opportunities are more likely to use currency derivatives. In addition, Rossi (2007) finds the existence of a relationship between profitability and use of currency derivatives by Brazilian firms. The author shows that more-profitable firms use currency derivatives more intensively, indicating that profitability is a complement for the use of derivatives. These facts make the ratio of capital expenses to total sales, which is a proxy for growth opportunities, and the firms' gross margin, which is a proxy for profitability, good instruments for the estimation of Equation (5).

The results shown in Table 6 indicate that there is no relationship between size and companies' exchange rate exposure. Although the sign is positive, it is not statistically significant. The results confirm that foreign revenue and import inputs play a role in the determination of companies' exchange rate exposure. Table 6 gives evidence that the ratio of foreign sales to total sales is positively related to the companies' exchange rate exposure, and the variable proxy for the amount of imports is negative and statistically significant, confirming that importers do not benefit from depreciations of the home currency.

The results confirm the hypothesis that operational hedges have positive effects on the companies' exchange rate exposure. A dummy that assumes the value one if the firm has foreign subsidiaries is statistically significant in all specifications. Therefore, contrary to the findings of Allayannis and Ihrig (2001), there is evidence that operational hedging is efficient for Brazilian companies.

Results in Table 6 also show that use of currency derivatives has a positive effect on companies' exchange rate exposure, alleviating the companies' exposure to exchange rate fluctuations. The result is robust with respect to the proxy for use of derivatives. If we use a dummy variable that assumes the value one in the case that the firm uses derivatives and zero otherwise instead of the ratio of total notional derivatives to total assets, we obtain similar results.

The results in Table 6 also point out that the ratio of foreign debt to total debt affects the companies' exchange rate exposure negatively. This result indicates the importance of the negative balance sheet effects on companies' value. The results confirm the idea that foreign currency–denominated debt exposes Brazilian companies to a significant source of risk and that the negative effect of the interaction between foreign debt and exchange rate fluctuations is not negligible.[16]

One potential problem in the instrumental variables estimation is that if the instruments are weak, the two-stage least squares estimates may be biased. The joint *F*-tests on the instrumental variables shown in Table 6 are above the relevant critical values (Staiger and Stock 1997; Stock and Yogo 2003). Therefore, according to these tests, our instruments are not weak, and our results are valid.

Finally, the results in Table 6 show that endogeneity is indeed a problem in our estimation. A standard Hausman test rejects the hypothesis that the coefficients are the same in the OLS and in the instrumental variables estimation; we thus follow the right procedure by estimating Equation (5) using an instrumental variables estimation.

Determinants of Time Variation in Companies' Exchange Rate Exposure

The results shown in Tables 4 and 5 indicate that when the country moves from a fixed to a floating exchange rate regime, there is not only a decrease in the number of companies

exposed to exchange rate fluctuations but also a change in the distribution of the firms. There is a reduction in the number of firms with a negative exchange rate exposure and an increase in the number of companies with a positive exposure. Table 6 results shed light on the question of whether changes in international activities or financial policies were the main factors driving these results. Changes in companies' exchange rate exposure are regressed from the floating to the fixed period against changes in international activities and corporate financial policies. The changes are calculated by the difference between the mean of the variables under the fixed exchange rate regime (1996–98) and the flexible exchange rate regime (1999–2006).

Table 6 indicates the factors that were behind the change in companies' exchange rate exposure that took place between the fixed and floating exchange rate periods. The results show that an increase in the size of the companies has a positive impact on the companies' exposure. This may be because larger firms can manage their exchange exposure more efficiently. Rossi (2007), for example, shows that the fixed costs of hedging lead size to be positively related to the use of derivatives; therefore, larger firms are more likely to engage in risk management practices.

In addition, the results from Table 6 point out the importance of corporate financial policies. They indicate that both use of currency derivatives and foreign currency–denominated debt played a role in the reduction of the number of companies exposed to exchange rate fluctuations since the adoption of the floating exchange rate regime and in the shift of the distribution of companies' exposure.

The results show that the increase in the use of currency derivatives and the reduction in companies' ratio of foreign currency–denominated debt to total debt and the consequent reduction in the currency mismatches on their balance sheets led Brazilian companies to be better prepared to face home currency depreciations. As a result, there was a reduction in the number of companies exposed to exchange rate fluctuations, and, on average, there was also a reduction in the negative impact of depreciations.

Conclusion

This paper studies exchange rate exposure and its determinants for a sample of nonfinancial Brazilian companies from 1996 to 2006. The results indicate that a large number of Brazilian companies are exposed to exchange rate fluctuations and that, on average, Brazilian companies do not benefit from home currency depreciations. However, the results indicate that there is substantial time variation in the companies' exposure. The number of companies exposed to exchange rate fluctuations is higher during moments of crisis and under the fixed exchange rate regime. In the case of Brazilian companies, although international activities represented by exports and imports, operational hedging, and financial policies are important determinants of the companies' exchange rate exposure, the reduction in the number of companies exposed to fluctuations in the exchange rate and the shift in the distribution of companies' exposure that took place when the country moved from the fixed to the floating exchange rate regime can be associated with the changes in corporate financial policies, especially use of derivatives and holding foreign currency–denominated debt.

The results are consistent with the hypothesis that the floating exchange rate regime reduces companies' external vulnerability by leading them to take measures against their exchange rate risk, inducing these companies to lower the currency mismatches in their balance sheets.

The results of this analysis indicate that the adoption of an exchange rate regime is a significant determinant of the countries' external vulnerability, because it plays an important role in companies' financial policies. This result is consistent with studies by Cowan et al. (2005) for Chile and Kamil (2006) for a set of Latin American countries that have found that a floating exchange rate regime alleviates currency mismatches on companies' balance sheets.

After the financial crises of the 1990s, most emerging markets underwent experiences similar to Brazil's by abandoning their fixed exchange rate regimes in favor of flexible ones, and as in the Brazilian case, this change made them less vulnerable to external shocks. It is important to emphasize that vulnerabilities remain and that governments should carry out additional economic reforms to improve their countries' institutions. However, as this study indicates, the adoption of a floating exchange rate regime by emerging markets like Brazil indeed leads companies to be more aware of the risk of keeping unhedged positions, reducing the possibility of huge economic downturns. Thus, even if the choice of the exchange rate might not be the primary solution to reducing countries' external vulnerability, it is clearly an integral part of the solution toward beneficial economic reforms.

Notes

1. The implicit guarantees theory asserts that due to the guarantees given by the government to companies, a fixed exchange rate regime would lead companies to disregard the exchange rate risk, biasing their borrowing toward foreign currency–denominated debt or reducing their hedging activities. Conversely, a floating exchange rate regime would induce companies to take their exchange rate exposure seriously, reducing the currency mismatches on their balance sheets. This literature thus establishes a possible relationship between companies' exchange rate exposure, financial policies, and the exchange rate regime. For this literature, see Burnside et al. (2001), Dooley (2000), and Schneider and Tornell (2003).

2. In an influential paper, Jorion (1990) finds that only a small proportion of U.S.-based multinational firms are exposed to fluctuations in the exchange rate. Similar results were found by Amihud (1994) using a sample of the thirty-two largest U.S.-based exporting firms.

3. Strictly speaking, a system of bands was adopted, with the top and bottom of the band being devalued at a fixed rate.

4. Securities and Exchange Commission of Brazil–CVM Instruction No. 235/1995.

5. The results are robust if a sample of all publicly traded companies is used.

6. This problem is minimized in the Brazilian case, given that most of the companies keep only one position in the derivatives markets, suggested by the fact that swaps are the preferred derivative (Rossi 2007).

7. Similar results were found using a parametric *t*-test for the comparison of the means under both periods. The equality of the means was rejected using a 5 percent level of significance.

8. Other examples of papers that discuss the use of derivatives in emerging countries are Broll et al. (2001), Lien and Zhang (2008), and Schiozer and Saito (2009).

9. For a survey about the evolution of methods for the estimation of companies' exchange rate exposure, see Muller and Verschoor (2006b).

10. Priestley and Odegaard (2007) develop an empirical methodology that orthogonalizes both the market portfolio and the exchange rate from common macroeconomic factors that may be correlated with individual stock returns but have nothing to do with exposure.

11. Similar results are found by Dominguez and Tesar (2006) for Thailand and by Muller and Verschoor (2007) and Parsley and Popper (2006) for Asian countries.

12. Other methods (not shown) were also used to estimate companies' exchange rate exposure. Muller and Verschoor (2006a) suggest a GARCH(1,1) specification to control for heteroskedasticity. Miller and Reuer (1998) suggest the inclusion of macroeconomic variables as a control. We then add the industrial production, unemployment rate, and inflation rate as control variables.

13. Examples are Allayannis and Ihrig (2001), Dominguez and Tesar (2006), Koutmos and Martin (2007), and Muller and Verschoor (2006a), among others.

14. See Dominguez and Tesar (2006) and Jorion (1990) for the role of foreign activities; Allayannis and Ihrig (2001) and Williamson (2001) for the importance of competitive structure; and Allayannis et al. (2001), Allayannis and Ofek (2001), Muller and Verschoor (2006b), and Nguyen et al. (2007) for the impact of hedging activities.

15. Ideally, measures of industry markups should be included to control for industry competitive structure. Unfortunately, these variables are not available.

16. This contrasts with Allayannis et al. (2003), who find no evidence that unhedged foreign currency debt was the primary cause of poor performance of a sample of companies during the Asian crisis.

References

Allayannis, G., and J. Ihrig. 2001. "Exposure and Markups." *Review of Financial Studies* 14, no. 3: 805–835.

Allayannis, G., and E. Ofek. 2001. "Exchange Rate Exposure, Hedging and the Use of Foreign Currency Derivatives." *Journal of International Money and Finance* 20, no. 2: 273–296.

Allayannis, G.; J. Ihrig; and J. Weston. 2001. "Exchange Rate Hedging: Financial Versus Operational Strategies." *American Economic Review* 91, no. 2: 391–395.

Allayannis, G.; G.W. Brown; and L.F. Klapper. 2003. "Capital Structure and Financial Risk: Evidence from Foreign Debt Use in East Asia." *Journal of Finance* 58, no. 6: 2667–2710.

Amihud, Y. 1994. "Exchange Rates and the Valuation of Equity Shares." In *Exchange Rates and Corporate Performance,* ed. Y. Amihud and R.M. Levich, pp. 49–59. New York: Irwin.

Bleakley, H., and K. Cowan. 2008. "Corporate Dollar Debt and Depreciations: Much Ado About Nothing?" *Review of Economics and Statistics* 90, no. 4: 612–626.

Bodnar, G., and M. Wong. 2003. "Estimating Exchange Rate Exposures: Issues in Model Structure." *Financial Management* 32, no. 1 (Spring): 35–67.

Bris, A.; Y. Koskinen; and V. Pons. 2004. "Corporate Financial Policies and Performance Around Currency Crises." *Journal of Business* 77, no. 4: 749–796.

Broll, U.; R. Mallic; and K.P. Wong. 2001. "International Trade and Hedging in Economies in Transition." *Economic Systems* 25, no. 2: 149–159.

Burnside, C.; M. Eichembaum; and S. Rebelo. 2001. "Hedging and Financial Fragility in Fixed Exchange Rate Regimes." *European Economic Review* 45, no. 7: 1151–1193.

Chow, E.; W. Lee; and M. Solt. 1997. "The Exchange Rate Risk Exposure of Asset Returns." *Journal of Business* 70, no. 1: 105–123.

Cowan, K.; E. Hansen; and L. Herrera. 2005. "Currency Mismatches, Balance Sheet Effects and Hedging in Chilean Non-Financial Corporations." Working Paper no. 521, Inter-American Development Bank, Washington, DC.

Dominguez, K., and L. Tesar. 2006. "Exchange Rate Exposure." *Journal of International Economics* 68, no. 1: 188–218.

Dooley, M. 2000. "A Model of Crises in Emerging Markets." *Economic Journal* 110, no. 460: 256–272.

Froot, K.; D. Scharfstein; and J. Stein. 1993. "Risk Management: Coordinating Corporate Investment and Financing Policies." *Journal of Finance* 48, no. 5: 1629–1658.

Galindo, A.; U. Panizza; and F. Schiantarelli. 2003. "Debt Composition and Balance Sheet Effects of Currency Depreciation: A Summary of the Micro Evidence." *Emerging Markets Review* 4, no. 4: 330–339.

Geczy, C.; B. Minton; and C. Schrand. 1997. "Why Firms Use Currency Derivatives." *Journal of Finance* 52, no. 4: 1323–1354.

Graham, J., and D. Rogers. 2002. "Do Firms Hedge in Response to Tax Incentives?" *Journal of Finance* 57, no. 2: 815–839.

Harris, M., and A. Raviv. 1991. "The Theory of Capital Structure." *Journal of Finance* 46, no. 1: 297–355.

Ihrig, J., and D. Prior. 2005. "The Effect of Exchange Rate Fluctuations on Multinationals' Returns." *Journal of Multinational Financial Management* 15, no. 3: 273–286.

Jensen, M., and W. Meckling. 1976. "Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure." *Journal of Financial Economics* 3, no. 4: 305–360.

Jorion, P. 1990. "The Exchange Rate Exposure of U.S. Multinationals." *Journal of Business* 63, no. 3: 331–345.

Kamil, H. 2006. "Does Moving to a Flexible Exchange Rate Regime Reduce Currency Mismatches in Firms' Balance Sheets?" Working paper, International Monetary Fund, Washington, DC.

Kiymaz, H. 2003. "Estimation of Foreign Exchange Exposure: An Emerging Market Application." *Journal of Multinational Financial Management* 13, no. 1: 71–84.

Koutmos, G., and A. Martin. 2007. "Modeling Time Variation and Asymmetry in Foreign Exchange Exposure." *Journal of Multinational Financial Management* 17, no. 1: 61–74.

Lien, D., and M. Zhang. 2008. "A Survey of Emerging Derivatives Markets." *Emerging Markets Finance and Trade* 44, no. 2 (March–April): 39–69.

Miller, K., and J. Reuer. 1998. "Firm Strategy and Economic Exposure to Foreign Exchange Rate Movements." *Journal of International Business Studies* 29, no. 3: 493–514.

Muller, A., and Verschoor, W. 2006a. "Asymmetric Foreign Exchange Risk Exposure: Evidence from U.S. Multinational Firms." *Journal of Empirical Finance* 13, nos. 4–5: 495–518.

———. 2006b. "Foreign Exchange Risk Exposure: Survey and Suggestions." *Journal of Multinational Financial Management* 16, no. 4: 385–410.

———. 2007. "Asian Foreign Exchange Risk Exposure." *Journal of the Japanese and International Economies* 21, no. 1: 16–37.

Nguyen, H.; R. Faff; and A. Marshall. 2007. "Exchange Rate Exposure, Foreign Currency Derivatives and the Introduction of the Euro: French Evidence." *International Review of Economics and Finance* 16, no. 4: 563–577.

Parsley, D., and H. Popper. 2006. "Exchange Rate Pegs and Foreign Exchange Exposure in East Asia." *Journal of International Money and Finance* 25, no. 6: 992–1009.

Priestley, R., and B. Odegaard. 2007. "Linear and Nonlinear Exchange Rate Exposure." *Journal of International Money and Finance* 26, no. 6: 1016–1037.

Rossi, J. 2007. "The Use of Currency Derivatives by Brazilian Companies: An Empirical Investigation." *Brazilian Review of Finance* 5, no. 2: 5–25.

Schiozer, R., and R. Saito. 2009. "The Determinants of Currency Risk Management in Latin American Nonfinancial Firms." *Emerging Markets Finance and Trade* 45, no. 1 (January–February): 49–71.

Schneider, M., and A. Tornell. 2003. "Balance Sheet Effects, Bailout Guarantees and Financial Crises." *Review of Economic Studies* 71, no. 1: 883–913.

Staiger, D., and J. Stock. 1997. "Instrumental Variables Regression with Weak Instruments." *Econometrica* 65, no. 3: 557–586.

Stock, J., and M. Yogo. 2003. "Testing for Weak Instruments in Linear IV Regression." In *Identification and Inference in Econometric Models: Essays in Honor of Thomas J. Rothenberg*, ed. D.W.K. Andrews and J.H. Stock, pp. 80–108. Cambridge: Cambridge University Press.

Williamson, R. 2001. Rate Exposure and Competition: Evidence from the Automotive Industry." *Journal of Financial Economics* 59, no. 3: 441–475.

Appendix: Description of Variables

Derivatives: Total notional amount of currency derivatives used by a firm. The amount of derivatives is reported in companies' annual reports under the item financial instruments.

Total foreign debt: Total foreign currency–denominated debt as indicated by companies' reports under the item loans and financing.

Total debt. Total amount of companies' debt. It is the sum in reals (domestic currency) of domestic and foreign currency–denominated debt.

(Net) Foreign debt: Total foreign debt minus the total notional amount of currency derivatives used by companies.

Capital expenses: Total amount spent in the acquisition of permanent assets.

Foreign sales: Sales in U.S. dollars converted to reals by the exchange rate at the end of the year.

Total sales: Total gross sales expressed in reals.

Total assets: Book value of firms' assets expressed in reals.

Foreign operations dummy. Dummy variable that assumes the value one if the company has foreign production subsidiaries, and zero otherwise.

Gross margin: Total calculated earnings before interest and taxes divided by total sales.

Imports: Ordered discrete variable representing the value of Brazilian companies' imports.

Source: Brazilian Secretary of Trade.