Exchange Rate Exposure, Foreign Involvement and Currency Hedging of firms - some Swedish evidence*

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Abstract

This paper investigates the effect of exchange rate fluctuation on a firm's value, the so-called exchange rate exposure, for a sample of Swedish firms. In contrast to previous results, using U.S. data, the values of Swedish firms, as reflected in the stock price, seem quite sensitive to movements in the exchange rate. Studying the cross sectional differences in exposure, the estimated exposure is positively and significantly related to the fractional of total sales made abroad and negatively related to the use of currency derivatives.

Keywords: exchange rate exposure, foreign activities, hedging.

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1. Introduction

For many companies exchange rate movements are a major source of uncertainty. Due to the rapid globalization of the business environment over the last decades few firms today could be thought of as purely domestic and unaffected by exchange rate fluctuations. The view that exchange rates affect a firm's value and therefore the price of its stock is widely held by economists, financial analysts and corporate managers[2]. What is surprising is the lack of empirical support for a statistically significant relation between firm value and the exchange rate (exchange rate exposure).

The research on exchange rate exposure has grown substantially over the last couple of years. Several recent studies try to establish that changes in foreign exchange rates affect a firm's value, measured as the firm's stock price, but the success so far has been limited. Jorion (1990) investigates the currency exposure for a sample of U.S. multinationals but can only find weak evidence of such a relation existing. Bodnar and Gentry (1993) examine all firms on the CRSP File, divided into thirty-nine industry portfolios, and find significant exposure for only eleven. Amihud (1994) focuses on the 32 largest U.S. exporters in terms of exports to total foreign sales. After correcting for movements in the market portfolio he can not find any contemporaneous effects, but when including lagged exchange rate changes as regressors a weak impact is found.

[2] Wall Street Journal, April 15, 1996, Bartov and Bodnar (1994).

Amihud also looks at the eight firms with the highest exports/sales ratio in an attempt to get an even more direct currency exposure, but the effect is still weak.

Bartov and Bodnar (1994) try to explain the limited success in finding a significant correlation by two possible drawbacks of earlier studies. One is the sample selection. They argue that it is important to only study firms that are heavily exposed to currency rate changes. Furthermore firms included in the sample should have the same ”sign” of exposure, i.e., either all firms benefit from a depreciation of the exchange rate or they benefit from an appreciation. A second possible drawback of earlier studies pointed out by Bartov and Bodnar is the existence of mispricing. When investors estimate the relation between firm value and exchange rate movements they might do this incorrectly and therefore introduce systematic errors. Therefore Bartov and Bodnar suggest the inclusion of lagged changes of the exchange rate and not only, as in most earlier studies, the contemporaneous effect. For a sample of firms, selected so as to maximize exposure, they investigate the correlation between abnormal returns, derived from the market model, and both contemporaneous and lagged changes in the dollar. They find no correlation with the dollar movement in the same time period but a one period lagged change has significant impact on the abnormal return. Other tests are performed in Bartov and Bodnar (1994) but the main result still is that it is hard to establish a clear link between stock returns and changes in the exchange rate.

If the sample selection is a big problem it seems reasonable to look more carefully at a single firm. Bilson (1994) tries this approach. Analyzing internal reports he finds that American Airlines cash flows are exposed to exchange rate movements, a weaker dollar against European currencies would help to increase short-run cash flows. However when examining how American Airlines

stock price movements are affected by changes in the dollar vs. the German mark over the period January 1985- December 1991 only a weak lagged effect is found.

In a recent study He and Ng (1998) look at 171 Japanese multinational firms and find significant exposure to exchange rate fluctuations for about 25 percent of the firms, i.e. a much higher percentage than Jorion's results from U.S. firms. He and Ng also look at the determinants of exposure and find that estimated exposure are positively related to the level of a firm's export ratio. Furthermore exposure is also related to variables that are proxies for firms' hedging incentives.

Another study, with a somewhat different focus, is Bartov, Bodnar and Kaul (1996). While all the papers mentioned above look at first moment effects, Bartov, Bodnar and Kaul focus on the second moment, the variance, to see whether a multinational firm's riskiness increases with exchange rate variability. Focusing on the period around the Bretton-Woods breakdown the authors find that the volatility of stock market returns in general increase after the switch to floating exchange rates. Furthermore the increase in volatility for multinational firms is significantly larger than for the control samples used.

When looking at the effects of exchange rate movements on stock prices one has to consider the possibility that a company's hedging policy is priced already. Companies can, in theory, hedge away their exchange rate exposure, implying a zero correlation between the stock price of the firm and the exchange rate. This problem is mentioned in most empirical studies, but hard to deal with since few companies report their hedging positions. In their study of exchange rate exposure for

Canadian firms Booth and Rothenberg (1990, p 15) relate differences in estimated exposure to industry classification, but note ”without knowing the degree of hedging undertaken by individual firms the intuition gained from knowing the industry classification of the firms...is of little help in assessing foreign exchange rate exposure.” In a recent paper Allayannis and Olek (1996) analyzes the link between exposure and the use of foreign currency derivatives. They use recently reported information on financial instruments with off balance sheet risk, which firms in the U.S. have been required to report under SFAS 105 since 1991, and investigate whether the use of currency derivatives reduces firms' exposure. They indeed find that the use of hedging instruments reduces exchange rate exposure, in the sense that estimated exposures are negatively correlated with the use of currency derivatives.

To summarize, the empirical evidence that exchange rates affect a firm's value is still weak. Considering the large degree of foreign involvement of many firms today, this lack of empirical evidence is puzzling, indicating the need for more research.

This paper contributes to the existing literature in several ways. First of all we study firms in a small open economy, Sweden[3]. One would expect firms in a more open economy to be more sensitive to movements in the exchange rate. Friberg and Nydahl (1998) show that the stock market, as a whole, is more exposed to changes in the effective exchange rate, the more open an economy is. Hence it is quite surprising that the major part of the empirical studies made so far

[3] It has come to our attention that independent research by Dahlquist et al. (1998) overlap with our study on some of these issues. However, the data sources and the general approach are rather different.

study firms in the least open economy of the OECD countries, the U.S.. We also conduct a cross sectional analysis and relate the estimated exposure coefficients to firm characteristics, like measures of foreign involvement. Furthermore, to illuminate the importance of hedging to explain differences in estimated currency exposure we use a unique data base collected at Sveriges Riksbank (the central bank of Sweden) including all major Swedish companies with foreign direct investments. For the year of 1995 companies were asked to report what positions they kept with the purpose of hedging their foreign assets. Relating this information to the estimated exposure we provide an important complement to the study of Allayannis and Olek (1996) on whether derivatives reduce exposure.

We find that a substantially larger percentage of firms in our sample are exposed to exchange rate changes compared to the results from studies using US data, and similar to the findings for Japan. These results seem quite robust to alternative model specifications, like the inclusion of lags, different measures of the effective exchange rate etc. Studying the determinants of exposure we find a positive, and statistically significant, relation between the estimated exposure and the ratio of foreign sales to total sales. Also the use of currency derivatives appear to reduce the exchange rate exposure of firms.

The rest of the paper is organized as follows. Section 2 gives a brief discussion of exchange rate exposure and how it can affect a firm. In section 3 we present the empirical results on how exchange rate movements affect the firm. The cross sectional differences of exposure are examined in section 4. Section 5 concludes.

2. Exchange rate exposure

In this section we discuss various types of exchange rate exposure. It should be noted that it is not obvious that a firm cares about its exposure and wants to hedge it. Miller and Modigliani (1958) show that a firm cannot increase its value by hedging (or any other financial policy). Their results however assume perfect markets. For example, the cost of financial distress is assumed to be zero. The real world on the other hand is not perfect and financial distress (and bankruptcy) can be very costly. Hence if hedging reduces cash flow variability and decreases the likelihood of financial distress, it will also increase the firm's value. For a more thorough discussion on how hedging can increase a firm's value see Sercu and Uppal (1995, Ch. 5).

Exchange rate exposure is usually divided (e.g. Shapiro (1996)) into three different types: transaction, translation and operating exposure. The combined effect of transaction exposure and operating exposure is usually referred to as economic exposure (Sercu and Uppal, 1995).

Transaction exposure arises from the possibility that future incomes (or costs) from a contract denominated in foreign currency change between the date when a firm commits to a transaction and the actual transaction date. It is clear that many companies see transaction exposure as a problem (e.g see the survey by Bodnar and Marston (1996)). However since this kind of exposure usually is well defined and short term, it can be (if the firm so desires) hedged quite easily using derivatives.

Translation exposure is the difference between assets and liabilities that are exposed to currency fluctuations. Consider an U.S. multinational firm that operates in several different countries and has subsidiaries operating in local currency. Even if the subsidiary faces no exchange rate risk at all in local currency the shareholders of the multinational firm might be interested in U.S. dollars. Therefore the remittance from the foreign unit of the firm are exposed to exchange rate fluctuations when it is translated back to U.S. dollars.

A more complex and more interesting measure of exchange rate exposure is economic exposure. If we define the value of a firm as the present value of expected future cash flows, economic exposure measures the degree to which movements in exchange rates affect the firm's value. This could be through existing contracts (transaction exposure) or by changing the value of future revenues and costs, so called operating exposure. Hence economic exposure depends on the operations of the firm (locations of factories, competitive structure etc.) and is in theory the type of currency exposure companies want to deal with, but in practice very complicated to identify and hedge.

Using economic exposure as the measure it is quite clear that few firms stay unaffected by currency fluctuations. It is also obvious that currency exposure will vary substantially across firms. In section 4 of this paper the cross sectional differences of the estimated exposure are analyzed.

3. The exchange rate exposure of Swedish firms

Adler and Dumas (1984) note that economic exposure can be measured through a simple regression with the changes in firm value as the dependent variable and the exchange rate changes as the regressor. Since the value of a firm should be reflected in its stock price this regression can be performed using the firm's stock price and the exchange rate. If we assume that changes in stock prices and exchange rates are approximately unanticipated[4], the exposure can thus be obtained from the following equation,

$$R_t = \alpha_0 + \beta_1 \Delta S_t + \alpha_1 R_{mt} + e_t \qquad t=1,.....T. \qquad (1)$$

R_t is the return, in local currency, on the individual firm's stock (percentage change in the stock price), ΔS_t is the percentage change in the exchange rate and e_t is an error term. We control for market movements by including the return on the market portfolio, R_{mt}. Therefore β_1 measures the firm's exposure to exchange rate changes independent of the market's exposure to these changes. The specification in (1) does not imply a causal relationship between exchange rates and the value of the firm; in general we would think of stock prices and exchange rates as endogenous variables determined jointly by the same underlying factors. Still, since a single firm's value is a small fraction of the total activity in the economy it seems plausible to believe that the exchange rate depends largely on factors other than the actions of a single firm.

[4] For discussion of the empirical evidence on the (non) forecastibility of exchange rates see, Meese and Rogoff (1983).

Equation (1) is estimated for a sample of 47 Swedish firms. We start with 347 large firms included in the Riksbank's foreign direct investment database. The criteria for being in this database, is to be a company registered in Sweden and have direct investments abroad. We exclude firms that are not quoted on the Stockholm Stock Exchange for any part of the period December 1, 1992, to February 6, 1997, reducing the sample size to less than a hundred firms. For those firms for which stock prices are available further back in time, the sample is extended back to, but not earlier than, January 1, 1990. Finally, firms for which foreign sales and foreign wage cost data were not available are excluded, leaving 47 firms. The stock prices and the foreign sales data are obtained from the FINDATA and FINLIS databases respectively. Daily data for the individual firms' stock prices are used to construct weekly returns. Using weekly data we hope to reduce some of the noise in the daily series but still have a large enough number of observations to give power to the test of the null hypothesis of no exchange rate exposure.

To approximate the returns on the market portfolio we use, in line with previous studies, a domestic market index, the Affärsvärlden General Index (AFGX) including most stocks on the Stockholm Stock Exchange. The returns on the market index and the returns on individual stocks are all measured in Swedish Kronor (SEK). For the exchange rate two trade weighted exchange rates indices, the MERM and the TCW are used.

The results of the basic regression

Equation (1) is estimated over two different sample periods. The first sample period includes observations from January 1990 to February 1997. Since the krona was pegged until November 1992 we also estimate (1) on a second sample period which runs from December 1992. The

distributions of the estimated exposure coefficients for the two different sample periods are presented in Table 1 and Table 2. All firms have data at least from December 1992. Due to the small number of firms we also use for the longer sample period firms that only have data for part of the period, e.g. 1991-1997, as long as this period does not include missing values. 27 of the 47 firms have no missing values for the period as a whole, 1990-1997.

Studying the results in Table 1 we note that including the period before the currency crisis in November 1992 increases the number of firms with significant exposure. This is plausible for two reasons. First we increase the sample size which may be crucial for testing. In fact using daily data for the shorter period the number of firms with significant exposure (at the five percent level) to changes in the TCW index increased from six to eleven (see Table A1 in the appendix). Furthermore the stock market jumped over eight percent after the currency peg was abandoned on November 19, 1992 (causing an immediate effective depreciation of the krona by more than ten percent). For a careful study of how this specific event affected individual stock prices see Frennberg (1994). The longer sample with varying sample size (Table 1) shows a rather large percentage of firms with significant exchange rate exposure. 12 out of 47 firms (26 percent) are significantly exposed to movements in the MERM index at the five percent level and 19 (40 percent) at the ten percent level. The percentage of firms with significant exposure is presented and discussed in most studies on exchange rate exposure but seldom related to what number we would expect by pure chance. To create a confidence interval for the fraction of firms with significant exposure to exchange rate changes, we can think of significant exposure for a firm as a Bernoulli variable, Z. Z takes the value 1 if a firm is significantly exposed at, say, the five percent level. This event occurs with the probability p and hence the standard deviation of the sample

mean of Z can be calculated as $\hat{\sigma}_{bn} = \sqrt{\frac{\hat{p}(1-\hat{p})}{N}}$ where p is the percentage of firms with significant exposure at the five percent level and N is the number of firms in the sample. A confidence interval for the fraction of firms with significant exposure can then be created as $\hat{p} \pm 1.96\hat{\sigma}_{bn}$, and we can check whether the five percent level falls inside this interval. For example in Table 1 we present the standard error of the percentage of significant firms at the five- and ten percent levels. For the longer sample, the fraction of firms with significant exposure at the five percent level, is indeed larger than what we would expect by pure chance.

Our results can be compared with the results from Jorion (1990) for U.S. firms, where only 15 out of 287 firms (about five percent) showed a significant exposure to the MERM index at the five percent level. Using the procedure suggested above to calculate standard errors we find that this percentage is not significantly different from what we would expect by random. Interestingly the percentage of firms with significant exposure in our Swedish sample is basically the same as the 25 percent found in He and Ng (1998) for Japan. However, it should be noted that our sample selection starts with firms for which data on foreign direct investments and hedging activities were available, while both Jorion (1990) and He and Ng (1998) only include firms with a foreign/total sales ratio above ten percent. As is shown in section 4, the foreign/total sales variable is highly correlated with exposure while FDI is not. This difference in sample selection suggests that the results for Sweden may by even stronger, in terms of the number of firms with significant exposure, with a different sample selection procedure. Looking at a subsample of 27 firms with no missing values over the whole period, (Table A2 in the appendix) the percentage of

firms with significant exposure is slightly higher, nine of these firms (33 percent) are significantly exposed to the MERM index at the five percent level.

Overall the results above give some support for the hypothesis that foreign exchange rates do affect stock returns. The fact that the exposure appears more important for Sweden than the U.S. accords with the argument by Friberg and Nydahl (1998) that it is important to look at firms in more open economies when studying exchange rate exposure. Firms in a small open economy like Sweden are exposed to exchange rate movements to a larger extent than, say, U.S. firms. In the next section several alternative specifications are used in an attempt to test the robustness of the results and highlight some issues that we believe are important when estimating exchange rate exposure.

The lagged response hypothesis

Bartov and Bodnar (1994) suggest that investors might not instantaneously see through the complex relation between exchange rate changes and firm value, but make systematic pricing errors for a time when valuing stocks which have been impacted by exchange rate changes. Investors will only gradually learn about the full impact of exchange rate changes on firm value as new information about the past performance arrives. Hence exchange rates could affect stock prices with a lag rather than contemporaneously. Bartov and Bodnar (1994) indeed find support of a lagged effect. We test this hypothesis by estimating the following extension of equation (1),

$$R_t = \alpha_0 + \beta_1 \Delta S_t + \beta_2 \Delta S_{t-1} + \alpha_1 R_{m,t} + u_t \qquad (2)$$

where one lag of the weekly changes in the exchange rate have been added. u_t is an error term. The results are presented in Table 2. The one period lagged changes in the exchange rate have a significant impact for only three out of 47 firms. This result contradicts the results from U.S. data but is in line with evidence presented in He and Ng (1998). In their study of Japanese multinational firms they estimated equation (2) using monthly data and found a lagged effect for six out of 171 firms. Furthermore as can be seen from Table 2 the contemporaneous effects stay the same. Further lags were also added but the result is unchanged. Our analysis therefore does not give any support for the mispricing hypothesis.

Single currencies vs. index

In the above regressions trade weighted exchange rate indices were used to capture currency movements. This is in line with earlier studies (e.g. Jorion (1990, 1991), Bartov and Bodnar (1994), Bodnar and Gentry (1993)). Even though using an exchange rate index is a convenient way to represent the effective movements of a currency, it might not be relevant for an individual firm. An individual firm could be exposed to a single currency, but basically be unaffected by the fluctuations in the trade weighted index. Therefore we also consider single currencies as regressors and estimate the exposure to them using multivariate regression. The two currencies believed to be most important for Swedish firms are the U.S. dollar (USD) and the German mark (DEM), so these are included in the multivariate regression. Three more single currencies that might be important for Swedish firms' profit, the Netherlands guilder (NLG), Finnish marka (FIM) and the British pound (GBP) were also considered. These currencies were chosen based on share of the Swedish export market, share of foreign direct investments of Swedish firm and their

use as a invoicing currency. For instance U.K. is Sweden's second largest export market (Friberg and Vredin, 1997) while the Netherlands is the country with the largest share of Swedish foreign direct investments (Sveriges Riksbank, 1996).

The choice as to which currencies to include in the regression is probably far from optimal. Ultimately we would like to construct an individual exchange rate index for each of the firms, considering firm specific information like the geographical diversification of foreign sales, invoicing currencies etc. Unfortunately such information is not readily available for a large number of companies. The following multivariate specification is estimated,

$$R_t = \alpha_0 + \sum_{j=1}^{5} \gamma_j \Delta S_t^j + \alpha_1 R_{m,t} + \nu_t \qquad j = \text{USD, DEM,NLG,FIM and GBP} \tag{3}$$

where ΔS_t^j is the percentage change in the price of foreign currency j in terms of the Swedish krona and ν_t is an error term. A multivariate test of the null that $\gamma_j = 0$ for j = USD, DEM, NLG, FIM and GBP, test for a significant exposure.

The results show that a breakdown to single currencies does not change the results. For the longer sample (see Table 3) 14 of 47 firms are significantly exposed at the five percent level to changes in the single currencies and 19 of 47 are exposed at the ten percent level. Similar results were obtained for the shorter sample.

The choice of market portfolio

In this paper we analyze the effect of exchange rate changes on stock returns apart from market exposure. This raises the question of how to represent the market portfolio. In our basic model we use the domestic market index for this purpose. In theory, however, if we believe in fully integrated capital markets, the world market portfolio should be the more appropriate one to use. Earlier studies of exchange rate exposure, mainly on U.S. data, correct for market movements using a domestic stock market index. This might be somewhat justified by the large fraction of the global market the U.S. market represents. The Swedish market however, is a very small fraction of the global market capitalization. Furthermore in January 1 1993 restrictions on foreign ownership of Swedish stocks were removed, giving foreigners full access to the Swedish stock market. In light of these facts the case for using a world market index seems rather strong. On the other hand empirical research in international finance has documented that investors prefer to invest in their own country, not fully taking advantage of the gains of international diversification, the so called home country bias (for an overview see Lewis, 1995). In Table 4 we present the estimated exposure coefficients for the period after December 1992 when a world market index is added to the basic regression. The world market index used is the Financial Times Actuaries World index recalculated to SEK. In Table 4 we present the estimates obtained for the shorter period (December 1992 and onwards) using the MERM index. Comparing the estimates in Table 4 with the first column of Table 1 it is easy to see that adding the world market index does not affect the exposure coefficients significantly. The number of firms with significant exposure also stays about the same.

To summarize, in this section several alternative specifications of the basic model of exposure are investigated. Substantial support is found for the hypothesis that exchange rate changes affect firms' stock prices. The inclusion of lags, as well as a breakdown of the exposure to single currencies is shown not to affect the results. Regardless of the specification used, the estimates of exchange rate exposure vary substantially across firms. This is in line with the results in Jorion (1990) and Bodnar and Gentry (1993). In the next section, we investigate whether it is possible to detect a systematic pattern between a firm's exposure and its characteristics, e.g. the firm's degree of foreign involvement, hedging activities etc.

4. The determinants of exchange rate exposure and the impact of hedging

In section 3 we show that the estimated exposure to exchange rate fluctuations varied substantially across companies. In this section the determinants of exchange rate exposure are investigated and related to this estimated exposure. Foreign involvement is an obvoius potential determinant. The foreign sales to total sales ratio is used as a measure of this involvement. We also study the impact of hedging on exposure in this section.

Basically all studies on exchange rate exposure mention hedging as one possible explanation of why a clear link between exchange rates and firm values is hard to establish. Since data on firms' hedging positions are difficult to obtain, very few studies explore this hypothesis further. One study that does empirically link currency hedging to exchange rate exposure is Allayannis and Ofek (1996). They are able to use recently reported information about financial instruments with

off balance sheet risk which U.S. firms have been required to report under SFAS 105 since 1991. Using this new source of data, they analyze the use of currency derivatives for all non-financial firms included in the S&P 500 index during 1992-1993. They also investigate whether the use of these instruments reduces the exchange rate exposure of a firm by relating estimated exposure coefficients (obtained from the equivalent of our equation (1)) to the use of currency derivatives. They find that currency hedging does indeed lower the exchange rate exposure.

Another issue ignored in earlier cross sectional studies of exchange rate exposure is that many firms also produce abroad and hence might have a natural hedge against currency fluctuations. To analyze this possibility we also include the fraction of total wage cost paid in foreign countries.

Data for Swedish firms' use of currency derivatives are not easily available. In this paper we use survey data on the use of different hedging instruments obtained from the department of financial statistics at Sveriges Riksbank[5]. They derive from a questionnaire on hedging activity, which is a part of the 1995 direct investment survey made by Riksbank. Firms report what foreign direct investments they have, and what positions they keep to hedge these investments (if hedging them at all). Table 5 shows the relative importance of use of different hedging instruments across firms in the Riksbank's 1995 survey (the numbers are similar for the subsample used in this study).

[5] We are given access to the hedging data under the agreement that results will be presented in such a way that individual firms could not be identified.

Most firms that choose to hedge their foreign direct investments seem to do so by using foreign loans, futures or swaps. It is interesting to note that very few firms use currency options to hedge their exposure. This is somewhat puzzling, since the inter-bank market for Swedish krona currency options is fairly developed and options often provide a more flexible hedging tool than other derivatives. The Swedish situation also seems to differ from the U.S. In a large survey produced by the George Weiss center at the Wharton School of Economics (Bodnar and Marston, 1996) 350 large U.S. firms answered detailed questions about their use of derivatives. Thirtyfour percent of the U.S. firms believed currency options to be the most important instrument in hedging translation exposure. Less than 1.5 percent of the total value of the Swedish firms' hedging instruments were options, according to the Riksbank's survey in 1995. Instead Swedish firms mainly use forwards and loans in foreign currency to hedge their translation exposure, these two instruments together represent more than 90 percent of the total value of hedging instruments, while foreign currency swaps represent approximately eight percent.

To determine empirically how a firm's exchange rate exposure is related to its degree of foreign involvement and its use of currency derivatives, we assume a linear relation between exposure and firm characteristics,

$$\beta_{1,i} = \delta_0 + \delta_1 F_i + \delta_2 D_i + \delta_3 W_i + \delta_4 Hedge_i \qquad i = 1,.....,N \qquad (5)$$

where F_i is the foreign to total sales ratio, D_i is the foreign assets/total assets ratio, W_i is the wage cost for employees in foreign countries/total wage cost and $Hedge_i$ is the value of the hedging position normalized by total assets.

What results might one expect from the estimates of equation (5)? Exporting firms are expected to benefit from an effective depreciation of the Swedish krona, i.e. an increase in the MERM index, and hence have a positive exposure. Furthermore this exposure should increase with the fraction of total sales made abroad. Of course many firms also import goods, giving rise to a negative effect of a depreciation. Still, even though the exposure coefficient would be reduced or even turn negative due to imports, a higher foreign/total sales ratio should increase exposure. Therefore, no matter what the sign or the size of the estimated exposure, we expect the coefficient to be positively correlated with the foreign to total sales ratio. We also expect that, in the absence of hedging, the amount of foreign direct investment should increase exposure. As shown above many firms with foreign direct investments claim to hedge their currency exposure. Therefore we would expect the use of currency derivatives to be negatively correlated with the estimated exposure. Moving production abroad could also serve as a hedge against currency fluctuations, implying a negative relation between the wage costs in foreign countries and currency exposure. Of course this reasoning assumes that the wage costs in foreign currency to some extent cancel out export revenues in the same currency (or a currency highly correlated with the same).

To estimate the parameters of equation (5) we substitute it into (1), which gives,

$$R_t = \alpha_0 + (\delta_0 + \delta_1 F_i + \delta_2 D_i + \delta_3 W_i + \delta_4 Hedge_i)\Delta S_t + \alpha_1 R_{mt} + e_t \qquad (6)$$

$i = 1, ...N \quad t = 1,.....T$

Equation (6) is then estimated jointly for all firms as a system of Seemingly Unrelated Regressions (SUR). Generalized Least Squares estimation accounts for correlated residuals across firms.

A well known problem with the ordinary standard errors for a SUR system like (6) is that they have a downward bias and hence the usual hypothesis test tend to reject to often. To account for this problem we use a bootstrap technique to improve inferences. It should be noted that utilizing bootstrap for better inference in SUR models is not an obvious choice. Several studies (e.g. Atkinson and Wilson, 1992) have shown that bootstrapped standard errors for the SUR model are also biased downwards and therefore cannot improve the situation. However in a recent paper Rilestone and Veall (1996) present Monte Carlo evidence that the bootstrap performs substantially better when applied to t-ratios (i.e. utilizing the so called percentile-t bootstrap) rather than to standard errors. Inspired by these results we use the percentile-t bootstrap to construct confidence intervals for the coefficients in (6). We employ the following steps in the bootstrap procedure

1. A bootstrap sample is constructed by randomly drawing, with replacement, T times from the original data for all firms and variables, where T is the number of weeks in the sample. In each random draw, one date in the original data set is selected, and the values for all variables for each firm in the sample on that date are used.

2. Equation (6) is estimated for the bootstrap sample and bootstrap t-values are computed as

$$\hat{t}^* = \frac{\hat{\theta}^* - \hat{\theta}}{\hat{\sigma}^*\left(\hat{\theta}^*\right)}$$

where $\hat{\theta}$ is the estimated parameter from the original data, $\hat{\theta}^*$ is the estimated parameter based on the bootstrap sample and $\hat{\sigma}^*\left(\hat{\theta}^*\right)$ is the standard deviation of the bootstrap estimator.

3. Steps 1 and 2 are repeated 10000 times and the bootstrap t-values are stored for each replication.

4. A (1-α/2)100% confidence interval is then be constructed by using the α/2% and (1-α/2)100% percentiles of the bootstrapped t-values. For example a 95% confidence interval is constructed as

$$\left[\hat{\theta} - \hat{\sigma}\left(\hat{\theta}\right)^*_{0.025}, \hat{\theta} - \hat{\sigma}\left(\hat{\theta}\right)^*_{0.975}\right]$$

In Table 6 the estimates of (6) are presented together with both the asymptotic standard errors and the bootstrapped confidence intervals for the coefficients.[6]

The estimated relationship between exposure and the foreign sales/total sales ratio is positive and significant. Direct investments in foreign countries are positively related to exposure but not significant. Wages paid to foreign countries do not seem to determine differences in exposure across firms, the coefficient is small and insignificantly different from zero. It is interesting that

the use of currency hedging instruments do appear to have a negative (significant at the ten percent level using asymptotic standard errors) impact on estimated exposure. This resembles the results found for US firms by Allayannis and Ofek (1996) and is consistent with the difficulty of finding a clear significant relationship between changes in exchange rates and firm value being due to hedging. Even though it is not plausible that a firm can hedge away its economic exposure totally by foreign currency transactions, as reported in Bodnar and Marston (1996) few firms even intend to do so, the use of currency contracts can create cash flows that reduce the correlation between firm value and the exchange rates.

[6] We also estimated (5) by Ordinary Least Squares using the estimated exposure coefficients from (7) as dependent variables. The results were similar to the ones obtained using SUR but with somewhat larger coefficients and smaller standard errors.

5. Conclusions

In this paper we investigate the relation between changes in firm value (defined as stock returns) and exchange rate fluctuations for a sample of Swedish firms. Using weekly data we find that about 26 percent of the 47 firms in the sample are significantly exposed to exchange rate changes, a significantly larger percentage than what we would expect by random. This is a substantially higher percentage than earlier results for U.S. companies. Investigating a possibly lagged effect we find little evidence that exchange rates affect firm values with a lag. The results also appear quite robust to choices of data frequencies, sample periods, exchange rate index, and proxy for the market portfolio.

A cross sectional analysis to link firm characteristics to exchange rate exposure is also conducted. It is shown that the level of foreign sales/total sales significantly increases exposure, while foreign direct investments and wage costs in foreign countries have no effect. We also add to the sparse evidence on whether derivatives reduce exposure. Using firm level data on hedging activities we find indications that the use of derivatives decreases exposure.

Appendix

Table A1. Distribution of estimated exchange rate exposure, β_1, of 47 firms using daily returns, 1992:12:01 - 1997:02:06.

	MERM	TCW
Minimum	-0.71496	-0.74913
First Quartile	-0.17631	-0.21572
Median	-0.04727	-0.06356
Third Quartile	0.04064	0.03855
Maximum	0.37635	0.38816
Cross-sectional Mean	-0.07717	-0.09472
Cross-sectional SD	0.24584	0.25799
Number of Firms (of 47 total) with significant exposure at 5% (10) level	11 (13)	11 (14)

AFGX used as the market portfolio. Robust standard errors are calculated according to White (1980).

Table A2. Distribution of estimated exchange rate exposure, β_1, of 27 firms using weekly returns, 1990:01:01 - 1997:02:06.

	MERM
Minimum	-0.76676
First Quartile	-0.37053
Median	0.00432
Third Quartile	0.30904
Maximum	0.55448
Cross-sectional Mean	-0.02518
Cross-sectional SD	0.40368
Number of Firms (of total 27) with significant exposure at 5% (10%)level	9 (12)

AFGX used as the market portfolio. Robust standard errors are calculated according to White (1980).

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Table 1. Distribution of estimated exchange rate exposure coefficients, β_1, for 47 firms with varying sample size.

	MERM (1990-1997)	MERM (1992-1997)	TCW (1992-1997)
Minimum	-1.20281	-1.04039	-0.87479
First Quartile	-0.42810	-0.26390	-0.30962
Median	-0.03474	0.02616	0.00428
Third Quartile	0.20767	0.23693	0.25053
Maximum	1.09468	0.95132	0.92423
Cross-sectional Mean	-0.11146	-0.03034	-0.03417
Cross-sectional SD	0.48083	0.43248	0.40293
Number of Firms (of total 47) with significant exposure at 5% and 10% level.	12* (0.0636) 19* (0.0715)	8* (0.055) 10 (0.056)	6 (0.049) 9 (0.057)
Number of firms with positive exposure at 5% level	6	4	
Number of firms with negative exposure at 5% level	6	4	

Robust standard errors are calculated according to White (1980). First column: Weekly returns, 1990:01:02 - 1997:02:06. AFGX used as market portfolio, MERM as exchange rate index. Second column: Weekly returns, 1992:12:02 - 1997:02:06, MERM as exchange rate index. Third column: Weekly returns, 1992:12:02 - 1997:02:06, TCW as exchange rate index. * denotes rejection of the hypothesis that the percentage of firms with significant exposure is larger than 5% and 10% respectively. Standard errors for the fraction of firms with significant exposure is given in parentheses

Table 2. Distribution of estimated exchange rate exposure of 47 firms using weekly returns, 1990:01:02 - 1997:02:06 and including one lag.

	MERM(t)	MERM(t-1)
Minimum	-1.20246	-0.44237
First Quartile	-0.42831	-0.07529
Median	-0.03467	0.10807
Third Quartile	0.20774	0.22013
Maximum	1.09474	1.26310
Cross-sect Mean	-0.11124	0.09283
Cross-sect SD	0.48070	0.29689
Number of firms of 47 total with significant exposure at 5% (10%) level	12(19)	3(6)
Number of firms with positive exposure at 5% level	6	1
Number of firms with negative exposure at 5% level	6	2

AFGX used as the market portfolio. Robust standard errors are calculated according to White (1980).

Table 3. Distribution of estimated exchange rate exposure, γ, of 47 firms using weekly returns and single currencies, 1992:12:01 - 1997:02:06.

	USD	DEM	FIM	NLG	GBP
Minimum	-1.10691	-1.79794	-1.02607	-1.27752	-1.02673
First Quartile	-0.32764	-0.33959	-0.17257	-0.31262	-0.09868
Median	-0.02047	-0.04282	0.05605	-0.03410	0.13295
Third Quartile	0.15073	0.15299	0.22607	0.26140	0.29822
Maximum	0.65343	0.87065	1.12051	0.56148	1.47392
Cross-sect Mean	-0.06893	-0.11247	0.03850	-0.09602	0.14670
Cross-sect SD	0.34810	0.45694	0.34391	0.41968	0.42985
Number of firms of 47 total with significant exposure at 5% (10%) level	5 (11)	5 (10)	5 (10)	4 (8)	2 (7)
Number of firms with at least one γ_j >0 at 5% level	3	2	2	1	1
Number of firms with at least one γ_j<0 at 5% level	2	3	3	3	1
$\gamma_j = 0, \forall j$	14(19)				

AFGX used as the market portfolio. Robust standard errors are calculated according to White (1980). The last row contains the number of firms for which a joint test of the null $\gamma_j = 0, \forall j$, can be rejected at the 5(10)% level.

Table 4. Distribution of estimated exchange rate exposure, β_1, of 47 firms using weekly returns on MERM index, 1990:01:02 - 1997:02:06. The returns from Financial Times World Index included as an extra factor.

$$R_t = \alpha_0 + \beta_1 \Delta S_t + \alpha_1 R_{m,t} + \alpha_2 R_{wm,t} + e_t$$

	MERM
Minimum	-1.20320
First Quartile	-0.42946
Median	-0.03914
Third Quartile	0.20893
Maximum	1.08921
Cross-sectional Mean	-0.11245
Cross-sectional SD	0.48107
Number of Firms of total 47 with significant exposure at 5% (10%) level	13(19)

Robust standard errors are calculated according to White (1980).

Table 5. Reported currency hedging position, by instruments, for the purpose of hedging foreign direct investments.

	Billions SEK	Percentage of total hedging position
Futures	98	48,0%
Foreign Debt	86	42,2%
Swaps	17	8,3%
Options (and other instruments)	3	1,5%
Total Hedging positions	204	100%
Total FDI Hedged FDI = 51%	401	

Source: Sveriges Riksbank, Foreign Direct Investment Survey, 1995.

Table 6. Simultaneous estimation of the firm characteristic regression by GLS,

$$R_t = \alpha_0 + (\delta_0 + \delta_1 F_i + \delta_2 D_i + \delta_3 W_i + \delta_4 Hedge_i)\Delta S_t + \alpha_1 R_{mt} + e_t$$

$i = 1, ...N \quad t = 1,.....T$

Parameter	Estimate
δ_0	-0.1510
	(0.0813)
	[-0.479, 0.031]
δ_1	$0.2936^{+++,}$ ***
	(0.094)
	[0.074, 0.633]
δ_2	0.2826
	(0.2509)
	[-0.366, 1.266]
δ_3	0.0520
	(0.0986)
	[-0.207, 0.334]
δ_4	-0.4483^{+}
	(0.2447)
	[-1.161, 0.128]

Asymptotic standard errors are presented in parentheses. t-percentile bootstrap confidence intervals are presented within brackets. $^{+}$, $^{++}$, $^{+++}$ represents significance at the one, five and ten percent level respectively using asymptotic standard errors. *, **, *** represents significance at the one, five and ten percent level respectively using bootstrap inference