Foreign Exchange Exposure – No Returns, only risk

Abstract

Returns of portfolios formed based on US dollar foreign exchange exposure are found to have a negative relationship with the absolute value of the foreign exchange exposure. The result is state dependent and visible during the appreciation periods of the US dollar. We relate this effect to mispricing where investors fail to consider to true impacts of the exchange rate changes on firm values and report several results supporting this claim.

Keywords: foreign exchange exposure, risk factor, expected exchange rate change.

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1 Introduction

Studies on foreign exchange exposure, i.e. the sensitivity of stock's returns on exchange rate changes, focus on revealing the existence of foreign exchange exposure and specify the determinants of the exposure. We examine the foreign exchange exposure from investors' perspectives. Our results from the U.S. stock market reveal the non-profitability stemming from mispricing of carrying the foreign exchange risk.

There are hundreds of papers testing the cross-section of expected returns with various factors, but the impact of FX exposure has received only limited attention. Recently, Harvey, Liu and Zu (2016) document 316 cross-sectional factors explaining a variation of expected returns. Interestingly, there are only two studies related to foreign exchange risk exposure (Ferson and Harvey (1993, 1994)).[1] The scarcity of studies is contradictory to the role of the foreign exchange risk. As the capital markets become more integrated, more exchange rates become floated, and the number of multinational companies and the amount of international trades increases, FX exposure become more important. The exchange rate volatility has been a prevalent feature in international finance since the collapse of Bretton Woods in 1973. After the collapse, several major currencies, foremost the U.S. dollar have been floating but it was not until the collapse of the ERM in 1992-1993 when the European currencies started to float freely. The common European currency, euro, has been market determined since its establishment in 1999, Japanese Yen has not had any pre-specified targets and Chinese RMB is gradually gaining a wider band which enables larger volatility of the RMB than ever before. The most notable event showing the significance of the foreign exchange rate exposure is when the Swiss National Bank announced unexpectedly in January 15, 2015 that they would de-peg the Swiss Franc from the euro. As a result Swiss Franc appreciated 30% and the Swiss stock market Index collapsed about 15% within two days. Hence, it is clear that the foreign exchange market plays an important role in explaining the performance of national stock market.

However, although a large body of research examines the FX exposure and the determinants, the evidence on the size, sign and significance of the foreign exchange risk exposure is still inconclusive resulting in a debate of the so-called *"foreign exchange exposure puzzle"* (see e.g. Jorion (1990), He and Ng (1998), Dominguez and Tesar (2006)). In short, the foreign exchange exposure puzzle is the situation of low stock price reaction to exchange rate movement. We are not going to contribute to this discussion.[2] Instead, we concentrate on the impact of foreign exchange

[1] Also Kolari, Moorman, Sorescu (2008) belongs to these studies but was omitted in the survey of Harvey et al. (2016).

[2] A large body of research examines the determinants of firm-level FX exposure (for a review, see Bartram and Bodnad, 2007). The amount of foreign sales has proven to be the major determinant of FX exposure of

exposure on stock valuation and study whether there is a reward from having FX; for a survey see e.g. Muller and Verschoor (2006).

In theory, the exposure is high for non-hedged importing and exporting firms. For exporting (importing) firms, devaluation of the domestic currency enlarges (diminishes) the profits and stock returns in domestic currency. This polarity can partly explain why the FX exposure for market risk may be close to zero since the broad stock market index in an open economy entails both importing and exporting firms. Thus, the sign of the market FX exposure can be strongly related to the structure of the industries and the size of exporting vs. importing companies. Additionally, a degree of FX exposure should be positively associated with a degree of internationalization.

However, FX exposure is not limited only to multinationals. Theoretically, in an open economy no firm is totally free of FX exposure (Aggrawal and Harper, 2010) as all firms are affected via indirect channels to exchange rate movements. For example, an increase in profits of exporting firms due to exchange rate changes may increase the wages in the exporting sectors, enlarging the exporting sector's relative size. This increases inflation in the non-manufacturing sector and in the whole economy. Similarly, exchange rate changes may have different impacts on import prices depending on the level of pass-through. The competitive structure of the market where the final output is sold also plays a role for the size of FX exposure. In an oligopolistic market, the impact of exchange rate movement on returns could be small since firms can react to exchange rate changes by changing the price they charge. Allayannis and Ihrig (2001) point out that as an industry's markups fall

nonfinancial firms (see e.g. Jorion (1990), Bartov and Bodnar (1994), Bodnar and Wong (2003)). The percentage of multinational firms that are subject to foreign exchange exposure varies across studies: Jorion (1990) reports 5%, Choi and Prasad (1995) 15% and Jongen et al. (2012) 33 % of multinationals, respectively are subject to foreign exchange exposure. Chow, Lee and Solt (1997a) indicate that there are economics of scales in hedging and the larger the firm the less foreign exchange exposure. Moreover, there is strong evidence that number of multinationals subject to foreign exchange exposure increases over time; see e.g. Chow et al. (1997a, b), Jongen et al. (2012), Muller and Verschoor (2006). Aggrawal and Harper (2010) show domestic firms are also exposed to FX risk. Other firm-specific factors like size, debt, book-to-market value, asset tangibility and R & D expenditure are shown to have an impact on the size of FX exposure. Dominguez and Tesar (2006) document that multinational status, foreign sales and the amount of a firms' international assets have an impact on the size of foreign exposure. Bartram and Karolyi (2006) indicate that FX betas of the multinationals are also related to regional factors, such as geography, strength of a currency and industrial characteristics (competition, number of firms, traded goods). Allayannis and Ihrig (2001) further find out that four of eighteen industries are significantly exposed to exchange rate movements via industry competition, exports, and imports. Bartram, Brown, and Minton (2010) model a firms' foreign exchange rate exposure as a function of market share, product substitutability, pass-through, sales and cost in foreign currency and show that corporations manage FX exposure by passing part of exchange rate changes through to customers using operation and financial hedges. Pritamani, Shome and Singal (2004) propose that estimates of foreign exchange exposure are typically biased because neither the value-weighted nor equally weighted market portfolio is an adequate market portfolio in estimating the foreign exchange exposure.

(rise), its FX exposure increases (falls) but in markets with intense competition, the effects of exchange rate movements on profits could be substantial.

Firms also endeavor to insulate themselves from potentially severe and rapid foreign exchange changes. Allayannis and Ofek (2001) show the lack of FX exposure among the large firms is due to the hedging activities. To the extent that exchange rate risk is fully covered, there should be no impact of exchange rate changes on stock returns and firm value and foreign exchange risk exposure would not be detected. In principle, firms can cover their foreign exchange risks either with financial and/or operational hedging and typically large international firms use both strategies but favour operational hedging which provides better protection during times of high financial market volatility (Hutson and Laing, 2014). Differences in pass-through to import/export prices can also partly explain the FX exposure. Bartram et al. (2010) estimate that firms are able to reduce their gross exchange rate exposure via the three channels by about 70%: pass-through and operational hedge decreases the exposure about 10-15 % whereas financial hedge reduces exposure about 40%. Hedging is also one of the reasons previous studies indicate that the impact of the FX exposure is time-varying.

Institutional changes, such as the introduction of the euro, also have significant impacts on FX exposure. Bartram and Karolyi (2006) indicate that the euro has led to lower market risk exposure in multinationals firms in and outside Europe depending on the fraction of their foreign sales or assets in Europe. They argue that foreign exchange risk is largely non-diversifiable and thus should be priced in asset markets.

We estimate the FX exposure for all the U.S. firms and examine its effects with two traditional ways. First, we sort the firms to portfolios based on their FX exposure and analyze the portfolio return differences. Kolari et al. (2008) also apply portfolio formation framework that is similar to ours but we extend their analysis by including more portfolio characteristics and include more comprehensive factor analysis. Second, we utilize Fama and MacBeth (1973) approach to examine whether FX exposure is related to asset returns.

We contribute to the literature with three interesting findings. First, our results show that the FX exposure does play a part in portfolio returns but contrary to the expectations. The extreme exposure portfolios, with high positive and low negative sensitivities to exchange rate movements, behave similarly and provide lower returns for two months after their formation than a portfolio without any exposure. Hence, the exposure to the exchange rate movements is not compensated and the FX exposure cannot be considered a risk factor. Second, these impacts are visible during the appreciation periods of the USD but not during depreciations. Third, we relate these effects to mispricing and provide three results supporting this view. First, the extreme portfolios experience substantially higher contemporaneous returns than the no-exposure portfolios when the FX exposure are estimated. Reversal on the following period indicates that investors realize their mistakes. Second, the firm characteristics of the extreme portfolios are often related to mispricing. That is, more volatile and illiquid, smaller and younger firms with less analyst coverage and higher mispricing values are found from the extremes. Third, once the mispricing and behavioral factors are included to the factor models, the alphas lose their significance indicating that mispricing and behavioral factors are able to capture their effects.

The study is organized as follows. In section 2, we form the FX exposures and present the data, variables and the descriptive statistics. In section 3, we form portfolios based on previous period's FX exposure and test the cross-sectional returns with Fama-MacBeth method. We estimate the equilibrium exchange rate in section 4 and examine trading strategies based on it. Section 5 concludes.

2 Foreign exchange risk exposure and the U.S. stock prices

2.1 Estimating foreign exchange risk exposure

Under rational expectations agents discounts the expected exchange rate changes. The expected exchange rate should be seen in current stock return and hence the coefficient of exchange rate changes should reflect the sensitivity of stock returns to unanticipated changes in exchange rates (Jorion, 1990). Dumas (1978), and Adler and Dumas (1983 and 1984) propose to estimate FX exposure using a single factor model in which firms' returns are regressed only on exchange rate changes. Instead of their model, we control for several risk factors that previous studies have found to influence expected stock returns and estimate the following seven-factor model for each stock for each month with daily data for more than 14 observations:

$$R_{i,d} = \beta_{0,i,t} + \beta_{1,i,t} R_{MKT,d} + \beta_{2,i,t} HML_d + \beta_{3,i,t} SMB_d + \beta_{4,i,t} RMW_d + \beta_{5,i,t} CMA_d + \beta_{6,i,t} MOM_d + \beta_{7,i,t} \Delta s_d + \varepsilon_{i,d}, \quad (1)$$

where $R_{i,d}$ is the excess return on firm i at day d, R_{MKT}, HML, SMB, RMW and CMA the traditional Fama-French 5-factors, MOM the momentum factor and Δs measures the change in the daily, effective USD exchange rate. The exchange rate exposure, firm i's sensitivity to the changes in foreign exchange rate of the USD, for each firm for each month t, is measured with $\beta_{7,i,t}$. As Ang et al. (2006) argue, in a setting where coefficients potentially vary over time, a one month window with daily data is a natural compromise between estimating coefficients with a reasonable degree of precision and pinning down conditional coefficients with time-varying factor loadings.

2.2 Data

Vast majority of previous studies on exchange rate exposure have concentrated only on a subset of firms. For example, Jorion (1990) studies only multinational corporations; Bartov and Bodnar (1994) examine firms which have reported impacts of changes in the value of the U.S. dollar in their financial statement; Aggrawal and Harper (2010) concentrate on companies which do not have foreign operations. We do not make such a selection but concentrate on the U.S. companies that satisfy our requirements (see below). As the exchange rate exposure can affect both domestic and foreign companies via various ways (see for example Dominguez and Tesar (2006)), we do not exclude any companies or concentrate on any specific subset. Although, the trade-weighted exchange rate cannot capture precisely the correct exchange rate exposure for each of the companies (it can capture it quite well for companies which have similar weightings in their international businesses as the U.S. in total, but even then it cannot adequately capture the effects e.g. from a depreciation of the exchange rate which leads to cheaper prices for a foreign competitor), but as the best common indicator for exchange rates, it works as a compromise and is also used most often in the previous studies.

The data for monthly and daily stock information, such as end-of-period closing prices, returns, shares outstanding etc. are from CRSP. Our sample period is from August 1975 to December 2019. Moreover, we concentrate only on common stocks (shrcd is 10 or 11) from NYSE, AMEX and NASDAQ (exchcd is either 1, 2 or 3) and remove observations from finance industry and regulated utilities. If the delisting return is missing, we use -30% as the return.[3] To dampen the effect of penny stocks, we remove the stocks with a price less than five dollars at the beginning of the holding period. The data on value-weighted market return and risk-free return are obtained from Kenneth French's data library.[4]

As the exchange rate, we use daily U.S. dollar exchange rate against major currencies (calculated by FED, March 1974=100) from Datastream (code S05966) which has the longest daily US$ effective exchange rate available. All the accounting data are from Compustat. We follow the usual conventions to time the variables that use accounting information. There needs to be at least a 6-month gap between fiscal year end and formation time which means that the book value of the equity from a fiscal year $y-1$ is used as the book value from July of year y to June of year $y+1$. To calculate the

[3] See Shumway (1997).

[4] http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

book-to-market ratio, this book value is divided by the market equity value at the end of December of year $y-1$.

These data are augmented with the firm characteristics and stock behaviour related data defined in Green, Hand and Zhang (2007) and the firm-level mispricing data by Stambaugh, Yu and Yuan (2015) (available in Robert F. Stambaugh's website). As factor models, commonly used FF5, FF6, Q4 Q5, BS6, M4 and DHS are used. FF5 refers to Fama and French 5-factor model (MKT, HML, SMB, CMA and RMW), FF6 to FF5 plus momentum factor, Q4 is the Hou, Xue and Zhang (2015) q-factor model (MKT, ME, IA, ROE), Q5 the Hou, Xue and Zhang (2020) q5-factor model (MKT, ME, IA, ROE, EG), BS6 is the Barillas and Shanken (2018) 6-factor model (MKT, SMB, IA, ROE, HML, MOM), M4 is the Stambaugh and Yuan (2017) mispricing factor model (MKT, SMB, MGM, PERF) and DHS the Daniel, Hirshleifer and Sun (2019) mispricing factors (MKT, PEAD, FIN). Data for these can be found from authors' websites.

3 Results

3.1. Portfolio results

Table 1 examines the behaviour and characteristics of FX exposure sorted portfolios.

TABLE 1 HERE

Portfolios for month t are formed using the value of $\beta_{7,i}$ from Equation 1 for month $t-1$ i.e. the coefficient that captures firm i's sensitivity to USD changes after controlling for the commonly used factors. NYSE breakpoints are used to form the portfolios, which leads to cross-sectional variation in number of firms in them. Columns have the differences in values for portfolios 6 and 1 (6-1); 6 and 11 (6-11); and 11 and 1 (11-1), and their corresponding t-values. For kurtosis and skewness, the columns refer to the values calculated from 6-1, 6-11 and 11-1 returns and do not capture the difference between averages of kurtosis' and skewness' between the corresponding portfolios.[5]

Panel A reports the differences in the month t average portfolio returns and standard deviations and shows a part of the main result of the study. It is found that the portfolios with the highest and lowest FX exposure on month $t-1$, i.e. portfolios 11 and 1, respectively, have significantly lower returns

[5] Values for individual portfolios are reported in Appendix 1.

and higher standard deviations than stocks with lower absolute FX sensitivity, i.e. portfolio 6. That is, those firms provide lower returns with higher risks than their closer-to-zero FX exposure counterparts do. Specifically, the average excess return on portfolio 6 is 0.89% per month, which is 0.20-0.21% (i.e. 2.40-2.42% per year) higher than the average return of portfolios 1 and 11. This return spread between the portfolios is statistically significant at the 5-10% level. The effect of FX exposure on returns can be further seen from the standard deviations, which are higher for the extreme FX exposure portfolios and increase linearly with the absolute value of exposure, as the Appendix 1 shows. The portfolio with lowest exposure (portfolio 6) also has the lowest standard deviation (4.95%) while the highest exposures are related to the highest return variation (6.56% for portfolio 1 and 6.44% for portfolio 11). Hence, the sensitivity to USD changes leads to smaller returns but higher portfolio variation.

The rest of the Table 1 concentrates on describing the portfolios. Panel B lists more FX portfolio related behaviour and information about the pre- and post-formation FX exposures. The extreme FX exposure portfolios 1 and 11 seem to produce fewer and less extreme outlier observations than the normal distribution while middle portfolios have a mild excess kurtosis in their return distribution. Figures in Appendix 1 further show that the returns of the portfolios are all negatively skewed with the middle portfolios being more skewed i.e. experiencing more very low than high returns. Pre-formation returns (Ret($t-1$)) show an interesting pattern. Contrary to period t returns, both the very low and very high FX exposure portfolios on period $t-1$ are related to substantially higher contemporaneous returns. Appendix 1 further shows that the average returns decrease linearly towards the middle portfolio. Pre- and post-formation betas are formed as the time-series mean of the cross-sectional averages of the portfolios. By construction, the pre-formation exposure increases monotonically from -3.89 to 3.73. The persistency of the FX exposure is close to non-existing, as the differences in port-formation FX exposures all converge to zero. Finally, the panel shows that the higher FX sensitivity portfolios comprise of more firms and the Portfolio 6.

Panel C of Table 1 reports the differences in average values of some stock characteristics and more information about their return behaviour. Compared to the middle FX exposure portfolio, the firms with higher sensitivity to the US dollar changes are smaller, more volatile and illiquid and have higher betas, slightly higher past returns, higher share turnover and higher mispricing. However, their book-to-market values differ from the middle portfolios only with an economically insignificant amount. For almost all of these characteristics, the values grow or decline monotonically from extremes towards the middle portfolio and the differences between these are highly significant. Excluding turnover, all of the above-mentioned characteristics are commonly related to higher risks and hence to higher returns which is in contrast with the results in Panel A.

Panel D lists differences in several accounting related values and ratios for the portfolios. In terms of both, statistical and economic significance, the extreme FX exposure firms have lower cash flow, dividend, earnings and income ratios, but higher long-term debt growth, earnings volatility and sales growth, than the middle FX exposure portfolios. The differences in profitability, leverage and sales to price are not economically significant.

Finally, Panel E of Table 1 shows that firms with higher absolute FX sensitivity are younger and have lower analyst coverage than the ones with less exposure. This is not surprising, as the smaller firms do not attract as much information as the larger and more established firms.

In general, the main message from Table 1 is clear. Investing based on FX exposure measured as in Equation 1, is not profitable and exposes an investor to unrewarded higher volatility.

Our second main results are presented in Table 2 which reports the longer period FX exposure portfolio returns and their differences for portfolios 1, 6 and 11.[6] All the panels A-C show average returns and their differences for months $t-1$, t , $t+1$, …, $t+5$ for portfolios formed using FX exposures estimated on month $t-1$. Panel A uses the whole sample, while panels B and C report the results using only those months t when the US dollar appreciates or depreciates, respectively.

Table 1 already reported the results for months $t-1$ and t and hence the main takeaway from Panel A is that the FX exposure effect dies only after two months i.e. the results are significant also for month $t+1$.

However, two striking results rise from panels B and C. First, when comparing the returns of month t between the panels, for all portfolios, the level of returns is substantially higher when the USD depreciates compared to the appreciation months. For month $t+1$, the return levels return to approximately the same level between the panels. It is also notable, that for month $t-1$, the return differences are opposite, i.e. before USD depreciation months, contemporaneous FX exposure portfolio returns are smaller than before USD appreciations. These differences range from approximately 0.62% to 1.04% per month with the highest values for portfolio 1.

Second, the findings of Panel A are related only to the USD appreciation periods of Panel B while there are no significant returns for 6-1 and 6-11 portfolios when the USD depreciates during month t. The impact lasts for two months and is close to symmetric for portfolios 6-1 and 6-11, although the latter

[6] Full portfolio returns are reported in Appendix 2.

has statistically slightly weaker and smaller returns (annualized $Ret(t)$ and $Ret(t+1)$ are 5.76% and 5.16%, respectively, for 6-1 and 4.32% and 3.12% for 6-11).

The main empirical findings of this study, summarized in Tables 1 and 2, are that the higher absolute value of FX exposure lead to lower returns and higher standard deviation, the effects last for two months and are observed only for the USD appreciation periods for which the level of portfolio returns is consistently lower than for depreciation periods.

In the following, we aim to provide possible explanations for these observations.

3.2 Factor sensitivities

Table 3 studies whether the FX exposure portfolio behaviour can be explained by conventional risk factor models and which factors are mostly driving the results. As Table 2 found the USD appreciation periods to dominate the results, only those are studied. Panel A shows the results for portfolio 6-1 and Panel B for portfolio 6-11. Second column of Table 3 (Alpha) shows factor risk-adjusted returns, alphas, and their t-statistics, evaluated with respect to an extensive list of factor models, while the rest of the columns report factor sensitivities and their significances.

The factor models used are: Fama and French (2015) five-factor model (FF5); Fama and French (2018) six-factor model (FF6 i.e. FF5+momentum factor); Hou, Xue and Zhang (2015) four-factor q model (Q4); Hou, Mo, Xue, and Zhang (2020) five-factor q^5 model (Q4+EG); Barillas and Shanken (2018) 6-factor model (BS6); Stambaugh and Yuan (2017) mispricing factor model (M4); and Daniel, Hirshleifer and Sun (2020) risk-and behavioral factor model (DHS).

Use of several models allows us not just to examine the significance and size of the alphas but also provides possible explanations of the result. For example, the FF5, FF6, Q4, Q5 and BS6 models are related to standard risk-based asset factors while the M4 and DHS stem more from mispricing explanations.

TABLE 3 HERE

For both Panels, the results for FF5 and FF6 show that the return spread is negatively and significantly related to market returns and SMB and positively to HML and RMW while CMA and MOM are not significant. Hence, the assets that behave as large, profitable, value stocks seem to be partly driving the results. When comparing the alpha values of 0.3% for 6-1 and around 0.2% for 6-11 to the 6-1 returns of 0.48% and 6-11 returns of 0.36%, it becomes evident that the traditional factor models are able to capture some of the return behaviour, but a large and significant part still remains to be explained. However, it should be noted that the FF5 and FF6 have the highest R^2s of the studied models.

Q4 shows that besides size, returns are also partly related to investments-to-assets (IA) and return on equity (ROE) factor. Compared to FF5 and FF6, Q4 model does not bring substantial improvements in explaining the FX exposure returns as alphas remain significant for it. However, although, the expected growth factor (EG) is not significant in either of the panels, alpha of 6-11 is no longer significant indicating that EG might capture some of its return behaviour.

Since BS6 uses components from the other factor models, its coefficients and their significances are rather similar. However, compared to Q4, when HML (Barillas and Shanken (2018) use the Ashness and Frazzini (2013) HML measure which mildly differs from the Fama-French HML factor[7]) is included to the model, IA loses its significance and for 6-11 return spread, momentum factor becomes significant.

Although, Q5 and BS6 have some success in explaining 6-11 FX exposure returns, the standard risk factor models experience difficulties in capturing 6-1 portfolio returns which are significant for all, FF5, FF6, Q4, Q5 and BS6 models.

However, once mispricing factor model M4 and the behavioural model DHS are used, the size and significance of portfolio 6-1 alpha also drop to zero. M4 and DHS show that investment measures related mispricing factor (MGMT, management) and the financing related long-horizon mispricing factor (FIN) are both positive, as well as highly statistically and economically significant determinants of the return spread. M4's profitability measures based mispricing factor, PERF (performance), also shows high statistical significance but its economic role is smaller. DHS's inattention factor (PEAD) capturing short-horizon mispricing is not related to FX exposure returns. Factor exposure results lent support to the view that the FX exposure (negative) premium might be due to mispricing.[8]

Although, we do not want to completely exclude the rational, risks or trading frictions related explanations, the results of Table 3 suggest that standard pricing factors have difficulties in explaining the relation between FX exposure and returns. Instead, the FX exposure return spreads seem to be more related to behavioural and mispricing factors. This interpretation is also in line with the observations from characteristics of Table 1: typically, more volatile, small, younger and more illiquid firms and those with smaller analyst coverage, are subject to higher mispricing. This is further

[7] For brevity, all the HML results are reported under the same column.

[8] What makes the DHS model interesting is that, although it can explain the difference between the 6-1 and 6-11 FX exposure portfolio returns, the alphas of individual portfolios for it are large and highly significant. See Appendix 3 (to save space, t-stats are not reported in the table).

supported by the Mispricing characteristic in Table 1 Panel C. Finally, if the asset is mispriced, we can expect a price reversal in the future as the arbitrageurs realize the potential for profits. This is supported by $Ret(t-1)$ results of Table 1 Panel B which show a large positive contemporaneous returns for extreme FX exposure portfolios followed by reversal on period t. [9]

3.3 Fama-MacBeth regressions

Portfolio sorts of Tables 1 and 2 provide consistent evidence of an inverse relation between the stock return sensitivity to the changes in the US dollar and the subsequent equity returns and Table 3 indicates that these results are driven by firms which behave similarly to large, profitable, value stocks. Since Jegadeesh et al. (2019) provide evidence of the importance of firm characteristics in explaining excess returns, it is important to examine whether the FX exposure's ability to forecast future returns is subsumed when we control for firm characteristics. For this, we run Fama-MacBeth regressions of monthly stock returns on lagged β_7 and several conventional control variables.

As the results of Tables 1, 2 and 3 show that the FX exposure's effect is close to identical between the extreme portfolios 1 and 11, we use an absolute value of the lagged β_7 as our FX exposure measure[10] Our set of control variables includes market beta (Beta), log of market capitalization (Size), log book-to-market (BM), operational profitability (OperProf), the amount of investments (Invest), cumulative returns for the period $[t-2, t-12]$ (Mom), turnover from the past three months (Turnover), idiosyncratic volatility (IdioVol), leverage (Lev), sales revenue (SP), and the return from the previous month. The measurement timing of the variables follows the convention of Fama and French (1992). Table 4 summarizes the results.[11]

TABLE 4 HERE

Beta is not significant in any of the specification and although Size has an expected, negative value, it is significant only in the specification 4. For all the other characteristics, the signs of coefficients are as expected: BM, Profitability and Mom all have positive and significant coefficients while the higher values of investments, idiosyncratic volatility and turnover are related to lower returns. Our main interest, however, lies in the coefficient of (absolute value of) FX exposure which is negative and

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[9] Appendix 1 further studies the relationship between size, BM and the FX exposure portfolios by double-sorting the assets according to Size and FX exposure and BM and FX exposure and examining their returns and alphas.

[10] Similar portfolio results can be found also for absolute FX exposure portfolios as are reported in Tables 1 and 2. The only difference is the slightly higher persistency of the exposure between periods $t-1$ and t. These are available from the authors upon request.

[11] Appendix 4 shows the results for three sub-samples: 3/1974-12/1989, 1/1990-12/2004 and 1/2005-12/2019.

strongly statistically significant even we control for the other predictors of the cross-section of equity returns. In specification (4), which controls for most predictors, the coefficient size of FX exposure decreases substantially due to the inclusion of Ret(t-1), i.e. the returns from the previous period. This emphasizes the reversal related effect of the FX exposure. Appendix 4 report rather similar, although slightly time-varying, findings for all the sub-samples. In terms of size and significance, FX exposure's effect has been the largest during the 15-year period after the collapse of the Bretton Woods system, i.e., 3/1974-12/1989, it declined during the period 1/1990-12/2004 and gained strength again for 1/2005-12/2019.

The results from Fama-MacBeth estimations support our previous findings by showing that FX exposure's effect is not captured by conventional stock characteristics.

4 Conclusions

Foreign exchange exposure's impact on asset returns has not been examined thoroughly in the previous studies as most studies concentrate on explaining why so few companies are subject to it. Our study contributes to the literature by presenting state dependent impact of the FX exposure and providing an explanation for it. We find that the FX exposure cannot be considered as a risk and carrying it is not rewarded with higher returns. Instead, the US firms experiencing higher sensitivity to the US dollars effective exchange rate fluctuations are found to provide lower returns during the following months.

We relate these findings to mispricing. We argue that, as exchange rate changes have several mechanisms via which they can affect the firm value, investors fail to correctly value their impact on companies. For both firm types, those with large positive and small negative exchange rate exposures, the contemporaneous returns are substantially larger than for the other companies, but both groups also experience a return reversal during the following months reflecting the partial correction of the mispricing. The extreme portfolios are typically smaller, younger, more volatile, less liquid and have higher betas, higher share turnover, higher mispricing and are followed by fewer analysts. All these features are also commonly related to mispriced assets. Moreover, the effects are concentrated only on the USD appreciation periods **and can be also found for high sentiment periods (THESE RESULTS ARE NOT REPORTED YET. WHAT OTHER RESULTS TO INCLUDE?)**. Commonly used risk factor models (FF5, FF6, Q4, Q5, BS6) are not able to capture the return behaviour but the behavioral (DHS) and mispricing models (M4) seem to do better job as the alphas disappear for those. Fama-MacBeth analysis further reveals that commonly used risk characteristics are not able to capture the FX exposure's impact.

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Tables

Table 1. FX exposure sorted portfolios and their characteristics

	6-1	t-stat	6-11	t-stat	11-1	t-stat
Panel A: Portfolio returns						
$Ret(t)$	0.20	1.87	0.21	2.08	-0.01	-0.12
RetStd	-1.61		-1.49		0.12	
Panel B: Portfolio characteristics						
Kurtosis	5.21		3.02		3.96	
Skewness	-0.78		-0.01		-0.06	
$Ret(t-1)$	-2.31	-13.76	-2.21	-13.81	-0.10	-0.86
Pre-formation FX exposure($t-1$)	3.86	45.65	-3.75	-44.72	7.62	45.39
Post-formation FX exposure(t)	0.01	0.76	0.00	-0.24	0.01	1.02
Number of firms in the portfolio	-112	-28.80	-136	-34.82	24	11.71
Panel C: Firm characteristics and return behavior						
Size	0.78	44.64	0.75	45.72	0.03	3.34
Book-to-market	0.02	2.30	0.02	3.64	-0.01	-1.88
Beta	-0.24	-50.13	-0.23	-48.74	0.00	-0.94
12-month momentum	-0.04	-6.79	-0.04	-6.61	0.00	-1.25
Return volatility	-1.63	-100.67	-1.55	-104.32	-0.08	-7.64
Idiosyncratic return volatility	-1.63	-86.58	-1.58	-85.69	-0.05	-3.85
Illiquidity	-0.78	-24.37	-0.73	-24.63	-0.05	-2.01
Share turnover	-0.38	-27.22	-0.37	-30.35	-0.01	-0.56
Mispricing	-4.80	-50.84	-4.44	-46.86	-0.36	-4.94
Panel D: Accounting variables and ratios						
Sales to price	-0.05	-2.57	-0.06	-3.09	0.01	0.64
Leverage	-0.06	-5.49	-0.06	-5.44	0.00	-0.12
Cash flow to debt	0.13	22.90	0.12	21.93	0.01	1.40
Cash-flow-to-price ratio	2.06	16.57	1.92	14.11	0.14	0.93
Dividend to price	0.62	38.98	0.60	38.53	0.02	1.80
Earnings to price	3.31	25.55	3.23	23.09	0.08	0.75
Gross profitability	0.00	-1.45	-0.01	-6.35	0.01	4.82
Growth in long-term debt	-0.08	-21.13	-0.07	-21.66	0.00	-1.05
Operating profitability	0.12	2.39	-0.02	-0.33	0.14	2.98
Return on assets	0.80	26.94	0.74	25.49	0.05	2.56
Earnings volatility	-0.93	-31.87	-0.88	-30.96	-0.05	-2.45
Return on equity	1.76	24.47	1.60	23.01	0.16	3.31
Sales growth	-0.06	-26.69	-0.06	-25.71	0.00	-0.78
Panel E: Other						
Age in years	4.04	40.08	3.91	39.96	0.12	2.75
Number of analysts covering stock	2.47	33.13	2.33	34.75	0.14	2.65

Table reports monthly average return behavior and characteristics differences of the FX exposure portfolios. FX exposure for month t for firm i is estimated using daily data for each month t and the model $R_{i,d} = \beta_{0,i,t} + \beta_{1,i,t}R_{MKT,d} + \beta_{2,i,t}HML_d + \beta_{3,i,t}SMB_d + \beta_{4,i,t}RMW_d + \beta_{5,i,t}CMA_d + \beta_{6,i,t}MOM_d + \beta_{7,i,t}\Delta s_d + \varepsilon_{i,d}$, where $R_{i,d}$ is the excess return on firm i at day d, R_{MKT}, HML, SMB, RMW and CMA the traditional Fama-French 5-factors, MOM the momentum factor and Δs measures the change in effective USD exchange rate. For each month, $\beta_{7,i,t}$ captures firm i's sensitivity to the changes in foreign exchange rate of the USD. Estimations are performed for all the common stocks in NYSE, AMEX and

NASDAQ for the period 1/1974-12/2019. 11 portfolios are formed using NYSE breakpoints of FX exposure $(t-1)$. In Panel A, $Ret(t-1)$ has the average returns for value weighted portfolios and Std are the standard deviations related to these. FX exposure ($t-1$) and FX exposure (t) are the pre- and post-formation portfolio FX exposures. 6-1, 6-11 and 11-1 refer to return differences between portfolios 6 and 1; 6 and 11; and 11 and 1, respectively, and t-stats are the t-values related to the differences. Results are similar for equally weighted portfolios and hence not reported here. All the variables in Panels C-E use the data defined in Green, Hand and Zhang (2007) except for Mispricing –variable which uses firm-level mispricing data by Stambaugh, Yu and Yuan (2015) (available in Robert F. Stambaugh's website).

Table 2: FX exposure portfolios during USD appreciation and depreciation periods

Portfolio	1	6	11	6-1	t-stat	6-11	t-stat
Panel A: Full data							
$Ret(t-1)$	3.09	0.78	3.00	-2.31	-13.78	-2.22	-13.85
$Ret(t)$	0.69	0.89	0.68	0.20	1.85	0.21	2.09
$Ret(t+1)$	0.73	0.95	0.78	0.22	2.12	0.17	1.71
$Ret(t+2)$	0.81	0.89	0.82	0.08	0.79	0.07	0.70
$Ret(t+3)$	0.84	0.81	0.80	-0.03	-0.3	0.01	0.07
$Ret(t+4)$	0.77	0.93	0.88	0.16	1.57	0.05	0.54
$Ret(t+5)$	0.91	0.98	0.86	0.07	0.69	0.11	1.20
Panel B: USD appreciation (t)							
$Ret(t-1)$	3.61	1.15	3.38	-2.47	-11.00	-2.23	-11.11
$Ret(t)$	-0.19	0.29	-0.07	0.48	3.00	0.36	2.49
$Ret(t+1)$	0.58	1.01	0.75	0.43	2.77	0.26	1.81
$Ret(t+2)$	0.62	0.81	0.61	0.19	1.31	0.20	1.43
$Ret(t+3)$	0.61	0.74	0.66	0.13	0.83	0.08	0.55
$Ret(t+4)$	0.58	0.88	0.75	0.29	1.99	0.13	0.92
$Ret(t+5)$	0.61	0.82	0.60	0.22	1.46	0.23	1.74
Panel C: USD depreciation (t)							
$Ret(t-1)$	2.57	0.42	2.62	-2.16	-8.63	-2.20	-8.82
$Ret(t)$	1.57	1.49	1.43	-0.09	-0.62	0.05	0.40
$Ret(t+1)$	0.87	0.89	0.80	0.01	0.09	0.09	0.60
$Ret(t+2)$	1.00	0.97	1.02	-0.03	-0.19	-0.06	-0.38
$Ret(t+3)$	1.07	0.87	0.94	-0.19	-1.30	-0.06	-0.45
$Ret(t+4)$	0.96	0.99	1.01	0.03	0.20	-0.02	-0.15
$Ret(t+5)$	1.21	1.13	1.13	-0.08	-0.59	0.00	0.01

Panel A of the table reports monthly average return differences of the FX exposure portfolios for months $t-1,\dots,t+5$. FX exposure for month t for firm i is estimated using daily data for each month t and the model $R_{i,d}=\beta_{0,i,t}+\beta_{1,i,t}R_{MKT,d}+\beta_{2,i,t}HML_d+\beta_{3,i,t}SMB_d+\beta_{4,i,t}RMW_d+\beta_{5,i,t}CMA_d+\beta_{6,i,t}MOM_d+\beta_{7,i,t}\Delta s_d+\varepsilon_{i,d}$, where $R_{i,d}$ is the excess return on firm i at day d, R_{MKT}, HML, SMB, RMW and CMA the traditional Fama-French 5-factors, MOM the momentum factor and Δs measures the change in effective USD exchange rate. Estimations are performed for all the common stocks in NYSE, AMEX and NASDAQ for the period 1/1974-12/2019. 11 portfolios are formed using NYSE breakpoints of FX exposure $(t-1)$. Panel B shows the same results but for only those months for which the USD effective exchange rate appreciates during month t. Panel C shows the results for those months for which the USD depreciates during month t. 6-1 and 6-11 refer to return differences between portfolios 6 and 1; and 6 and 11, respectively, and t-stats are the t-values related to the differences.

Table 3: Factor sensitivities during USD appreciation (t)

Model	Alpha	MKT	HML	SMB	RMW	CMA	Mom	IA	ROE	EG	MGMT	PERF	PEAD	FIN	R^2
Panel A: Portfolio 6-1 returns															
FF5	**0.30**	-0.12	0.20	-0.38	0.35	0.09									0.64
	2.96	-4.76	4.39	-10.19	7.20	1.25									
FF6	**0.31**	-0.12	0.18	-0.38	0.35	0.10	-0.02								0.65
	3.06	-4.80	3.88	-10.10	7.24	1.42	-0.83								
Q4	**0.33**	-0.13		-0.40				0.35	0.20						0.57
	2.90	-4.67		-10.78				5.85	4.12						
Q5	**0.27**	-0.12		-0.40				0.35	0.17	0.09					0.57
	2.17	-4.00		-10.55				5.74	3.02	1.17					
BS6	**0.26**	-0.14	0.28	-0.40			0.05	0.05	0.29						0.62
	2.34	-5.25	5.41	-10.17			1.16	0.63	5.43						
M4	0.20	-0.09		-0.40							0.41	0.08			0.60
	1.70	-3.18		-10.00							9.69	2.61			
DHS	0.03	-0.09											-0.03	0.45	0.54
	0.20	-3.06											-0.46	13.68	
Panel B: Portfolio 6-11 returns															
FF5	**0.21**	-0.18	0.15	-0.30	0.30	0.06									0.63
	2.29	-7.53	3.61	-8.73	6.54	0.88									
FF6	**0.20**	-0.18	0.16	-0.31	0.29	0.05	0.02								0.63
	2.12	-7.47	3.66	-8.75	6.40	0.67	0.77								
Q4	**0.21**	-0.18		-0.31				0.28	0.20						0.57
	2.03	-7.24		-9.14				5.02	4.49						
Q5	0.14	-0.17		-0.30				0.27	0.16	0.10					0.57
	1.25	-6.33		-8.89				4.89	3.20	1.47					
BS6	0.14	-0.19	0.26	-0.32			0.08	0.00	0.25						0.62
	1.42	-7.86	5.33	-8.97			2.20	0.01	5.10						
M4	0.14	-0.15		-0.33							0.33	0.09			0.60
	1.25	-5.36		-8.87							8.51	3.31			

DHS	0.06	-0.17							-0.08	0.34	0.53
	0.53	-6.03							-1.42	11.20	

Table reports alphas and factor sensitivities for FX exposure portfolio return spreads for USD appreciation periods with respect to several factor models. FX exposure for month t for firm i is estimated using daily data for each month t and the model $R_{i,d} = \beta_{0,i,t} + \beta_{1,i,t}R_{MKT,d} + \beta_{2,i,t}HML_d + \beta_{3,i,t}SMB_d + \beta_{4,i,t}RMW_d + \beta_{5,i,t}CMA_d + \beta_{6,i,t}MOM_d + \beta_{7,i,t}\Delta s_d + \varepsilon_{i,d}$, where $R_{i,d}$ is the excess return on firm i at day d, R_{MKT}, HML, SMB, RMW and CMA the traditional Fama-French 5-factors, MOM the momentum factor and Δs measures the change in effective USD exchange rate. For each month, $\beta_{7,i}$ captures firm i's sensitivity to the changes in foreign exchange rate of the USD. Estimations are performed for all the common stocks in NYSE, AMEX and NASDAQ for the period 1/1974-12/2019. 11 portfolios are formed using NYSE breakpoints of FX exposure $(t-1)$. Panel A presents the differences between returns of FX exposure portfolios 6 and 1 while Panel B shows the results for return differences of portfolios 6 and 11. FF5 refers to Fama and French 5-factor model (MKT, HML, SMB, CMA and RMW), FF6 to FF5 plus momentum factor, Q4 is the Hou, Xue and Zhang (2015) q-factor model (MKT, ME, IA, ROE), Q5 the Hou, Xue and Zhang (2020) q5-factor model (MKT, ME, IA, ROE, EG), BS6 is the Barillas and Shanken (2018) 6-factor model (MKT, SMB, IA, ROE, HML, MOM), M4 is the Stambaugh and Yuan (2017) mispricing factor model (MKT, SMB, MGM, PERF) and DHS the Daniel, Hirshleifer and Sun (2019) mispricing factors (MKT, PEAD, FIN). For each factor model, table shows alphas and their significances on the second column as well as the factor loadings, corresponding t-values and R^2s related to the models on the rest of the columns.

Table 4. Fama-MacBeth Regressions of Monthly Stock Returns

Model	Intercept	Fx Exposure	Beta	Size	BM	Operprof	Invest	Mom	Turnover	IdioVol	Lev	SP	Ret(t-1)
(1)	1.10	-0.11	-0.07										
	6.11	-5.82	-0.40										
(2)	2.21	-0.11	0.00	-0.47	0.17								
	2.35	-7.06	0.02	-1.29	2.47								
(3)	1.67	-0.11	-0.01	-0.30	0.16	0.09	-1.15	0.59					
	1.88	-7.24	-0.10	-0.88	2.46	2.61	-6.65	3.72					
(4)	3.61	-0.05	0.21	-0.97	0.11	0.08	-1.18	0.63	-0.24	-9.03	-0.02	0.02	-0.03
	4.32	-3.84	1.71	-3.07	1.78	2.54	-6.94	3.75	-3.92	-4.39	-0.81	1.01	-8.85

Table reports results of Fama-MacBeth (1973) regressions of monthly stock returns, in percent, on lagged FX exposure, market betas, log market capitalization (size), log book-to-market rate (BM), operational profitability (OperProf), the amount of investments (Invest), cumulative returns for the period $[t-2, t-12]$ (Mom), turnover from the past three months (Turnover), idiosyncratic volatility (IdioVol), leverage (Lev), sales revenue (SP), and the return from the previous month. The sample period is 3/1974-12/2019. Table reports the average coefficients and the Newey-West adjusted t-statistics.

Figures

Appendix

Appendix 1. FX exposure sorted portfolios and their characteristics

	1	2	3	4	5	6	7	8	9	10	11
Panel A: Portfolio returns											
$Ret(t)$	0.69	0.87	0.97	0.93	0.89	0.89	0.92	0.96	0.97	0.89	0.68
RetStd	6.56	5.93	5.40	5.22	5.06	4.95	5.07	5.28	5.37	5.74	6.44
Panel B: Portfolio characteristics											
Kurtosis	2.35	2.84	2.77	3.25	3.62	3.15	3.36	3.24	2.82	3.27	2.61
Skewness	-0.41	-0.56	-0.55	-0.77	-0.80	-0.73	-0.59	-0.69	-0.68	-0.65	-0.66
$Ret(t-1)$	3.09	1.38	1.17	1.01	0.89	0.78	0.93	0.98	1.11	1.34	3.00
Pre-formation FX exposure($t-1$)	-3.89	-1.74	-1.12	-0.69	-0.34	-0.02	0.29	0.64	1.06	1.64	3.73
Post-formation FX exposure(t)	-0.01	-0.01	0.00	-0.01	0.00	0.00	0.02	0.00	0.00	0.01	0.00
Number of firms in the portfolio	273	183	165	158	158	162	157	159	164	181	298
Panel C: Firm characteristics and return behavior											
Size	11.99	12.50	12.69	12.79	12.82	12.77	12.82	12.79	12.70	12.54	12.02
Book-to-market	-0.68	-0.67	-0.68	-0.68	-0.68	-0.66	-0.68	-0.67	-0.67	-0.68	-0.68
Beta	1.26	1.17	1.11	1.08	1.05	1.03	1.05	1.08	1.11	1.16	1.26
12-month momentum	0.24	0.21	0.20	0.20	0.20	0.19	0.20	0.19	0.20	0.21	0.23
Return volatility	3.61	2.61	2.34	2.18	2.08	1.98	2.06	2.16	2.31	2.56	3.53
Idiosyncratic return volatility	6.52	5.58	5.25	5.05	4.96	4.89	4.93	5.05	5.21	5.54	6.47
Illiquidity	1.38	0.83	0.73	0.66	0.62	0.60	0.61	0.66	0.70	0.82	1.33
Share turnover	1.45	1.22	1.14	1.10	1.08	1.07	1.08	1.10	1.14	1.22	1.44
Mispricing	51.70	49.13	48.14	47.51	47.19	46.90	47.03	47.45	47.85	48.89	51.34
Panel D: Accounting variables and ratios											
Sales to price	2.31	2.22	2.19	2.17	2.20	2.25	2.22	2.19	2.20	2.24	2.32
Leverage	1.00	0.94	0.92	0.92	0.93	0.94	0.94	0.93	0.93	0.95	1.00
Cash flow to debt	0.11	0.20	0.23	0.24	0.24	0.24	0.24	0.23	0.23	0.21	0.12
Cash-flow-to-price ratio	3.70	5.15	5.50	5.76	5.87	5.76	5.89	5.61	5.57	5.29	3.83
Dividend to price	1.26	1.59	1.73	1.81	1.86	1.87	1.87	1.82	1.73	1.59	1.28
Earnings to price	2.12	4.24	4.88	5.21	5.34	5.44	5.31	5.14	4.96	4.28	2.20
Gross profitability	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.47	0.47
Growth in long-term debt	0.29	0.25	0.23	0.22	0.22	0.21	0.21	0.22	0.22	0.24	0.28
Operating profitability	9.48	9.53	9.61	9.65	9.66	9.61	9.66	9.68	9.63	9.72	9.62
Return on assets	0.55	1.07	1.24	1.30	1.33	1.34	1.33	1.30	1.25	1.12	0.60
Earnings volatility	2.61	2.04	1.84	1.75	1.69	1.69	1.70	1.75	1.83	1.99	2.57
Return on equity	1.20	2.29	2.68	2.84	2.90	2.96	2.92	2.83	2.70	2.41	1.36
Sales growth	0.22	0.19	0.17	0.16	0.16	0.15	0.16	0.16	0.17	0.18	0.22
Panel E: Other											
Age in years	13.45	15.73	16.73	17.36	17.59	17.49	17.60	17.32	16.84	15.79	13.58
Number of analysts covering stock	5.65	7.17	7.71	8.04	8.14	8.13	8.16	8.06	7.82	7.34	5.80

Table reports the return behavior and characteristics of the FX exposure portfolios. FX exposure for month t for firm i is estimated using daily data for each month t and the model $R_{i,d} = \beta_{0,i,t} + \beta_{1,i,t}R_{MKT,d} + \beta_{2,i,t}HML_d + \beta_{3,i,t}SMB_d + \beta_{4,i,t}RMW_d + \beta_{5,i,t}CMA_d + \beta_{6,i,t}MOM_d + \beta_{7,i,t}\Delta s_d + \varepsilon_{i,d}$, where $R_{i,d}$ is the excess return on firm i at day d, R_{MKT}, HML, SMB, RMW and CMA the traditional Fama-French 5-factors, MOM the momentum factor and Δs measures the change in effective USD exchange rate. For each month, $\beta_{7,i}$ captures firm i's sensitivity to the changes in foreign exchange rate of the USD. Estimations are performed for all the common stocks in NYSE, AMEX and NASDAQ for the period 1/1974-12/2019.

Portfolios are formed using NYSE breakpoints of FX exposure $(t-1)$. In Panel A, $Ret(t-1)$ has the average returns for value weighted portfolios and Std are the standard deviations related to these. In Panel B, Kurt and Skew are the kurtosis and skewness related to the FX exposure portfolios. FX exposure ($t-1$) and FX exposure (t) are the pre- and post-formation FX exposures. Results are similar for equally weighted portfolios and hence not reported here. All the variables in Panels C-E use the data defined in Green, Hand and Zhang (2007) except for Mispricing –variable which uses firm-level mispricing data by Stambaugh, Yu and Yuan (2015) (available in Robert F. Stambaugh's website).

Appendix 2. FX exposure portfolios during USD appreciation and depreciation periods

Portfolio	1	2	3	4	5	6	7	8	9	10	11
Panel A: Full data											
$Ret(t-1)$	3.09	1.38	1.17	1.01	0.89	0.78	0.93	0.98	1.12	1.33	3.00
$Ret(t)$	0.69	0.87	0.97	0.92	0.90	0.89	0.92	0.97	0.97	0.89	0.68
$Ret(t+1)$	0.73	0.91	0.90	0.90	0.88	0.95	0.96	0.93	0.91	0.90	0.78
$Ret(t+2)$	0.81	0.99	0.87	0.85	0.90	0.89	0.91	0.88	0.93	0.89	0.82
$Ret(t+3)$	0.84	0.94	0.95	0.88	0.92	0.81	0.89	0.87	0.91	0.90	0.80
$Ret(t+4)$	0.77	0.83	0.91	0.97	0.90	0.93	0.90	0.93	0.93	0.97	0.88
$Ret(t+5)$	0.91	0.95	0.87	0.85	0.92	0.98	0.95	0.88	0.89	0.84	0.86
Panel B: USD appreciation											
$Ret(t-1)$	3.61	1.77	1.50	1.34	1.20	1.15	1.29	1.32	1.45	1.77	3.38
$Ret(t)$	-0.19	0.03	0.29	0.24	0.26	0.29	0.23	0.29	0.29	0.22	-0.07
$Ret(t+1)$	0.58	0.90	0.91	0.89	0.86	1.01	0.90	0.91	0.92	0.84	0.75
$Ret(t+2)$	0.62	0.94	0.77	0.74	0.86	0.81	0.87	0.81	0.83	0.74	0.61
$Ret(t+3)$	0.61	0.80	0.87	0.78	0.79	0.74	0.75	0.75	0.91	0.71	0.66
$Ret(t+4)$	0.58	0.68	0.82	0.88	0.75	0.88	0.80	0.90	0.80	0.82	0.75
$Ret(t+5)$	0.61	0.71	0.59	0.70	0.74	0.82	0.77	0.66	0.65	0.63	0.60
Panel C: USD depreciation											
$Ret(t-1)$	2.57	0.99	0.83	0.69	0.58	0.42	0.58	0.64	0.78	0.90	2.62
$Ret(t)$	1.57	1.72	1.64	1.61	1.54	1.49	1.61	1.65	1.65	1.55	1.43
$Ret(t+1)$	0.87	0.92	0.89	0.91	0.89	0.89	1.01	0.95	0.90	0.96	0.80
$Ret(t+2)$	1.00	1.04	0.98	0.96	0.93	0.97	0.96	0.94	1.03	1.04	1.02
$Ret(t+3)$	1.07	1.08	1.04	0.98	1.05	0.87	1.03	0.98	0.91	1.09	0.94
$Ret(t+4)$	0.96	0.98	1.00	1.06	1.05	0.99	1.00	0.97	1.06	1.11	1.01
$Ret(t+5)$	1.21	1.19	1.15	0.99	1.11	1.13	1.12	1.10	1.13	1.06	1.13

Panel A of the table reports monthly average returns of the FX exposure portfolios for months $t-1,\dots,t+5$. FX exposure for month t for firm i is estimated using daily data for each month t and the model $R_{i,d} = \beta_{0,i,t} + \beta_{1,i,t}R_{MKT,d} + \beta_{2,i,t}HML_d + \beta_{3,i,t}SMB_d + \beta_{4,i,t}RMW_d + \beta_{5,i,t}CMA_d + \beta_{6,i,t}MOM_d + \beta_{7,i,t}\Delta s_d + \varepsilon_{i,d}$, where $R_{i,d}$ is the excess return on firm i at day d, R_{MKT}, HML, SMB, RMW and CMA the traditional Fama-French 5-factors, MOM the momentum factor and Δs measures the change in effective USD exchange rate. For each month, $\beta_{7,i}$ captures firm i's sensitivity to the changes in foreign exchange rate of the USD. Estimations are performed for all the common stocks in NYSE, AMEX and NASDAQ for the period 1/1974-12/2019. Portfolios are formed using NYSE breakpoints of FX exposure $(t-1)$. Panel B shows the same results but for only those months for which the USD effective exchange rate appreciates during month t. Panel C shows the results for those months for which the USD depreciates during month t.

Appendix 3. FX exposure portfolio alphas

	1	2	3	4	5	6	7	8	9	10	11
Panel A: Full data											
FF5	-0.10	-0.03	0.13	0.04	0.01	0.09	0.05	0.09	0.08	0.01	-0.12
FF6	-0.04	0.04	0.19	0.08	0.04	0.13	0.09	0.14	0.12	0.05	-0.07
Q4	0.01	0.07	0.22	0.11	0.07	0.15	0.14	0.17	0.15	0.07	-0.03
Q5	0.09	0.09	0.27	0.11	0.06	0.16	0.13	0.18	0.13	0.10	0.03
BS6	0.04	0.04	0.18	0.06	0.01	0.08	0.07	0.11	0.10	0.02	-0.03
M4	0.02	0.09	0.19	0.04	0.02	0.09	0.07	0.10	0.09	0.05	-0.09
DHS	0.40	0.41	0.49	0.35	0.31	0.37	0.39	0.40	0.38	0.35	0.28
Panel B: USD appreciation											
FF5	-0.21	-0.15	0.13	0.00	0.02	0.10	-0.02	0.08	0.08	0.06	-0.12
FF6	-0.15	-0.06	0.21	0.07	0.08	0.17	0.06	0.16	0.14	0.14	-0.03
Q4	-0.07	0.01	0.27	0.18	0.18	0.27	0.18	0.25	0.23	0.21	0.05
Q5	-0.01	0.02	0.34	0.23	0.19	0.27	0.17	0.29	0.23	0.28	0.12
BS6	-0.11	-0.09	0.19	0.07	0.08	0.15	0.08	0.16	0.13	0.13	0.00
M4	-0.07	0.03	0.25	0.08	0.10	0.14	0.05	0.14	0.12	0.17	0.00
DHS	0.49	0.44	0.66	0.46	0.50	0.52	0.45	0.52	0.53	0.60	0.46

Table reports alphas of the FX exposure portfolios with respect to several factor models: FF5, FF6, Q4, Q5, M4, DHS and BS6. FX exposure for month t for firm i is estimated using daily data for each month t and the model $R_{i,d} = \beta_{0,i,t} + \beta_{1,i,t}R_{MKT,d} + \beta_{2,i,t}HML_d + \beta_{3,i,t}SMB_d + \beta_{4,i,t}RMW_d + \beta_{5,i,t}CMA_d + \beta_{6,i,t}MOM_d + \beta_{7,i,t}\Delta s_d + \varepsilon_{i,d}$, where $R_{i,d}$ is the excess return on firm i at day d, R_{MKT}, HML, SMB, RMW and CMA the traditional Fama-French 5-factors, MOM the momentum factor and Δs measures the change in effective USD exchange rate. For each month, $\beta_{7,i}$ captures firm i's sensitivity to the changes in foreign exchange rate of the USD. Estimations are performed for all the common stocks in NYSE, AMEX and NASDAQ for the period 1/1974-12/2019. Portfolios are formed using NYSE breakpoints of FX exposure $(t-1)$. FF5 refers to Fama and French 5-factor model (MKT, HML, SMB, CMA and RMW), FF6 to FF5 plus momentum factor, Q4 is the Hou, Xue and Zhang (2015) q-factor model (MKT, ME, IA, ROE), Q5 the Hou, Xue and Zhang (2020) q5-factor model (MKT, ME, IA, ROE, EG), BS6 is the Barillas and Shanken (2018) 6-factor model (MKT, SMB, IA, ROE, HML, MOM), M4 is the Stambaugh and Yuan (2017) mispricing factor model (MKT, SMB, MGM, PERF) and DHS the Daniel, Hirshleifer and Sun (2019) mispricing factors (MKT, PEAD, FIN).

Appendix 4

When comparing the coefficient sizes of FX exposure in Panels A-C, it becomes clear that it has had the largest effects during the 15 year period after the collapse of the Bretton Woods system, i.e. 3/1974-12/1989. The effect is substantially weaker during the period 1/1990-12/2004 and gains strength again for the last period in Panel C, 1/2005-12/2019. All the Panels also show the weakening the FX exposure's impact when the previous period's returns are included.

Fama-MacBeth Regressions of Monthly Stock Returns: Sub-samples

Model	Intercept	Fx Exposure	Beta	Size	BM	Operprof	Invest	Mom	Turnover	IdioVol	Lev	SP	Ret(t-1)
Panel A: 3/1974-12/1989													
(1)	1.41	-0.17	-0.23										
	4.83	-6.73	-0.91										
(2)	3.31	-0.17	-0.09	-0.83	0.37								
	2.00	-7.50	-0.39	-1.29	3.41								
(3)	2.42	-0.16	-0.03	-0.56	0.33	0.15	-1.16	0.99					
	1.57	-7.39	-0.15	-0.93	3.25	2.21	-5.31	5.04					
(4)	4.91	-0.07	0.31	-1.42	0.26	0.15	-1.41	1.05	-0.62	-13.88	0.04	0.00	-0.06
	2.98	-3.43	1.50	-2.20	2.26	2.06	-6.33	4.84	-4.45	-3.65	1.01	-0.27	-8.77
Panel B: 1/1990-12/2004													
(1)	0.91	-0.04	0.06										
	2.58	-1.29	0.16										
(2)	3.24	-0.07	0.13	-0.89	0.16								
	1.75	-2.67	0.40	-1.18	1.15								
(3)	2.64	-0.06	0.11	-0.67	0.19	0.06	-1.29	0.89					
	1.49	-2.28	0.36	-0.95	1.37	0.98	-4.95	4.65					
(4)	4.45	-0.04	0.23	-1.30	0.19	0.08	-1.32	0.91	0.00	-4.78	-0.03	-0.01	-0.03
	3.11	-1.70	0.96	-2.34	1.80	1.54	-5.09	4.83	0.00	-1.56	-0.73	-0.45	-4.97
Panel C: 1/2005-12/2019													
(1)	0.95	-0.10	-0.02										
	3.52	-3.04	-0.07										
(2)	0.01	-0.10	-0.03	0.34	-0.04								
	0.01	-3.09	-0.12	0.79	-0.51								

(3)	-0.10	-0.10	-0.12	0.35	-0.04	0.05	-0.99	-0.15					
	-0.09	-3.70	-0.61	0.87	-0.47	1.40	-2.53	-0.43					
(4)	1.40	-0.04	0.07	-0.18	-0.13	0.01	-0.81	-0.10	-0.09	-8.14	-0.08	0.07	-0.02
	1.29	-1.69	0.41	-0.49	-1.70	0.46	-2.17	-0.26	-2.81	-2.34	-1.34	2.35	-3.49

Table reports results of Fama-MacBeth (1973) regressions of monthly stock returns, in percent, on lagged FX exposure, market betas, log market capitalization (size), log book-to-market rate (BM), operational profitability (OperProf), the amount of investments (Invest), cumulative returns for the period $[t-2, t-12]$ (Mom), turnover from the past three months (Turnover), idiosyncratic volatility (IdioVol), leverage (Lev), sales revenue (SP), and the return from the previous month. Panels A-C show the results for three sample periods: 3/1974-12/1989, 1/1990-12/2004 and 1/2005-12/2019. Table reports the average coefficients and the Newey-West adjusted t-statistics.