Adjusting Stock Market Values to Exchange Rate Exposure: The Case of ASTRA, SCA and STORA.

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Abstract: Europe's two largest forest product companies SCA and STORA are located in Sweden. One of the largest firms in Sweden is ASTRA, which is a pharmaceutical company. In this paper I analyze how the variance of these firms' values and their stock returns sensitivity to exchange rates and interest rates are affected by different hedging strategies. First are new share price series constructed there gains and losses due to not undertake any hedging practices for transaction and translation exposure are realized. There after are the exposure coefficients obtained from the adjusted share price compared to the exposure coefficients obtained using the firms core share price as a dependent variable. The results show that SCA and STORA manage to reduce the exchange rate exposure significantly, but that both SCA and STORA´s stock return are still sensitive to contemporaneous changes in exchange rates. The linear multiple regression method was unable to detect any significant exchange rate exposure for ASTRA. However, the hedging of translation and transaction exposure do not necessarily imply that the variance of the firm's value is reduced.

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International trade and investments of a firm imply that the exposure to exchange rates and interest rates become a main concern. The profitability and value of multinational firm's can be substantially affected by fluctuations in exchange rates and interest rates. This study analyzes how the hedging of translation exposure by borrowing in local currencies as well as the use of forward rate agreements for transaction hedging affect the variance of firm's value and their stock returns sensitivity to exchange rates and interest rates. An appreciation or depreciation of the domestic currency implies a change of foreign assets and debts that result in translation gains or losses when converted to the domestic currency. In the same manner are prices in product and factor markets affected. This can alter the firm's competitiveness and thereby influence cash flows. The firm's value is also altered due to changes in the value of foreign transactions. Changes in interest rates affect both the costs of raising capital and the return on capital. Movements in interest rates may also affect the production cost as well as the demand for the products. Each firm's sensitivity to changes in the macroeconomic environment depends on their operating profiles, financial strategies, and other firm-specific variables. For multinational firm's the operating profile and financial strategies may differ among the divisions. Thus, taken together, exchange rates and interest rates can affect the value of the firm in complicated and diverse ways. Therefore, even though most firms are actively trying to reduce the exposure the overall picture of how the firm's value is affected by changes in macroeconomic variables is often less clear. The knowledge of a firm's macroeconomic exposure is valuable for both risk-management and strategic management of the firm.

There are several studies of exchange rate exposure using the method of regression analyses. Studies using portfolio data (Jorion 1990, Bodnar and Gentry 1993, Khoo 1994) have found small or no relation between fluctuations in exchange rates and stock returns while studies on the firm level have found that exchange rates do affect the firm value, see Choi and Prasad (1995) among others. This study contributes too earlier studies by using a stock return that is adjusted for transaction and translation hedges. Thus, an estimator of exposure before hedging is obtained. By comparing the exposure coefficients obtained from the unadjusted stock return with the exposure coefficients obtained from the adjusted stock return it is possible to evaluate the management of risks.

The results in this paper indicate that hedging practices do reduce the contemporaneous exposure of the firm's stock return but that hedging for transaction and translation exposure do not necessarily reduce the variance of the firm's value. This suggests the possibility that the results obtained by Jorion (1990), and Bodnar and Gentry (1993), and Khoo (1994) may be due to firms hedging practices.

The regression analysis method is carried out by estimating a linear multiple regression model. The explanatory variables are factors that can be considered to affect the firm's value. The dependent variable should be an indicator of the firm's value, in this case the firm's stock value. Alternative indicators of the firm's value can be commercial cash flow or sales revenues as applied in Oxelheim and Wihlborg (1995). The coefficients of the regressors are measures of exposure. However, the results of the estimations will only capture residual exposure after existing hedging practices. On the other hand there are advantages of this method compared to conventional exposure measurements based on accounting data. The informative value of accounting data is limited since the data do not capture the simultaneous impact of macroeconomic changes. For example, the accounting based measure include immediate effects from exchange rate and interest rate changes but not the effect from changes in the firm's competitiveness. For management purposes, a firm needs to know how the value of the firm's assets before hedging is altered for a given exchange rate and interest rate movement, and the importance of the variability caused by exchange rates and interest rates, so that it can decide whether and how to hedge against future movements.

The largest export sector in Sweden is the forest product sector. It can be expected that companies in the forest product sector are exposed to exchange rates and interest rates since most of their products are exported while very little input factors are imported. The two largest forest product companies in Europe are SCA and STORA, which are both located in Sweden. One of the largest firms in Sweden is ASTRA, which is a pharmaceutical company. This paper analyses ASTRA, SCA and STORA's exposure using multiple linear regression analysis. SCA and STORA are one of the world's leading manufacturers in a number of product areas, such as pulp, printing papers, fine papers and packaging paper and board. These firms were listed on foreign stock exchanges in order to increase the international diversification of share ownership.[1] STORA shares have been listed on the Stockholm Stock Exchange since 1901 and on the Frankfurt and London Stock Exchanges since 1989. ASTRA and SCA are both listed on the London Stock Exchange and as American Depository Receipt. The paper is organized as follow: Section I discuss the data and the source of the data. Section II discusses ASTRA, SCA and STORA's operating profile, financial positions and hedging strategies. Section III discusses firm specific determinants. Section IV describes the estimated model. Section V offers concluding remarks.

I. Data

To obtain accurate estimates of the exposure coefficients when using regression analysis of time series demand a stable firm structure as well as stable policy regimes. The macroeconomic environment changed in October 1992 when the Swedish basket exchange rate regime collapsed and was replaced by a floating exchange rate. The starting date of the sample is therefore set to December 30, 1992.

Weekly data is used for the period December 30, 1992, to December 27, 1995, and is constructed from daily data. The Wednesday closing prices is used, this to avoid the day of the week effect for the stock indices. The share price for ASTRA, SCA and STORA is provided by FINDATA. The hedging data are provided by each firms financial service unit. The data used for the Swedish stock market index is the Sweden Share prices General (Affärsvärlden). The three-month Treasury bill rates, the yield on the ten-year government bonds for Germany, Sweden and US as well as exchange rates are provided by the Swedish centralbank.

II. Operating profiles and hedging strategies.

In order to perform the analyzes information about ASTRA, SCA and STORA's operating profiles, financial positions, competitors and hedging strategies is needed. SCA and STORA are two of the world's largest forest-products groups, ranking beside such companies as North America's International Paper, Georgia-Pacific and Stone Container. There are a large number of competitors due to the production of many different products. The main competitors are located in Sweden, Germany, France, Finland, US and Canada. More than 40% of SCA and STORA's manufacturing capacity is located outside Sweden. Manufacturing is conducted in Sweden, Germany, France, Belgium and UK. SCA and STORA´s products are sold to more than 85% in Europe and the single most important market is Germany, accounting for approximately 24% of sales. However, it should be pointed out that both SCA and STORA do not focus on market shares but rather emphasize projected profitability. There is one important difference between SCA and STORA. SCA's largest production segment is hygiene paper while STORA's largest production segment is printing paper. ASTRA has become one of Sweden's most international companies, with operations in 50 countries and more than 90 percent of sales in foreign markets. Two-thirds of the work force are employed by Astra´s foreign operations. Main competitors are Merck, located in US, as well as Glaxo Wellcome located in UK. In comparison to SCA and STORA is ASTRA's market more diversified and therefore is ASTRA less dependent on a single market.

The yearly average external sales by market between 1993 to 1995 were the following:

Table 1. Goes here.

Due to a high proportion of sales, as well as production in foreign countries, there is a potentially exchange rate exposure.

II.A. Risk and hedging policy.

International industrial operations entail various forms of risk. These risks are both commercial and financial. Examples of the latter include interest and currency risks, which are global in nature. ASTRA, SCA and STORA have similar hedging strategies. Fixing interest rates for periods of less than one year minimizes the interest rate risk, which is the risk that a reduced return on capital employed cannot be offset by a reduction in its financial costs.

A considerable portion of ASTRA, SCA and STORA's products are sold in countries other than those in which they are produced, thereby creating a transaction risk. Transaction risk means the risk that the firm's domestic currency value of a specific future cash flow in a foreign currency is affected due to changes in exchange rates. This risk is often minimized by covering of net flows for a period of time. This means that the impacts of any currency fluctuations are delayed by that amount of time.

ASTRA, SCA and STORA's yearly average transaction exposure in the four most important currencies measured in million of SEK is presented in Table 2, as well as it's size in relation to the firms total stock value.[2]

Table 2 goes here.

A major part of ASTRA, SCA and STORA's capital is employed outside Sweden. The risk that fluctuations in exchange rates affect the value of the firms net foreign asset is referred to the translation risk. In the local subsidiaries, the firms' assets outside Sweden are financed in part by loans denominated in local currencies and partly by equity. To avoid exposure on the part of the foreign assets, which are financed through equity, the firms often create a corresponding exposure in the particular currency. This eliminates the risk of changes in exchange rates affecting the firm's net foreign assets. The company's financial strength is measured in solidity, via an equity/ asset ratio measured as shareholders equity including minority interest in relation to capital employed. Thus, one incentive for hedging of the translation risk is to reduce the fluctuation of the equity/asset ratio. The composition of long-term debts in foreign currencies related to the translation hedge, as well as its size in relation to the firms total stock values, are presented in Table 3.

Table 3 goes here

ASTRA's transaction and translation exposure as a percentage of market capitalization is low compared to SCA and STORA.

Exchange rate exposure can to some extent be reduced if the company has a high production flexibility. Let us assume that the demand in Germany for SCA and STORA products increases. This demand can be meet by either increased exports or invest in increased production capacity in Germany. In general does increased export result in a higher exchange rate exposure compare to shifting production. This since shifting production to Germany would imply that the production costs and sales revenues would be denoted in the same currency. In fact, one of SCA and STORA's largest manufacturing facilities is located in Germany which is SCA and STORA's largest single market.

III. Information in firms stock price.

The largest shareholders in ASTRA, SCA and STORA are investment groups and pension funds, which are managed by professional and well-informed individuals. Thus, well-informed individuals set the price of the stock. This implies that the price sensitivity to macroeconomic factors that is considered to affect the firm’s value is incorporated in the stock price.

The firms stock price reflect the firms value after hedging practices this since investors have the information about hedging strategies then they set the price. Changes in exante macroeconomic factors that affect the stock price can be due to a lack of an appropriate hedging strategy for those variables. Changes in the stock price can also reflect changes in the competitive position. This can be due to changes in macroeconomic factors that do not directly affect the firm’s currency positions and therefore the firms lack a hedging strategy. STORA publicly reveal that at a dollar exchange rate of more than SEK 8 per US dollar, Swedish pulp mills have lower total costs for manufacturing and marketing pulp in Europe than their primary competitors in North America.

Another problem is that the macroeconomic variables respond simultaneously to changes in fundamentals like fiscal and monetary policy. This may complicate the measurement of the impact of macroeconomic changes on the firm’s value and thereby a sufficient hedging may not be obtained. This problem can, however, be solved by the use of the linear multiple regression model that is described in the next section.

IV. Measurement of Macroeconomic Exposure

A general method used to measure a firm’s exposure is to apply the linear multiple regression technique. The multiple regression model overcomes the measurement problem related to simultaneous changes in variables. However, the model must be specified using apriori assumptions about the variables that affect the firm's value. Information about the firm's currency positions as well as the firm's market environment gives some guidance about relevant variables. Considering the information presented in section two about markets, production location, location of main competitors as well as currency positions are data from the following countries chosen: Germany, Sweden and US. The following model is used to measure the firm's exposure:

Let us express the rate of return on the firms stocks R_S, in terms of percentage change in the firm's stock price,

(4) $$R_S = \frac{(P_t^S - P_{t-1}^S)}{(P_{t-1}^S)}$$

where P_t^S is the firm's stock price at time t.

(5) $$R_S = \alpha + \varphi R_{m,t} + \beta_i \sum_{i=1}^{2} \left[LC/FC_i\right]_t + \delta_i \sum_{i=1}^{3} \left[3M_i\right]_t + \phi_i \sum_{i=1}^{3} \left[10Y_i\right]_t + \varepsilon_t$$

where

$3M_i$ = the three month call money market rate in Germany, Sweden and US.

$10Y_i$ = the ten-year government bond rate in Germany, Sweden and US.

R_m = the Swedish stock market index.

S_i= the exchange rate between Sweden and Germany and US.

and where

(6) $$LC/FC_i = S_i - \left(\hat{\gamma}_0 + \hat{\gamma}_1 R_m\right)$$

is the residual of the regression of the exchange rate movement S_i against the rate of return on the stock market. All variables are in logarithmic form.

The coefficients $\varphi, \beta, \delta, \phi$ and γ are the exposure coefficients. However, in order to obtain the firm specific exposure, the exposure coefficients must be adjusted for the inherent market exposure. That is to ask what the market index is a proxy for in terms of the used interest rates and exchange rates. Therefore, a second regression is performed with the market index as the dependent variable.

(7) $$R_M = \alpha + \pi_i \sum_{i=1}^{2} [S_i]_t + \lambda_i \sum_{i=1}^{3} [3M_i]_t + \chi_i \sum_{i=1}^{3} [10Y_i]_t + \varepsilon_t$$

The obtained coefficients in (7) are thereafter multiplied by φ, the market coefficient in the firm specific regression, the sum is added to the exposure coefficients in (5). Each coefficient indicates now how much the firm's value changes due to a one percent change in the variable. The exchange rate coefficients (β) are expected to be positive. A depreciation of the domestic currency relative to the home currencies of competitors improves a domestic firm's competitiveness. The interest rate coefficients (δ) and (ϕ) are in general expected to be negative since higher interest rates offset the demand for the firm's products and increase the payments on loans. However, the sign of the interest rate coefficients also depends on the underlying factors causing the movement in interest rates. A potential problem in estimating the multiple regression model arises from the possibility that the Swedish stock market index, exchange rates and interest rates may be highly intercorrelated giving rise to multicollinearity. Multicollinearity implies that the measured variables are too highly intercorrelated to allow precise analysis of their individual effects. If so, there is two different ways to deal with this problem. One is to exclude highly correlated variables. A second method is to reduce any bias due to correlated variables by orthogonalizes the factors and use the residuals from a multiple side regression. To find out those variables that may cause multicollinearity the correlation between the variables are estimated and presented in Table 4. However, the estimated model did not have any problem with multicollinearity.

Table 4 goes here

Since ASTRA, SCA and STORA are listed on foreign stock exchanges it is possible that the world stock index should enter as the market variable. Equation (5) was estimated then a world stock index entered the equation. However, the world stock index was not significant and the inclusion of the world stock index did not affect the significance or coefficients of the other variables.

IV.A. Estimated Coefficients and Interpretations.

The contemporaneous form of equation (5) was estimated using Ordinary Least Squares (OLS) to obtain sensitivity coefficients for the unadjusted and adjusted stock value of ASTRA, SCA and STORA. Table 5 presents the results for the unadjusted and the adjusted stock value as well as the results for the regression with the market index as the dependent variable. The initial model is reduced and the reductions are based upon a F–test as well as the FPE information criteria. The model specification is tested for autocorrelation, heteroscedasticity, autoregressive conditional heteroscedasticity, normality and functional form mis-specification (RESET). Reported sensitivity coefficients are coefficients that are significant at the 5% level. Equation (7) was first estimated in a contemporaneous form but due to borderline acceptance of the autocorrelation and normality the model was respecified to include one lag. The only difference between the two models is that the lag of the long-term interest rate in Sweden is significant.

Table 5 goes here

Considering the information about external sales and exposure, provided in Table 1 to 3, at least SCA and STORA´s exchange rate exposure is expected to be high. The exposure coefficients, on the other hand, indicate a low exchange rate exposure.

ASTRA´s return is unaffected by fluctuations in the exchange rates. However, if the SEK/DEM depreciate with one percent the return of STORA increases with 0.42 percent. The sensitivity toward exchange rate changes in the DEM is expected since Germany is STORAs single largest market, which implies that a depreciation of the SEK/DEM results in a higher SEK cash-flow. However, due to the similarities between SCA and STORA it was somewhat unexpected that the USD entered as significant in the regression for SCA and not the DEM. If the SEK/USD depreciate with one percent the value of SCA increases with 0.37 percent. On the other hand is STORA sensitive to the long-term interest rate in US. All firms return react negatively to higher short-term interest rates in US. Thus, both ASTRA, SCA and STORA are affected by the US economy.

The coefficients for the interest rates indicate that higher interest rates in Sweden reduce the return of STORA. One of STORA´s product areas is building materials and the building sector is sensitive toward changes in the long-term interest rate.

The positive signs of the coefficients for the long-term interest rate in US are contradicting. However, the positive sign for the US long-term interest rate may be explained by changes in the competitive positions. The US producers face higher interest payments on loans while the domestic demand fall that implies that the cost for each produced unit increase. Under the assumption of integrated interest rates and given that other variables are constant, a 1% simultaneous increase in interest rates results in a 0.60% fall in SCA´s return and 0.45% fall in STORA´s return. Further, investments of plant and equipment for production of pulp and paper, which is capital intensive, are partly financed with loans. This can explain the interest rate sensitivity toward changes in the long-term and short-term interest rate.

Since the firms unadjusted stock return is used, the method only measures residual exposure, it is possible that the results reflect the success of the hedging practices of the firm. When exchange rate movements explain only a small proportion of the variability in the return. The next step in the analysis will therefore be to adjust the firm’s stock return for hedging practices.

IV.B. Exposure and Firm's value.

Firm's objectives for hedging or not hedging may differ. If exchange rates follow a random walk then in the long-run, gains and losses from not undertaking any hedging strategies would cancel out. However, for this argument to be valid the trade structure needs to be stable.

One incentive for hedging is to reduce the variance of the firm's value. The firm's emphasis projected profitability of each investment. In order to evaluate the profitability on the investment stage, stable input data of cost and benefits are needed. This implies that changes in macroeconomic factors that can affect outcome of the analyses are unwanted. A different interpretation can be obtained then evaluating the firm's relation to the stockholders. In order to forecast expected dividends are factors that can endanger the outcome eliminated. However, the main incentive for hedging the translation risk is to protect shareholders equity.

In order to evaluate the firm's hedging for translation risk are ASTRA, SCA and STORA´s stock value adjusted. The question is what would the stock value be if all foreign loan related to the translation hedging be if the debts were denominated in the Swedish currency. By using weekly exchange rates are debts in the firms four most important currencies converted to SEK. Adjustments for changes in the debt structures are made. Exchange rate movements will now result in a gap between the value of the firm's foreign assets and the domestic loan. For example, assume that the SEK depreciate, this would result in a higher value of the firms foreign assets and thereby a higher value of the firm. Since the firm's value is measured by the value of all shares, the unhedged share price would be higher then the hedged share price. Therefore is the weekly hedged stock price adjusted with obtained profit or loss. Changes in interest rate payments are however neglected. Graphs of ASTRA, SCA and STORA´s stock value before and after adjustments for translation hedges are presented in Fig 1. The graphs show that for SCA and STORA the unhedged stock value is higher for the whole sample period. This is due to the strong depreciation of the SEK that results in higher values of foreign assets. Since ASTRA´s translation exposure is small in relation to the firm’s total stock value, it is not possible to see any differences between the hedged and unhedged stock value. However, one of the purposes of hedging is to reduce the variance of the firm’s value. In Table 4 are the variance and correlation coefficients for the exchange rates, as well as for changes in the firm’s value presented. If the firms decide to not hedge the translation risk the variance of STORA´s value would increase from to 0.0278 to 0.0315 while the variance of ASTRA’s and SCA’s value would be almost unaffected.

If the firms determine to not hedge the translation exposure, how would the return be affected by macroeconomic changes? The obtained exposure coefficients for the regression using unhedged translation exposure are presented in Table 6. ASTRA’s sensitivity to interest rates and exchange rates would be unaffected which reflect the low translation exposure in relation to ASTRA’s total stock value. Both SCA and STORA have a high translation exposure in relation to their total stock value, this shows up as increased sensitivity to the SEK/DEM exchange rate. If the SEK/DEM depreciate with one percent the return of SCA would increase with 0.73% and the return from STORA would increase with 1.19%, assuming the other variables constant. Interest rates are still significant in determining the firm’s value. The exposure coefficient of the long-term interest rate in US becomes significant for SCA while it decreases slightly for STORA such that a one percent increase in the long-term interest rate increases the return of STORA by 0.31% an the return for SCA by 0.23%. However, the figures for the interest rate exposure, then not using translation hedges, should be evaluated with care since changes in interest rate payments is not included in the adjustment for translation exposure.

The next step in the analysis is to evaluate the transaction exposure. The quarterly transaction exposure measured in SEK is converted into each local currency using the mean exchange rate. Gains or losses from unhedged positions are obtained by subtracting the amount of SEK obtained in the end of the period from the amount of expected SEK in the beginning of the period. By adding the gains and losses in the different currencies is the total transaction exposure in the firms four most important currencies obtained. However, this approach assumes that the transactions are equally distributed over time. If not, it is easy to construct a case there all transactions' results in a loss or gain. What would the sensitivity of the firm's stock return be if the firm's decided to hedge translation exposure but not transaction exposure? The exposure coefficients presented in Table 7 differ very little from the exposure coefficients obtained from the first regression on the hedged stock return. ASTRA is still not sensitive to exchange rates. However, SCA's sensitivity to changes in the SEK/USD is almost the same while STORA's sensitivity to the SEK/DEM exchange rate increases from 0.42 to 0.49. Stated differently, if the exchange rates appreciate by 10%, the hedging increase the STORA´s value by 0.7%.

Now assume that neither the transaction exposure nor the translation exposure is hedged. As before ASTRA is still not sensitive to changes in the exchange rates. Compared to the case where both the transaction exposure and the translation exposure is hedged SCA's total interest rate exposure from a 1% simultaneous change in both long-term and short-term interest rates decreases from 0.6% to 0.5% while it increases for STORA from 0.45% to 0.79%. See Table 8.

As expected SCA's and STORA's exchange rate exposure increases such that a 1% depreciation of the SEK against the other currencies increase SCA's return with 1.16% and STORA's return with 1.25%. To summarize, transaction hedges reduces the exchange rate exposure while the results for the interest rate exposure are mixed. To evaluate the total effect of the firms hedging practices are the variances there no hedging occurs compared with the variances and exposure coefficients obtained from the hedged stock value. Using the variance in Table 4, the hedging practices for transaction exposure contribute to increase the variance of ASTRA's and STORA's value while the variance of SCA's value is almost unaffected. This is somewhat unexpected given the reduction of the exchange rate exposure. However, the difference in the variances is small. The hedging for the translation exposure reduce the variance of STORA's value from 3.15% to 2.78% while the variance of ASTRA's and SCA's value is almost unaffected. Due to the depreciation of the SEK over the sample period, the unhedged mean stock value would be higher for all firms. However, if the exchange rate had appreciated over the sample period the unhedged stock value would be lower than the hedged stock value. The results can therefore not be used to argue for using unhedged positions.

V. Summary and Conclusion.

ASTRA, SCA and STORA's exposure to exchange rates and interest rates have been evaluated using the linear multiple regression method. By adjusting the firm's stock value for currency positions used to reduce the translation and transaction exposure are sensitivity or exposure coefficients obtained before and after different hedging practices are applied. By comparing the different exposure coefficients can the firms hedging practices be evaluated. For such measures to be relevant, the determinants of a firm's present exposure must be the same as those that prevailed during the estimation period, that is December 30, 1992 to December 27, 1995. The main incentives for firms to reduce the translation exposure by financing foreign investments by borrowing in local currencies are following. First, to protect shareholders equity. Second, to reduce the fluctuation of the equity/ asset ratio. To summarize, the results show that SCA and STORA manage to reduce the exchange rate exposure significantly, but that SCA's stock return is still sensitive to changes in SEK/USD and STORA's stock return to the SEK/DEM exchange rate. The linear multiple regression method was unable to detect any significant exchange rate exposure for ASTRA event though 90% of its income is generated abroad. One explanation is that ASTRA is more diversified among countries and that we therefore are unable to detect exposure to a single currency. However, the hedging of translation and transaction exposure do not necessarily imply that the variance of the firms value is reduced. This might be explained by higher volatility of forward rates. For the forest product companies SCA and STORA it is clear that the hedging of the translation exposure do reduce the variance of the firms value. Further, SCA and STORA's hedging is not optimal in the sense that their hedged return are exposed to contemporaneous changes in exchange rates.

[1] The percentage of the firm's capital owned by foreigners is presented in Table 1 in appendix.
[2] The firms total stock value are presented in Table 1 in appendix