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Measuring the economic importance of exchange rate exposure

Craig Doidge [a], John Griffin [b,*], Rohan Williamson [c]

[a] *Rotman School of Management, University of Toronto, Canada*
[b] *McCombs School of Business, University of Texas, Austin, USA*
[c] *McDonough School of Business, Georgetown University, Washington, DC, USA*

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Abstract

This paper re-examines the nature and the economic significance of the exchange rate to firm value relation using a database of non-financial firms from over 18 countries. Our main contribution is to apply a portfolio approach to investigate the economic importance of exposure. We find that firms with high international sales outperform those with no international sales during periods of large currency depreciations by 0.72% per month, whereas they underperform by 1.10% per month during periods of large currency appreciations. In contrast to the previous literature, our evidence shows that exchange rate movements can have an economically significant impact on firm value.

JEL classification: F31; F37; G15
Keywords: Exchange rate exposure; Firm value

While finance theory, firm-level survey results, and common intuition strongly support the notion that firm value is sensitive to exchange rate movements, empirical support is mixed. Studies that examine exchange rate exposure generally find some evidence of a relation between exposure and its theoretical determinants but that the economic importance of this relation is small. In this paper, we use firm-level data from 18 countries to systematically examine the nature of exposure around the world. To assess the economic magnitude of exchange rate exposure, we use a portfolio approach that is new to the exposure literature. Our main result is that exchange rates play an economically sizeable role in explaining stock returns.

* Corresponding author.
E-mail address: John.griffin@mccombs.utexas.edu (J. Griffin).

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Prior studies in the empirical exposure literature have primarily focused on estimating exposure in a regression framework and testing whether the estimated exposure betas are consistent with the theoretical determinants of exposure. Jorion (1990) finds evidence of significant exchange rate exposure and shows that the level of foreign sales is the main determinant of exchange rate exposure for large U.S. multinational firms. However, Amihud (1994) and Bartov and Bodnar (1994) find no evidence of contemporaneous exposure for U.S. multinationals, although Bartov and Bodnar do show that U.S. firms respond to past quarterly exchange rate movements. Using a sample of Japanese firms, He and Ng (1998) uncover a strong contemporaneous relation between foreign sales and exposure but find no evidence of a lagged relation. Dominguez and Tesar (2001, 2006) find a link between foreign activity and exposure in a sample of firms from eight non-U.S. countries, including Japan.

The various findings regarding the nature of the exposure relation highlight the need for a systematic comparison of exchange rate exposure across time, countries, and determinants. To this end, we expand the investigation of the nature of the relation between exposure and firm characteristics by using unique firm-level data with broad coverage across markets. Our study begins with the linear regression framework that is traditionally used in the exposure literature. Consistent with the previous literature, we find that the number of firms that are exposed to exchange rate movements is greater than what can be attributed to chance, but that exchange rate movements are often not statistically or economically important. We then evaluate whether exchange rate exposure varies in a manner consistent with firm-level characteristics such as international sales, foreign income, foreign assets, and firm size and find that international sales is most reliably related to exposure.

A common finding in the empirical exposure literature is that exchange rate movements do not explain a large proportion of the variation in stock returns. Although it is not the focus of the analyses, Jorion (1990) and Bartov and Bodnar (1994) find that exchange rates have low explanatory power (as measured by R^2) for explaining individual stock returns. Griffin and Stulz (2001) demonstrate that in a variety of settings, exchange rate movements explain only a small amount of movement in international industry (and U.S. individual) stock returns. Our results based on the regression framework provide a broader confirmation of previous evidence that exchange rate movements do not explain much of the variation in individual firms' stock returns.

The main contribution of this paper is to employ a portfolio approach to measure the economic importance of exposure. Evidence that suggests the economic importance of exposure is small is based on calculating the fraction of the variation of firms' stock returns that are related to exchange rate movements. For some applications, such as hedging, a firm-level perspective may be relevant. However, from the perspective of a portfolio manager, an investor who holds a diversified portfolio, or simply an economist who wishes to assess the average relation between firm value movements and exchange rates, the relevant issue is whether exchange rate movements affect the returns on certain groups of stocks more than others.

To evaluate the economic impact of exchange rate movements on stock returns, we form portfolios that are long in firms with high international sales and short in firms with no international sales. This approach, which has not been used in the existing exposure literature, has two main advantages. First, it focuses on returns rather than changes in the adjusted R^2. If exchange rates impact firms with high international sales and firms with no international sales differently, then the difference in returns between these groups of firms should be an informative gauge of the impact of exchange rates on firm value. Second, the regression framework assumes that exposures are linear and constant, which is unlikely to be true in many cases. The portfolio approach allows exposures to be both non-linear and time varying.

Consistent with theory, we find that during periods of large currency depreciations (appreciations), firms with high international sales outperform (underperform) those with no international sales in 14 of 18 (16 of 18) countries. Although the magnitude of these effects varies widely across countries, during periods of large currency depreciations, the average difference in returns between the high and no international sales portfolios is 0.72% per month, whereas during currency appreciations these same firms underperform by an economically and statistically significant −1.10% per month. When we use these portfolios in a regression, we find that, overall, a 1% appreciation in the home currency leads to a 0.21% loss in firm value for firms with high international sales as compared to firms with no international sales.

We also find that these patterns are present in both high and low book-to-market equity firms but are concentrated in large firms. This suggests that our findings are not driven by some risk or behavioral explanation related to book-to-market equity or small cap firms. One problem with our portfolio sorts on international sales is that some firms with international sales have offsetting exposures if they also have operations abroad. Further, firms with no international sales may face significant exposures if they face foreign competitors. To address this issue, we directly form portfolios based on firms' past (estimated) exchange rate exposures. Such an analysis allows us to gauge whether our sorts on international sales truly capture firms with exchange rate exposure. The results of the direct sorts on past exposures are consistent with the results based on international sales sorts: during periods of large currency depreciations, the average difference in returns is 0.22% per month, whereas during currency appreciations the difference is an economically and statistically significant −1.40% per month.

Our findings provide evidence that exposure does vary systematically with international activity and that these relations are important for understanding variation in stock returns. Our results are particularly strong since we are only able to measure exposure net of firms' operational and financial hedging activities. These findings have implications for the international asset pricing literature in that showing that exposure broadly affects groups of stocks makes it possible that exposure can also be priced. The results should also be of interest in the many applications that seek to understand the sources of cross-sectional and time-series variation in stock returns.

The remainder of the paper is organized as follows. Section 1 connects our approach to the theoretical and empirical literature that examines the relation between firm value and exchange rate movements. Section 2 describes the data, shows some basic properties of its coverage, and displays basic firm-level regression results for all firms. Section 3 relates exposure betas to its determinants through cross-sectional regression analysis. Section 4 presents portfolio returns during different periods of currency movements for portfolios that are long firms with high international sales and short firms with no international sales. Section 5 briefly examines some remaining issues related to exposure, and Section 6 concludes.

1. Exchange rate exposure and firm value

1.1. Theoretical review

The theoretical exchange rate exposure literature supports the common belief that exchange rate changes should impact firms through various mechanisms, including imports and exports from foreign markets. Shapiro (1975) argues that a multinational firm with export sales and foreign competition should exhibit exchange rate exposure and that the firm's exposure should be related to the proportion of export sales, the level of foreign competition, and the degree of substitutability between local and imported factors of production. Levi (1994) supports these

ideas by showing that the main impact on the value of a multinational firm is the profitability of sales in the foreign country; Marston (2001) demonstrates that net foreign revenues are the main component of a firm's exchange rate exposure. Marston also argues that for an oligopolistic firm, exposure is a function of the firm's own elasticity of demand and the cross-elasticity of demand with its competitors.[1] Bodnar et al. (2002) show that pass-through can impact exchange rate exposure because firms with inelastic demand can pass price changes on to consumers. Allayannis and Ihrig (2001) argue that industry markup and competition play key roles in exposure and show that low markup U.S. industries have high exchange rate exposure. While the exchange rate exposure literature demonstrates that exposure can be non-linear, offsetting within a firm, and multifaceted, the theory also points to an economically important relation between exchange rates and firm value.

Over the past 30 years, firms and industries that were once national have become more global, resulting in large increases in international activity. Additionally, large real exchange rate changes followed the breakdown of the Bretton Woods system in 1973. These deviations in exchange rates away from purchasing power parity have an average half-life of 4 or 5 years (Froot and Rogoff, 1995) and lead to large movements in price markups and profit margins (Knetter, 1993; Froot and Klemperer, 1989). These factors all suggest that exchange rate movements should have a measurable effect on firm value.

1.2. Our approach relative to the empirical literature

Theory suggests that the exposure relation can be complex, while empirical data related to exposure determinants are limited. Nevertheless, we are able to obtain firm-specific proxies for exposure determinants such as sales from foreign production, sales exported abroad, foreign income, and foreign assets.[2] A major advantage of our study is that the data are gathered from a consistent source across firms and countries, which facilitates cross-country comparisons.

Most empirical exposure studies focus on U.S. firms (e.g., Jorion, 1990; Bartov and Bodnar, 1994) or international industries (e.g., Bodnar and Gentry, 1993; Griffin and Stulz, 2001; Bodnar et al., 2002). A potential problem with examining only U.S. firms is that they may differ widely in their exposure even after controlling for the level of foreign sales. Indeed, recent studies show more evidence of exposure in industries and firms outside the U.S. (e.g., Bodnar and Gentry, 1993; Griffin and Stulz, 2001; Dominguez and Tesar, 2001). Examining exposure at an industry level is potentially problematic, as a movement in exchange rates may lead to offsetting affects on net importing and exporting firms within an industry.[3] To address these concerns, we examine exposure using a large sample of individual firm data from 18 different countries.

This is not the only study to examine exposure for individual firms outside the U.S. However, studies using non-U.S. firms often find results that are not consistent with U.S. studies or with each other. For example, He and Ng (1998) find that, in Japan, exposure is increasing in firm size and foreign sales. Similarly, Bodnar and Wong (2003) show that large U.S. firms have more

[1] Bessembinder (1992) shows that the size of the home country and strategic interactions of the firm and its competitors play important roles in firms' exchange rate exposure. Other theoretical arguments focus on particular aspects of the exchange rate to firm value relation such as future exchange rates and changes in domestic prices (Hekman, 1985; Hodder, 1982).

[2] We do not have information on firm-level competition and hence cannot evaluate this effect directly. To the extent that firms with foreign activity also have foreign competitors, then we control for this indirectly.

[3] Consistent with this argument, Williamson (2001) finds varying exposure for firms within the automotive industry and that the exposure is affected by a firm's foreign operations.

exposure, even after controlling for the level of foreign sales. Conversely, Dominguez and Tesar (2006) study firms in eight countries and find that exposure is larger for small firms but is linked to foreign activity. Our individual firm and cross-sectional regression approach to examining exposure casts the results of the literature in a familiar context, albeit using a more extensive sample of firms and larger number of countries. We then move on to investigate how the use of a portfolio approach can change inferences.

To model the relation between exchange rates and firm value, the traditional regression framework assumes that exchange rate changes have a linear and constant impact on firm value.[4] There is ample evidence that the nature of exposure varies across countries and time (e.g., Bodnar and Gentry, 1993; Williamson, 2001). Rather than trying to address these issues in a regression framework, we take a different approach: we form portfolios of firms with high international sales and portfolios of firms with no international sales and then compute the average returns of the portfolios during periods of appreciating or depreciating currency movements. Therefore, we can analyze the average magnitude of exposure without assuming a linear or constant exposure relation. This is the first paper that assesses the economic importance of exposure in this manner.

A final issue is the derivatives' usage. One reason that the exposure literature may fail to find evidence of significant exposures is that exposure is measured net of operational and financial hedging activities. At the same time, recent research finds a somewhat conflicting picture about the extent that hedging reduces net exchange rate exposure.[5] While this is an important issue, it is difficult to address in large-scale studies due to data constraints, and like the rest of the exposure literature, we do not have data on the use of derivatives. We do attempt to address the issue, albeit in an indirect way. To the extent that large firms are more likely to use derivatives than small firms, we may indirectly account for derivatives usage in our analysis because we examine the relation between firm size and exposure.[6] The bottom line, however, is that for firms that hedge effectively, our results will understate the magnitude of exchange rate exposure.

2. Preliminaries

2.1. Data and summary statistics

Stock return and market capitalization data for individual firms are from the Datastream International database. Foreign sales, export sales, total sales, foreign assets, total assets, foreign income, and total income are from the Worldscope database. For each country, we use the value-

[4] Only in simplified situations does the theoretical literature predict a linear relation and this methodological issue may mask exposure (Dewenter et al., 2005). While non-linearities can be accounted for in a regression framework, the exact functional form of the non-linearity is generally not known, and one has to make an assumption about the functional form to incorporate it in the analysis (see for example, Bartram, 2004). Even if the exposure-return relation is linear, but varies through time, an exposure regression will be mis-specified if an imperfect proxy is used to capture the time-variation in exposure.

[5] A recent study by Allayannis and Ofek (2001) shows that the use of foreign currency derivatives does reduce exposure. However, Bodnar et al. (1998) show that less than half of payables and receivables are hedged and that most hedges are short-term. Brown (2001) and Brown et al. (2005) find that firms hedge for many speculative reasons that are inconsistent with financial theory. Guay and Kothari (2003) argue that even assuming perfect hedging, derivatives positions held by U.S. non-financial firms are only around 1/15th the size of the estimated effect on firm market value from a three standard deviation movement in relative currency value. However, these studies do not examine the effect of operational hedges, which are probably even more important for mitigating exposure.

[6] For U.S. evidence that shows that large firms are more likely to hedge, see Mian (1996), Bodnar et al. (1998), and Allayannis and Ofek (2001).

weighted stock market index constructed by Datastream as our proxy for the market.[7] For most of the analysis we use the Bank of England trade-weighted exchange rates, but for robustness we later use the country's bilateral cross-rates with the predominate regional rate. The sample period is from January 1975 to July 1999, but coverage in some markets does not begin until later, and for specifications that require Worldscope data it is important to note in many countries, data is often not available prior to 1990.[8] Further details about the database are provided in the Data Appendix and in Table A1.

The data item "Foreign sales" is sales revenue from goods produced and sold abroad, whereas "Export sales" is sales revenue from goods produced domestically and sold abroad.[9] To make them comparable across firms, foreign sales and export sales are scaled by total sales. We define "International sales" as the combined total of foreign sales and export sales as a fraction of total sales. For most of the analysis, we rely on international sales since it has the broadest coverage across countries, although results based on foreign sales or export sales alone are qualitatively similar. We also use data on "Foreign assets" and "Foreign income", where foreign assets are scaled by total assets and foreign income is scaled by foreign sales.[10] Finally, it is important to note that Worldscope distinguishes between firms that report and those that do not report data.

Table 1 shows summary statistics for the full sample. There is a large cross-section of 17,929 firms from 18 countries. Coverage is extensive – all countries have over 100 firms and the median country has 299 firms. Table 1 also displays the percentage of firms in each country with Worldscope data for foreign sales, export sales, foreign assets, and foreign income. It is important to note that we include firms that report zeroes for each of these items. Of the 18 countries, 11 have more than 50% of the firms reporting foreign sales data. The cross-country mean (median) percentage of firms that report foreign sales is 52.4 (54.7). The information on export sales, foreign assets, and foreign income is not as comprehensive. Across countries, on average, 15.7%, 31.0%, and 34.0% of firms report data on export sales, foreign assets, and foreign income.

The average level of these variables is also reported for the firms that have Worldscope coverage on each variable. On average, the percentage of foreign sales as a fraction of total sales is 28.9% and the average percentage export sales as a fraction of total sales is 30.2%. For foreign assets, the average as a percentage of total assets is 10.0% and foreign income is 3.6% of foreign sales. While the coverage varies across variables and countries, the fairly extensive coverage allows for a rich examination of exchange rate exposure across determinants and countries.

2.2. Firm-level exposure regressions

To put our analysis in context with previous work, we employ the regression framework that is used as the standard method to estimate exposure in the literature and we apply it to a much larger

[7] Using data for U.S. firms, Bodnar and Wong (2003) show that the choice of market portfolio (value-weight vs. equal weight) is an important consideration in exposure studies. However, in eight (non-U.S.) countries, Dominguez and Tesar (2006) find that the choice between equal-weighted and value-weighted indices does not have a significant impact on their results.

[8] Prior to the 1990s many of the foreign activity variables (such as export sales) are unavailable or coverage is incomplete.

[9] Note that the foreign sales variable does not include foreign expenses. Ideally, we should use firms' net foreign sales in the analysis – foreign sales minus foreign expenses. If foreign profit margins are similar to domestic margins, the ratio of foreign sales to total sales will be similar to percentage of net foreign sales.

[10] We scale foreign income by foreign sales because total income can be small or negative due to fluctuations in domestic income that are unrelated to foreign income. However, we also use foreign income scaled by total income and find qualitatively similar results.

Table 1
Summary statistics

Country	Total # of firms	% of firms with FS data	Average FS (%)	% of firms with ES data	Average ES (%)	% of firms with FA data	Average FA (%)	% of firms with FI data	Average FI (%)
Australia	947	23.4	16.7	3.2	27.9	23.3	16.4	23.1	6.1
Belgium	121	45.5	31.9	7.4	20.5	22.3	5.7	21.5	0.5
Canada	956	32.2	26.5	11.8	35.8	32.4	22.2	30.2	5.7
Denmark	176	35.8	52.2	27.8	50.6	8.5	10.8	8.0	0.9
France	649	52.9	31.3	18.8	26.4	21.6	7.4	21.7	1.7
Germany	562	68.3	27.4	36.3	20.5	37.5	1.5	36.8	0.3
Hong Kong	490	56.5	32.6	2.5	57.8	15.7	2.9	40.4	11.9
Italy	169	76.3	32.1	16.0	23.4	32.5	3.9	30.8	0.5
Japan	2705	72.6	7.5	37.4	11.9	69.6	2.6	69.0	0.6
Malaysia	348	75.0	6.7	3.5	22.3	72.9	5.0	69.7	2.9
Netherlands	250	59.2	43.4	10.4	21.9	17.2	14.3	16.0	2.8
New Zealand	146	29.1	21.7	12.7	22.8	28.4	16.9	28.4	5.1
Norway	181	24.4	52.5	9.6	49.3	7.1	13.1	7.1	2.5
Singapore	188	72.0	25.6	2.06	65.2	27.2	22.3	70.2	9.9
Spain	105	44.8	19.0	25.7	24.7	19.1	0.0	19.1	0.0
Switzerland	179	63.7	59.1	3.4	32.9	21.2	17.4	16.8	3.12
U.K.	2308	60.1	23.1	26.0	15.2	50.9	8.2	53.1	5.4
U.S.	7449	51.3	11.6	27.3	13.7	50.3	9.8	49.5	4.2
Mean (Total)	996 (17,929)	52.4	28.9	15.7	30.2	31.0	10.0	34.0	3.6
Median	299	54.7	26.9	12.3	24.1	25.3	9.0	29.3	2.9

The "Country Lists" and "Deadlists" in Datastream International are used to identify the set of firms in each country. Data on foreign sales (export sales; foreign assets; foreign income) as a percent of total sales (total sales; total assets; foreign sales), denoted as FS (ES; FA; FI) are from Worldscope. Firms with FS (ES; FA FI) Data is the percentage of firms in each country that have FS (ES; FA; FI) data available during the sample period. Average FS (ES; FA; FI) is the average FS (ES; FA; FI) for those firms in a country that have data available in the Worldscope database. The sample period is from 1975 to 1999.

set of countries. Specifically, we examine the impact of exchange rates on firm value using the following models:

$$R_i = \alpha_i + b_i R_M + \eta_i \quad (1)$$

$$R_i = \alpha_i + b_i R_M + d_i R_{FX} + \eta_i \quad (2)$$

where R_i is the monthly stock return, R_M is the country-specific value-weighted market return, and R_{FX} is the percentage change in the monthly foreign currency per home currency exchange rate. d_i is the estimate of exchange rate exposure.[11] Specifically, d_i is the exposure elasticity that measures the firm's average exposure over the estimation period. Because the market return is included in the regression, d_i measures the exposure elasticity of the firm as the difference between the firm's total exposure elasticity and the market's exposure elasticity, adjusted by the firm's market beta. If d_i equals zero, it does not mean that the firm has zero exposure, but rather,

[11] Adler and Dumas (1984) show how exposure can be estimated and interpreted in a linear regression framework. See Jorion (1990) and Bodnar and Wong (2003) for a discussion of why it is important to include the market return in Eq. (2).

the firm has the same exposure as the market portfolio. Therefore, d_i is the change in firm i's returns that can be explained by changes in the exchange rate, after conditioning on the market. A negative exchange rate coefficient corresponds to a decrease in the firm's stock returns when the home currency appreciates (as would be the case for an exporter). We estimate regressions (1) and (2) over 5-year intervals. The choice of a 5-year estimation interval trades off the need to have a longer period to obtain more precise estimates versus the need to account for time variation in firms' exposures.

Several methods are used to examine the significance of the coefficients. First, the absolute value of each firm's exchange rate coefficient (and average absolute value of the t-statistic) is aggregated across firms in a given country. Second, the percentages of the exchange rate coefficients that are significant at the 5% level (upper and lower 2.5% levels) are examined as a statistical measure of performance. The percentage change in the adjusted R^2 measures the incremental or marginal explanatory power of the exchange rate and is computed as the difference between the average adjusted R^2 in regressions (2) and (1) divided by the adjusted R^2 in (1).

Table 2 shows that the magnitude of the absolute value of the average exposure coefficient is quite large. An exposure coefficient with an absolute value of one would indicate that a 1% movement in the exchange rate leads to a 1% positive or negative movement in equity returns (net of the market). The absolute value of the exchange rate exposure coefficient varies widely across countries from a low of 0.30 in Malaysia to 1.79 in Norway. Across countries, the mean absolute value of the exposure coefficient is one and the median coefficient is 0.96. However, the standard errors are large as well.

The large standard errors can also be seen by examining the percentage of firms with significant coefficients at the 5% level. By chance, one should expect 2.5% significance in each tail; we find that the numbers in both tails are greater than 2.5% in most countries. Norway has the largest percentage of firms with significantly positive coefficients at 8.6%, while Belgium has the largest percentage of firms with significantly negative coefficients at 9.3%. The overall average across countries is 4.2% of firms in the positive tail and 4.0% of firms in the negative tail. Our results that show significant exchange rate exposure are similar to findings by Jorion (1990) for U.S. multinationals. We also examine the bilateral cross-rate with the major regional currency in a particular region (the cross-rates are the Yen for Asian countries and the U.S., the Deutschmark for European countries, and the U.S. dollar for all other countries including Japan and Germany). Inferences are similar to those obtained here with trade-weighted exchange rates.[12]

The final column in Table 2 shows the increase in explanatory power from the simple market model in Eq. (1) to the market model with the trade-weighted exchange rate in Eq. (2). The increase in explanatory power is greatest in Canada and Norway at 7.8% and 6.6%, respectively. The cross-country average increase in adjusted R^2 is only 2.1%.

In Table 2, Panel B, we tabulate regression results for countries that do not have sufficient data on firms' foreign operations to use in later analyses. In these countries, which are primarily classified as emerging markets, we find a large cross-sectional variation of exchange rate exposure across countries. Overall, in emerging countries, 7.0% of firms have a positive and significant exchange rate exposure, while 3.6% of firms have a negative and significant exposure.

[12] Another approach would be to examine the significance of the regional cross-rates, as well as the trade-weighted exchange rate, and any other relevant cross-rate all jointly (see e.g. Dominguez and Tesar, 2001). Such an approach would most likely result in finding more joint significance, but it is not clear how such joint significance should be evaluated. A promising avenue for future research would be to define the appropriate exchange rates at the individual firm level.

Table 2
Firm-level regressions

Country	N	d_i	t-statistic	%+	%−	% Change
Panel A: Countries used in later analysis						
Australia	1645	0.76	(0.86)	5.1	1.8	2.1
Belgium	354	1.36	(0.96)	3.1	9.3	2.4
Canada	2300	1.55	(0.95)	4.3	2.7	7.8
Denmark	363	1.59	(0.92)	1.1	7.4	3.3
France	1374	1.36	(0.81)	3.4	2.7	−0.1
Germany	1396	0.99	(0.92)	2.6	3.6	0.1
Hong Kong*	942	0.56	(0.98)	6.4	4.0	2.0
Italy	500	0.92	(0.92)	5.4	3.6	1.0
Japan	7296	0.41	(0.92)	5.6	3.5	2.0
Malaysia*	790	0.30	(0.78)	3.0	1.3	−0.3
The Netherlands	793	1.39	(0.84)	2.4	3.7	1.2
New Zealand	178	0.91	(0.83)	1.5	5.5	0.4
Norway	302	1.79	(1.05)	8.6	3.6	6.6
Spain	190	1.23	(0.92)	4.7	6.3	1.6
Singapore*	417	0.46	(0.95)	5.5	4.1	1.3
Switzerland	530	0.63	(0.83)	2.1	2.8	0.2
U.K.	6068	0.61	(0.90)	6.0	2.6	2.3
U.S.	16 819	1.09	(0.90)	5.4	2.8	3.2
Mean	2348	1.00	(0.90)	4.2	4.0	2.1
Median	792	0.96	(0.92)	4.5	3.6	1.8
Panel B: Mostly developing countries						
Argentina*	77	2.18	(0.86)	1.3	5.2	0.6
Austria	227	1.72	(0.79)	1.8	2.6	−0.4
Bangladesh*	112	1.63	(1.01)	3.6	11.6	4.2
Brazil*	116	4.16	(1.29)	8.6	11.2	85.0
Chile*	247	7.45	(0.85)	7.3	2.0	0.7
China*	388	0.32	(0.71)	2.5	1.2	−0.3
Colombia*	21	0.92	(0.93)	4.8	0.0	−0.1
Finland	128	1.38	(1.07)	3.9	10.2	6.8
Greece	252	2.12	(1.09)	14.7	4.0	7.9
India*	871	0.46	(0.76)	1.6	1.3	−0.8
Indonesia*	292	0.66	(1.83)	35.3	2.7	42.4
Ireland	159	1.89	(0.86)	2.5	7.5	1.1
Israel*	29	0.48	(0.87)	3.4	3.4	0.0
Kenya*	78	0.39	(0.72)	2.6	2.6	−0.9
Korea*	1479	0.56	(1.21)	20.2	1.4	9.22
Mexico*	123	0.48	(1.12)	13.1	4.9	4.5
Morocco*	38	0.62	(0.90)	2.6	2.6	0.6
Pakistan*	124	0.36	(0.70)	2.4	0.8	−2.5
Peru*	55	1.60	(0.80)	5.6	1.8	−0.1
Philippines*	190	1.50	(0.90)	5.8	3.7	1.7
Portugal	132	1.88	(0.92)	3.0	5.3	3.8
South Africa*	768	0.78	(0.90)	4.3	4.9	2.9
Sri Lanka*	137	0.41	(0.83)	6.6	4.4	2.5
Sweden	369	1.14	(0.96)	7.3	3.8	3.6
Taiwan*	507	0.53	(1.07)	11.6	0.2	2.7
Thailand*	541	0.64	(1.09)	12.3	3.1	9.1
Turkey*	267	0.89	(0.76)	1.9	2.6	−0.4
Venezuela*	24	0.33	(0.91)	12.5	0.0	0.3
Zimbabwe*	58	0.37	(0.68)	0.0	0.0	−2.2

Table 2 (*continued*)

Country	N	d_i	t-statistic	%+	%−	% Change
Mean	269	1.98	(0.94)	7.0	3.6	6.3
Median	137	0.78	(0.90)	4.3	2.7	1.1

This table shows the results of the regression: $R_i=\alpha_i+b_iR_M+d_iR_{FX}+\eta_i$, where R_i is the monthly stock return, R_M is the Datastream local monthly stock index return, and R_{FX} is the Bank of England (BOE) trade-weighted exchange rate. Countries marked with an asterisk (*) do not have BOE rates and the Japanese Yen bilateral rate is used instead. Rates are quoted as foreign currency per one unit of home currency. The regression is estimated over the sub-periods 1975–1979, 1980–1984, 1985–1989, 1990–1994, and 1995–1999 for all firms that have at least 36 observations in each sub-period. N is the number of sub-period – firm observations for a country. The reported d_i coefficients and t-statistics are the average (of the absolute value) for all firms in the country over the sample period from 1975 to 1999. %+ (%−) is the percentage of firms in the country with positive (negative) d_i coefficients that are significant at the 5% level. % Change is the percentage difference between the adjusted R^2 of the estimated regression and the adjusted R^2 of the market model regression. Panel A presents results for countries with sufficient Worldscope data that we can use in subsequent analysis. Panel B contains regressions for mostly developing countries with insufficient data from Worldscope to use in subsequent analysis.

While these mean exposure coefficients indicate more significant exposure in emerging markets, the median exposure coefficients are similar to those in Panel A (for mostly developed markets), indicating that the significance is concentrated in a few countries. Because we do not have sufficient data on foreign activity for firms in the countries in Panel B, we do not include them in the rest of the analysis.

Overall, the unconditional analysis for individual firms indicates that the average exposure coefficient is quite large in magnitude and that there are slightly more firms that have statistically significant exchange rate coefficients than can be attributed to chance. However, the coefficients are not estimated with much precision and the significance varies widely across firms and countries. Further, exchange rate movements do not explain a large fraction of the variation in individual stock returns. To obtain a deeper understanding of the exchange rate to firm value relation, it is important to consider the determinants of exposure.

3. The determinants of exchange rate exposure

To further understand the relation between exchange rate exposure and foreign activity across firms and countries, we turn to cross-sectional regression analysis. In the theoretical literature, one of the main determinants of exchange rate exposure is the level of foreign activity. Therefore, one would expect that firms with more international sales (the sum of foreign sales and export sales relative to total sales), foreign income, and foreign assets would exhibit more sensitivity to exchange rate movements. Firm size may proxy for more hedging activity, or alternatively, larger firms may be likely to be more international than small firms and thus have more exposure.

3.1. Pooled regressions

We begin by pooling firm-level data across all countries. The dependent variable in each regression is the estimate of d_i (or the absolute value of the estimate of d_i) from regression (2), estimated over a 5-year interval. Recall that d_i is a "residual" exposure elasticity because it is estimated net of the market (or country) exposure. For these regressions, we include as independent variables a number of variables from Worldscope that are not available for many

firms prior to 1990. Therefore, the sample period for these regressions is from 1990 to 1999 and we split the sample period into two sub-periods, 1990 to 1994 and 1995 to 1999. We are reluctant to use the full sample period because we would have to estimate d_i assuming that exposure is constant over a 10-year period. Further, the independent variables would have to be averaged over the full 10-year period rather than over a 5-year sub-period.

Some of our variables have predictions for the direction of exposure, while others focus more on the magnitude of exposure. For this reason, we separately estimate regressions on both exposure coefficients and the absolute value of these coefficients. So that more precise beta estimates from the first-pass regressions will be given more importance, we use weighted least squares where the weights are the inverse of the standard error of d_i. The *t*-statistics are computed with heteroskedasticity consistent standard errors that do not assume independence within countries.

Panel A of Table 3 reports the cross-sectional regressions from 1990 to 1994. In the first three columns of the table with raw exposure betas as the dependent variable, we use different measures of foreign activity. Foreign activity variables have negative coefficients that are significant at the 1% level. The most explanatory power is captured by the international sales variable.[13] Because theory does not have a specific prediction about the direction of exposure for firm size, we use the absolute value of the exposure betas as the dependent variable in specification (4). Firms with high international sales have more absolute exposure and consistent with a hedging argument, large firms have significantly less absolute exposure. In Panel B of Table 3 we estimate the regressions for the 1995–1999 period. The results are consistent with those in the earlier sub-period: firms with more international sales and smaller firms have more exposures.

3.2. Country-specific results

To further examine the importance of our results and how they vary across countries, we estimate cross-sectional regressions on a country-by-country basis in Table 4, where the exposure betas are estimated over the 1995 to 1999 period. The size coefficients are now interacted with the sign of the exposure betas. This approach allows us to simultaneously examine predictions regarding both the direction and magnitude of exposure.[14] We use international sales as our measure of foreign activity since other proxies of foreign activity lead to similar results and international sales has better coverage over the sample period. The firm-specific variables, size and international sales, are the focus of these weighted least squares cross-sectional regressions. International sales is negatively related to exposure betas in 14 of 18 countries and the relation is significantly negative at the 10% level in seven countries (France, Germany, Italy, Japan, Singapore, U.K., and the U.S.). Positive exposure estimates are smaller for large firms in 16 of the 18 countries and negative exposure estimates are larger for large firms in 16 of 18 countries as well, indicating that large firms have less absolute exposure than small firms. For positive (negative) exposures, size is significant in 12 (11) countries. It should also be noted that these exposure betas contain estimation error, which could be driving the greater absolute exposure for smaller firms. Interestingly, the variation in exposure betas that can be explained from the

[13] It is important to understand why the foreign assets variable is negatively related to exposure betas since one might expect it to be an exposure hedge. Recall that the foreign sales variable is defined as sales based on foreign assets abroad and therefore, foreign assets may simply be a proxy for foreign sales. Consistent with this explanation, we find that these variables are highly correlated (0.87).

[14] Theory predicts a negative relation between international sales and exposure betas. Therefore, we do not interact international sales with the sign of the exposure beta.

Table 3
Cross-sectional regressions: determinants of exposure

	Panel A: 1990–1994				Panel B: 1995–1999			
	$\hat{d_i}$			abs($\hat{d_i}$)	$\hat{d_i}$			abs($\hat{d_i}$)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Constant	0.454	0.406	0.443	0.616	−0.109	−0.178	−0.145	0.662
	(35.82)	(23.05)	(23.01)	(30.74)	−(7.72)	−(10.77)	−(8.27)	(34.00)
International sales	−0.292			0.128	−0.365			0.278
	−(3.52)			(2.48)	−(4.11)			(4.72)
Foreign income		−0.251				−0.229		
		−(2.47)				−(3.11)		
Foreign assets			−0.424				−0.421	
			−(5.32)				−(3.13)	
Size				−0.087				−0.052
				−(5.78)				−(2.42)
N	7175	5803	5486	7175	9426	7473	7323	9426
Adjusted R^2	0.070	0.054	0.059	0.132	0.045	0.034	0.037	0.168

This table shows the results of regression models where d_i (or the absolute value of d_i), the estimated foreign exchange beta from the regression $R_i = \alpha_i + b_i R_M + d_i R_{FX} + \eta_i$ is the dependent variable. R_i is the monthly stock return, R_M is the Datastream local monthly stock index return, and R_{FX} is the Bank of England (BOE) trade-weighted exchange rate. Trade-weighted rates are not available for Hong Kong, Malaysia, and Singapore so the Japanese Yen bilateral rate is used instead. Rates are quoted as foreign currency per one unit of home currency. The regression is estimated over periods from 1990 to 1994 (Panel A), and from 1995 to 1999 (Panel B). The sample includes firms from 18 countries that are listed in Table A1. Sample sizes differ across regression specifications due to different data availability of the independent variables. All independent variables are averaged over the period. International sales is the sum of foreign sales and export sales divided by total sales. Foreign income is scaled by foreign sales and foreign assets is scaled by total assets. Size = log(firm market value/country average market value), where all market values are in U.S. dollars. Country dummies are included in all specifications. The regressions are estimated by weighted least squares, where the weights are the inverse of the standard error of d_i. t-statistics are computed using heteroskedasticity consistent standard errors that do not assume independence within countries.

Table 4
Country-level cross-sectional regressions

Country	Sample size	Constant	*t*-statistic	International sales	*t*-statistic	Size × Positive	*t*-statistic	Size × Negative	*t*-statistic	Adjusted R^2
Australia	191	0.106	(2.80)	0.336	(3.30)	−0.010	−(0.46)	−0.146	−(6.15)	0.091
Belgium	44	−0.811	−(1.55)	−0.612	−(1.05)	−0.498	−(2.34)	0.170	(1.10)	0.251
Canada	262	0.291	(3.00)	0.218	(1.19)	−0.160	−(3.80)	0.137	(1.44)	0.060
Denmark	84	−0.552	−(1.19)	−0.430	−(0.67)	−0.142	−(0.55)	0.531	(3.68)	0.132
France	329	0.030	(0.20)	−0.490	−(1.76)	−0.201	−(3.36)	0.327	(5.79)	0.158
Germany	370	−0.083	−(0.67)	−0.593	−(2.70)	−0.324	−(6.89)	0.210	(4.69)	0.273
Hong Kong*	263	0.102	(1.95)	0.076	(0.84)	−0.240	−(7.67)	0.033	(0.91)	0.246
Italy	111	0.271	(1.74)	−0.397	−(1.85)	0.000	(0.00)	0.313	(4.69)	0.204
Japan	1871	0.086	(6.63)	−0.555	−(11.04)	−0.093	−(11.69)	0.070	(7.76)	0.231
Malaysia*	223	0.057	(2.47)	−0.173	−(1.38)	−0.090	−(4.45)	0.027	(1.02)	0.090
The Netherlands	129	−0.549	−(1.85)	−0.178	−(0.42)	−0.453	−(4.94)	0.198	(2.44)	0.223
New Zealand	37	0.233	(1.70)	−0.494	−(1.07)	0.247	(1.66)	0.217	(1.33)	0.155
Norway	42	0.805	(4.02)	−0.668	−(1.59)	−0.273	−(1.38)	−0.003	−(0.03)	0.101
Spain	136	−0.118	−(1.40)	0.043	(0.26)	−0.193	−(2.82)	0.203	(3.45)	0.207
Singapore*	57	0.410	(1.85)	−1.413	−(2.13)	−0.303	−(2.33)	0.670	(3.20)	0.271
Switzerland	105	−0.203	−(0.93)	−0.172	−(0.73)	−0.093	−(1.14)	0.145	(2.75)	0.176
U.K.	1176	0.130	(3.32)	−0.332	−(4.38)	−0.150	−(9.82)	0.169	(10.64)	0.243
U.S.	3996	0.106	−(5.87)	−0.433	−(5.84)	−0.283	−(20.12)	0.218	(20.68)	0.267

For each country, the table shows the results of the regression, $\hat{d_i} = \gamma + \delta_{1i}\mathrm{IS}_i + \delta_{2i}\mathrm{Size}_i \times \mathrm{Positive} + \delta_{3i}\mathrm{Size}_i \times \mathrm{Negative} + \varepsilon_i$ where d_i is the estimated foreign exchange beta from the regression $R_i = \alpha_i + b_i R_M + d_i R_{FX} + \eta_i$. R_i is the monthly stock return, R_M is the Datastream local monthly stock index return, and R_{FX} is the Bank of England (BOE) trade-weighted exchange rate. Countries marked with an asterisk (*) do not have BOE rates and the Japanese Yen bilateral rate is used instead. Rates are quoted as foreign currency per one unit of home currency. The regression is estimated over the period from 1995 to 1999. The sample includes firms from 18 different countries. All independent variables are averaged over the period. Size = log(firm market value/country average market value), where all market values are in U.S. dollars. International sales is the sum of foreign sales and export sales divided by total sales. Positive (Negative) is a dummy variable that equals one if d_i is positive (negative) for firm i. The regressions are estimated by weighted least squares, where the weights are the inverse of the standard error of $\hat{d_i}$. *t*-statistics are computed using heteroskedasticity consistent standard errors.

exposure determinants varies from about 6% in Canada to almost 27% in the U.S., possibly due to the wide heterogeneity of firms in the U.S. Across countries, the average adjusted R^2 for the exposure beta regressions of 18.8 indicates that a large fraction of the variation in exposure betas can be captured simply by size and international sales.

Overall, our results indicate that smaller firms and firms with high foreign activity are those that have more exchange rate exposure. The finding is fairly widespread and is not driven by a particular country, although the magnitude and the significance vary across countries. This result reinforces the pooled results presented in Table 3. Our finding that international sales is an important determinant of exposure is consistent with findings for the U.S. in Jorion (1990) and Allayannis and Ofek (2001), for Japan in He and Ng (1998), and for eight developed markets in Dominguez and Tesar (2006). The finding that small firms have more exposure is consistent with Dominguez and Tesar (2006). However, it is important to note that smaller firms may have exposure betas that are estimated with lower precision and hence exhibit wider variation. Our portfolio approach in the next section will allow us to estimate the aggregate exposure of large and small firm portfolios that are free from estimation error at the firm level. Our cross-sectional findings suggest that exchange rates may play an important economic role in explaining average cross-sectional differences in stock returns between firms of various sizes and different levels of international operations.

4. The economic impact of exchange rate exposure

Our previous analysis shows that exposure is related to variables that can be linked theoretically to exchange rate exposure, but the low incremental explanatory power of the exchange rate relative to the market model shown in Table 2 indicates that exchange rates are not a major factor in explaining the variation in individual firm stock returns. However, one might argue that this finding is not surprising since stock returns have many sources of variation, including idiosyncratic movements. Furthermore, for many applications such as portfolio allocation and diversification analysis, the relevant question is not what determines variation in a particular stock, but rather, what are the sources of common co-variation that affect groups of stocks.

4.1. Portfolios formed on international sales

The simple regression analysis assumes that a firm's exposure is constant or linear throughout a 5-year period, although its level of foreign activity may change. To allow for variation and possible non-linearity, we aggregate stocks into portfolios that should exhibit high and low exposure and regroup firms annually according to their foreign activity. This simple grouping approach examines relative performance during different periods of exchange rate movements and hence avoids problems of assuming a constant linear relation between exchange rates and returns that is not imposed by theory.

It should be noted that to the extent that international sales or any other grouping variable is an imperfect proxy for exposure, such an approach will likely underestimate the economic importance of exposure. Nevertheless, this lower bound should be informative in evaluating the relation between exchange rate movements and stock returns. For firms in each country, in June of each year, we form portfolios based on the previous year's international sales. So that portfolios will be diversified and not subject to extreme movements due to a particular firm, we require at least five firms in a portfolio before it is included in the analysis. The portfolio composition is

rebalanced annually. One portfolio is formed for firms with over 25% international sales and another portfolio is formed for those with zero international sales. The difference between the returns on the two portfolios is equivalent to being long stocks with high international sales and short stocks with no international sales. We then partition the time-series returns of the high minus no international sales portfolio into four periods based on relative movements of the trade-weighted exchange rate.

We use the following procedure to define exchange rate 'regimes'. For each country, we compute the standard deviation of the exchange rate change over the sample period. Exchange rate changes that are less than one standard deviation, in absolute value, from zero (16.1% confident interval) are defined as small movements and exchange rate changes that are greater than one standard deviation from zero are defined as large movements. Thus, we have four regimes of both large and small appreciations and depreciations. We calculate the average value-weighted returns of the high minus no international sales portfolio for the firms in each country in each exchange rate 'regime'.

The results in Table 5 indicate an economically large role for exchange rates. The overall high minus no international sales portfolio at the bottom of the table is a value-weighted portfolio comprised of all firms. For this overall portfolio, we find that firms with high international sales gain an economically and statistically significant 0.72% per month relative to firms with no international sales during periods of large depreciations in exchange rates. During periods of large appreciations, firms with high international sales underperform those with no international sales by a highly statistically and economically significant −1.10% per month.[15]

For small depreciations in exchange rates, the overall portfolio results indicate that on average, firms with high international sales do about the same as those with no international sales (a statistically insignificant average difference of 0.13% per month). For small appreciations in exchange rates, firms with high international sales underperform those with no international sales in 12 of 18 countries. For the overall portfolio, firms with high international sales underperform by a statistically insignificant −0.25% per month.

Fig. 1 summarizes the results for the periods of large currency appreciations or depreciations. During periods where exchange rates depreciate by more than one standard deviation, firms with high international sales outperform those with no international sales in 14 of 18 markets. The differences are statistically significant at the 10% level in four markets (France, Japan, The Netherlands, and Switzerland). An even stronger relation between exchange rates and stock returns holds for large currency appreciations. For large home currency appreciations, firms with high international sales underperform those with no international sales in 16 of 18 markets. These differences are statistically significant at the 5% level in France, Japan, Switzerland, and the U.K.

Fig. 1 also highlights the magnitude of the relation. An investor short high international sales firms in Japan and long those with no international sales would make close to 4% per month (48% if annualized) during periods of currency appreciations or, if they reversed their position, close to 2% a month during depreciations. Given that investors cannot perfectly forecast exchange rate moves, this return is not obtainable. However, to the extent that currencies have long-run predictability (Froot and Rogoff, 1995), these results suggest that the role of exposure and currency movements may be of substantial interest to investors.

It is interesting to examine cross-country differences in the nature of exposure, particularly in countries such as Japan, the U.K., and the U.S. that have well-diversified high and no international sales portfolios, with an average of more than 100 firms in each portfolio. The high

[15] We also calculate the returns for the overall portfolio without Japan and obtain similar statistical significance.

Table 5
High minus no international sales portfolio returns

Country	N_N	N_H	$<-1.0\times\sigma_i$			0 to $-1.0\times\sigma_i$			0 to $1.0\times\sigma_i$			$>1.0\times\sigma_i$		
			N_{FX}	HMN	p-val	N_{FX}	HMN	p-val	N_{FX}	HMN	p-val	N_{FX}	HMN	p-val
Australia	37	28	24	0.18	0.86	64	−0.47	0.41	73	0.35	0.52	19	−0.44	0.74
Belgium	9	19	18	2.15	0.21	53	2.49	0.03	51	−0.21	0.82	21	−0.02	0.99
Canada	54	77	36	0.34	0.47	85	0.48	0.21	78	−0.22	0.60	28	−0.28	0.76
Denmark	5	53	7	1.82	0.27	27	0.16	0.90	29	0.95	0.30	8	−1.98	0.45
France	53	145	18	2.36	0.03	50	0.03	0.98	54	1.21	0.08	21	−2.10	0.03
Germany	43	92	29	0.33	0.72	84	0.94	0.06	84	−0.32	0.62	42	−1.01	0.22
Hong Kong*	21	35	28	−0.17	0.84	57	0.09	0.90	66	0.70	0.22	16	−1.11	0.27
Italy	21	47	11	3.56	0.32	67	−0.25	0.81	56	0.27	0.79	9	−1.82	0.73
Japan	552	190	22	1.96	0.07	96	0.63	0.36	79	−0.42	0.61	42	−3.97	0.03
Malaysia*	82	14	14	2.94	0.14	57	−0.68	0.34	61	−0.88	0.17	11	−0.81	0.58
The Netherlands	12	73	22	1.31	0.05	51	−1.52	0.21	47	−1.01	0.17	23	−0.78	0.34
New Zealand	15	13	14	−3.66	0.08	23	0.39	0.68	35	−0.37	0.59	11	0.11	0.97
Norway	6	24	5	−0.77	0.79	19	−2.63	0.13	18	−1.25	0.46	5	−0.26	0.97
Singapore*	12	34	19	0.03	0.97	35	−1.60	0.21	61	−1.71	0.30	16	1.36	0.04
Spain	10	17	10	0.55	0.66	52	0.32	0.67	39	−2.68	0.02	6	−1.05	0.27
Switzerland	6	66	16	2.36	0.07	35	1.59	0.03	41	0.60	0.49	15	−2.22	0.02
U.K.	133	242	35	0.53	0.41	88	0.01	0.97	82	−0.28	0.46	34	−0.96	0.05
U.S.	698	320	39	−0.26	0.56	73	−0.10	0.73	92	−0.11	0.66	35	−0.04	0.94
Portfolio	1769	1489	367	0.72	0.01	1016	0.13	0.50	1046	−0.25	0.18	362	−1.10	0.00

Each year, firms are sorted into three bins based on international sales (IS): IS=0%, 0% to 25%, and >25% in year $t-1$. Monthly value-weighted portfolio returns are then created in the following year. High minus no (HMN) is the return on a portfolio that is long firms with IS>25% and short firms with IS=0%. Portfolios comprised of less than 5 firms are deleted. The returns on each portfolio are computed from July to June in year t. The returns are then computed over four different exchange rate 'regimes'. The exchange rate is the Bank of England (BOE) trade-weighted exchange rate. Countries marked with an asterisk (*) do not have BOE rates and the Japanese Yen bilateral rate is used instead. Rates are quoted as foreign currency per one unit of home currency. N_N (N_H) is the average number of firms in the IS=0 (>25%) portfolio. N_{FX} is the number of monthly observations in each exchange rate regime. σ_i is the monthly standard deviation of the exchange rate change for country i. The first (last) columns show periods of large home currency depreciations (appreciations), defined as exchange rate changes that are less (greater) than $-1.0\times\sigma_i$ ($1.0\times\sigma_i$). The middle columns show periods of small depreciations (appreciations). For the overall portfolio results, all difference portfolios with observations on a given date are used in the calculation. p-val is the p-value for the HMN portfolio return.

minus no international sales return is 1.96%, 0.53%, and −0.26% per month in Japan, the U.K., and the U.S., respectively, during large currency depreciations and −3.97%, −0.96%, and −0.04% per month during large currency appreciations. Overall, Japan, and to a lesser extent the U.K., indicate a strong economic and statistically significant relation between exchange rate movements and changes in firm value, whereas no such relation is present in the U.S.

To check the robustness of these results, rather than use standard deviations to define exchange rate regimes, we define changes in the exchange rate between 0% and 3% as small changes and changes greater than 3% as large changes. These (unreported) results indicate that the magnitude of returns on the difference portfolios for large exchange rate movements is similar to those displayed in Table 5.

4.2. Portfolios formed on FX betas

Our portfolio approach can also be applied to portfolios formed according to firms' past estimated foreign exchange exposures. The advantage of this approach is that the exposure betas

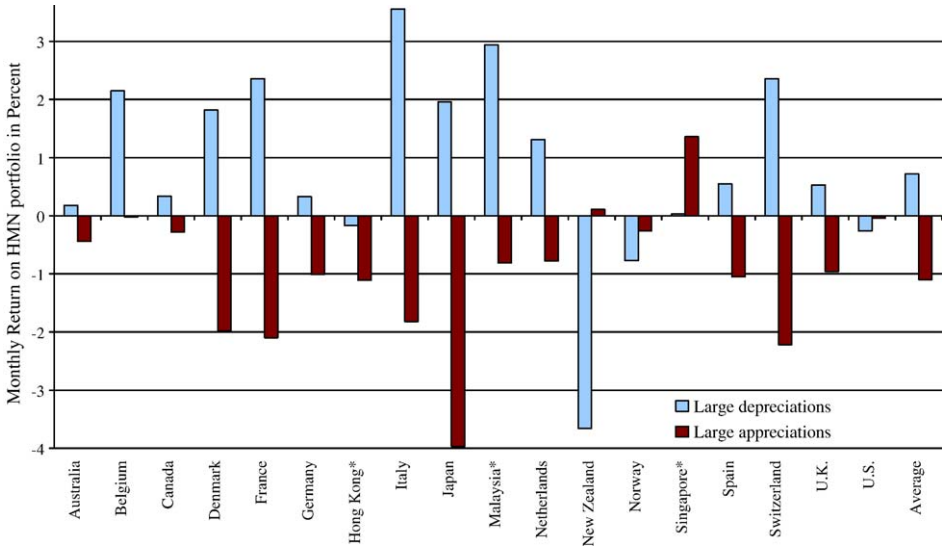

Fig. 1. Returns to high minus no international (HMN) sales in periods of large currency appreciations and depreciations. This figure displays the returns to a portfolio of firms that is long firms with high international sales and short firms with no international sales in months where the local currency appreciates or depreciates by more than one standard deviation. Each year, firms are sorted into three bins based on international sales (IS):IS=0%, 0% to 25%, and >25% in year $t-1$. Monthly value-weighted portfolio returns are then created in the following year. HMN is the return on a portfolio that is long firms with IS>25% and short firms with IS=0%. The returns on the HMN portfolio are computed from July to June in year t. The returns on this difference portfolio are computed over the whole time period and then returns are displayed for two different exchange rate 'regimes'. Portfolios comprised of less than 5 firms are deleted. The exchange rate is the Bank of England (BOE) trade-weighted exchange rate. Countries marked with an asterisk (*) do not have BOE rates and the Japanese Yen bilateral rate is used instead.

are more closely linked to theory than sorts according to international sales. The disadvantage is that many of the betas are not estimated precisely (see Table 2). We estimate market model regressions similar to those used in Table 2 over 5-year rolling windows beginning in 1975, where the estimation window ends in June of each year. We then follow a traditional asset pricing approach to form portfolios, where we rank stocks in the following July to June according to the firm' standardized foreign exchange betas. To focus the analysis on firms with more precisely estimated exposure betas, the betas are standardized by the time-series standard error from the firm-level regression. We then form value-weighted portfolios over the sample period. The portfolio is long firms in the bottom 15% (within a country) of standardized exposure betas and short those in the top 15%. The portfolio is formed this way to be consistent with the portfolios formed on international sales (recall from Eq. (2) that a negative exchange rate beta corresponds to a decrease in the firm's stock returns when the home currency appreciates). We refer to this portfolio as the low minus high (LMH) FX portfolio in the text below and in Table 6.

Table 6 presents the returns to the low minus high FX portfolios in the four states of foreign exchange movements. The results are similar to the international sales results in Table 5 and for large home currency appreciations, the magnitude of exposure is even greater. In months where countries experience large currency depreciations, firms with low FX betas earn 0.22% per month more than those with high FX betas, as compared to underperforming by −1.40% during months of currency appreciations of more than one standard deviation. Noticeably, these results are more

Table 6
Low minus high FX beta portfolio returns

Country	N_N	N_H	$<-1.0\times\sigma_I$			0 to $-1.0\times\sigma_i$			0 to $\times\sigma_i$			$>\times\sigma_I$		
			N_{FX}	LMH FX	p-val	N_{FX}	LMH FX	p-val	N_{FX}	LMH FX	p-val	N_{FX}	LMH FX	p-val
Australia	28	28	32	0.89	0.12	83	0.53	0.45	96	0.21	0.66	24	1.16	0.16
Belgium	8	8	25	−1.10	0.40	91	−0.02	0.98	91	0.01	0.99	19	−2.72	0.07
Canada	49	50	38	0.21	0.77	87	−0.15	0.72	80	−0.11	0.81	30	0.03	0.98
Denmark	16	16	9	2.49	0.34	23	0.11	0.92	26	−1.41	0.11	9	0.07	0.96
France	28	27	26	0.22	0.81	92	−0.02	0.97	95	0.12	0.75	22	−1.20	0.55
Germany	31	31	31	1.55	0.01	80	0.66	0.07	83	−0.23	0.56	41	−1.41	0.02
Hong Kong*	17	17	40	−1.32	0.11	82	−0.71	0.30	91	0.77	0.34	22	−0.02	0.99
Italy	11	11	22	3.65	0.15	111	0.15	0.88	89	0.34	0.76	13	−1.66	0.26
Japan	171	171	20	2.34	0.12	94	0.59	0.31	78	−0.71	0.24	43	−2.77	0.03
Malaysia*	34	34	10	−1.99	0.55	33	−0.67	0.62	42	−1.78	0.05	6	−5.69	0.46
The Netherlands	20	20	32	−0.76	0.50	81	0.39	0.50	80	−0.63	0.35	42	−0.13	0.86
New Zealand	9	9	12	−5.58	0.04	19	0.00	1.00	29	0.54	0.69	7	−0.53	0.85
Norway	7	7	16	2.70	0.31	58	−0.98	0.36	66	1.38	0.15	10	−2.61	0.37
Singapore*	14	14	19	−0.50	0.80	34	−1.14	0.09	58	0.10	0.87	16	−0.23	0.87
Spain	11	10	5	−2.75	0.28	39	1.37	0.21	32	0.33	0.77	3	1.93	0.30
Switzerland	13	13	28	−0.10	0.92	89	0.52	0.20	80	0.16	0.76	38	−0.02	0.98
U.K.	146	148	33	1.08	0.14	88	0.59	0.03	81	−0.11	0.82	33	−1.10	0.13
U.S.	330	327	40	0.68	0.22	71	0.32	0.41	91	−0.32	0.25	34	−0.82	0.15
Portfolio	944	942	398	0.22	0.21	1184	0.11	0.31	1197	−0.19	0.16	378	−1.40	0.00

Each year, firms are sorted into three bins in year $t-1$ based on the FX beta. Monthly value-weighted portfolio returns are then created in the following year. LMH FX is the return on a portfolio that is long firms with low FX betas and short firms with high FX betas. The rolling betas are estimated over the prior 60 months as described in the text. These first-pass time-series regressions include the local market return. To weight the precision of the betas, we divide each beta by its standard error from the time-series regression. We then form portfolios in each country, each year based on the previous year's standardized FX beta. High beta firms are those in the bottom 15% (large positive exposures) and low beta firms are those in the top 15% (large negative exposures). Portfolios comprised of less than 5 firms are deleted. The returns on each portfolio are computed from July to June in year t. The returns are then computed over four different exchange rate 'regimes'. The exchange rate is the Bank of England (BOE) trade-weighted exchange rate. Countries marked with an asterisk (*) do not have BOE rates and the Japanese Yen bilateral rate is used instead. Rates are quoted as foreign currency per one unit of home currency. N_N (N_H) is the average number of firms in the low (high) FX beta portfolio. N_{FX} is the number of monthly observations in each exchange rate regime. σ_i is the monthly standard deviation of the exchange rate change for country i. The first (last) columns show periods of large home currency depreciations (appreciations), defined as exchange rate changes that are less (greater) than $-1.0\times\sigma_i$ ($1.0\times\sigma_i$). The middle columns show periods of small depreciations (appreciations). For the overall portfolio results, all difference portfolios with observations on a given date are used in the calculation. p-val is the p-value for the LMH FX portfolio return.

precise in countries with a larger number of firms. For example, in Japan, the U.K., and the U.S., companies with low past FX betas outperform those with high past FX betas by 2.34%, 1.08%, and 0.68% in periods of currency depreciations. In contrast, during periods of currency appreciations the low FX beta firms underperform by −2.77%, −1.10%, and −0.82% in Japan, the U.K., and the U.S., respectively. The difference in the performance of these long-short portfolios in periods of large depreciations and appreciations is economically significant.

4.3. Controlling for BE/ME and size

One possibility is that our return patterns are driven by some relation between international sales and the well-known book-to-market (BE/ME) equity patterns in returns. Daniel and Titman

(1997) show that using the actual BE/ME characteristics captures variation in expected returns better than using imprecisely estimated Fama and French (1993) HML factors. This convention holds irrespective of whether the BE/ME return patterns are due to risk (Fama and French, 1993) or mispricing (Daniel and Titman, 1997; Griffin and Lemmon, 2002). Furthermore, Griffin (2002) finds that controlling for book-to-market equity effects is best done on a local rather than global basis. Thus, to address whether our results are driven by book-to-market equity patterns in returns, we use a double-sorting procedure. First, we sort firms into high and no international sales portfolios. The firms in the high international sales portfolio are then split into high and low BE/ME based on the median BE/ME in June of year $t-1$. The BE/ME cutoff from the high international sales portfolio is also used to split the no international sales portfolio into high and low BE/ME. We then examine the returns to high minus no international sales portfolios separately for both the high and low BE/ME groups. Note that this double sort imposes additional data requirements and instead of forming two portfolios from the data, we now form four. The effect is that these results include fewer observations in many countries and we no longer have enough firms to include all of the countries that were included in Table 5.

For the high book-to-market equity (value) firms in Panel A of Table 7, overall we find that firms with high international sales gain 0.34% per month relative to firms with no international sales during periods of large depreciations but lose −1.11% per month during large appreciations. For the low book-to-market equity (growth) stocks in Panel B, overall we find that firms with high international sales gain 0.82% per month relative to firms with no international sales during periods of large depreciations but lose −0.96% per month during large appreciations. The difference between high and low international sales firms is evident in firms with both high and low book-to-market equity, which is inconsistent with differences in book-to-market equity driving the results in Table 5.

We also form portfolios by ranking according to two size groups in the same way that we did with BE/ME. The results in Table 8 show that the effects of exposure on stock returns are present in large stocks (in Panel A) but not in the small stock group (Panel B). Even though these results seem to indicate that there is less exposure in small stocks (which is inconsistent with the hedging theory), we are hesitant to conclude too much from these results. First, recall that some of these portfolios have a very small number of firms due to the additional data requirements of the double sort. Second, it is possible that the smaller firms in some countries we examine have international sales figures which are noisier and less stable than those of larger firms. For France, Germany, and Japan, it seems that small firms with high international sales underperform during currency appreciations and outperform during currency depreciations. However, in some countries like Spain, the results are reverse, but these countries contain portfolios of only a few firms. Future analysis should examine exposure with more complete data for small firms.

4.4. Time-series regressions using the portfolio approach

To further investigate the benefits of using the portfolio approach, we estimate, on a country-by-country basis, regressions of the high and no international sales portfolio returns on contemporaneous exchange rate movements. Since the firms in each portfolio change annually, these regressions do not impose a constant relation between a particular firm and exchange rates across long periods of time but do impose one for the portfolio. By forming portfolios and reducing the noise in individual stock returns, we can potentially obtain more precise exposure estimates.

Firms with no international sales either could have no foreign activity or could be net importers. Therefore, we expect that the exposure coefficient on the no international sales

Table 7
High minus no international sales portfolio returns: high vs. low book-to-market equity

Country	N_N	N_H	$<-1.0\times\sigma_i$			0 to $-1.0\times\sigma_i$			0 to $1.0\times\sigma_i$			$>1.0\times\sigma_i$		
			N_{FX}	HML	p-val	N_{FX}	HML	p-val	N_{FX}	HML	p-val	N_{FX}	HML	p-val
Panel A: High book-to-market equity														
Australia	19	15	22	−0.88	0.50	48	−0.36	0.60	53	0.99	0.20	20	0.17	0.87
Canada	21	32	36	−0.04	0.95	85	0.47	0.33	78	−0.46	0.40	28	−0.46	0.66
France	16	51	17	1.82	0.26	42	0.89	0.29	52	0.49	0.50	20	−1.98	0.07
Germany	19	65	18	1.40	0.20	48	0.95	0.20	42	−0.18	0.83	23	−1.74	0.11
Hong Kong*	7	21	11	−2.71	0.13	35	0.10	0.93	39	−0.97	0.44	10	3.04	0.27
Japan	260	103	16	0.73	0.59	81	0.34	0.63	72	0.68	0.32	34	−3.11	0.02
Malaysia*	24	5	10	2.39	0.18	30	0.69	0.64	38	−0.93	0.44	5	−4.48	0.49
The Netherlands	5	34	20	3.38	0.01	46	0.83	0.29	44	−0.80	0.39	22	−3.10	0.01
New Zealand	2	4	10	−4.66	0.16	10	0.15	0.94	23	−1.00	0.36	4	4.99	0.24
Singapore*	5	17	14	1.84	0.15	27	−0.09	0.92	44	−0.46	0.69	10	0.16	0.96
Spain	4	5	7	−0.16	0.94	41	3.20	0.00	31	−2.38	0.05	4	2.31	0.65
U.K.	82	108	35	0.60	0.56	88	−0.13	0.80	82	−0.27	0.60	34	−1.28	0.16
U.S.	334	127	39	−0.57	0.44	73	−0.37	0.36	92	0.59	0.09	35	−0.81	0.07
Portfolio	797	588	255	0.34	0.33	654	0.44	0.04	690	−0.16	0.46	249	−1.11	0.01
Panel B: Low book-to-market equity														
Australia	11	15	22	−0.44	0.73	48	0.42	0.66	53	0.08	0.92	20	−0.05	0.98
Canada	19	32	36	0.33	0.65	85	−0.32	0.50	78	0.73	0.16	28	−0.43	0.71
France	6	51	17	3.31	0.01	42	0.81	0.64	52	1.59	0.15	20	−2.01	0.24
Germany	33	64	18	2.03	0.10	48	0.87	0.17	42	0.23	0.77	23	−1.01	0.21
Hong Kong*	11	20	11	1.88	0.43	35	−0.47	0.70	39	1.49	0.04	10	−1.36	0.50
Japan	195	104	16	3.08	0.02	81	0.30	0.62	72	−0.10	0.88	34	−3.41	0.01
Malaysia*	40	4	10	2.60	0.48	30	−0.63	0.62	38	0.03	0.98	5	−3.00	0.29
The Netherlands	6	34	20	1.11	0.34	46	−0.36	0.67	44	−0.40	0.67	22	−1.31	0.28
New Zealand	9	5	10	−1.23	0.43	10	−0.62	0.68	23	−0.20	0.85	4	−0.38	0.86
Singapore*	6	16	14	−1.17	0.61	27	−0.24	0.79	44	0.69	0.55	10	5.37	0.08
Spain	3	5	7	0.97	0.62	41	1.10	0.24	31	−1.26	0.26	4	−1.39	0.17
U.K.	33	110	35	0.52	0.50	88	−0.21	0.58	82	−0.13	0.77	34	−0.82	0.18
U.S.	180	129	39	−0.01	0.99	73	−0.32	0.40	92	−0.64	0.05	35	−0.21	0.71
Portfolio	550	589	255	0.82	0.02	654	0.05	0.82	690	0.15	0.47	249	−0.96	0.01

Each year, firms are sorted into three bins based on International Sales (IS): IS=0%, 0% to 25%, and >25% in year $t-1$. The firms in the high IS portfolio are split into low book-to-market equity (1/Market-to-Book) and high book-to-market (BE/ME) portfolios based on the median BE/ME equity in June of year $t-1$. The median BE/ME from the high IS portfolio is also used to split the IS=0% portfolio into high and low BE/ME portfolios. Monthly value-weighted portfolio returns are then created in the following year. High minus no (HMN) is the return on a portfolio that is long firms with IS>25% and short firms with IS=0%. Panel A contains results for the high market-to-book firms, and low market-to-book firms are in Panel B. Portfolios comprised of less than 3 firms are deleted. The returns on each portfolio are computed from July to June in year t. The returns on this portfolio are computed over four different exchange rate 'regimes'. The exchange rate is the Bank of England (BOE) trade-weighted exchange rate. Countries marked with an asterisk (*) do not have BOE rates and the Japanese Yen bilateral rate is used instead. Rates are quoted as foreign currency per one unit of home currency. N_N (N_H) is the average number of firms in the IS=0 (>25%) portfolio. N_{FX} is the number of monthly observations in each exchange rate regime. σ_i is the monthly standard deviation of the exchange rate change for country i. The first (last) columns show periods of large home currency depreciations (appreciations), defined as exchange rate changes that are less (greater) than $-1.0\times\sigma_i$ ($1.0\times\sigma_i$). The middle columns show periods of small depreciations (appreciations). For the overall portfolio results, all difference portfolios with observations on a given date are used in the calculation.

Table 8
High minus no international sales portfolio returns: Large vs. small firms

Country	N_N	N_H	$<-1.0\times\sigma_I$			0 to $-1.0\times\sigma_i$			0 to $1.0\times\sigma_i$			$>1.0\times\sigma_I$		
			N_{FX}	HML	p-val	N_{FX}	HML	p-val	N_{FX}	HML	p-val	N_{FX}	HML	p-val
Panel A: Large firms														
Australia	4	15	23	−0.24	0.83	58	−0.25	0.69	66	0.63	0.39	19	0.37	0.71
Canada	13	37	36	0.73	0.22	85	0.71	0.12	78	0.30	0.54	28	−0.41	0.69
France	14	72	17	2.36	0.05	43	0.73	0.47	52	1.38	0.04	20	−2.13	0.05
Germany	13	45	30	0.83	0.44	75	0.95	0.14	82	0.42	0.47	40	−0.96	0.31
Hong Kong*	13	14	28	−0.21	0.80	57	−0.16	0.80	66	0.81	0.12	16	−1.23	0.24
Italy	6	21	10	4.08	0.29	60	−0.09	0.93	52	−0.37	0.75	9	−2.29	0.68
Japan	74	91	22	2.38	0.06	96	1.25	0.08	79	0.31	0.62	42	−3.59	0.04
Malaysia*	22	7	11	3.29	0.31	42	−0.70	0.40	46	−0.55	0.50	8	0.53	0.86
The Netherlands	3	36	16	1.25	0.27	38	0.90	0.33	37	−0.48	0.60	16	−2.03	0.03
New Zealand	3	6	10	−4.59	0.25	10	0.15	0.92	23	−0.22	0.87	4	6.49	0.31
Singapore*	6	16	17	−0.77	0.59	29	0.03	0.97	51	−0.25	0.74	11	2.96	0.04
Spain	8	9	10	0.67	0.60	52	0.37	0.63	39	−2.77	0.01	6	−1.30	0.23
U.K.	28	117	35	0.68	0.33	88	0.03	0.93	82	−0.10	0.80	34	−0.84	0.16
U.S.	178	156	39	−0.08	0.86	73	−0.09	0.78	92	0.04	0.89	35	0.04	0.93
Portfolio	385	642	304	0.65	0.04	806	0.34	0.07	845	0.07	0.71	288	−0.98	0.01
Panel B: Small firms														
Australia	32	14	23	−1.76	0.11	58	−0.87	0.33	66	−0.89	0.35	19	1.77	0.25
Canada	38	35	36	−0.50	0.33	85	0.05	0.90	78	−0.61	0.09	28	1.44	0.13
France	40	72	17	1.66	0.10	43	−0.09	0.86	52	−0.35	0.43	20	−1.36	0.13
Germany	28	43	30	0.40	0.68	75	1.06	0.07	82	−0.39	0.47	40	−2.65	0.00
Hong Kong*	6	12	28	−1.29	0.29	57	0.65	0.43	66	−1.48	0.23	16	−0.12	0.93
Italy	15	21	10	1.26	0.21	60	−1.33	0.18	52	−0.09	0.88	9	2.10	0.04
Japan	452	92	22	1.00	0.32	96	0.31	0.51	79	0.05	0.91	42	−1.61	0.02
Malaysia*	54	5	11	−0.01	1.00	42	1.31	0.39	46	−1.30	0.21	8	−2.01	0.44
The Netherlands	9	38	16	−0.55	0.41	38	−3.45	0.08	37	−0.78	0.16	16	−1.20	0.28
New Zealand	8	5	10	−2.00	0.19	10	−2.56	0.16	23	−2.54	0.05	4	−1.94	0.48
Singapore*	5	14	17	−1.29	0.40	29	0.02	0.99	51	1.65	0.18	11	1.14	0.59
Spain	3	8	10	−3.20	0.09	52	−1.25	0.34	39	−1.21	0.43	6	6.28	0.08
U.K.	98	113	35	−0.35	0.57	88	0.55	0.09	82	−0.50	0.04	34	−0.79	0.02
U.S.	485	149	39	0.18	0.64	73	0.18	0.57	92	0.00	1.00	35	−0.45	0.15
Portfolio	1273	621	304	−0.35	0.17	806	−0.11	0.62	845	−0.48	0.01	288	−0.29	0.37

Each year, firms are sorted into three bins based on International Sales (IS): IS=0%, 0% to 25%, and >25% in year $t-1$. The firms in the high IS portfolio are split into large market value (MV) and small MV portfolios based on the median MV in June of year $t-1$. The median MV from the high IS portfolio is also used to split the IS=0% portfolio into large and small MV portfolios. Monthly value-weighted portfolio returns are then created in the following year. High minus no (HMN) is the return on a portfolio that is long firms with IS>25% and short firms with IS=0%. Panel A contains results for the large market capitalization firms and small market cap firms are in Panel B. Portfolios comprised of less than 3 firms are deleted. The returns on each portfolio are computed from July to June in year t. The returns on this portfolio are computed over four different exchange rate 'regimes'. The exchange rate is the Bank of England (BOE) trade-weighted exchange rate. Countries marked with an asterisk (*) do not have BOE rates and the Japanese Yen bilateral rate is used instead. Rates are quoted as foreign currency per one unit of home currency. N_N (N_H) is the average number of firms in the IS=0 (>25%) portfolio. N_{FX} is the number of monthly observations in each exchange rate regime. σ_i is the monthly standard deviation of the exchange rate change for country i. The first (last) columns show periods of large home currency depreciations (appreciations), defined as exchange rate changes that are less (greater) than $-1.0\times\sigma_i$ ($1.0\times\sigma_i$). The middle columns show periods of small depreciations (appreciations). For the overall portfolio results, all difference portfolios with observations on a given date are used in the calculation.

Table 9
Regressions for portfolios formed on international sales

Country	N	No international sales (0%)				High international sales (>25%)				HMN	
		N_N	b_I	d_i	t-stat	N_H	b_i	d_i	t-stat	d_i	t-stat
Australia	180	37	0.81	0.12	(1.40)	28	1.12	−0.04	−(0.86)	−0.16	−(1.53)
Belgium	143	9	0.49	0.21	(0.28)	19	0.98	−0.43	−(0.66)	−0.63	−(0.79)
Canada	227	54	0.89	0.21	(1.30)	77	1.11	−0.20	−(2.28)	−0.41	−(2.24)
Denmark	71	5	0.54	0.64	(1.15)	53	0.78	0.10	(0.28)	−0.54	−(0.74)
France	143	53	0.40	−0.36	−(0.62)	145	1.01	−0.04	−(0.25)	0.32	(0.55)
Germany	239	43	0.49	0.06	(0.29)	92	1.05	−0.24	−(2.00)	−0.30	−(1.26)
Hong Kong*	167	21	0.89	−0.04	−(0.71)	35	1.01	−0.01	−(0.09)	0.04	(0.38)
Italy	143	21	1.11	0.17	(0.44)	47	0.76	−0.57	−(1.33)	−0.74	−(1.31)
Japan	239	552	0.88	0.25	(2.18)	190	0.92	−0.30	−(3.40)	−0.55	−(3.25)
Malaysia*	143	82	0.84	0.01	(0.28)	14	0.95	−0.18	−(1.75)	−0.19	−(2.14)
The Netherlands	143	12	0.61	−0.75	−(1.88)	73	0.99	−0.28	−(1.80)	0.47	(1.16)
New Zealand	83	15	0.71	0.16	(0.52)	13	0.93	0.64	(2.22)	0.49	(1.02)
Norway	47	6	0.78	0.00	(0.00)	24	1.06	−0.06	−(0.16)	−0.06	−(0.06)
Singapore*	131	12	1.23	−0.24	−(0.87)	34	1.31	−0.11	−(0.39)	0.13	(1.06)
Spain	107	10	0.84	0.25	(1.54)	17	1.05	−0.45	−(2.91)	−0.70	−(3.06)
Switzerland	107	6	0.35	−0.02	−(0.12)	66	0.86	−0.16	−(1.42)	−0.14	−(0.68)
U.K.	239	133	0.83	0.17	(2.09)	242	1.03	−0.02	−(0.56)	−0.19	−(2.12)
U.S.	239	698	0.93	−0.04	−(0.78)	320	1.05	−0.07	−(1.93)	−0.02	−(0.30)
Average	155	98	0.76	0.04	(0.36)	83	0.99	−0.13	−(1.07)	−0.18	−(0.85)
Portfolio	2791	142	0.81	0.09	(1.89)	107	1.00	−0.12	−(2.79)	−0.21	−(2.77)

Each year, firms are sorted into three bins based on international sales (IS): IS=0%, 0% to 25%, and >25% in year $t-1$. Monthly value-weighted portfolio returns are then created in the following year. HMN is the return on a portfolio that is long firms with IS>25% and short firms with IS=0%. Portfolios comprised of less than 5 firms are deleted. Time-series regressions (similar to Eq. (2)) are then estimated on each country portfolio. The exchange rate is the Bank of England (BOE) trade-weighted exchange rate. Countries marked with an asterisk (*) do not have BOE rates and the Japanese Yen bilateral rate is used instead. Rates are quoted as foreign currency per one unit of home currency. N_N (N_H) is the average number of firms in the IS=0 (>25%) portfolio. N is the number of months in the sample period. b_i is the coefficient on the market index and d_i is the coefficient on the exchange rate change. The t-statistic tests the hypothesis that $d_i=0$ and is computed using heteroskedasticity consistent standard errors. The overall portfolio results are from a pooled cross-sectional time series regression, with dummy variables (not reported) for each country.

portfolio is either zero or positive. Pooling the firms together across countries and estimating the regression reveals that there is a positive and marginally significant exchange rate coefficient of 0.09.[16] Similar time-series regressions on a country-by-country basis are estimated for portfolios of high international sales firms. The portfolio of firms with high international sales is likely to be exporters and should have a negative exposure coefficient. Table 9 shows that all but two countries (Denmark and New Zealand) have a negative exchange rate exposure for the high international sales portfolio. In seven of the 18 countries, the portfolios of firms with high international sales exhibit significant exchange rate exposure (at least at the 10% level), with some showing large changes in explanatory power. For example, in Japan, the exposure coefficient is −0.30 (t-statistic=−3.40). A pooled regression reveals that firms with high international sales have a significantly negative exposure coefficient of −0.12 (t-statistic=−2.79),

[16] All pooled regressions are estimated with country-specific dummy variables that are not reported. The inclusion of the dummy variables does not impact the results.

indicating that they are negatively affected by a home currency appreciation and that they benefit from a home currency depreciation.

The final two columns show the results for the high minus no international sales difference portfolios (the market return is not included). Consistent with the portfolio return results in Table 5, Table 9 shows that the relation between the difference portfolio and exchange rates is negative in 13 of 18 countries. However, the results vary across countries, with a 1% currency appreciation leading to a −0.55 relative loss of firm value in Japan and −0.19 in the U.K., but only −0.02 in the U.S. On average, exchange rates have a negative coefficient of −0.21, indicating that a 1% appreciation in the home currency leads to a 0.21% loss in firm value for firms with high international sales as compared to firms with no international sales.

The portfolio regression results across countries indicate a more important role for exchange rates than those at the firm level. These findings confirm our previous results that exchange rates impact firm value in an economically important and sensible way – firms with high levels of international sales outperform those with no international sales during periods of large currency depreciations and underperform during currency appreciations.

5. Other issues

5.1. Lagged exposure

Bartov and Bodnar (1994) conclude that U.S. investors find it difficult to incorporate the effects of exposure into stock prices. To examine this market inefficiency explanation with the portfolio approach, we perform tests similar to those in Table 5 except that we partition on the previous month's exchange rate movement. In unreported results, we find that firms with high international sales generally perform slightly better (worse) than those with no international sales following a large depreciation (appreciation) in exchange rate movements in the previous month. However, the economic magnitude of these results is small and overall they are generally insignificant. The lagged exchange rate effect is insignificant for most of the countries except for the US.[17] The lack of a significant lagged effect indicates that mispricing is likely not a main driver of the low magnitude of exposure found in previous studies.

5.2. Foreign income and exposure

Foreign income may be a better proxy for exposure, as it is the net income or cash flows accruing to a firm from foreign sources that should affect firm value. The disadvantage of partitioning on foreign income is that there are fewer firms that report foreign income and firm–months coverage is about half of what it is for international sales. Nevertheless, we examine the returns to portfolios that are long firms with high foreign income and short firms with no foreign income. These (unreported) partitions are similar in nature to those performed for international sales in Table 5. Firms with high foreign income gain during currency

[17] We also examine similar results separately for firms above and below the median market cap in each country and do not find a lagged reaction to 1 month exchange rates for either small or large firms. In addition, we use the regression framework similar to Table 9 and do not find significant lagged exchange rate effects even after controlling for the contemporaneous relation.

depreciations and lose relative to firms with no foreign income during currency appreciations. However, because of the more restrictive foreign income coverage, inferences are less precise than with the international sales results. Overall, the foreign income sorts provide supporting evidence that the exchange rate movements affect the relative returns of stocks with income generated abroad.

5.3. Cash flow forecasts

A final question that we address is whether cash flow exposure is greater or less than stock price exposure. Because cash flow data is usually only gathered on an annual basis, we collect average analyst earnings forecasts through IBES on a monthly basis.[18] We then calculate changes in analyst earnings estimates on an individual firm basis and sort firms into high and no international sales portfolios. Within each country, we then estimate regressions of earnings forecast changes for both the high and no international sales portfolios, as well as for the difference between the earnings changes of the high and no international sales portfolio on contemporaneous and lagged exchange rate movements. In general, we find almost no evidence that contemporaneous or lagged exchange rate movements are related to changes in cash flow estimates. It is possible that analysts simply do not update their earnings estimates frequently or in response to small changes in cash flows, or that they update them primarily in response to other factors. Nevertheless, it is interesting that firm value is related to exchange rate movements despite the fact that analyst earnings forecasts do not move systematically with exchange rates.

6. Conclusion

This paper examines the nature and the economic magnitude of exchange rate exposure using a unique firm-level database that covers many countries. Using time-series regressions over 5-year windows, we find that more firms are exposed to exchange rate movements than can be attributed to chance; however, exchange rates do not explain a large portion of the variation in individual firm stock returns. We estimate cross-sectional regressions of exchange rate betas on determinants of exposure and find that firm size, the level of international sales, foreign income, and foreign assets are all significantly negatively related to exposure.

We document that the use of portfolios dramatically improves our ability to observe the economic importance of exchange rate exposure. We evaluate the average magnitude of these exposure effects by examining the relative performance of firms with high international sales as compared to those with no international sales during different periods of currency movements. Firms with high international sales outperform those with no international sales in periods of currency depreciations, but underperform during periods of currency appreciations. These patterns are pervasive across countries and are economically important. In 16 of 18 countries, firms with high international sales underperform those with no international sales during periods of currency appreciations by an average of 1.10% per month. We find that our results cannot be explained by book-to-market equity risk but are more concentrated in large firms which may have more exposure. Additionally, the patterns we document with international sales are evident when

[18] Because the coverage for this data is not as extensive as it is for international sales, we do not have data for the complete set of countries in our sample.

we form portfolios according to a firm's past foreign exchange exposure beta. These findings, combined with the individual stock regression results, show that while exposure may only explain a small proportion of the variation in stock returns for a particular firm, this effect is pervasive across firms with international activities; hence, exchange rates are important for explaining cross-sectional differences in stock returns.

Overall our results provide evidence that exchange rate movements do affect firm value in a manner consistent with theory and that exchange rate movements have an economically significant impact on differences in average stock returns. The portfolio return difference between firms with high and no international sales (or exposure betas) is often greater than 1% a month and is even higher in some countries. These findings should be of interest to policy makers who wish to understand the effects of relative exchange rate movements on certain sectors of the economy and to investors who under- or overweight multinational corporations in their portfolios. It should be promising to consider the impact of exchange rate movements in portfolio optimization, value-at-risk, performance attribution, and other analyses that seek to understand major sources of co-variation among stock returns.

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Appendix A. Data Appendix

To be included in the sample, firms must have at least 36 consecutive monthly return observations and must not be classified by Datastream as a financial firm. In addition, only countries that have at least 40 firms with data on foreign activity are included in the sample. Further, in each country, we require that there are firms that report zero foreign activity and firms that report non-zero foreign activity. Data for both currently listed (alive) and delisted (dead) firms are from Datastream International. The alive stocks are from the 'Country Lists' in Datastream, while the 'dead' stocks come from the 'Deadlists' files. Returns include the change in stock price plus any dividends paid by the firm in a given month.

Financial firms are excluded because of the potential issues with making inferences concerning exchange rate exposure. We exclude preferred shares (except in countries where preferred shares are the main share class, e.g. Brazil), convertible shares, warrants, investment certificates, participation certificates, units, mutual funds, and foreign listed shares. In many countries, firms have several classes of equity, e.g. 'A', 'B', 'C', etc. share series. The distinction between these share classes differs across countries. For example, in Denmark the 'A' shares carry enhanced voting rights, usually on a 10-to-1 basis, while the 'B' shares carry ordinary voting rights. In China, 'A' shares are restricted to nationals, while 'B' and 'H' shares

Table A1
This table provides summary statistics for the countries included in the main sample

Country	Start date	Alive firms	Dead firms	Total # of firms
Australia	1975	763	184	947
Belgium	1975	75	46	121
Canada	1975	743	213	956
Denmark	1975	145	31	176
France	1975	401	248	649
Germany	1975	492	70	562
Hong Kong	1975	459	31	490
Italy	1975	120	49	169
Japan	1975	2605	100	2705
Malaysia	1980	346	2	348
The Netherlands	1975	152	98	250
New Zealand	1988	98	48	146
Norway	1975	108	73	181
Singapore	1975	178	10	188
Spain	1987	80	25	105
Switzerland	1975	131	48	179
U.K.	1975	1172	1136	2308
U.S.	1975	5627	1822	7449
Total		13695	4234	17929

The "Alive" firms are from the "Country Lists" in Datastream International. The "Dead" firms come from the "Deadlists". To be included in the sample, a firm must have at least 36 return observations during the sample period from 1975 to 1999 and must not be classified as a financial firm. The tabulations in this table impose no further data requirements.

are available to foreigners. Therefore, when there are multiple share classes in a country, we try to select the most representative share class by choosing:

1. The share class with ordinary voting rights.
2. The share class that is most widely traded.
3. The share class that is available for foreign investment.

These criteria are similar to the criteria that Worldscope uses to select the most representative share class for a firm. However, these criteria are not necessarily mutually exclusive. For example, in some cases, shares that are restricted to nationals are also the most widely traded – in these cases we choose the share class that is most widely traded even though it is restricted to only nationals. We also apply other screens to minimize the influence of reporting errors.

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