A Firm-Specific Analysis of the Exchange-Rate Exposure of Dutch Firms

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BIBLIOGRAPHIC DATA AND CLASSIFICATIONS		
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A FIRM-SPECIFIC ANALYSIS OF THE EXCHANGE-RATE EXPOSURE OF DUTCH FIRMS

by

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September 2002

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Abstract

We examine the relationship between exchange-rate changes and stock returns for a sample of Dutch firms over 1994-1998. We find that over 50% of the firms are significantly exposed to exchange-rate risk. Furthermore, all firms with significant exchange-rate exposure benefit from a depreciation of the Dutch guilder relative to a trade-weighted currency index. This result confirms that firms in open economies, such as the Netherlands, exhibit significant exchange-rate exposure. We collect unique information on the most relevant individual currencies for each firm with respect to their influence on firm value. Our results indicate that the use of a trade-weighted currency index and the use of individual exchange rates are complements. We also measure the determinants of exchange-rate exposure. As expected, we find that firm size and the foreign sales ratio are significantly and positively related to exchange-rate exposure. In contrast with our hypothesis, off-balance hedging using derivatives has no significant effects. Finally, in line with theory, we find that exposure is significantly reduced through on-balance sheet hedging, i.e. through foreign loans and by producing in factories abroad.

1. Introduction

Foreign exchange rates are an important source of uncertainty for firms. Nevertheless, most empirical studies to date fail to find a strong relationship between exchange-rate changes and the firm's stock market return, which is a proxy for the change in firm value. As described by Jorion (1990), the common approach is to use a regression model to explain the firm's stock returns by the return on a trade-weighted basket of currencies and a correction for the market index. The early paper of Jorion (1990) and later studies of Amihud (1994) and Choi and Prasad (1995) investigate US firms and detect few firms with significant exchange-rate exposure. Similar international studies that investigate several countries, such as Bodnar and Gentry (1993), Dominguez and Tesar (2001) and Doidge, Griffin and Williamson (2002), also find a surprisingly low number of firms that demonstrate significant sensitivity to exchange-rate movements.

The specification of the regression model has been studied by Bartov and Bodnar (1994), who focus on the lagged influence of exchange-rate changes. Bodnar and Wong (1999) have tested the influence of the correction for the market index. Instead of a trade-weighted index, Dominguez and Tesar (2001) and Nydahl (2001) use several individual currencies. Ihrig (2001) creates firm-specific weighted indices based on where the firm's subsidiaries are located. The robustness of the exposures is tested by measuring its determinants. Early studies (e.g. Jorion, 1990 and Amihud, 1994) and large-scale international studies (e.g. Doidge, Griffin and Williamson, 2002) find that larger firms and firms with more international sales have larger exposures. Recent studies, such as from Allayannis and Ofek (2001) and Nydahl (2001) show that derivatives usage reduces foreign-exchange exposure. Despite these efforts, the low exposures remain a puzzling phenomenon.

There are several potential reasons why previous studies fail to find significant exchange-rate exposures. The first and most obvious reason is that few firms in the samples are exposed. In this case the results correctly show low exposures. Most studies focus on the US, which is one of the least open economies in the world. One may therefore expect that exchange-rate exposure is more prevalent in other countries with more open economies. The second reason is that the methodology employed does not correctly capture the firm's sensitivity to exchange-rate changes. For example, studies generally use trade-weighted exchange-rate indices. Weights are derived from national trade figures with foreign countries. Using

these exchange-rate indices implicitly assumes that the characteristics of individual firms are uniformly related to these national figures. This is obviously not the case and therefore using a trade-weighted exchange-rate index may bias the results of empirical studies. Finally, the third reason is that firms have shielded themselves against exchange rate risk. Corporate on- and off-balance sheet hedging activities can reduce the firm's exposure.

In this study we address the key issues mentioned above. In the first place, we examine the exchange-rate exposure of Dutch firms. The Netherlands is one of the most open economies in the world. In 1998, Dutch exports and imports were respectively 50.4% and 46.7% of GDP. In comparison, in the US exports and imports were only respectively 9.2% and 12.8% of GDP (United Nations, 1999). Therefore, we expect to find more firms to be significantly exposed to exchange-rate risk compared to studies that have focused on the US.

The second contribution of our paper is the use of firm-specific exchange rates. Existing studies measure exposure using a trade-weighted exchange-rate index. As an alternative to this common practice we collect data on firm-specific currencies. More specifically, in a questionnaire we ask firms to indicate up to three foreign currencies that had most influence on firm value. Some previous studies also use individual currencies. However, these studies either include the same currencies for each firm (e.g. Nydahl, 2001) or are limited by the availability of annual report data (e.g. Ihrig, 2001).

Our third contribution is that we use detailed information on the firm's on- and off-balance hedging activities. This allows us to test whether hedging influences exchange-rate exposure. Recent studies on exposure measurement include the nominal value of derivatives transactions divided by total assets as a proxy for financial hedging (Allayannis and Ofek, 2001). Accounting guidelines in the Netherlands do not require firms to disclose detailed information on the use of derivatives. We therefore use a questionnaire in which we ask the firms to indicate on a yearly basis what percentage of their exchange-rate exposure they hedged using derivatives (off-balance sheet hedging) and using on-balance sheet instruments (for instance by changing the location of production facilities or by using loans in foreign currency for hedging purposes). With this information we can discriminate between the impact of on- and off-balance sheet hedging on the firm's exposure. Previous studies mainly focus on off-balance sheet hedging.

Using standard methodology, we first estimate the exchange-rate exposure of Dutch firms, using bi-weekly data, by regressing stock returns on the returns of a trade-weighted exchange-rate index and an equal-weighted market index. We find that more than 50% of the firms are significantly exposed to exchange-rate risk. The average exposure coefficient is 1.55, indicating that a depreciation of the guilder with 1% coincides with an increase of 1.55% in the stock price of the average Dutch firm in our sample. Both the number of significantly exposed firms and the average exposure coefficient are much higher than in the US. This result suggests that the level of openness of an economy has a large impact on the number of firms with significant exchange-rate exposure and partly explains why earlier studies have found so few firms with significant exposure. Our results are in line with other studies that focus on relatively open economies, i.e. Bodnar and Gentry (1993) for Canadian, Japanese and US firms, He and Ng (1998) for Japanese firms and Nydahl (2001) for Swedish firms.

The results for the use of individual currencies show that this approach is a complement of the use of a trade-weighted exchange-rate index. We find that 47% of the firms without a significant exposure based on the trade-weighted index have a significant exposure for at least one of the individual exchange rates. In contrast, 50% of the firms with a significant exposure based on the trade-weighted index have no significant exposure for the individual exchange rates. These two results imply that both individual currencies and an exchange-rate index have to be considered in order to detect the currency exposure of a specific firm.

Finally, we examine the determinants of exposure. Similar to previous studies, we find that exchange-rate exposure is positively related to the foreign sales ratio and to firm size (e.g. Jorion, 1990 and Doidge, Griffin and Williamson, 2002). We find that exchange-rate exposure is significantly and negatively related to on-balance sheet hedging. Hence, firms that engage in more on-balance sheet hedging have lower exchange-rate exposure. With respect to off-balance sheet hedging, we find no significant impact on exchange-rate exposure. This finding contrasts with Allayanis and Ofek (2001) and Nydahl (2001) as both studies find a significant negative impact of the use of derivatives (off-balance sheet hedging) on exposure. However, our result is in line with survey evidence by Bodnar, De Jong and Macrae (2002), who show that Dutch firms use derivatives mainly for the reduction of transaction risks, while economic exposure remains largely unhedged.

The remainder of this paper is organized as follows. Section 2 discusses the empirical evidence on measuring exchange-rate exposure. Section 3 describes the data. Section 4 analyzes the exchange-rate exposure of Dutch firms using both a trade-weighted exchange-rate index and firm-specific exchange rates. Section 5 examines the determinants of the exchange-rate exposure and section 6 concludes.

2. Empirical evidence of exchange-rate exposure

Firms can be exposed to exchange-rate risk through various channels. For instance, a firm with foreign sales is exposed to exchange-rate risk because the value of the foreign sales, in terms of the domestic currency, changes when the exchange rate changes. However, the same firm may source inputs from abroad, thereby increasing or decreasing its exchange-rate exposure, depending on whether the imports and exports are in the same currency. Furthermore, this firm may also have assets and liabilities abroad. Again, this can increase or decrease a firm's exposure. Exchange-rate exposure is not limited to exporters, importers or multinational firms. Even a domestic firm with no foreign activities may be exposed to exchange-rate risk, for example a local firm facing import competition.

Exchange-rate exposure is the influence of exchange-rate changes on the future cash flows of the firm. Since firm value represents the present value of future cash flows, exchange-rate exposure is the sensitivity of firm value to exchange-rate changes. Following seminal work by Adler and Dumas (1984), empirical studies have measured exchange-rate exposure by the slope coefficient from a regression of stock returns on exchange-rate changes. To prevent misspecification of the model, these studies generally add the return on a market index to control for market movements. Especially early empirical studies find a surprisingly limited number of firms with significant exchange-rate exposure, particularly in the US. More recent international studies find mixed evidence of significant exposure to exchange-rate risk. Below, we discuss the findings of various international studies on exchange-rate exposure.

For a set of US firms, Jorion (1990) finds very weak support for exchange-rate exposure. Over the period from 1971 to 1987 only 15 out of 287 internationally operating firms show significant exposure at the 5%-level. The mean exposure is –0.093 which implies that a depreciation of the US dollar with 1% leads

to an average loss of firm value of 0.09%. Jorion (1990) also finds that exchange-rate exposure is time varying. The author constructs three sub-periods and finds that only 190 firms have an exposure coefficient with the same sign in the first and second period and merely 159 firms have the same exposure sign in the second and the third period. Amihud (1994) tests the exchange-rate exposure of a portfolio of 32 US exporting firms between 1982 and 1988. He finds the exposure coefficient to be insignificantly different from zero, which suggests that there is no contemporaneous effect of exchange-rate movements on the value of exporters. However, using quarterly data, the author finds evidence of a lagged effect. Bartov and Bodnar (1994) examine contemporaneous and lagged effects for a sample of 208 US firms that report foreign currency adjustments in their past annual financial statements and have exposures of the same sign. Like Jorion (1990) and Amihud (1994) they also find no significant contemporaneous exchange-rate exposure. However, they do find significant exchange-rate sensitivity when regressing contemporeneous stock returns against a lagged change in the value of the dollar. Choi and Prasad (1995) examine exchange-rate exposure of a sample of 409 multinational firms that have foreign sales, profits and assets of at least 25% of their respective totals. Over a time frame between 1978 and 1989, 61 firms demonstrate significant exposure at the 10%-level. In contrast to the findings of Jorion (1990), Choi and Prasad (1995) find a positive mean exposure coefficient (0.16), which indicates that the average US firm benefits from a depreciation of the US dollar.

The aforementioned studies for US firms exemplify the difficulty of providing evidence on exchange-rate exposure. Several studies find that firms in small and open economies are more sensitive to exchange-rate changes than firms in large and less open economies. Bodnar and Gentry (1993) examine exchange-rate exposure at industry level for Canada, Japan and the US over 1979-1988. For the US and Canada they find that respectively 11 out of 39 industries (28%) and 4 out of 19 (21%) have significant exchange-rate exposures. In contrast, the results for Japan indicate that 7 out of 20 industries (35%) are significantly exposed at the 10%-level. Bodnar and Gentry (1993) also test the hypothesis that small and open economies are more sensitive to exchange-rate exposure by investigating the inter-industry variance of the exposure coefficients. They find that the variance of the exposure coefficients is smaller for the US than for Canada and Japan. As the US is the largest and least open economy of the three countries, the results suggest that industries in smaller and more

open economies are likely to be more exposed to exchange-rate fluctuations. He and Ng (1998) study exchange-rate exposure of Japanese multinational firms over a period from 1978 to 1993. They find that 43 (25%) out of a total of 171 firms with a foreign sales ratio of at least 10% yield significant positive exposure coefficients at the 5%-level. In addition to the 43 firms with positive exposure, only 2 firms have significant negative coefficients, emphasizing the strong export orientation of the Japanese economy. Glaum, Brunner and Himmel (2000) measure the impact of the US dollar on German firms. The authors find that over the period 1974-1997 31% of the 71 firms are significantly exposed. In sub-periods, this percentage is lower and the authors conclude that the exposures are unstable over time. Nydahl (2001) studies exchange-rate exposure of Swedish firms with a foreign sales ratio of at least 10% and sufficient data on foreign direct investments and hedging activities. He finds that 19 out of 47 Swedish firms (40%) are exposed to exchange-rate risk (at the 10%-level) over the period 1990-1997. Nydahl (2001) finds a cross-sectional mean exchange-rate exposure of –0.11, which implies that on average Swedish firms lose value when the home currency depreciates. The author also uses 5 bilateral exchange rates chosen on the basis of their share of Swedish exports, their share of foreign direct investment and the use as an invoicing currency.

Two studies with a large set of international firms are Dominguez and Tesar (2001) and Doidge, Griffin and Williamson (2002). The latter study is the most comprehensive international study on exchange-rate exposure. Using individual firm data from over 27,000 stocks in 21 developed and 29 emerging markets, they still find surprisingly low exchange-rate sensitivity levels. Moreover, they detect quite some cross-sectional variation that cannot be explained fully by exchange-rate determinants. Interestingly, they find that exchange rates affect firm value mainly in periods of large exchange-rate changes. Dominguez and Tesar (2001) study over 2000 firms in 8 countries. The authors use a trade-weighted exchange-rate index, the US dollar and the currency of the largest trading partner. The results show that the trade-weighted exchange-rate index understates the exposure.

The aforementioned studies typically use a trade-weighted exchange-rate index as a proxy for a firm's exposure to individual exchange rates. Ideally, we would like to have information on the relevant exchange rates for each firm. While some studies (e.g. Dominguez and Tesar, 2001) use individual exchange rates, the selection is not based on firm-specific information. Ihrig (2001) constructs a company-specific

exchange-rate index using the number and location of each multinational's subsidiaries. Using this company specific exchange-rate index, she finds 16% of the firms to be significantly exposed to exchange-rate risk versus 10% when using a trade-weighted exchange-rate index.

3. Data

We focus on the exchange-rate exposure of all Dutch non-financial firms listed at Euronext Amsterdam and with stock-price data for at least three full years between January 1, 1994 and December 31, 1998. In total 117 firms meet this requirement. We mailed a questionnaire to the CFO or the treasurer of these firms.[1] The questionnaire was returned by 47 firms, yielding a total response rate of 40.2%. The response rate is high for a non-anonymous questionnaire.[2] The analyses in the next sections are based on the dataset of 47 firms. In the questionnaire, we pose three questions concerning the firm's exchange-rate exposure and its on- and off-balance hedging policies (see Appendix). In addition to the results of the questionnaire, we collect yearly firm-specific data from Worldscope and price information from Datastream.

We use Datastream stock-price data and exchange rates. For stock returns we use the total return index series. Furthermore, we use a trade-weighted Dutch guilder exchange rate based on a broad set of currencies that is compiled by JPMorgan and provided by Datastream.[3] In addition, we collect all relevant bi-lateral exchange rates from Datastream in order to calculate the firm-specific exchange rates. We use nominal exchange rates rather than real exchange rates. Due to the high

[1] First, we contacted the firms by telephone. Thereafter, we sent an initial questionnaire with a broad range of questions. In total, only 21 firms returned the questionnaire. Therefore, we sent a second questionnaire with a limited number of questions. In total 26 firms returned the second questionnaire. The first and the second questionnaire have three questions in common that we use in this study.

[2] To our knowledge, no study on exchange-rate exposure has yet used a questionnaire. However, we can compare our response rate with those of international studies on derivatives usage: for instance, Bodnar, Hayt and Marston (1998) generated a response rate of 21% and Loderer and Pichler (2000) report a response rate of 29%.

[3] Due to the introduction of the Euro in 1999 and the conversion of the foreign-exchange rates of participating countries in the preceding years, we use the broad based trade-weighted Dutch guilder index compiled by JPMorgan. This index encompasses 45 currencies. For the Netherlands, the following currencies have a weight over 5% in the index: Deutsche Mark (27.5%), Belgian Franc 10.7%, French Franc (9.7%), UK Pound (9.1%) and US Dollar (8.9)%. In many studies the currencies of the G-10 countries are used. However, with the introduction of the Euro half of the G-10 currencies are replaced. See Leahy (1998) for a discussion on foreign-exchange indices.

correlation between nominal and real exchange rates for low inflation countries this is not likely to bias our results.[4]

We calculate bi-weekly returns as log differences. Studies to date have looked at many different return horizons. We use bi-weekly data because of the noise in daily and weekly series. With daily data the problem of non-synchronous trading arises. There may be some non-alignment of stock returns and exchange-rate series. Due to the relatively short time horizon of five years and because we want to maintain power, we choose to focus on bi-weekly returns rather than on monthly data. We test for robustness using weekly and monthly data. For the monthly data we use data on the fifteenth day of each month in order to circumvent end-of-the-month effects as in Williamson (2001). We calculate weekly and bi-weekly returns from Wednesday to Wednesday in order to prevent an end-of-the-week effect. In case the fifteenth day or Wednesday is missing, we take the first following trading day available.

As is common in studies on exchange-rate exposure, we add a market index to reduce noise. Regarding the market index, we follow Bodnar and Wong's (1999) recommendation and use an equal-weighted market index for the Dutch stock market. The advantage of using this index over a value-weighted index is that the equal-weighted index has a much lower correlation with the exchange-rate index, which reduces the exchange-rate exposure reflected in the index.[5]

The sample-selection procedure is an important aspect in the analysis of exchange-rate exposure as it can strongly influence the results. In contrast to other studies we do not apply criteria to warrant that only international firms are included in our sample. We limit our time horizon to 1994-1998 for three reasons. First, we choose to focus on the pre-Euro period, as in 1999 the Euro was introduced in the Netherlands. Second, earlier studies (e.g., Jorion, 1990) have shown that exchange-rate exposure can be time varying. Therefore, measuring exposure over longer time horizons may lead to biased results. A third reason is that the relatively short time frame warrants that the respondents to the questionnaire will likely be able to fill in the questionnaire to a large extent based on their own tenure with the firm, which increases the accuracy of the responses.

[4] See Bodnar and Gentry (1993).

[5] Over our sample period, the correlation between the returns on the JPMorgan exchange-rate index and the equal-weighted market index is 0.34, while it is 0.49 for the value-weighted index.

4. The exchange-rate exposure of Dutch firms

In this section we discuss the results of our analysis of the exchange-rate exposure of Dutch firms. We first examine the exchange-rate exposure of the 47 firms that responded to our questionnaire using a trade-weighted exchange-rate index. Subsequently, we extend our exposure analysis by using firm-specific exchange rates.

4.1 Exposure to the trade-weighted exchange-rate index

In line with previous research in this area, we estimate the firm's exchange-rate exposure using the following model:

$$R_{it} = \beta_{0i} + \beta_{1i} R^{m}{}_{t} + \beta_{2i} FX^{JPM}{}_{t} + \varepsilon_{it} \qquad \text{for } t = 1, \ldots T \qquad (1)$$

where R_{it} is the rate of return on the ith firm's common stock in period t; $R^{m}{}_{t}$ is the return on the equal-weighted market portfolio in period t; and $FX^{JPM}{}_{t}$ is the return on the trade-weighted exchange-rate index, measured in guilders per unit of foreign currency in period t. Thus, an appreciation of the trade-weighted exchange-rate index implies a depreciation of the Dutch guilder. The regression coefficient, β_{2i}, measures the exchange-rate exposure.[6] We estimate equation (1) for each firm in our sample using Ordinary Least Squares (OLS) regressions. Because our data potentially exhibits autocorrelation and heteroskedasticity, we employ Newey and West (1987) standard errors. Table 1 presents the results of regressing the bi-weekly stock returns on the equal-weighted market index and the trade-weighted Dutch guilder.

[Insert Table 1 here]

Table 1 shows that 24 (51%) of the Dutch non-financial firms are significantly exposed to exchange-rate risk at the 10%-level and 18 firms (38%) are significantly exposed to exchange-rate risk at the 5%-level.[7] If we compare our results with previous studies, we can conclude that Dutch firms are more frequently exposed to

[6] However, as Adler and Dumas (1984) indicate, equation (1) does not imply a causal relationship between exchange rates and firm value as stock prices and exchange rates are endogenous variables that are determined jointly. Thus, for instance exchange-rate exposure may show the simultaneous impact of a monetary shock on stock prices and exchange rates.

[7] Many studies report exposures per industry. In our sample, 23 frms are from the manufacturing sector, 13 are from the services sector and 11 are from the trade sector. The presence of significantly exposed firms (at the 10%-level) hardly differ between industries. The percentages are respectively 52%, 54% and 45%.

exchange-rate changes. For example, Jorion (1990) finds only 5% of the US firms to be exposed, while He and Ng (1998) find that 26% of the Japanese firms exhibit significant exchange-rate exposure. Even if we compare our results with European studies, we also find that Dutch firms are more exposed. For instance, for Swedish firms Nydahl (2001) finds 26% of the firms to be significantly exposed.

The mean exposure coefficient in Table 1 is 1.55, indicating that the average Dutch firm in our sample gains 1.55% in value in case the guilder depreciates with 1%. Furthermore, of the total of 47 firms, 40 firms have a positive exposure coefficient. Most notably is that all 24 firms with significant exposure have positive exposure coefficients, ranging from 1.09 to 10.92.[8] Regarding the direction of exposure, the findings of earlier studies are mixed. Whereas Choi and Prasad's (39 firms with significantly positive coefficients versus 22 negative), He and Ng's (43 positive and 2 negative) and our results (all 24 firms have significantly positive coefficients) strongly indicate that on average firms benefit from a depreciation of the home currency, other studies show different results. For instance, Nydahl finds 6 firms with significantly positive and 6 firms with significantly negative exposure coefficients.

Our results, in combination with the sampling procedures, corroborate our hypothesis that in open economies, such as the Netherlands, firms exhibit more exchange-rate exposure compared to less open economies, such as the US.

4.2 Robustness analyses

In the previous analysis we use bi-weekly contemporaneous returns and assume that exposure is constant over the five-year horizon. In order to test the robustness of our results, we perform several sensitivity tests. First, we measure exchange-rate exposure using weekly and monthly data. The results are presented in Table 2.

[Insert Table 2 here]

Table 2 shows that on the basis of weekly data (column 1) 25 firms out of 47 (53%) are significantly exposed to exchange-rate risk at the 10%-level. When comparing the

[8] The exposure coefficients of the three firms with the largest exposures are 10.93, 6.48 and 3.63. We cannot provide details about these firms because we ensured anonimity to the firms. However, the

bi-weekly results with the weekly results, we find that 21 out of 24 firms (88%) that are significantly exposed on the basis of bi-weekly data are also significantly exposed to exchange-rate risk on the basis of weekly data. Conversely, only three firms that are exposed on a bi-weekly basis are not exposed on a weekly basis. All 21 firms with significant exchange-rate exposure coefficients on the basis of weekly and bi-weekly data have the same (positive) signs. For monthly data, Table 2 (column 2) indicates that 21 firms (45%) are significantly exposed to exchange-rate risk at the 10%-level when using monthly data. When comparing the bi-weekly results with the monthly results, 13 out of 21 firms (62%) that are significantly exposed to exchange-rate risk on the basis of bi-weekly data are also significantly exposed on the basis of monthly data. All coefficients have the same (positive) signs. This analysis shows that the exposure and especially the sign pattern seem consistent over the weekly, bi-weekly and monthly return horizons.

While we use contemporaneous returns, previous studies in the US, notably Bartov and Bodnar (1994) and Amihud (1994), have found significant relationships between lagged exchange-rate changes and stock returns. Such lags suggest that it takes time before the impact of exchange-rate changes is reflected in stock prices and suggests market inefficiency. We test for lagged responses by the following extension of equation (1):

$$R_{it} = \beta_{0i} + \beta_{1i}R^{m}{}_{t} + \beta_{2i}FX^{JPM}{}_{t} + \beta_{3i}FX^{JPM}{}_{t-1} + \beta_{4i}FX^{JPM}{}_{t-2} + \varepsilon_{i.}$$
$$for\ t = 1, \ldots. T, \qquad (2)$$

The results are reported in Table 2 (columns 3, 4, and 5) and repeat that 24 out of 47 firms are significantly exposed at the 10%-level on the basis of contemporaneous exchange-rate changes. Out of these 24 firms, 8 firms also show significant exposure at a one-period lag. None of these firms exhibits significant exposure at a two-period lag.[9] Hence, our results suggest that for Dutch firms the contemporaneous effect of exchange-rate changes on stock returns is most important. Our findings contrast with those of Bartov and Bodnar (1994) and Amihud (1994), but are in line with recent studies by He and Ng (1998) and Nydahl (2001).

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three firms have in common that most of their revenues are denominated in a foreign currency, while most costs are in Guilders. This combination induces the large exposures we detect.

[9] In addition, 3 firms are exposed at a one-period lag, but have no contemporaneous exposure. At a two-period lag 10 firms exhibit significant exposure. However, of these 10 firms only 4 are also significantly exposed to the contemporaneous exchange rate.

Our final robustness test investigates the consistency of the exposures over the five years of our sample period. An important result from previous studies is that exposure is time varying. We therefore test whether the exposure signs are consistent on a yearly basis. From the sample of 47 firms, 44 firms have sufficient yearly data on a weekly basis to calculate yearly exposure coefficients. In total, 19 of the 44 firms (43%) have the same sign in each of the five years. Furthermore, 10 firms (23%) have the same sign in four out of five years and the coefficient of the opposite sign is very often only very small. These results indicate that the exposure signs are to a large extent consistent over the full period of five years. Besides, in this sample of 44 firms, 21 firms have significant exchange-rate exposure over the full five-year period. Of these 21 firms, 16 firms (76%) have the same sign in each of the individual years of the total five-year period.

4.3 Exposure to firm-specific exchange rates

An important drawback of most previous empirical studies on exchange-rate exposure is the use of a trade-weighted exchange-rate index as a proxy for firm-specific exchange rates. When examining an individual firm's exchange-rate exposure it is not the exchange-rate index that is relevant, but the individual bilateral exchange rates the firm is exposed to. Therefore, an obvious way for improving the estimation of exchange-rate exposure seems to use firm-specific exchange rates.[10]

Through our questionnaire we gathered data on firm-specific exchange rates. We asked the firms to indicate which (up to) three foreign currencies had the largest impact on firm value over 1994-1998.[11] In total, 35 firms responded to this question. Out of the 35 firms, 33 (94%) mentioned the US dollar (USD) as one of the three most important currencies. With 23 firms (66%) mentioning the British pound (GBP), this is the second most often-mentioned foreign currency. The Japanese yen and the Swedish crone follow in third place as they are both mentioned by 5 firms (14%). These figures indicate the large influence of two currencies, the US dollar and the British pound, on firm value of Dutch non-financials. Both currencies are from outside the Euro-zone. This implies that the introduction of the Euro in 1999 will

[10] Doidge, Griffin and Williamson (2002) suggest that a "… promising avenue for future research would be to define the appropriate exchange rates at the individual firm level" (p.12).

[11] Loderer and Pichler (2000) provide survey evidence on the ability of financial managers to estimate currency exposures. The results show that managers are hardly able to quantify their exposures. In

most probably have had limited influence on our analysis over the 1994-1998 period, even though some conversion between the EU-currencies may have taken place before the actual introduction of the Euro.

In order to test the influence of the individual exchange rates we adapt equation (1) to include up to three exchange rates:

$$R_{it} = \beta_{0i} + \beta_{1i}R^{m}{}_{t} + \beta_{2i}FX^{A}{}_{t} + \beta_{3i}FX^{B}{}_{t} + \beta_{4i}FX^{C}{}_{t} + \varepsilon_{i}$$
$$\text{for } t = 1, \ldots T, \qquad (3)$$

where $FX^{A}{}_{i}$ is the return in period t of the exchange rate mentioned in the questionnaire under A by firm i, and $FX^{B}{}_{i}$ and $FX^{C}{}_{i}$ respectively refer to the return of the currencies mentioned under B and C in the questionnaire. The results are reported in Table 3.

[Insert Table 3 here]

The first column in Table 3 shows the results for the US dollar in equation (3). For the 33 firms that indicate to have USD exposure, we find 8 (24%) firms with a significant exposure. All significant exposures have a positive sign, indicating the importance of the US dollar for the Dutch economy. The results for the British pound are reported in the second column. We find that 5 (22%) firms are significantly exposed. An interesting result is that we find more firms with a negative exposure than with a positive exposure to the British pound. In the third column we aggregate the results for the other currencies. We find 8 (26%) firms out of 31 that have significant exposures.

In the sample of 35 firms that provided information on firm-specific currencies, we find that 17 firms, or 49%, have at least one currency with significant exchange-rate exposure. A comparison with the results for the trade-weighted exchange-rate index in equation (1) shows that 16 of the 35 (46%) firms have a significant exposure to this index. Although these findings suggest that the results of the two approaches are comparable, this is not the case. Out of the 16 firms *with* a significant exposure to the index, 8 firms have at least one significant exposure in the regressions with individual currencies. Thus, the remaining 8 firms are only exposed to the index and not to the exchange rates reported by the firms. When we consider

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our study we do not require managers to quantify their exposures, but merely to mention the

the 19 firms *without* a significant exposure to the index, we find 10 firms with no significant exposure to one of the individual currencies. Thus, the remaining 9 firms are only exposed to one of the individual currencies and not to the index. This result indicates that the two approaches are complements. Four sets of firms can be distinguished. The first set of 10 firms (29%) is not exposed to the trade-weighted index nor to individual currencies. The second set consists of 8 firms (23%) that are only exposed to the index. Apparently, for those firms the index better matches the relevant exchange rates than individual currencies can. The third set contains 9 firms (26%) with only an exposure to one or more individual currencies. For this group of firms the index does not capture the relevant currencies. As expected, in this group of 9 firms, we find 7 firms with an exposure to a currency other than the US dollar.[12] Finally, the fourth set consists of 8 firms (23%) with an exposure to both the index and individual currencies.[13]

The results for individual currencies show that this approach and the use of a trade-weighted exchange-rate index are complements. About half of the firms *without* a significant exposure based on the trade-weighted index have a significant exposure for at least one of the individual exchange rates. In contrast, half of the firms *with* a significant exposure based on the trade-weighted index have no significant exposure for the individual exchange rates. These results imply that financial managers should both investigate the influence of their home currency against a broad basket of currencies and investigate the exchange rates that are specifically relevant to the firm.

5. The determinants of exchange-rate exposure

So far, our analysis has focused on the measurement of the exchange-rate exposure of Dutch firms. The results indicate that exchange-rate exposure is significant for 51% of

currencies that are expected to influence firm value.

[12] The correlation between the trade-weighted exchange-rate index and the US dollar is 0.88.

[13] In order to determine whether the exchange-rate index has added value to the individual currencies, we add the index to the specification in equation (3). In case the *t*-value of the coefficient for the index is significant, the index has additional explanatory power. In total we find that 8 firms have *t*-values significant at the 10%-level. As expected, 4 firms are in the second set, where only the index matters. Most interesting is that the other 4 firms are in the group of 8 firms with an exposure to both the trade-weighted index and the individual currencies.

the firms. Because there is much variation in exposure between the firms, it is interesting to examine the determinants of exchange-rate exposure. This allows us to explain and predict which factors increase or decrease the exposure. In this section we will first describe the factors that are expected to drive exchange-rate exposure. Then, we specify our econometric model. Finally, we measure the determinants for our sample.

5.1 Empirical evidence and hypotheses

An important source of exchange-rate exposure is formed by a firm's foreign activities. We expect foreign sales to increase a firm's exposure, because foreign revenues are generally denominated in foreign currency. We hypothesize that the higher the percentage of foreign sales in relation to total sales, the higher the exchange-rate exposure. Using samples of US multinationals, Jorion (1990) and Choi and Prasad (1995) find the expected positive effect of the foreign sales ratio on exchange-rate exposure.

Firm size is not a direct source of exchange-rate exposure. Typically, larger firms are more internationally oriented and therefore have more exposure than smaller firms. Larger firms also more often are multinationals. In contrast, smaller firms tend to be more domestically focused. We hypothesize that firm size has a positive effect on exchange-rate exposure. Choi and Prasad (1995) and Allayanis and Ofek (2001) find a significant positive effect of size on exposure.

Firms that are exposed to exchange-rate risk can actively reduce currency risk along two lines. First, firms can hedge exchange-rate risk by entering into derivatives contracts, such as forwards, futures or options. We hypothesize that hedging with these off-balance sheet contracts has a negative effect on exchange-rate exposure (see also Allayanis and Ofek, 2001, and Nydahl, 2001). The second measure a firm can take to reduce its exposure is through on-balance sheet hedging. On the asset side, firms can move factories to its sales markets and as a result revenues and expenses are incurred in the same currency. On the liability side, firms can engage in loan contracts in a foreign currency that creates an outflow offsetting foreign currency inflows in the same currency. We hypothesize that on-balance sheet hedging has a negative effect on exchange-rate exposure.

He and Ng (1998) investigate the determinants of exposure for Japanese firms, but include no direct measure of hedging activity. Instead, the authors define

an indirect measure by choosing variables that are hypothesized to explain hedging. Their results for dividends, the quick ratio, book-to-market and leverage confirm expectations. Unfortunately, the indirect variables may partly represent direct determinants of exposure, which makes the findings difficult to interpret. Nydahl (2001) investigates the determinants of exposure for Swedish firms and includes survey data for a single year on derivative usage (futures, swaps and options) and foreign debt. Unfortunately, only the currency positions in monetary values are reported. For example, off-balance and on-balance instruments are included on an equal basis, while the sensitivity to currency changes of off-balance instruments is expected to be much higher. For on-balance hedging on the asset side, the fraction of foreign wages is included. The variable is strongly biased towards service-oriented firms and against manufacturers. The results show that hedging significantly reduces the exposure. Allayannis and Ofek (2001) collect detailed information on the use of currency derivatives in US firms in 1993. SFAS 105 requires firms to disclose information on financial instruments, which allows Allayannis and Ofek (2001) to calculate the notional value of the contracts. The results indicate a strong negative relation between derivatives and exposure.

5.2 Data and variables

In order to measure the foreign sales ratio and firm size we use data from Worldscope over the period 1994 to 1998 for the 47 firms we examine in section 4. In case of missing data we use annual reports. Foreign sales (FS) is defined as the amount of sales in foreign countries, divided by total sales of the firm. The average foreign sales ratio is 0.40. The standard deviation is 0.32 and 10 firms have no foreign sales. Firm size (SIZE) is the logarithm of the book value of total assets. On average the value of total assets is circa US$ 1.7 billion, with a standard deviation of US$ 3.4 billion.

Since information on both on- and off-balance sheet hedging is not publicly available in The Netherlands, we gathered this information through our questionnaire. By asking the firms directly to indicate which part of their exchange-rate exposure they hedged on- and off-balance, we obtain a unique dataset.

Our first question in the questionnaire concerns the percentage of exchange-rate exposure that is hedged with derivatives, in each of the five years from 1994 to 1998. Per firm, we use the average over the period. On average, the percentage of off-balance sheet hedging (OFFHEDGE) is 0.25 with a standard

deviation of 0.36. In total, 26 (55%) firms indicate that they use no derivatives. This finding is more or less similar to Bodnar, De Jong and Macrae (2002), who find that 43% of the Dutch firms don't use currency derivatives. Our second question asks what percentage of total exposure the firm hedges through its operations. As examples foreign currency loans and moving factories abroad are provided. On average, the percentage of on-balance sheet hedging (ONHEDGE) is 0.19 with a standard deviation of 0.34. In total, 28 (60%) firms indicate that they do not use balance-sheet items for hedging purposes. Of these 28 firms, 12 firms use derivatives and 16 firms do not hedge at all.

5.3 Regression analyses

The goal of our regression model is to explain the firm's exposures that are obtained with the basic regressions in section 4. An obvious solution is a two-step approach. In the first step, exposures are estimated. In the second step, the determinants of the exposure are regressed on the estimated exposures. In order to measure the determinants of currency exposure in the second step, the following regression model is tested:

$$B_{2i} = \gamma_0 + \gamma_1 FS_i + \gamma_2 SIZE_i + \gamma_3 OFFHEDGE_i + \gamma_4 ONHEDGE_i + u_i$$
$$\text{for } i = 1, \ldots N \qquad (4)$$

where B_{2i} is the exposure of firm i, i.e the estimate for β_{2i} in equation (1), FS_i is the foreign sales ratio, $SIZE_i$ is firm size, $OFFHEDGE_i$ is the percentage off-balance sheet hedging and $ONHEDGE_i$ is the percentage on-balance sheet hedging. Jorion (1990) argues that the two-step estimation with Ordinary Least Squares (OLS) leads to dependence between B_{2i} across the equations in (1), because the coefficients are estimated over the same sample period. As a result the estimation of equation (4) violates the OLS assumption that error terms are not correlated. This yields biased standard errors in equation (4). Jorion (1990) suggests to use a one-step approach. We substitute equation (4) into (1) and obtain:

$$R_{it} = \beta_{0i} + (\gamma_0 + \gamma_1 FS_i + \gamma_2 SIZE_i + \gamma_3 OFFHEDGE_i +$$
$$\gamma_4 ONHEDGE_i) FX_t + \beta_{1i} R^m{}_t + \varepsilon_{it} \text{ for } t = 1, \ldots T \text{ and } i = 1, \ldots N \qquad (5)$$

Equation (5) can be estimated jointly for all firms in one step using a system of Seemingly-Unrelated Regressions (SUR).[14] The results of the SUR model are reported in Table 4.

[Insert Table 4 here]

In the first column of Table 4 we estimate the SUR model in equation (5) with a constant β_0 over all firms. In the model in the second column we introduce firm-fixed effects. The results are very similar. The adjusted R-squared of the regressions are acceptable. As a robustness check we also follow the two-step approach and separately estimate equations (1) and (4). The results are similar, as the coefficients have the same sign. However, the standard errors are smaller, which is probably due to the low number of observations in the second step.

The result in the first column for the coefficient γ_1, describes the impact of foreign sales on exposure. The estimate for the coefficient is 0.646, which implies a positive effect of foreign sales on exchange-rate exposure. The *t*-value is 2.39 and the coefficient is significantly different from zero at the 5%-level. Firm size is significantly positive, at the 1%-level. The results for foreign sales and firm size are in line with our hypotheses and similar to findings of Jorion (1990) and Choi and Prasad (1995).

The sensitivities for off-balance sheet hedging are positive, yet insignificant. This finding contrasts with our hypothesis that hedging reduces exposure. Our results also contrast with the conclusions of Nydahl (2001) and Allayanis and Ofek (2001), who find a significant negative effect. Our explanation for the absence of the expected positive effect is twofold. First, firms that are confronted with economic exposure hardly ever choose to fully eliminate this risk. Survey results by Bodnar, De Jong and Macrae (2002) show that both Dutch and US firms tend to use derivatives to hedge the risk of contractual commitments and short-term anticipated transactions. On the other hand, long-term anticipated transactions and competitive exposure are far less hedged with derivatives. This survey evidence explains why firms with higher exposure are more likely to hedge, without actually reducing the economic exposure that is measured in the regression analysis. A second

[14] We eliminate outliers, defined as observations with an exposure outside the interval of the mean plus

explanation for our findings is the lack of information about hedging with derivatives that is provided to investors. The information in annual reports normally does not allow investors to predict the outcomes of derivatives usage. Thus, as information on hedging is not freely available, it is not surprising that investors are not fully aware of the firms' hedging programs, as a result of which this information is not fully impounded in stock prices.

Hedging with on-balance sheet instruments has the hypothesized negative effect, and is significant at the 5%-level. This implies that Dutch firms successfully reduce their exposures with foreign assets and liabilities. An obvious question is why this effect does show up in our results, in contrast to derivatives usage. Again, we suggest that the explanation is twofold. First, on-balance sheet hedging has a long-term orientation. Moving production facilities abroad and using foreign debt has an impact over a far longer time horizon than the (average) maturity of derivative contracts. Therefore, on-balance sheet hedging is more likely to be related to economic exposure, while off-balance hedging is more linked to reducing transaction exposure. Second, on-balance hedging is more visible in annual accounts and thus allows a better judgment by investors about the effects on currency exposure.

6. Conclusion

We examine the relationship between exchange-rate changes and stock returns for a sample of Dutch non-financial firms between 1994 and 1998. We find that more than 50 percent of the firms are significantly exposed to exchange-rate risk. Furthermore, all firms with significant exchange-rate exposure benefit from a depreciation of the Dutch guilder. The results confirm that firms in an open economy exhibit far more exchange-rate exposure than firms in less open economies. We use a questionnaire to gather firm-specific data on the three most important foreign currencies and on the firm's hedging policies. Our results indicate that the use of a single trade-weighted basket of currencies and the use of individual exchange rates are complements. We also measure the determinants of exchange-rate exposure. With respect to the determinants of exposure, we find total assets and the foreign sales ratio to be

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or minus four times the standard deviation. One observation is removed.

significantly and positively related to the firms' exchange-rate exposure. In contrast with expectations, derivatives usage (off-balance hedging) has no significant effects. Finally, exposure is significantly reduced by the use of foreign loans and foreign operations (on-balance sheet hedging).

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Table 1: Distribution of bi-weekly exchange-rate exposure coefficients

Regression analysis (OLS) for exchange-rate exposure coefficients, β_{2i}, using equation (1): $R_{it} = \beta_{0i} + \beta_{1i} R^{m}_{t} + \beta_{2i} FX^{JPM}_{t} + \varepsilon_{it}$, where R_{it} is the bi-weekly stock return of firm i in period t, R^{m}_{t} is the bi-weekly return of the equal-weighted CBS index of the Dutch stock market in period t, FX^{JPM}_{t} is the bi-weekly return of the trade-weighted currency index for the Dutch guilder in period t. The data represents observations of 47 firms from 1994 to 1998. The standard errors are corrected for heteroscedasticity and autocorrelation according to Newey and West (1987).

	β_{2i}
Minimum	-1.04
First quartile	0.51
Median	1.39
Third quartile	2.11
Maximum	10.92
Cross-sectional mean	1.55
Cross-sectional standard deviation	1.91
Firms with significant exposure at the:	
1%-level	9
5%-level	18
10%-level	24
Firms with positive significant exposure at 10%-level	24
Firms with negative significant exposure at 10%-level	0

Table 2: Robustness analyses for return horizon and lagged effects

Columns (1) and (2) contain results of regression analysis (OLS) for exchange-rate exposure coefficients, β_{2i}, using equation (1): $R_{it} = \beta_{0i} + \beta_{1i} R^m_t + \beta_{2i} FX^{JPM}_t + \varepsilon_{it}$, where R_{it} is respectively the weekly (column 1) and monthly (column 2) stock return of firm i in period t, R^m_t is respectively the weekly (column 1) and monthly (column 2) return of the equal-weighted CBS index of the Dutch stock market in period t, FX^{JPM}_t is respectively the weekly (column 1) and monthly (column 2) return of the trade-weighted currency index for the Dutch guilder in period t. In columns (3), (4) and (5) are regressions for contemporaneous, β_{2i}, and lagged exchange-rate effects, β_{3i} and β_{4i} , for equation (2): $R_{it} = \beta_{0i} + \beta_{1i} R^m_t + \beta_{2i} FX^{JPM}_t + \beta_{3i} FX^{JPM}_{t-1} + \beta_{4i} FX^{JPM}_{t-2} + \varepsilon_i$. The data represents observations of 47 firms from 1994 to 1998. The standard errors are corrected for heteroscedasticity and autocorrelation according to Newey and West (1987).

	Return horizon		**Lagged effects**		
	(1) β_{2i} **weekly data**	**(2)** β_{2i} **monthly data**	**(3)** β_{2i} **contempo-raneous**	**(4)** β_{3i} **first lag**	**(5)** β_{4i} **second lag**
Minimum	-0.83	-3.81	-1.32	-3.41	-1.64
First quartile	0.37	0.48	0.56	0.23	-0.16
Median	1.28	1.44	1.41	0.59	0.36
Third quartile	1.83	2.05	1.94	1.39	1.13
Maximum	5.83	4.83	11.05	3.58	3.28
Cross-sectional mean	1.24	1.19	1.55	0.76	0.48
Cross-sectional standard deviation	1.23	1.60	1.91	1.11	1.07
Firms with significant exposure at the:					
1%-level	17	6	9	2	2
5%-level	21	14	19	8	7
10%-level	25	21	24	10	11
Firms with positive significant exposure at 10%-level	25	17	24	9	8
Firms with negative significant exposure at 10%-level	0	4	0	1	3

Table 3: Distribution of exchange-rate coefficients for firm-specific currencies

Regression analysis (OLS) for exchange-rate exposure coefficients using equation (3): $R_{it} = \beta_{0i} + \beta_{1i}R^{m}_{t} + \beta_{2i}FX^{A}_{t} + \beta_{3i}FX^{B}_{t} + \beta_{4i}FX^{C}_{t} + \varepsilon_{i,}$ where R_{it} is the bi-weekly stock return of firm i in period t, R^{m}_{t} is the bi-weekly return of the equal-weighted CBS index of the Dutch stock market in period t, and FX^{A}_{t}, FX^{B}_{t}, and FX^{C}_{t} are the bi-weekly returns of the firm-specific exchange rates in period t. The data represents observations of 35 firms from 1994 to 1998. The standard errors are corrected for heteroscedasticity and autocorrelation according to Newey and West (1987).

	USD	**GBP**	**Other currencies**
Minimum	-0.42	-0.71	-5.01
First quartile	-0.11	-0.13	-0.44
Median	-0.36	-0.25	-0.07
Third quartile	0.67	0.53	0.45
Maximum	5.41	1.37	5.86
Cross-sectional mean	0.67	0.19	-0.15
Cross-sectional standard deviation	1.17	0.55	1.76
Number of observations	33	23	31
Firms with significant exposure at the:			
1%-level	1	0	1
5%-level	3	1	6
10%-level	8	5	8
Firms with positive significant exposure at 10%-level	8	2	6
Firms with negative significant exposure at 10%-level	0	3	2

Table 4: Determinants of exchange-rate exposure

Regression analysis (SUR) for determinants of exposure for equation (5): $R_{it} = \beta_{0i} + (\gamma_0 + \gamma_1 FS_i + \gamma_2 SIZE_i + \gamma_3 OFFHEDGE_i + \gamma_4 ONHEDGE_i) FX^{JPM}_t + \beta_{1i} R^m_t + \varepsilon_{it}$, where R_{it} is the bi-weekly stock return of firm i in period t, R^m_t is the bi-weekly return of the equal-weighted CBS index of the Dutch stock market in period t, FX^{JPM}_t is the bi-weekly return of the trade-weighted currency index for the Dutch guilder in period t. FS_i is foreign sales ratio and $SIZE_i$ is the logarithm of the book value of total assets (Worldscope). $OFFHEDGE_i$ ($ONHEDGE_i$) is the percentage of exposure hedged with off-balance (on-balance) sheet instruments, obtained from the questionnaire. Model (1) is the SUR-estimation of equation (5) without firm-fixed effects and model (2) includes firm-fixed effects. The coefficients for β_{0i}, β_{1i} and the firm-fixed effects are not reported. The data represents observations of 46 firms from 1994 to 1998. *t*-values are in parentheses. ** and *** indicate significant coefficients at the 5% and 1%-level respectively.

Coefficient (Variable)	**Model (1)**	**Model (2)**
γ_0 (FX_t)	-2.706	-2.678
	(-3.17)***	(-3.14)***
γ_1 (FS_i FX_t)	0.646	0.622
	(2.39)**	(2.302)**
γ_2 ($SIZE_i$ FX_t)	0.610	0.608
	(3.97)***	(3.96)***
γ_3 ($OFFHEDGE_i$ FX_t)	0.289	0.271
	(1.01)	(0.95)
γ_4 ($ONHEDGE_i$ FX_t)	-0.492	-0.478
	(-2.05)**	(-2.01)**
Observations	5809	5809
Cross-sections	46	46
Adjusted R-squared	0.072	0.077
Fixed effects	NO	YES

Appendix: Questionnaire regarding the exchange-rate exposure of Dutch non-financial listed firms

1. What percentage of total exchange-rate exposure did you hedge with derivatives during the period 1994 – 1998? Please fill in a percentage between 0 – 100% for each year. If you don't know the answer, please indicate with an X.

1994: ……% 1995: ……% 1996: ……% 1997: ……% 1998: ……%

2. What percentage of total exchange-rate exposure did you hedge operationally during the period 1994 – 1998? (for instance through loans in foreign currency or through opening factories abroad with the special purpose to hedge your exchange rate risk). Fill in a percentage between 0 –100%. If you don't know the answer, please indicate with an X.

1994: ……% 1995: ……% 1996: ……% 1997: ……% 1998: ……%

3. Which three currencies (excluding the Euro: this currency was introduced in 1999) had the largest impact on the stock price (firm value) of your firm during the period 1994 – 1998? (In case the stock price was influenced by less than three currencies, please only mention these currencies. If no currency had an impact on the stock price, please indicate with an X at 'none' and return the questionnaire.

Currency A: ……
Currency B: ……
Currency C: ……
None: ……

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