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THE EFFECT OF EXCHANGE RATE FLUCTUATIONS ON THE PERFORMANCE OF SMALL AND MEDIUM SIZED ENTERPRISES: IMPLICATIONS FOR BREXIT

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Abstract

This paper develops an innovative technique that takes into account the time varying nature of exchange rate (XR) exposures and separates these exposures into those that increase stock market returns and those that reduce them to study the effect of XR fluctuations on the performance of UK small and medium sized enterprises (SMEs). It provides evidence that XR fluctuations have a strong negative effect on SME performance at the industry and individual firm level for both depreciations and appreciations of the GBP against the USD and a residual index of all other currencies except the euro. For the euro, the exposures are much smaller at the industry level and generally not statistically significant. At the firm level they are also more evenly divided between performance enhancing and performance decreasing. Differences of exposures to currency variations between export-oriented firms and domestically-focused firms are also analyzed. Our results have policy implications for Brexit.

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Keywords: SME; share price performance; asymmetric exchange rate exposure; good/bad exposures.

Highlights:

- Exchange rate exposures that increase and reduce market returns are identified.
- Exchange rate fluctuations have a negative effect on UK SME performance.
- These conclusions are observed at the industry and individual firm level.
- Exposures to Euro fluctuations are less significant than to the USD moves.
- Performance reducing exposures for SMEs are more likely with foreign sales.
- These results have policy implications for Brexit.

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1. INTRODUCTION

The large and growing literature on exchange rate (XR) exposure suggests that although it can be reduced or eliminated through the use of financial and operational hedging techniques,[1] this exposure remains a significant source of corporate risk.[2] However, most of our understanding of XR exposure comes from studies that rely on samples dominated by large corporate enterprises involved in international trade.[3] Another common feature of these studies is that they all fail to carry out an analysis of whether or not the estimated exposures are performance enhancing or performance reducing. In this paper we address these issues by looking at a sample of UK small and medium sized enterprises (SMEs). We estimate their exposures to the XR and then develop an innovative methodology to analyze whether the exposures are performance enhancing or performance reducing. To the best of our knowledge, it is the first paper to empirically estimate XR exposures of SMEs and to separate these exposures into those that increase firm performance and those that reduce it.

The UK sample we construct is particularly interesting for the study of XR exposure because the British pound has been following a strict, free floating XR regime since the Bank of England was granted operational independence over monetary policy in 1997. Furthermore, small and medium sized enterprises (SMEs) form the backbone of the UK economy, representing around 54% of gross

[1] The use of derivatives to hedge this exchange rate (XR) exposure is now well-documented standard practice for large firms with foreign operations or commercial interests. For US firms, there are studies such as Géczy, Minton and Schrand (1997), Goldberg et al. (1998), Howton and Perfect (1998), Graham and Rogers (2002), Allayannis and Ofek (2001). Studies of non-US firms include Berkman and Bradbury (1996) on New Zealand firms, Hagelin (2003) on Swedish firms and Pramborg (2005) on Swedish and Korean firms, Batten et al. (1993) and Nguyen and Faff (2003) on Australian firms, and Heaney and Winata (2005) on Australian firms. The International Swaps and Derivatives Association (ISDA) 2009 derivative usage survey reports that today 94% of the world's 500 largest companies representing a wide range of geographic regions and industry sectors use derivatives for risk management on a regular basis (http://www.isda.org/researchnotes/pdf/ISDA-Research-Notes2.pdf)

[2] See, for example, Jorion (1990), Agarwal and Ramaswami (1992) Bodnar and Gentry (1993), Amihud (1994), Choi and Prasad (1995), Donnelly and Sheehy (1996), He and Ng (1998), Miller and Reuer (1998), Hagelin and Prambourg (2004), Rees and Unni (2005), Makar and Huffman (2008), Clark and Mefteh (2011) to mention only a few.

[3] For example, see Jorion, 1990, Jorion, 1991, Bodnar and Gentry, 1993, Amihud, 1994, Khoo, 1994, Choi and Prasad, 1995, Miller and Reuer, 1998, He and Ng, 1998, Dominguez, K.M.E. & Tesar, L.L., 2006, Hutson and Stevenson, 2010, Bartram et al., 2010, Chaieb, I. & Mazzotta, S., 2013, Bergbrant, et.al., 2014. One exception, Aggarwal and Harper (2010), shows that significant XR exposure exists even for "domestic" firms with no direct exposure to currency movements. Importantly, it also shows that this exposure is negatively related to firm size. See also Hodder (1982), Levi (1994) and Marston (2001).

value added, 56% of employment and 52% of turnover. SMEs also differ from the larger corporate enterprises in several important ways. Their size and their limited access to human and financial resources make them particularly vulnerable to market imperfections such as informational asymmetry as well as operational and financial constraints. For instance, Mulligan (1997) finds that transactions costs for small firms are excessively high. Titman and Wessels (1988) highlight that SMEs are likely to suffer from financial distress. Whited (1992) and Fazzari and Peterson (1993) show that due to limited internal finance and costly external finance, small firms are more likely to be affected by financial constraints than large firms.[4] Furthermore, the ownership and decision-making structures of SMEs are considerably different from the large, widely owned firms. Pennings and Garcia (2004) show that in SMEs decisions are made by managers who are responsible for multiple business functions rather than the specialized functions of larger firms. This could affect XR exposure if risk perception and the operating and financial decisions are more jointly determined than those in large firms.[5] The ownership of SMEs is also often concentrated and, therefore, they have different factors influencing their agency costs, which are key determinants of risk taking. Finally, there is anecdotal evidence that SMEs are particularly vulnerable to XR risk.[6] We argue that because of their size, ownership structure and limited access to human and financial resources, SMEs are particularly vulnerable to the uncertainty and competitive pressures transmitted by the fluctuations in the XR.

Our empirical design includes several important features. Rather than following the methodology in many of the studies cited above that calculate an average exposure using monthly data over a period of several years, we use weekly data with a one-year, non-overlapping, rolling window

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[4] As an incremental source of firm risk, exchange rate volatility could be considered to have a negative effect on firm performance. The positive theory of corporate hedging developed by Smith and Stulz (1985), argues that imperfect capital markets can create conditions where unhedged exposure reduces firm value through an increase in external claims on the cash flow stream flowing from the firm's assets, such as taxes paid to government, bankruptcy costs (both direct and indirect) paid to accountants, lawyers and the firm's non-investor stakeholders, and/or agency costs to align managerial interests with the interests of capital suppliers.

[5] Interestingly, 40% of larger SMEs say that they do not directly cover their exposure to currency risk (Moneycorp, 2009).

[6] The Financial Times (7/7/09) reports, "The pound's volatility affected 92 per cent of small businesses surveyed, with 42 per cent of finance directors saying that the impact was 'significant' or 'serious'". Moneycorp (2009) finds that 30% of the 500 UK SMEs it surveyed rely on imports, which on average make up 20% of their costs. See also: https://www.ft.com/content/338d3d5a-269c-11e3-bbeb-00144feab7de and

https://www.eiuperspectives.economist.com/sites/default/files/Adapting%20in%20Tough%20Times_0.pdf to estimate annual XR exposures. There are several reasons for this. First of all, a weakness of the monthly data used in many previous studies cited above is that it requires a long-time span. A year of weekly data amounts to 52 observations, the equivalent of over 4 years of monthly data. While a firm's exposure to movements in a single foreign exchange series may reasonably be assumed to remain constant over the period of one year, this cannot confidently be assumed for a period of three or four years, or longer, especially for a freely floating XR regime. Furthermore, there is strong evidence of time variation in exposure.[7] The period under consideration starts in 1998, the first full year of central bank independence, and ends in 2014, the last full year before the beginning of the Brexit issue. This period was particularly volatile, characterized by evolving trade patterns and increasing economic competition from China and the other emerging markets, sharp swings in commodity prices and financial turbulence associated with the dot.com crisis, the mortgage bust and several sovereign banking crises and/or debt defaults. Annual XR exposures make it possible to account for these changing conditions and their impact on corporate decision-making and performance. Finally, there is evidence that statistically significant exposure to weekly exchange rate movements is widespread at the firm and industry levels.[8] Finally, weekly sampling captures the effect of floating and also reduces some of the problems of white noise and heteroskedacity associated with daily data.

We measure XR exposure at the industry level as well as at the firm level. To measure exposure at the industry level,[9] we group individual firms into industry panels and use a mixed panel effects model. This technique explicitly allows for heterogeneous exposure of firms within the same industry and makes it possible to measure industry level exposure using firm level data rather than industry indices. The economic argument is that although an unexpected change in the exchange rate should affect an industry's overall competitiveness, the effect can differ from firm to firm. This

[7] See e.g. Jorion (1990); Glaum et al. (2000); Williamson (2001); Starks and Wei, 2006, Chaieb and Mazzotta, 2013).

[8] For example, Dominguez and Tesar (2006) find that for five of the eight countries in their sample over 20% of firms are exposed to weekly exchange rate movements and exposure at the industry level is generally much higher, with over 40% of industries exposed in Germany, Japan, the Netherlands and the UK.

[9] See Chaieb and Mazotta, 2013.

technique also makes statistical sense since a larger number of observations yield more precision and higher testing power while overcoming the potential loss of information and bias induced when firms are grouped together in an index. Individual firm exposures are measured in traditional firm-by-firm regressions.

Finally, and importantly, we employ an empirically innovative two-step procedure to detect possible XR exposure asymmetries and analyze the effect of the floating XR on firm performance. In step 1 we measure the exposures of each industry or firm to currency appreciations and depreciations. In step 2 we compare the signs of the exposure coefficients with the sign of the XR move to determine whether each individual exposure has a positive or negative effect on the firm's stock performance.

This paper makes several interesting contributions to the literature. First, it confirms that XR exposures for SMEs are larger in magnitude and more often significant than for large firms. Secondly, it finds that the magnitude and significance of XR exposures at the industry level varies from industry to industry and from currency to currency and that all significant exposures in all currencies exert a negative impact on an industry's performance. However, all statistically significant industry exposures are concentrated on the dollar (USD) and other currencies than the dollar and the euro (RES). 61% of USD exposures and 78% RES exposures are significant, while only 22% of the euro exposures are significant. Furthermore, the absolute values of three of the four statistically significant euro exposures are smaller than the corresponding statistically significant exposures of the other two currencies. Thus, we provide evidence that UK industries have less exposure overall and, importantly, less performance reducing exposure to the euro than to the other currencies. We attribute this result to UK integration into the European Union whereby innovations and imbalances arising in member countries are already partially resolved through flows of goods, services, labor and capital. To the extent that Brexit reduces or eliminates these flows between the UK and the eurozone, transmission of innovations and imbalances will shift to the XR. Our results with respect to the non-euro currencies suggest that this type of shift would have undesirable performance reducing effects on the competitive environment of the industries where UK SMEs operate.

In a third contribution we find that for individual SMEs in the UK, there are significant differences in XR exposures between appreciations and depreciations of the British Pound (GBP) with respect to the bilateral XR changes against the EUR, USD and RES, as well as between exporting and non-exporting firms. These exposures vary over time in response to changes in economic conditions and firm specific circumstances. Finally, and most importantly, we also provide strong evidence that XR fluctuations have a significant performance reducing effect on individual UK SMEs. The market returns of all the SMEs in our sample have statistically significant exposure to changes in the XR and, on average, these XR changes affect the market returns negatively. Sixty percent of significant exposures are performance reducing and the difference between positive and negative exposures is statistically significant at the 1% level.[10] Again, the euro stands in contrast to the other currencies. Only 52% of euro exposures are return reducing, while 63% of exposures to the other currencies are return reducing. Interestingly, we find that "the percentage of performance reducing exposures for SMEs with foreign sales is greater than for those without exports and that the distribution of these exposures across industries differs considerably. Thus, we confirm the undesirable, performance reducing effects of XR fluctuations at the individual firm level that we found at the industry level and what this implies for a Brexit that would reduce the flows of goods, services, labor and capital between the UK and the eurozone.

The rest of the paper is organized as follows. Section 2 reviews the literature, before section 3 describes the data and outlines the methodology. Section 4 presents the empirical results and section 5 concludes.

[10] As a comparison, only 51.8% of the exposures are price reducing for the sample of the 250 largest non-financial firms in the UK ranked by market value for each year-end over the same period.

2. REVIEW OF THE LITERATURE:

Economic theory and empirical evidence offer some guidance about the channels though which XRs affect the profitability of firms. Kearns and Patel (2016) analyze the trade channel, though which a currency depreciation can improve net exports, and the financial channel, through which the same currency depreciation can deteriorate a firm's net worth. In particular, they find evidence that the financial channel partly offsets the trade channel, mostly for emerging market economies.

2.1 The trade channel

The trade channel originates from the elasticities and absorption approach to balance of payments theory, which emphasizes the role of exchange rate fluctuations on individual firm performance through relative price changes and income redistribution and their effects on suppliers, customers, and competitors.[11] Dominguez and Tesar (2001) explain that a currency depreciation improves the profitability of exporting firms since their merchandises benefit from lower prices abroad. However, their profits could be reduced if they import intermediate products, whose domestic prices rise due to the depreciation that increases their cost of production. Firms that do not export, but import intermediate goods, would also suffer the same fate. Actually, even firms that do not trade internationally or are not involved in international business would be indirectly affected by currency fluctuations as a result of foreign competition, since domestic sales depend on the domestic price of competing imports. Other studies show that competition is a first-order determinant of XR exposure: Shapiro (1975) and Allayannis and Ihrig (2001) in the domestic market from which exports originate; Dekle (2005) in the export market; and Bergbrant et al. (2014) in international and domestic product markets.

Dominguez and Tesar (2006) also highlight the fact that foreign competition may impact the XR exposure of firms in the traded sector as well as the non-traded sector, but that increased

[11] For some of the original work see: Meade (1951), Alexander (1952 and 1959), Pearce (1961), Tsiang (1961), Gerakis (1964) and Caves and Johnson (1968). Further analysis on the parameters and transmission mechanisms that determine a firm's sensitivity to exchange rate movements include Shapiro (1975), Dumas (1978), Hodder (1982), Flood and Lessard (1986), Booth and Rottenberg (1990), Levi (1994), Marston (2001), Allayannis and Ihrig (2001), Bodner et al. (2003), Clark (2002), Clark and Ghosh (2004).

international trade or business activities as well as a smaller size raise a firm's XR exposure. In particular, they find that over 70% of UK firms are significantly exposed to exchange rate risk while using an international stock market index as a proxy for the world market in their standard CAPM model, but the percentage of exposed UK firms falls to about 10% with a British stock market index as a local index instead of a world index. The direction of exposure is positive for 70% of the firms against a trade-weighted basket of currencies and for 45% against the U.S. dollar. They also assume that the level of competitiveness of the firm's industry has a negative impact on its profit margin and on its ability to reduce XR pass-through, which would lower its exposure, but recognize that "*for the vast majority of firms, we are unable to identify the factors that could account for that exposure*" (p. 191).

Di Mauro et al. (2008) point out globalization may have changed the international economic transmission mechanisms of XR shocks and weakened pass-through and exposure. Market integration has increased competition and reinforced the pricing-to-market (PTM) behavior of exporters to defend their market shares, thereby lowering the responsiveness of trade flows to XR changes. This is of course limited by the ability to lower profit margins when the environment becomes very competitive. The formation of global value chains (GVC) has raised the import content of exports and also generated a decline of the XR effects on trade volumes. On the other hand, increased competition and lower trading costs have given importers an incentive to raise their exchange rate elasticities. However, the empirical evidence suggests that XR pass-through moderately decreased in the eurozone, as a result of the rising role of the euro as a currency of invoice as well as shifts in the sectoral composition of trade flows away from commodity-based goods toward manufactured products (where PTM is more frequent). Lastly, the effect of XR fluctuations on corporate profits appeared to remain stable overall, despite some important cross-country and firm-level heterogeneity.

Ollivaud et al. (2015) finds empirical evidence of a downtrend for the XR pass-through to the terms of trade, for nine out of eleven OECD nations studied, including the UK, in spite of its constant share of foreign value added in gross exports. The authors attribute this to the increasing importance of GVC in the production process of firms, and other factors for the UK, such as changes in the composition of trade flows. Ahmed et al. (2016) also conclude from their empirical study that GVC participation has lowered the XR elasticity of exports (by 22% on average for a panel of 46 nations).

Mouradian (2017) constructs a microeconomic model to explain the impact of XR fluctuations on the profits of heterogeneous import-competing and exporting firms, while separating two opposite effects on XR pass-through, a profit margin effect ("idiosyncratic cost pass-through") and a volume effect ("strategic complementarity elasticity"). The author demonstrates that the former is U-shaped, whereas the latter is hump-shaped, in the firm's market power, but that the XR elasticity of a firm's profit monotonically increases with its price elasticity of demand. Consequently, small firms with low market share and high price elasticity of demand do not have room to reduce their profit (in response to a currency depreciation for import-competing firms or a currency appreciation for exporting firms). As a result of their almost complete XR pass-through and strong exposure, they tend to incur large losses of sales volume (in the domestic or export market) and profits. The empirical study confirmed these hypotheses, and concluded that smaller French firms' profits were hurt by the euro appreciation during most of the period of study (1999-2007).

Demian et al. (2018) estimate the XR elasticity of exports for firms in 10 European countries (the UK not being included) and 22 sectors, and conclude that taking into account their heterogeneity in terms of productivity more than doubles their estimated value from 34% to 77%. They also find that these elasticities are greater for appreciations than for depreciations, especially for small firms, which often need an agreement with a foreign partner to penetrate an export market. This barrier to entry tends to result in upward limits on exported quantities, in case of a currency depreciation, and compels firms to raise the prices of its exported products, sold at constant volumes. On the other hand, small firms often face very competitive markets and are constrained downwards on their low profit margin and prices, in case of a currency appreciation which hurt their competitiveness, with no other choice than reducing the volume of their exports. Since most of XR adjustment occurs through changes in quantities, XR elasticities tend to be higher for appreciations than for depreciations.

2.1. The financial channel

The financial channel, through which XR changes affect a firm's or a country's net worth, occurs through its balance sheet when there is an imbalance in the currency denomination of its assets and liabilities. Also known as the valuation channel, it was first discussed by Lane and Shambaugh (2010) to analyze the effect of XR changes on countries' net foreign asset positions. The authors constructed a database of "financially-weighted" effective exchange rate indices to calculate international currency exposures for 145 countries, the same way trade-weighted effective exchange rates are built to study the international trade channel for various nations. This channel is also called the risk-taking channel by Kearns and Patel (2016), who construct similar debt-weighted effective exchange rates, and find evidence that the trade channel is partly offset by the financial channel, in particular for emerging market economies. Avdjiev et al. (2019) confirm that both channels have opposite effects, and presents country- and firm-level empirical evidence that a stronger dollar leads to a decrease in cross-border lending in US dollars and capital expenditures in emerging market economies.

The same channel could operate for small firms in the UK. Given that London is the world center of the dollar-denominated deposits with the LIBOR used as the reference rate for dollar-denominated loans, and the EURIBOR for euro-denominated loans, small UK firms could be affected by "financial" changes in exchange rates if they borrowed in one of the two main currencies to benefit from possibly lower interest rates. Indeed, a currency appreciation relative to a foreign currency used for international borrowing by a firm, would decrease the cost of foreign borrowing and raise the supply of loans, since it would lower the perceived risk of default and improve the creditworthiness of the borrowing firm.

3. RESEARCH METHODS AND DATA

3.1 Sample Selection and Data

This study considers the period from 1998 to 2014, which starts in the first full year of floating following the independence of monetary policy by the Bank of England and ends in 2014, the last full year before the beginning of the Brexit issue. It includes the crises caused by the dot.com and mortgage bubbles. Following Sogorb-Mira (2005), Garcia-Teruel and Martinez-Solano (2008), Psillaki and Daskalakis (2009) and Belghitar and Khan (2013), we adopt a quantitative definition of SMEs, based on firm total assets, annual turnover and number of employees. In each year non-financial firms that meet the following criteria as defined in the UK's Company Act (2006) are considered as SMEs: (1) total assets less than or equal to £11.4 million; (2) annual turnover less than or equal to £22.8 million; (3) total number of employees less than or equal to 250. Summary descriptive statistics for the sample of the SMEs are collated in table 1. For comparison purposes, we also select a sample of large firms. This sample consists of 250 non-financial firms taken from the top 500 non-financial firms in the UK ranked by market value for each year-end over the period of analysis. The data for generating firm XR exposures is obtained from DataStream.

As discussed above, to account for the particularly volatile period under consideration and the time-varying nature of XR exposures, we use weekly data with a one-year, non-overlapping, rolling window to estimate XR exposures. This is a preferable choice of sample frequency, since the monthly data used in many previous studies require a time span of several years. As argued above, a firm's exposure to an exchange rate may reasonably be assumed to remain constant over the period of one year, but this cannot reasonably be assumed for a period of three or four years or longer. A rolling one-year window makes it possible to capture changes in XR exposures due to the evolution of the international economy, macroeconomic policy and firm strategy. Weekly sampling also reduces some of the econometric problems related to white noise and heteroskedacity that are often associated with daily data.

[Insert Table 1 about here]

3.2 Model Determination

Estimation of the individual XR exposures builds on a large body of previous studies, which involves a time-series regression of changes in the exchange rate against the return on a firm's stock while controlling for market return (see e.g. Dumas, 1978, Adler and Dumas, 1980, and Hodder,1982). Jorion's (1990) two-factor model is the starting point for most estimates of XR exposure:

$$r_{i,t} = \beta_{i,0} + \beta_{i,m} r_{m,t} + \beta_{i,x} r_{x,t} + \varepsilon_{i,t} \tag{1}$$

where r_{it} is the rate of return on the *ith'* firm's common stock, r_{mt} is the rate of return on the market factor and r_{xt} is the rate of change of the exchange rate for period t. The betas, β_{i0}, β_{im}, and β_{ix} are estimated coefficients, where β_{i0} is a constant, β_{im} represents sensitivity to the market factor and β_{ix} represents the exposure to fluctuations in the exchange rate.

3.2.1 The market risk factor

In order to assess the effect of the exchange rate on the performance of SMEs, it is important to have an accurate estimate of their XR exposure.[12] From equation (1) it is clear that the choice of the market risk factor and the definition of the XR risk factor are crucial. The market risk factor controls for the effects of macroeconomic variables that can co-vary simultaneously with the exchange rate. Bodnar and Wong (2003), Fraser and Pantzalis (2004), Dominguez and Tesar (2001) and Starks and Wei (2003) showed that the choice of the market risk factor can bias the estimates of the exposure

[12] Many studies show little relationship between XR movements and firm returns. Examining the monthly stock returns of 287 US multinationals from 1971 to 1987, Jorion (1990) finds that the influence of nominal exchange rate movements on stock returns is statistically significant for only 5% of the firms in his sample. These findings are confirmed in Jorion (1991) for 20 value-weighted industry portfolios. Many other studies, such as Bodnar and Gentry (1993), for 39 two-digit industry portfolios from 1979 to 1988, Amihud (1994) for the 32 largest US exporting firms from 1982 to 1988, Choi and Prasad (1995) for 409 multinational firms from 1978 to 1989, Miller and Reuer (1998) 404 US manufacturing companies from 1988 to 1992, also find a low percentage of significant XR exposures. Where non-US firms are concerned, He and Ng (1998) for their sample of 171 Japanese multinationals and Khoo (1994) for his sample of the listed Australian mining companies find a very low percentage of significant exposures. Using a sample from 23 developed countries for the period 1984–2003, Hutson and Stevenson (2010) find that only 11% of 3788 firms have significant exposure. Kiymaz (2003), however, finds that about 50% of his sample of 109 Turkish firms has significant exposure.

coefficients and that an appropriate market risk factor improves the number of significant XR exposures. As we showed in the preceding section, firms in a country at least partially integrated into the international economic and financial system will be affected by foreign economic activity as well as by national macroeconomic variables. Thus, in order to avoid a potential omitted variable problem, the market risk factor should reflect international economic conditions as well as local economic conditions. To account for the UK's integration in international capital markets and avoid a potential omitted variable problem with the local index,[13] we use the MSCI World Index as the market risk factor, $r_{m,t}$.[14]

3.2.2 The currency risk factors

An appropriate currency risk factor is equally important for accurate XR exposure estimation. The single currency method used by Booth and Rotenberg (1990), Williamson (2001), Glaum, Brunner and Holger (2000), Entorf and Jamin (2004), Priestley and Ødegaard (2004), to mention only a few, is arguably adequate for countries with a single dominant trading partner. When more than one currency is involved, however, something more is required. In this case, trade-weighted exchange rate indices are often used (Jorion, 1990; Bodnar and Gentry, 1993; Amihud, 1994; Bartov and Bodnar, 1994; Dropsy and Nazarian-Ibrahimi, 1994; Choi and Prasad, 1995; Donnelly and Sheehy, 1996; Chow et al, 1997; He and Ng, 1998; Chow and Chen, 1998; Bodnar and Wong, 2003). Using trade-weighted indices overcomes the problem of multiple risk sources but disregards the problem of correlations between exchange rates, thereby underestimating exposures by omitting variables needed

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[13] It also avoids the size problem studied by Bodnar and Wong (2003). As a robustness check, we also estimated the exposure coefficients using the FTSE-500 as the proxy for the market factor. The results, available on request, are qualitatively and quantitatively similar but slightly weaker.

[14] The MSCI World Index is a free float-adjusted market capitalization index that is designed to measure global developed market equity performance. As of June 2006 the MSCI World Index consisted of the following 23 developed market country indices: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hong Kong, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, the United Kingdom and the United States (This definition is given by Morgan Stanley Capital International).

to capture the divergent movements in currency values.[15] Tests using trade-weighted baskets of currencies may also lack power if a firm is mostly exposed to only a few currencies within the basket (Williamson, 2001). Several solutions to this problem have been used and they all provide substantially higher proportions of significant XR exposures compared to other research. Miller and Reuer (1998) use principal components analysis to select the currency risk factors for their sample of US firms. Clark and Mefteh (2011) consider the major trading currency directly and construct an orthogonalized index of the residual currencies with respect to the major one for their sample of French firms. Another methodology involves the construction of indices specific to a region (Muller and Verschoor, 2006), an industrial sector (Khoo, 1994) or specific to individual firms (Ihrig, 2001). To capture the divergent movements in individual currency values we consider the UK's major trading currencies, the US dollar (USD) and the euro (EUR) along with a composite residual index (RES) that includes all the other currencies.

3.3 Estimation Models and Methods

3.3.1 Measuring firm level effects

The methodology for analyzing the effect of exchange rate changes on stock price performance involves using the weekly data and regression analysis to estimate the XR exposures for the individual firms for each calendar year. These exposures are then broken down and classified according to whether they increase the firm's share price (good exposures) or whether they decrease it (bad exposures). The net effect of XR exposures is then calculated for all firms taken together, for firms broken down by industry and according to whether or not they have foreign operations.

The XR exposures of the USD and the EUR, the UK's major trading currencies, are directly estimated in our regressions. To capture the effect of other currencies, we regress the GBP trade-

[15] Fraser and Pantzalis (2004) show that when more currencies are included in an index, more firms with significant exposures are detected, irrespective of whether or not the firm operates in the country of a particular currency. This is evidence that all firms are subject to foreign exchange exposure, not just those operating in foreign countries.

weighted, weekly index returns $r_{x,t}$ on the bilateral USD/GBP returns, noted $r_{usd,t}$, and the bilateral EUR/GBP, noted $r_{euro,t}$, over the whole period 1998-2014 and save the residuals in a first stage. All returns are measured with the GBP as the unitary currency, that is, the number of units of foreign currency for one GBP. The residuals, noted $r_{res,t}$, represent the percentage change in the exchange rate due to currencies other than the USD and the EUR. We then rewrite equation (1) with three currency risk factors, $r_{usd,t}$, $r_{euro,t}$ and $r_{res,t}$:

$$r_{it} = \beta_{i0} + \beta_{im} r_{mt} + \beta_{i,usd} r_{usd,t} + \beta_{i,euro} r_{euro,t} + \beta_{i,res} r_{res,t} + \varepsilon_{it} \qquad \text{t = 1...T} \qquad (2)$$

where $\beta_{i,usd}$ measures XR exposure to the USD, $\beta_{i,euro}$ measures XR exposure to the EUR and $\beta_{i,res}$ measures exposure to currencies other than the USD and the EUR.

The first step in identifying "good" exposures, those that increase returns, and "bad" exposures, those that reduce returns, requires distinguishing between positive (GBP appreciations) and negative (GBP depreciations) movements in the exchange rate.[16] This involves separating the vector of exchange rate returns into two vectors, one with positive moves and zeroes everywhere else and the other with negative moves and zeroes everywhere else.[17] Applying this methodology, we re-write equation (2) by decomposing $r_{usd,t}$, $r_{euro,t}$ and $r_{res,t}$ into their positive and negative components as follows:

$$r_{i,t} = \beta_0 + \beta_{i,m} r_{m,t} + \beta^a_{i,usd} r^a_{usd,t} + \beta^d_{i,usd} r^d_{usd,t} + \beta^a_{i,euro} r^a_{euro,t} + \beta^d_{i,euro} r^d_{euro,t} + \beta^a_{i,res} r^a_{res,t} + \beta^d_{i,res} r^d_{res,t} + \varepsilon_{i,t} \qquad (3)$$

where the superscript "*a*" refers to appreciations of the GBP and the superscript "*d*" refers to depreciations. $r^a_{usd,t}$ ($r^d_{usd,t}$) takes the value of positive (negative) moves in the USD/GBP exchange rate and zeroes everywhere else, $r^a_{eur,t}$ ($r^d_{eur,t}$) takes the value of positive (negative) moves in the

[16] The second step outlined below involves combining the signs of appreciations (+) and depreciations (-) with the signs of the estimated exposure coefficients. If the estimated coefficient has the same sign as the move in the exchange rate, the effect is positive = good. If the signs are different the effect is negative = bad.
[17] See for example, Koutmos and Martin (2003) p. 371.

EUR/GBP exchange rate and zeroes everywhere else, and $r^a_{res,t}$ ($r^d_{res,t}$) takes the value of positive (negative) moves in the RES/GBP exchange rate and zeroes everywhere else. Thus, $\beta^a_{i,usd}$ ($\beta^d_{i,usd}$) measures exposure to appreciations (depreciations) of the GBP with respect to the USD, $\beta^a_{i,eur}$ ($\beta^d_{i,eur}$) measures exposure to appreciations (depreciations) of the GBP with respect to the EUR and $\beta^a_{i,res}$ ($\beta^d_{i,res}$) measures exposure to appreciations (depreciations) of the GBP with respect to the residual currencies.

From equation (3) it is clear that good exposures are those that when multiplied by the percentage change in the exchange rate, give positive results. Bad exposures are those that give negative results when multiplied by the percentage change in the exchange rate. For example, consider $r^a_{usd,t}$ at time t, which is positive (i.e. an appreciation of the GBP relative to the USD). If $\beta^a_{i,usd}$ is positive, it is a good exposure because $\beta^a_{i,usd} \times r^a_{usd,t}$ is positive. If $\beta^a_{i,usd}$ is negative, it is a bad exposure because $\beta^a_{i,usd} \times r^a_{usd,t}$ is negative. The same analysis can be applied to depreciations of the GBP. If $\beta^d_{i,usd}$ is negative, it is a good exposure because $\beta^d_{i,usd} \times r^d_{usd,t}$ is positive. If $\beta^d_{i,usd}$ is positive, it is a bad exposure because $\beta^d_{i,usd} \times r^d_{usd,t}$ is negative.

3.3.2 Measuring the industry effect of XR changes

As argued above, individual firm XR exposure can be affected by changes in individual firm circumstances and management decisions. In order to obtain an accurate estimate of the industry effect of XR changes, these firm specific effects must be filtered out. Prior studies have indicated that the effects of XR changes vary with respect to industry and industry structure (see, among others, Marston, 2001; Bodnar et al., 2002). To account for the effect of industry structure while filtering out firm specific characteristics, we follow Chaieb and Mazotta (2013) and cluster firms into industry panels to estimate industrial level exposure with a mixed panel effects model. As discussed above, this technique explicitly allows for heterogeneous exposure of firms within the same industry and makes it possible to measure industry level exposure using firm level data rather than industry indices. The economic argument is that although an unexpected change in the exchange rate should affect an industry's overall competitiveness, the effect can differ from firm to firm. This technique also makes sense statistically in terms of more observations that yield more precision and higher testing power while overcoming the potential loss of information and bias induced when firms are grouped together. More specifically, we estimate equation (4) where we allow firm level exposure to be random.

$$r_{i,t} = \beta_0 + (\beta_m + \beta_{i,m})r_{m,t} + (\beta^a_{usd} + \beta^a_{i,usd})r^a_{usd,t} + (\beta^d_{usd} + \beta^d_{i,usd})r^d_{usd,t} + (\beta^a_{euro} + \beta^a_{i,euro})r^a_{euro,t} + (\beta^d_{euro} + \beta^d_{i,euro})r^d_{euro,t} + (\beta^a_{res} + \beta^a_{i,res})r^a_{res,t} + (\beta^d_{res} + \beta^d_{i,res})r^d_{res,t} + \varepsilon_{i,t} \quad (4)$$

where r_{it} is the rate of return on the *ith'* firm's common stock, superscript "*a*" refers to appreciations of the GBP and the superscript "*d*" refers to depreciations, β_m, β^a_{usd}, β^d_{usd}, β^a_{euro}, β^d_{euro}, β^a_{res}, β^d_{res} are the average industry exposure coefficients. $\beta_{i,m}$, $\beta^a_{i,usd}$, $\beta^d_{i.usd}$, $\beta^a_{i,euro}$, $\beta^d_{i,euro}$, $\beta^a_{i,res}$, $\beta^d_{i,res}$ are firm specific deviations from the common coefficients. The firm specific deviation coefficients are treated as random variables having zero mean and constant variance. The maximum likelihood estimator is adopted to estimate equation 4. The absolute values of the average industry coefficients indicate the magnitude of the XR effect on competition in the corresponding industry. Combining the sign of the coefficient with the direction of the movement in the XR indicates whether the overall effect was positive (good effect) or negative (bad effect).

4. EMPIRICAL RESULTS

4.1 SMEs vs Large Firms

Table 2 reports the results of the XR exposures estimated from equation (3) for the whole period. Exposures were calculated year by year and firm by firm and then averaged. As a means of comparison, we also report the corresponding results for the sample of large firms over the same period. It is clear that there is a marked difference in the exposures between the two groups. In most cases, the exposures differ in magnitude as well as sign. Interestingly, the difference is statistically significant for the USD and the residual index but not for the euro. Furthermore, the percentage of significant exposures is much higher for SMEs than it is for the large firms. This is strong evidence for the argument outlined in the introduction that the effects of exchange rate fluctuations are likely to be different for SMEs and large firms. Turning to the argument that innovations and imbalances emanating from countries in the eurozone are transmitted to a large extent by the flow of goods, services, labor and capital throughout this area rather than through XR adjustments, we compare the absolute values of the euro exposures with those of the other two currencies. We can see that compared to the other two currencies the magnitudes of the euro exposures are much smaller for both the SMEs and the large firms. For example, the absolute value of the mean SME $\beta^a_{i,euro}$ = $|-0.1895|$ is inferior to the absolute value of the mean SME $\beta^a_{i,usd}$ = $|-0.2349|$ and to the absolute value of the mean SME $\beta^a_{i,res}$ = $|-0.4816|$. Similarly for the large firms, $\beta^a_{i,euro}$ = $|0.1872|$ is less than $\beta^a_{i,usd}$ = $|0.4142|$ and than $\beta^a_{i,res}$ $|1.8754|$ With regards to the euro appreciation exposures, for the SMEs, $\beta^d_{i,euro}$ = $|-0.0013|$ is lower than $|0.1805|$ and than $|0.1133|$. For the large firms, $\beta^d_{i,euro}$ = $|0.008|$ is inferior to $|0.1536|$ and to $|2.5079|$.

When we look specifically at SMEs, it is clear in table 2 that significant exposures are spread fairly evenly across the three currencies. Appreciations of the GBP against the residual index had the highest number of significant exposures (914) and appreciations of the GBP against the EUR had the lowest number (774), and the share of significant coefficients ranges from 20.1% to 23.8% across the whole time sample. Not surprisingly, the percentage of significant coefficients is much lower for large firms, between 8.0% and 14.4%. It is also interesting to note in results not reported here but available on request, that individual firm exposures vary considerably from year to year and that significant exposure is widespread across firms and over time. The majority of firms have at least one significant exposure every year. On average, 58% of firms had at least one significant exposure in any year and, over the whole period, every firm in the sample had at least one significant exposure.

[Insert table 2 about here]

4.2 Industry Effect

Table 3 reports the results of the industry-by-industry exposure regressions estimated using the linear mixed model detailed in section 3.3.2.[18] These exposure coefficients represent the magnitude of the XR effect on the industry's competitive environment with respect to appreciations ("a") and depreciations ("d") of the GBP relative to each currency. Combining the sign of the coefficients with the signs of the XR vectors (the "a" vectors are positive and the "d" vectors are negative) defines whether the effect is "good" (improves the competitive environment) or "bad" (worsens the competitive environment). A positive (negative) coefficient with an "a" vector is "good" (bad) and a positive (negative) coefficient with a "b" vector is "bad" (good).

First of all, the magnitudes of exposures vary considerably from one industry to another. However, the asymmetric exposures to GBP appreciations and depreciations are similar for all three currencies. Indeed, all significant exposures to appreciations of the GBP are negative, and all significant exposures to depreciations are positive. More precisely, significant exposures to appreciations of the GBP with respect to the USD (7 out of 9) are all negative, while significant exposures to depreciations (4 out of 9) are all positive. Similarly, significant exposures to GBP appreciations with respect to the residual currencies RES (7/9) are all negative and significant

[18] We report the coefficient estimates, their t-statistics, and the standard deviation of the firm random coefficients.

exposures to depreciations (7/9) are all positive. Thus, for these two currencies, all significant XR exposures to GBP fluctuations have a "bad" effect on the industries' competitive environment.

The euro, however, stands in contrast to these two currencies in several respects. Although the same asymmetry in exposures to appreciations and depreciations with respect to the euro can be observed, only 1/9 exposures to GBP appreciations is significant and only 3/9 exposures to GBP depreciations are significant. The fact that the hypothesis of no exposure to changes in the EUR/GBP exchange rate can only be rejected for 22% of the industries on average is evidence of their overall low sensitivity to fluctuations in the value of the euro. Furthermore, in only one industry (industrials) is the absolute value of the euro exposure (to a GBP depreciation) smaller than for the other currencies. Overall the results of Table 3 indicate that the effect of XR fluctuations on the competitive environment for UK SMEs is generally negative for all industries, except telecom and utilities, and more significantly for the dollar and the residual currencies than for the euro. Furthermore, it appears that the absolute values of significant appreciation exposures are greater than depreciation exposures in all but two cases (Basic Materials, Consumer Services).

[Insert table 3 about here]

4.3 Firm Level Effects

Panel A of table 4 shows the number of good and bad significant exposures with respect to appreciations and depreciations of the GBP vis-a-vis the USD, the EUR and the RES for three samples: all firms, firms with foreign sales, and firms with only domestic sales. A generalized sign test[19] shows that the difference between bad and good exposures is significant at a 1% level for all changes in the USD and RES. Among these significant differences, bad exposures are always far more numerous than good exposures for both appreciations and depreciations. Again, the euro stands in

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[19] $z = \dfrac{bad - Np^{+}}{\sqrt{Np^{+}(1-p^{+})}}$ where *bad* is the number of bad exposures, *N* is the number of observations in the sample and $p^{+} = 0.5$ is the expected percentage of bad exposures if there is no difference between the two. The *z* statistic has an approximate unit normal distribution for large samples.

contrast. For appreciations with respect to the euro, the percentage of "bad" exposures is much lower than for the other two currencies, while differences are not significant for depreciations, as pointed out above. Taken together, only 52% of significant euro exposures are bad, while 63% of exposures with regard to the two other currencies are bad. Overall, 60% of all significant XR exposures are bad and cause a reduction in the share price.[20] As expected, firms with foreign sales (panel B) suffer from a higher percentage of significant bad exposures to appreciations of the GBP than to depreciations. It is interesting, however, that the bad exposures outnumber the good exposures even for depreciations of the GBP with respect to the USD and RES (while the difference is insignificant for the EUR). In fact, firms with foreign sales register a higher percentage of bad exposures for depreciations with respect to the USD and RES than firms with no foreign sales. These results are once again consistent with the conclusions of Demian et al. (2018), regarding the asymmetric XR exposures, and with the findings of Dominguez and Tesar (2006), concerning the impact of international trade activities on XR exposures.

[Insert table 4 about here]

Table 5 gives the breakdown of good and bad exposures by industry and shows that overall all British industries suffer from bad XR exposures. For large enough industry samples (thus excluding telecom and utilities), bad exposures are always far more numerous than good exposures for both appreciations and depreciations of the GBP with respect to the USD and RES, as well as for appreciations relative to the euro. As in Table 4, percentages of "bad" exposures to GBP depreciations vis-a-vis the euro are lower for the whole sample, and more specifically for Basic Materials, Industrials, Technology and Oil and Gas. Some asymmetries are also detected: for exposures to GBP variations with respect to the RES, exposures to appreciations are more numerous than those to depreciations, except for Technology. Overall, these conclusions confirm our previous findings presented in Table 3.

[Insert table 5 about here]

[20] These results stand in contrast to the results for large firms, not reported here but available on request, where 52% of the exposures are good and 48% are bad.

Tables 6 and 7 show the industry breakdown for firms with and without foreign sales. A comparison of the two tables suggests that exposures to appreciations and depreciations of the three currencies can differ considerably depending on whether a firm has foreign sales or not. Overall, the number of significantly bad exposures is greater among export-oriented firms than for domestically-minded firms for the three currencies (with the exception of GBP depreciations relative to the euro, as before). This observation is consistent with the results obtained in Table 4 where firms with foreign sales were found to be more exposed to XR fluctuations than firms without foreign sales. However, the sector of activity of firms can play a role. For example, in the consumer goods industry for depreciations with respect to the USD, 47.62% of significant exposures for firms with foreign sales are "bad", whereas for firms with no foreign sales, this percentage reaches 81.82%. Except for exposures to depreciation relative to the euro, this sector of activity appears to be the one where the number of negatively exposed internationally-minded firms are the lowest of all industries, and lower than the number of domestically-focused firms. On the other hand, technology, industrials and health care tend to exhibit the highest numbers of negatively exposed firms with foreign sales, relative to firms without foreign sales. Differences like this in the distributions of "good" and "bad" exposures between firms with and without foreign sales, depending on their sector of activity, confirm the existence of distinct exposure profiles for the various types of firm. Once again, our results tend to be consistent with the conclusions of Dominguez and Tesar (2006) concerning the role of international trade activities in raising XR exposures. These authors also posited that that in more competitive industries, profit margins are higher and PTM is more likely, thereby lowering XR exposure, whereas in less competitive industries, complete XR pass-through and higher XR exposure are to be expected. However, this and other studies have difficulties finding specific patterns among different industries.

[Insert tables 6 and 7 about here]

5. CONCLUSION

This paper analyzes the effect of exposures to a freely floating XR on the performance of UK SMEs for the period 1998 to 2014 and develops an innovative methodology to study whether the GBP appreciations and depreciations against the dollar, the euro, and a residual currency, increase or decrease their stock market returns. The empirical results offer several interesting conclusions, most of whom are also synthesized in Table 8.

[Insert table 8 about here]

First, they confirm that SMEs are more often and more intensely exposed than large firms.

Second, an industry by industry analysis shows that exchange rate fluctuations generally have a negative effect, when significant, on the economic environment for all industries and for all currencies studied (U.S. dollar, euro, and an orthogonalized index of residual currencies). Indeed, asymmetric exposures to appreciations and depreciations of the British Pound relative to the three aforementioned currencies are found. More precisely, all significant exposures to appreciations of the GBP are negative, and all significant exposures to depreciations are positive. When multiplied by the percentage change in the value of the GBP, the significant exposure coefficients all suggest a "bad" exposure to these exchange rate variations.

Third, firm level regressions confirm the undesirable performance reducing effects of the XR fluctuations found at the industry level: a sign test shows that the difference between the number of significant bad and good exposures is significant at a 1% level for all exchange rate changes, except for the depreciations of the pound with respect to the euro. Among these significant differences, bad exposures are always far more numerous than good exposures for both appreciations and depreciations. A comparative analysis is also conducted between three samples, composed of all firms,

firms with foreign sales, and firms without foreign sales. Some asymmetries are detected: (i) exposures (absolute values) to appreciations are greater than those to depreciations; (ii) export-oriented firms suffer from greater exposures to XR fluctuations than domestically-minded firms.

Fourth, the euro exposures differ from the USD and RES. The frequency of significant euro exposures is lower than it is for the other currencies and the magnitude of exposures is smaller. While 70% of the industry exposures are significant for the non-euro currencies, only 22% of the industry exposures to the euro are significant. Furthermore, in all but seven cases the absolute values of the euro exposures are much smaller than those of the other currencies. With respect to the exposures for individual SMEs, significant exposures to the euro are far less numerous than for the other currencies and of these only 52% of euro exposures are return reducing, while 63% of exposures to the other currencies are return reducing. Furthermore, the absolute values of the exposures to the euro are significantly smaller than those of the other currencies. These results are not sensitive to whether or not the SME has foreign sales, although the distribution of the exposures differs considerably across industries. Thus, at both the industry and firm level, UK SMEs have less exposure overall in terms of magnitude and significance and, importantly, less performance reducing exposure to the euro than to the other currencies. We attribute this result to UK integration into the European Union whereby innovations and imbalances arising in member countries are resolved through flows of goods, services, labor and capital rather than through XR adjustments. This leads to an interesting conclusion. To the extent that Brexit weakens integration by reducing or eliminating the flows of goods, services, labor and capital between the UK and the eurozone, transmission of innovations and imbalances will shift to the XR. Based on our results for the USD and RES, this would increase exposure and cause a net loss in performance for SMEs across the board. Indeed, the Bank of England (2018) modelled scenarios based on different assumptions about Brexit,[21] and suggested that its impact could be an initial loss of GDP in the range of 1% (best case scenario) to 10% (worst case scenario).

[21] https://www.bankofengland.co.uk/report/2018/eu-withdrawal-scenarios-and-monetary-and-financial-stability

Given this evidence and the particularities of SMEs outlined in the introduction, especially their susceptibility to market imperfections such as informational asymmetry and operational and financial constraints, and the fact that SMEs are more prone to bankruptcy costs than the large corporates, this is a strong argument in favor of hedging activity to reduce or eliminate these costs.[22] This brings up the question of what form the hedging activity should take. In-house hedging programs are costly to set up and manage and for SMEs the potential benefits may not be large enough to offset these costs. This is especially true in so far as much of the XR exposure for SMEs seems to be associated with factors not directly associated with foreign operations. Thus, the scope for techniques employed by large multi-nationals, such as pass through, operational hedging and foreign currency debt, is limited. Moreover, just identifying these indirect exposure factors and their magnitude complicates the problem and widens the range of expertise required for an effective hedging program. Consequently, it might be more profitable for SMEs to look for a solution outside the firm. In this context, hedging SME XR exposure is an area that financial institutions may want to exploit by providing risk management services that are specific to SMEs. To answer these questions, further research needs to identify more precisely the transmission mechanisms through which exchange rates affect SME returns.

[22] Clark and Judge (2005) find strong evidence linking the decision to hedge and the expected costs of financial distress.

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Table 1: SMEs descriptive statistics

	Employees				Total assets (£000)				Sales (£000)				Foreign sales to total sales (%)				
Industry	Min	Mean	Max	SD	Min	Mean	Max	SD	Min	Mean	Max	SD	Min	Mean	Max	SD	N
Basic Materials	2	77.84	246	67.87	11	4853.8	11351	3057.42	0	5844.07	22460	6053.22	0	39.33	98.5	36.44	367
Consumer Goods	2	77.25	249	64.28	30	4944	11325	3068.6	0	5580.43	22643	6006.44	0	16.56	99.84	27.76	297
Consumer Service	2	69.74	249	63.51	1	4826.1	11386	3093.26	0	5404.09	22536	5743.24	0	17.28	99.96	28	753
Health Care	3	75.33	249	64.5	4	4888.2	11252	3037.35	0	6060.47	22395	6066.01	0	30.03	99.9	33.46	439
Industrials	4	72.44	249	64.16	18	4722.6	11391	3114.12	0	5572.99	22714	5736.18	0	18.81	99.93	26.52	863
Oil & Gas	3	68.63	248	63.07	20	4658.8	11099	3009.72	0	5282.14	22693	5555.77	0	29.96	97.77	38.95	213
Technology	2	77.78	249	66.49	5	5251.1	11345	3149.79	0	5979.44	22746	6099.43	0	29.14	99.97	31.41	842
Telecommunication	2	86.73	245	66.14	77	5053	11188	3250.43	0	6388.84	21500	5974.11	0	20.01	93.56	28.09	53
Utilities	10	44.73	145	38.12	466	3769	9918	2964.68	34	3446.07	16760	4683.33	0	15.78	31.55	22.31	13
Total	2	74.23	249	64.95	1	4903.1	11391	3100	0	5699.78	22746	5900.63	0	23.59	99.97	30.54	3840

Table 2: Descriptive statistics of exposure coefficients by currency

		Mean	*SD*	*% of significant coefficients & (Number of significant coefficients.)*
$\beta^{a}_{i,us}$	*SMEs*	-0.2349***	2.72	20.2 (775)
	Large firms	0.4142***	15.9	12.5 (530)
		[3.99]***		
$\beta^{d}_{i,us}$	*SMEs*	0.1805***	2.68	21.9 (842)
	Large firms	0.1536***	18.2	14.4 (611)
		[7.70]***		
$\beta^{a}_{i,euro}$	*SMEs*	-0.1895***	3.54	20.1 (774)
	Large firms	0.1872***	18.7	11.1(473)
		[1.50]		
$\beta^{d}_{i,euro}$	*SMEs*	-0.0013***	3.25	20.2 (777)
	Large firms	0.008***	17.1	10.1 (429)
		[-1.16]		
$\beta^{a}_{i,res}$	*SMEs*	-0.4816***	3.02	23.8 (914)
	Large firms	1.8754***	14.9	11.5 (488)
		[-12.91]***		
$\beta^{d}_{i,res}$	*SMEs*	0.1133***	2.83	20.8 (800)
	Large firms	2.5079***	13.9	08.0 (342)
		[8.11]***		
R^2	*SMEs*	14,8%		
	Large firms	14,6%		

The table shows the average currency exposure over the period of study (1998-2014) for small and large samples. Test of difference in the means are in brackets. ***, **, * denote significance at the 1%, 5% and 10% levels.

Table 3: Mixed effect regression with random slopes for SMEs

	β^a_{usd}	β^d_{usd}	β^a_{euro}	β^d_{euro}	β^a_{res}	β^d_{res}	R^2
Basic Material	-0.265**	0.319**	-0.053	0.007	-0.4708**	0.2225**	15,3%
	(-2.26)	(3.24)	(-0.32)	(0.06)	(-5.08)	(3.62)	
	[0.537]	[0.513]	[0.975]	[0.401]	[0.4900]	[0.1896]	
Consumer goods	-0.199*	0.101	-0.186	0.029	-0.2856**	0.2140**	15,5%
	(-1.79)	(1.07)	(-1.45)	(0.26)	(-5.81)	(4.37)	
	[0.158]	[7.14e-06]	[1.55e-07]	[1.76e-07]	[0.725]	[1.362]	
Consumer services	-0.232**	0.255**	-0.12	0.125*	-0.2756**	0.1633**	14,9%
	(-3.28)	(4.28)	(-1.40)	(1.72)	(-9.23)	(6.14)	
	[8.78e-07]	[9.09e-07]	[0.123]	[2.69e-06]	[0.811]	[2.13e-06]	
Health Care	-0.131	0.05	0.016	0.0001	-0.1368**	0.1355**	14,6%
	(-1.50)	(0.60)	(-0.15)	(0.0002)	(-2.83)	(3.40)	
	[0.185]	[0.359]	[0.246]	[0.001]	[1.599]	[0.629]	
Industrials	-0.308**	0.122**	-0.130*	0.192**	-0.2309**	0.1787**	14,6%
	(-4.71)	(2.48)	(-1.86)	(2.68)	(-7.36)	(5.72)	
	[0.414]	[0.0002]	[6.99e-06]	[0.536]	[0.1323]	[0.1690]	
Oil & Gas	-0.462**	0.411**	-0.148	0.019	-0.5755**	0.2788**	16,4%
	(-2.65)	(3.19)	(-0.80)	(0.12)	(-4.25)	(2.87)	
	[0.767]	[0.318]	[1.99e-10]	[3.09e-08]	[0.5247]	[0.2339]	
Technology	-0.258**	0.055	-0.124	0.152**	-0.2143**	0.1858**	15,2%
	(-3.89)	(0.91)	(-1.55)	(2.18)	(-6.03)	(7.04)	
	[0.0003]	[0 .252]	[9.37e-06]	[3.54e-08]	[2.152]	[5.94e-07]	
Telecom	-0.484*	0.092	-0.443	0.265	-0.177	-0.551	18,1%
	(-1.87)	(0.40)	(-1.26)	(1.03)	(-0.13)	(-0.45)	
	[3.03e-10]	[0.469]	[0.701]	[7.52e-09]	[1.02e-09]	[7.11e-10]	
Utilities	-0.251	0.376	0.249	0.469	-0.4643	-0.1363	16,3%
	(-0.46)	(1.04)	(-0.39)	(1.01)	(-1.06)	(-0.31)	
	[0.841]	[0.0001]	[4.31e-07]	[0.0001]	[3.57e-08]	[2.77e-07]	

The table reports are the average exposure coefficients estimated from equation (4). The coefficient t-tests are between parentheses. The standard deviations of firm random coefficients are in square brackets

Table 4: Number of significant exposures for SMEs

	$\beta^{a}_{i,us}$			$\beta^{d}_{i,us}$			$\beta^{a}_{i,euro}$			$\beta^{d}_{i,euro}$			$\beta^{a}_{i,res}$			$\beta^{d}_{i,res}$		
PANEL A (R^2 = 14,8%)	Bad	Good	Total	Bad	Good	Total	Bad	Good	Total	Bad	Good	Total	Bad	Good	Total	Bad	Good	Total
All firms	529	318	847	569	349	918	470	386	856	429	436	865	693	331	1024	541	350	891
%	62.46	37.54	100	61.98	38.02	100	54.91	45.09	100	49.60	50.40	100	67.68	32.32	100	60.72	39.28	100
Sign Test	7.25***			7.26***			2.87***			0.23			11.31***			6.40***		
PANEL B (R^2 = 14,9%)																		
Firms with FS	209	114	323	221	124	345	168	132	300	144	159	303	277	94	371	213	109	322
%	64.71	35.29	100	64.06	35.94	100	56	44	100	47.52	52.48	100	74.66	25.34	100	66.15	33.85	100
Sign Test	5.28***			5.22***			2.078**			-0.86			9.50***			5.98***		
PANEL C (R^2 = 14,7%)																		
Firms with no FS	320	204	524	348	225	573	302	254	556	285	277	562	416	237	653	328	241	569
%	61.07	38.93	100	60.73	39.27	100	54.32	45.68	100	50.71	49.29	100	63.71	36.29	100	57.64	42.36	100
Sign Test	5.07***			5.13***			2.03**			0.33			7.00***			3.65***		

Note: FS: Foreign Sales. ***, **, * denotes significance at the 1%, 5% and 10% levels. Sign test: $z = \frac{bad - Np^{+}}{\sqrt{Np^{+}(1-p^{+})}}$ where *bad* is the number of bad exposures, *N* is the number of observations in the sample and $p^{+} = 0.5$ is the expected percentage of bad exposures if there is no difference between the two. The *z* statistic measures the significance of the difference between the number good and bad exposures and has an approximate unit normal distribution.

Table 5: Number of significant exposures by industry for SMEs

Industry	$\beta^{a}_{i,us}$			$\beta^{d}_{i,us}$			$\beta^{a}_{i,euro}$			$\beta^{d}_{i,euro}$			$\beta^{a}_{i,res}$			$\beta^{d}_{i,res}$		
	Bad	Good	Total	Bad	Good	Total	Bad	Good	Total	Bad	Good	Total	Bad	Good	Total	Bad	Good	Total
Basic Materials	62	35	97	70	26	96	47	39	86	43	58	101	94	33	127	50	35	85
%	63.92	36.08	100	72.92	27.08	100	54.65	45.35	100	42.57	57.43	100	74.02	25.98	100	58.82	41.18	100
Consumer Goods	41	25	66	37	25	62	46	26	72	39	24	63	48	30	78	33	29	62
%	62.12	37.88	100	74.49	25.51	100	63.89	36.11	100	61.9	38.1	100	61.54	38.46	100	53.23	46.77	100
Consumer Services	72	62	134	89	70	159	78	77	155	80	74	154	116	72	188	104	74	178
%	53.73	46.27	100	55.97	44.03	100	50.32	49.68	100	51.95	48.05	100	61.7	38.3	100	58.43	41.57	100
Health Care	67	36	103	59	50	109	59	47	106	50	39	89	80	26	106	66	39	105
%	65.05	34.95	100	54.13	45.87	100	55.66	44.34	100	56.18	43.82	100	75.47	24.53	100	62.86	37.14	100
Industrials	112	60	172	122	75	197	100	94	194	91	112	203	142	75	217	116	81	197
%	65.12	34.88	100	61.93	38.07	100	51.55	48.45	100	44.83	55.17	100	65.44	34.56	100	58.88	41.12	100
Oil & Gas	40	21	61	48	19	67	34	19	53	19	28	47	57	18	75	28	23	51
%	65.57	34.43	100	71.64	28.36	100	64.15	35.85	100	40.43	59.57	100	76	24	100	54.9	45.1	100
Technology	116	68	184	126	76	202	94	77	171	90	93	183	143	74	217	132	62	194
%	63.04	36.96	100	62.38	37.62	100	54.97	45.03	100	49.18	50.82	100	65.9	34.1	100	68.04	31.96	100
Telecom.	14	10	24	14	6	20	12	5	17	14	7	21	12	3	15	12	6	18
%	58.33	41.67		70	30	100	70.59	29.41	100	66.67	33.33	100	80	20	100	66.67	33.33	100
Utilities	5	1	6	4	2	6	0	2	2	3	1	4	1	0	1	0	1	1
%	83.33	16.67	100	66.67	33.33	100	0	100	100	75	25	100	100	0	100	0	100	100
Total	529	318	847	569	349	918	470	386	856	429	436	865	693	331	1024	541	350	891
%	62.46	37.54	100	61.98	38.02	100	54.91	45.09	100	49.60	50.40	100	67.68	32.32	100	60.72	39.28	100

Note: The R^2 coefficient are the same as in Table 3.

Table 6: Number of significant exposures by industry for SMEs with foreign sales

Industry	$\beta^{a}_{i,us}$			$\beta^{d}_{i,us}$			$\beta^{a}_{i,euro}$			$\beta^{d}_{i,euro}$			$\beta^{a}_{i,res}$			$\beta^{d}_{i,res}$		
	Bad	Good	Total	Bad	Good	Total	Bad	Good	Total	Bad	Good	Total	Bad	Good	Total	Bad	Good	Total
Basic Materials	12	6	18	16	7	23	15	5	20	8	14	22	12	6	18	16	7	23
%	66.67	33.33	100	69.57	30.43	100	75	25	100	36.36	63.64	100	66.67	33.33	100	69.57	30.43	100
Consumer Goods	13	12	25	10	11	21	8	9	17	14	5	19	13	12	25	10	11	21
%	52	48	100	47.62	52.38	100	47.06	52.94	100	73.68	26.32	100	52	48	100	47.62	52.38	100
Consumer Services	26	19	45	27	20	47	23	19	42	19	24	43	26	19	45	27	20	47
%	57.78	42.22	100	57.45	42.55	100	54.76	45.24	100	44.19	55.81	100	57.78	42.22	100	57.45	42.55	100
Health Care	31	15	46	26	21	47	29	14	43	21	16	37	31	15	46	26	21	47
%	67.39	32.61	100	55.32	44.68	100	67.44	32.56	100	56.76	43.24	100	67.39	32.61	100	55.32	44.68	100
Industrials	45	24	69	54	26	80	34	39	73	33	46	79	45	24	69	54	26	80
%	65.22	34.78	100	67.5	32.5	100	46.58	53.42	100	41.77	58.23	100	65.22	34.78	100	67.5	32.5	100
Oil & Gas	14	6	20	15	7	22	9	6	15	8	10	18	14	6	20	15	7	22
%	70	30	100	68.18	31.82	100	60	40	100	44.44	55.56	100	70	30	100	68.18	31.82	100
Technology	61	28	89	66	32	98	47	38	85	38	41	79	61	28	89	66	32	98
%	68.54	31.46	100	67.35	32.65	100	55.29	44.71	100	48.1	51.9	100	68.54	31.46	100	67.35	32.65	100
Telecom.	5	4	9	6	0	6	3	1	4	2	3	5	5	4	9	6	0	6
%	55.56	44.44	100	100	0	100	75	25	100	40	60	100	55.56	44.44	100	100	0	100
Utilities	2	0	2	1	0	1	0	1	1	1	0	1	2	0	2	1	0	1
%	100	0	100	100	0	100	0	100	100	100	0	100	100	0	100	100	0	100
Total	209	114	323	221	124	345	168	132	300	144	159	303	209	114	323	221	124	345
%	64.71	35.29	100	64.06	35.94	100	56.00	44.00	100	47.52	52.48	100	64.71	35.29	100	64.06	35.94	100

Note: The R^2 coefficient are the same as in Table 3.

Table 7: Number of significant exposures by industry for SMEs with no foreign sales

Industry	$\beta^{a}_{i,us}$			$\beta^{d}_{i,us}$			$\beta^{a}_{i,euro}$			$\beta^{d}_{i,euro}$			$\beta^{a}_{i,res}$			$\beta^{d}_{i,res}$		
	Bad	Good	Total	Bad	Good	Total	Bad	Good	Total	Bad	Good	Total	Bad	Good	Total	Bad	Good	Total
Basic Materials	50	29	79	54	19	73	32	34	66	35	44	79	81	26	107	45	26	71
%	63.29	36.71	100	73.97	26.03	100	48.48	51.52	100	44.3	55.7	100	75.7	24.3	100	63.38	36.62	100
Consumer Goods	28	13	41	27	14	41	38	17	55	25	19	44	29	21	50	22	22	44
%	68.29	31.71	100	81.82	18.18	100	69.09	30.91	100	56.82	43.18	100	58	42	100	50	50	100
Consumer Services	46	43	89	62	50	112	55	58	113	61	50	111	79	56	135	78	49	127
%	51.69	48.31	100	55.36	44.64	100	48.67	51.33	100	54.95	45.05	100	58.52	41.48	100	61.42	38.58	100
Health Care	36	21	57	33	29	62	30	33	63	29	23	52	35	14	49	33	26	59
%	63.16	36.84	100	53.23	46.77	100	47.62	52.38	100	55.77	44.23	100	71.43	28.57	100	55.93	44.07	100
Industrials	67	36	103	68	49	117	66	55	121	58	66	124	83	58	141	68	57	125
%	65.05	34.95	100	58.12	41.88	100	54.55	45.45	100	46.77	53.23	100	58.87	41.13	100	54.4	45.6	100
Oil & Gas	26	15	41	33	12	45	25	13	38	11	18	29	36	16	52	15	19	34
%	63.41	36.59	100	73.33	26.67	100	65.79	34.21	100	37.93	62.07	100	69.23	30.77	100	44.12	55.88	100
Technology	55	40	95	60	44	104	47	39	86	52	52	104	65	43	108	59	39	98
%	57.89	42.11	100	57.69	42.31	100	54.65	45.35	100	50	50	100	60.19	39.81	100	60.2	39.8	100
Telecom.	9	6	15	8	6	14	9	4	13	12	4	16	7	3	10	8	2	10
%	60	40	100	57.14	42.86	100	69.23	30.77	100	75	25	100	70	30	100	80	20	100
Utilities	3	1	4	3	2	5	0	1	1	2	1	3	1	0	1	0	1	1
%	75	25	100	60	40	100	0	100	100	66.67	33.33	100	100	0	100	0	100	100
Total	320	204	524	348	225	573	302	254	556	285	277	562	416	237	653	328	241	569
%	61,07	38,93	100	60.73	39.27	100	54,32	45,68	100	50,71	49,29	100	63,71	36,29	100	57,64	42,36	100

Note: The R^2 coefficient are the same as in Table 3.

Table 8: Schematical effects of the appreciations (a) and depreciations (d) of the U.S. dollar, euro, and residual currency basket

	β^a_{usd}	β^d_{usd}	β^a_{euro}	β^d_{euro}	β^a_{res}	β^d_{res}
Mean values of coefficients						
Large firms	- ***	+ ***	- ***	- ***	- ***	+ ***
SMEs	+ ***	+ ***	+ ***	+ ***	+ ***	+ ***
Basic Material (SMEs)	- **	+ **	n.s.	n.s.	- **	+ **
Consumer goods (SMEs)	- *	n.s.	n.s.	n.s.	- **	+ **
Consumer services (SMEs)	- **	+ **	n.s.	+ *	- **	+ **
Health Care (SMEs)	n.s.	n.s.	n.s.	n.s.	- **	+ **
Industrials (SMEs)	- **	+ **	- *	+ **	- **	+ **
Oil & Gas (SMEs)	- **	+ **	n.s.	n.s.	- **	+ **
Technology (SMEs)	- **	n.s.	n.s.	+ **	- **	+ **
Telecom (SMEs)	- *	n.s.	n.s.	n.s.	n.s.	n.s.
Utilities (SMEs)	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Dominant (significant) exposures						
SMEs	Bad ***	Bad ***	Bad ***	n.s.	Bad ***	Bad ***
SMEs with foreign sales	Bad ***	Bad ***	Bad ***	n.s.	Bad ***	Bad ***
SMEs without foreign sales	Bad ***	Bad ***	Bad ***	n.s.	Bad ***	Bad ***

Note; ***, **, * denote significance at the 1%, 5% and 10% levels. n.s. = not significant