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Higher moment exchange rate exposure of S&P500 firms ☆

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ABSTRACT

We examine the impact of higher order moments of changes in the exchange rate on stock returns of U.S. large-cap companies in the S&P500. We find a robust negative effect of exchange rate volatility on S&P500 company returns. The consumer discretionary and the consumer staples sectors have significant negative exposure to exchange rate volatility suggesting that exchange rate volatility affects stock returns through the channel of international operations. In terms of industries, the household products and personal products industries have significant negative exposure as well. The impact in the financial sector suggests that derivatives and hedging activity can mitigate exposure to exchange rate volatility. We find weak evidence that exchange rate skewness has an effect on S&P500 stock returns, but, find evidence that exchange rate kurtosis affects returns of companies that are more exposed to exchange rate volatility.

1. Introduction

Globalization has increased the exposure of firms to exchange rate risks, and fluctuations in exchange rates may sometimes lead to significant profits or losses to firms. For example, in 2007 the weakness of the U.S. dollar led to an increase in 4th quarter profits for IBM of about 7%, but the fluctuations in 2008 resulted in a profit decline for Coca-Cola Co. The U.S. dollar has experienced an appreciation against major currencies and an increase in volatility since the 4th quarter of 2013. The first quarter 2014 earnings releases and conference calls of many S&P500 companies cited the potential negative impact of the fluctuations in the U.S. dollar on their earnings. For example, *"This quarter, currency was a 1% headwind to new software license, and a 2% headwind to hardware and total revenue. In addition, EPS this year was reduced by $0.02 due to a currency re-measurement non-operating loss for Venezuela."* – *Oracle (March 19, 2014).* And, *"Foreign exchange transactions reduced net sales growth by one percentage point."* – *General Mills (March 19, 2014).*

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Motivated by the potential effects of exchange rates on firm value and asset returns, we study the impact of higher order moments of changes in the exchange rate on stock returns of U.S. large-cap companies in the S&P500. Specifically, we examine the exposure to the realized volatility (variance), skewness and kurtosis of the distribution of percentage changes in the U.S. dollar exchange rate, as measured by the trade weighted dollar index, or the foreign exchange value of the U.S. dollar against major foreign currencies We use a panel of 500 U.S large-cap (S&P500) companies and a sample period of quarterly observations from 2001Q1 to 2013Q4.

Our results are in the spirit of and extend earlier studies of exchange rate exposure. A typical way to quantify exchange rate exposure in earlier studies was to measure the sensitivity of stock returns to exchange rate returns. Adler and Dumas (1984) first pointed out that exchange rate exposure should be the regression coefficient of asset returns on exchange rate changes. Jorion (1990) and many others measured the exchange rate effects on U.S. multinational firms based on Adler and Dumas's method, e.g. Bartov and Bodnar (1994). However, many studies failed to find significant exposure to changes in exchange rates, especially for U.S. firms, including Bartov and Bodnar (1994), Griffin and Stulz (2001), and Doidge, Karolyi, and Stulz (2003). Those studies point to the use of currency derivatives and hedging as the main culprit for the lack of significant exposure, e.g. Bodnar and Marston (2001) and Allayannisa and Ofek (2001). In this line of research, the strategy of estimation for exchange rate exposure is a linear relationship between exchange rate loss and unfavorable exchange rate movements according to the relationship

$$Loss = \delta \times (exposure) \tag{1}$$

where δ is the unfavorable change in exchange rates. Two major types of exposure that fit in this relationship are transaction and translation exposure.[1]

Our contribution here is several fold. First, we measure higher moment exposure whereas most other studies only measure the first-moment or linear exposure to exchange rate. Higher moments of the percentage change in exchange rates can be used to better estimate the non-accounting based exposure of firms. The equation below summarizes a firm's potential loss as a function of exchange rate exposure when higher moments are considered

$$Loss = \sigma \times (higher\ moments\ exposure) \tag{2}$$

where σ is the probability of exchange rate deviating from its original value. According to expression (2), the higher exchange rate volatility, skewness or kurtosis is, the larger the value of σ, and thereby the greater the loss. Second, we use a panel of individual stock data instead of simply portfolio level time series, which improves estimation efficiency, provides for other fixed effects and controls and allows for heterogeneity among firms.

In terms of the second moment of the distribution of the change in exchange rates, Fig. 1 shows the standardized volatility of the dollar index and returns of the S&P500 index.[2] In periods when exchange rates are more volatile, returns of the S&P500 index tend to go down and the reported unconditional contemporaneous correlation is negative and statistically significant. As an alternative to the realized exchange rate volatility measure, the JP Morgan Exchange Rate Volatility Index is the implied exchange rate volatility calculated from the currency options of the U.S. Dollar against the currencies of the major trade partners of the U.S. Fig. 2 shows the time series lines of the standardized JP Morgan Exchange Rate Volatility Index and the exchange rate volatility measure calculated above. As shown in Fig. 2 the two series follow a similar pattern, the unconditional contemporaneous correlation is positive, strong and statistically significant.

Unexpected exchange rate volatility may impact stock returns in several ways. First, higher exchange rate volatility can increase transaction costs and depress international trade. Cushman (1983) finds that exchange rate volatility reduces the volume of international trade. Arize and Osang (2000) show that an increase in exchange rate volatility exerts significant negative effect on trade volume in both the short-run and the long-run. Second, exchange rate volatility can reduce the net present value of companies' investment projects abroad. Kiyota and Urata (2004) find that higher exchange rate volatility results in losses in investment in foreign countries. Third, higher exchange rate volatility can increase hedging costs. Brown (2001) finds that as exchange rate volatility increases firms have more incentive to hedge.

Empirically, we first examine whether or not returns of the S&P500 companies have exposure to exchange rate volatility using a panel fixed effect approach and a conditional heteroskedasticiy approach. Then, we examine whether or not exchange rate exposure varies across sectors and industries in the S&P500 portfolio. We use the variance of the percentage change of the dollar index as a measure of realized exchange rate volatility, and use panel data to control for heterogeneity across sectors and companies. There are three major findings in this part: i. The S&P500 portfolio has significant negative exposure to exchange rate volatility; ii. Sectors and industries that are more engaged in international business are more negatively exposed to exchange rate volatility than sectors that are relatively closed; iii. We find some support for the hypothesis that exchange rate volatility increases hedging costs.

[1] Transaction exposure arises from the effect that exchange rate movements have on a company's obligations to make or receive payments denominated in foreign currencies in the future. Translation exposure arises from the effect of exchange rate movements on a company's consolidated financial statement. Proper use of currency derivatives can reduce transaction and translation exposure, e.g. Hagelin and Pramborg (2004).

[2] The measure of exchange rate volatility is calculated as the quarterly variance of the weekly returns of the trade-weighted dollar index (major currencies). The trade weighted dollar index is a measurement of the foreign exchange value of the U.S. dollar against major foreign currencies. The volatility of the returns of the dollar index we first calculate the weekly percentage changes of the trade weighted dollar index and then calculate the quarterly variances of those percentage changes.

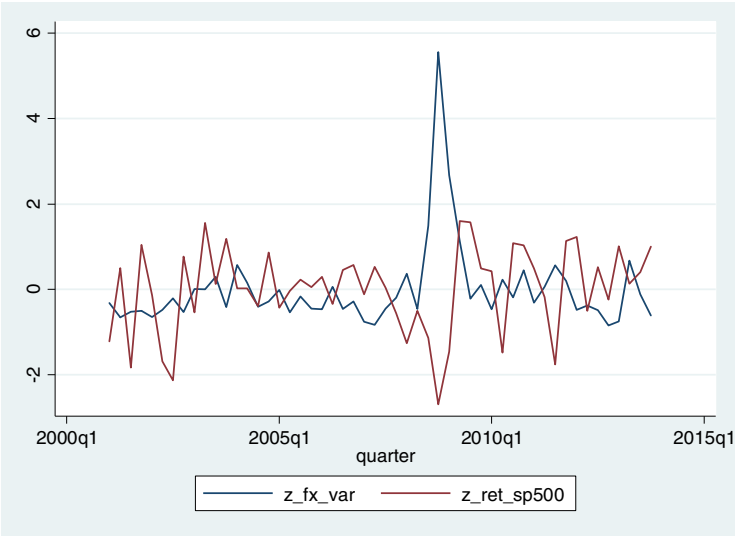


Fig. 1. Exchange Rate Volatility and S&P500 Returns. *Corr(z_fx_var, z_ret_sp500) = −0.4388 (p-value = 0.000).*

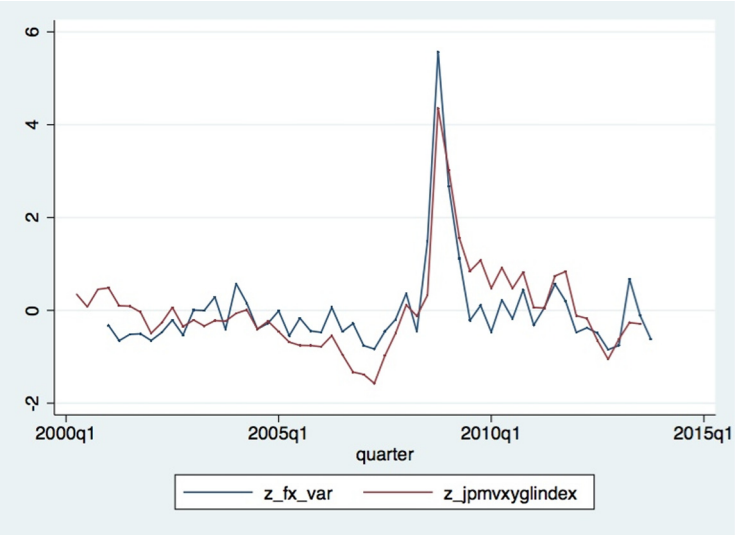


Fig. 2. Exchange Rate Volatility and JP Morgan Exchange Rate Volatility Index. *Corr(z_fx_var, z_jpmvxyglindex) = 0.8460 (P-value = 0.000).*

In addition to volatility of exchange rate returns, skewness and kurtosis of the exchange rate returns could also affect stock returns. Rafferty (2012) identifies a global currency skewness factor that covaries positively with a currency portfolio. More importantly, skewness of exchange rate returns may be an indicator of crash risk. That is, the more negatively skewed the returns of a currency are, the higher the frequency this currency depreciates sharply.[3] On the other hand, kurtosis can be described as the degree to which a distribution is weighted towards its tails, given the variance of the distribution. That is to say, kurtosis measures the probability mass in the tails of the distribution. It captures the probability of outcomes that are farther away from the mean of the distribution, e.g. Dittmar (2002). Given a variance level, the larger (lower) the kurtosis, the higher (lower) the probability for the exchange rate to deviate farther from the mean and thus to become more (less) unpredictable. In the context of U.S. large-cap companies, we ask whether or not stock returns have exposure to the skewness and kurtosis of exchange rate returns. In terms of skewness, we find weak evidence of exposure, however, we find significant negative exposure to kurtosis for a sample of firms that have significant exposure to exchange rate volatility.

In summary, the key findings of this paper are that, in our sample period, there is a robust negative effect of exchange rate volatility on S&P500 company returns, predominantly in the consumer discretionary and the consumer staples sectors. In

[3] Rafferty (2012) also finds that skewness risk is positively priced using an alternative asset pricing method for currency portfolios.

terms of industries, the household products and personal products industries have significant negative exposure as well. In the financial sector, our findings suggest that derivatives and hedging activity can mitigate exposure to exchange rate volatility. However, we find weak evidence that exchange rate skewness has an effect on S&P500 stock returns, but, find evidence that exchange rate kurtosis affects returns of companies that are more exposed to exchange rate volatility.

The paper is organized as follows. In Section 2 we provide a literature review and Section 3 provides data details. Section 4 is the core of the paper with econometric specifications and results from alternative specifications by company, company within a sector and within an industry. We summarize the findings and provide concluding remarks in Section 5.

2. Literature review

Exchange rate exposure has received significant attention in the literature. Adler and Dumas (1984) define exchange rate exposure as the sensitivity of the asset return to changes in exchange rates while Jorion (1990) studies a sample of 287 U.S. multinational firms and finds that some firms have significant exchange rate exposure. Jorion (1990) also finds that exchange rate exposure varies across firms and that foreign to domestic sales ratio is a significant determinant of the changes.[4] Amihud (1993) studies a sample of 32 large U.S. exporters from 1978 to 1988 and finds no significant exchange rate exposure. Bartov and Bodnar (1994) use a sample of U.S. firms to study the relationship between stock returns and exchange rates. They fail to find significant correlation between exchange rate changes and the returns in their sampled firms.[5]

More recent studies on the relationship between exchange rates and stock returns also fail to find significant exchange rate exposure, and this is especially true for samples of U.S. firms. Griffin and Stulz (2001) examine the importance of exchange rate movements for stock returns using a sample of U.S. and Japanese companies. They find that weekly exchange rate shocks explain almost nothing of the relative performance of industries. Doidge et al. (2003) also find similar results.

The determinants of exchange rate exposure have received considerable attention in literature too. Bodnar and Gentry (1993) examine the exchange rate exposure of different industry sectors using a sample of U.S., Japanese and Canadian firms. They study the determinants of the dispersion of exchange rate exposure across industries and find that a set of industry characteristics systematically determines the exchange rate exposure of an industry. Those characteristics include export ratio, input penetration ratio, reliance on internationally priced inputs, and foreign to total assets ratio. Choi and Prasad (1995) develop a firm valuation model to study the determinants of exchange rate exposure and find that firm-specific operational factors such as foreign operating profits, sales and assets are also affecting exchange rate exposure. Williamson (2001) studies a sample of automobile firms and finds that exchange rate exposure is linked to the competition within the industry. Nucci and Pozzolob (2001) find a relationship between monopoly power and exchange rate exposure. Allayannis and Ihrig (2001), Campa and Goldberg (1995, 1999) also find that market structure has a significant effect on a firm's exchange rate exposure.

What is the channel of the effect of exchange rates on firm values or stock returns? The focus has been on the channel of the exchange rate effect on a company cash flow. For example, Bodnar and Marston (2001) point out that exchange rates have an effect on a firm's cash flow and thus affects its valuation. They further establish a model that describes the three specific channels through which exchange rate is affecting firm value. These channels are i. Producing domestically but selling internationally; ii. Producing with imported components; iii. Producing abroad. However, as for why researchers do not find significant exchange rate effects in most companies, studies show that this is because of the use of currency derivatives. Bodnar and Gentry (1993) surveys the use of currency derivatives and finds that the exchange rate exposure is low for a sample of 103 firms that use currency derivatives. Allayannisa and Ofek (2001) also find that nonfinancial firms in the S&P500 portfolio use currency derivatives to hedge against exchange rate risk and that the use of currency derivatives significantly reduces their exchange rate exposure.

While the exposure to changes in exchange rates has been intensively examined, the exposure to volatility and other higher moments of exchange rate changes has received much less attention. Koutmos and Martin (2003) investigate the impact of first and second moment exchange rates on stock returns using companies in nine U.S. sectors and daily data from 1992 to 1998 only. They find significant negative second moment exposure in the consumer sectors and significant positive exposure in the financial sector. As mentioned above, exchange rate volatility could affect stock returns through three channels. The first channel is through depressing international trade associated with a firm. These trades include selling product produced domestically to foreign countries, importing intermediate goods for domestic production, or producing using facilities in foreign countries. Exchange rate volatility can create friction in international trade thus increasing transaction costs. This could reduce a firm's international sales, increase importing costs or the costs of producing abroad. For example, Arize and Osang (2000) find that the volatility in exchange rate has a significant negative effect on the export demand of less developed countries; and Côté (1994) surveys the literature on the effect of exchange rate volatility on international trade and finds that exchange rate volatility tends to reduce the level of trade.

The second channel is through reducing the net present value of investment projects located abroad. Cushman (1985, 1988) points out that higher exchange rate volatility lowers the certainty equivalent level of the expected exchange rate.

[4] See also Bartov et al. (1996), Miller and Reuer (1998), and Dominguez and Tesar (2001) on this vein and, more recently, Chou, Lin, Hung, and Lin (2017) who focus on exposure to bilateral exchange rates for multinational firms' values.

[5] More recently, Brusa, Ramadorai, and Tarun (2014) find that currency risk is priced in the cross-section of international equity returns.

The more volatile exchange rates are, the less the certainty equivalents of exchange rate levels are. Because the certainty equivalent level of exchange rates is part of a firm's function to calculate net present value of investment projects abroad, volatility in exchange rates could affect the values of firms. Goldberg and Kolstad (1994) finds that as exchange rate gets more volatile, the expected values of investment projects located abroad are reduced accordingly. In a study of a sample of U.S. and Japanese firms, Kiyota and Urata (2004) also find that higher exchange rate volatility results in losses in investment denominated in foreign currencies. The third channel is that higher exchange rate volatility increases hedging costs. Geczy (1997) find that firms with extensive exchange rate exposure are more likely to use currency derivatives. Allayannisa and Ofek (2001) also examine the determinants of the use of currency derivatives. They find that the decision to use derivatives depends significantly on foreign exposure factors, such as foreign sales and foreign trade. Brown (2001) studies a large multi-national durable equipment manufacturer and finds that when the firm is anticipating more volatile future currency value it uses more currency derivatives. Companies based their budgets for exchange rate risk management on the calculation of the amount of potential loss and the probability of that amount of loss. Given the mean of the distribution of exchange rate percentage changes, higher volatility results in higher probability of realizing the estimated amount of loss and therefore companies increase their incentive of hedging.

Finally, Rafferty (2012) identified a global currency skewness risk factor and found that currency portfolios that have higher average excess returns covary more positively with the skewness risk factor.

3. Data

This study uses quarterly data for 52 quarters in the 13-year period from 2001Q1 to 2013Q4. We use a panel data set consisting of individual stocks of the S&P500. The data includes quarterly returns of the 500 constituents of the S&P500 index, quarterly exchange rate volatility, quarterly returns of the Russell 3000 total return index, and quarterly data of company-specific factors.[6] We use panel data to account for the heterogeneity across sectors and companies and to obtain more efficient parameter estimates.

Table 1 shows the first set of descriptive statistics. The quarterly stock returns are calculated from the adjusted closing prices. The measure of exchange rate volatility is the quarterly variance of the weekly returns of the trade-weighted dollar index (major currencies) and the exchange rate variance (z) variable is the standardized exchange rate variance. The quarterly returns of the Russell 3000 are calculated from the adjusted closing price of the Russell 3000 index.[7] The Russell 3000 total return index is used to capture the systematic market return. Table 2 presents the descriptive statistics of firm specific variables. Company specific variables include price-to-book ratio, earnings-per-share, price to earnings (PE) ratio, long-term debt to total assets, current ratio, and inventory turnover. Price-to-book and PE ratios are used as proxies of the valuation factors; earnings-per-share is a proxy for earnings; long-term debt to total asset represents the leverage status of a firm.

Each firm in the data set is classified into a sector and an industry within that sector according to the MSCI Global Industry Classification Standard. There are ten sectors in the S&P500 portfolio. These sectors are the consumer discretionary sector, consumer staples sector, energy sector, financials sector, healthcare sector, industrials sector, information technology sector, materials sector, telecommunication services sector, and the utilities sector. The sector data are from Standard & Poor's.[8]

Fig. 3 presents scatter plots of the S&P500 company stock return and exchange rate volatility. We note that the outliers to the right represent quarters during the financial crisis of 2008.

The next set descriptive statistics in Table 3 refers to skewness and kurtosis of exchange rate returns. The skewness and kurtosis are calculated as the quarterly skewness and kurtosis of the weekly returns of the trade weighted dollar index, and the variables are standardized to make the results comparable.

Figs. 4 and 5 present scatter plots of the S&P500 firms' stock returns, and exchange rate returns skewness and kurtosis. Similarly to volatility, we note that the outliers to the right represent quarters during the financial crisis of 2008.

4. Econometric Models and results

In this paper, we use a panel of individual stock data to estimate the exposure of the whole portfolio. There are many advantages to using panel data. Panel data provides a larger number of data points, increasing degrees of freedom and hence improving the estimation efficiency and precision. Also, using panel data makes it possible to control for heterogeneity of firms and missing and other unobserved variables through well-defined fixed effects.

We use two strategies to estimate the effects of exchange rate volatility on stock returns. The first one is the panel fixed effect method. The estimation model of the panel fixed effect method is specified as follows:

$$stock\_return_{i,t} = \beta_o + \beta_1 market\_return_t + \gamma FX\_volatility_t + \boldsymbol{\alpha}' Company\_Specific\_Factors_{i,t} + \eta_i + \delta_t + u_{i,t} \quad (3)$$

[6] All data are from Bloomberg unless otherwise noted.

[7] The Russell 3000 total return index is a market capitalization weighted equity index published and maintained by the Russell Investment Group that seeks to be a benchmark of the entire U.S. stock market.

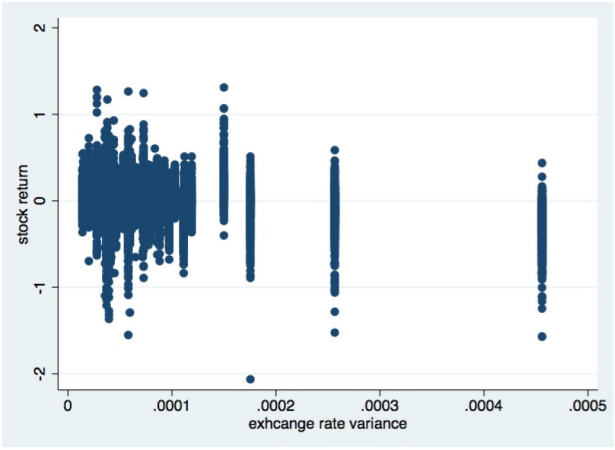
[8] A detailed list of sectors, industries and companies is included in the Appendix.

Table 1
Descriptive Statistics – Stock Return, Exchange Rate Volatility, Russell 3000 Returns.

VARIABLE	Stock Return	Exchange Rate Variance	Exchange Rate Variance (z)	Russell 3000 Return
Mean	0.0203637	0.0000731	0	0.0111164
Median	0.034408	0.000054	−0.2781212	0.0216529
Standard Deviation	0.1806992	0.000069	1	0.0918538
Skewness	−0.98199	3.77133	3.77133	−0.7100836
Kurtosis	10.15035	19.97646	19.97646	2.999402
Max	1.302627	0.0004568	5.560104	0.1573199
Min	−2.072662	0.0000146	−0.8477942	−0.2421999
N	22,817	24,683	24,683	24,683

Table 2
Descriptive Statistics – Company Specific Factors.

VARIABLES	EPS	PE Ratio	Account payable turnoever	Price-to-book ratio	Long-term debt to equity	Current ratio
Mean	0.4942175	50.93961	10.0294	6.030075	19.93297	1.955599
Median	0.45	17.3485	8.2502	2.5927	18.0161	1.5319
Standard Deviation	4.117078	2478.055	8.497206	129.4738	15.90423	1.691036
Skewness	−78.41905	104.7812	4.553069	94.02237	1.651325	8.130233
Kurtosis	7812.912	11047.45	40.39122	9499.318	10.70536	158.3477
Max	34.6	273397.1	139.8885	13921.42	176.0491	52.9163
Min	−459	0.6948	−1.2591	0.1	0	0. 1011
N	23,698	21,971	18,651	22,744	23,829	20,599



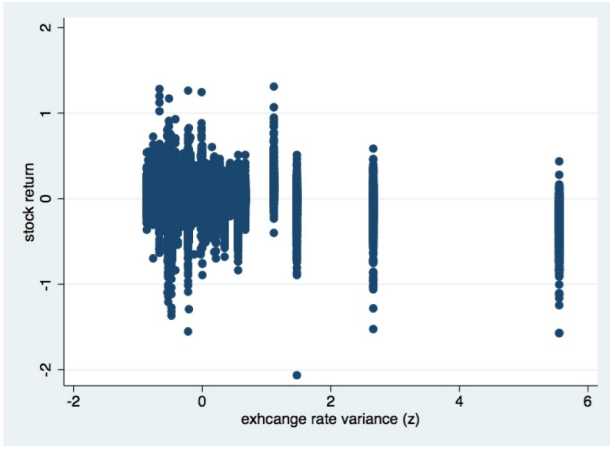


Fig. 3. Scatter Plots of Stock Return and Exchange Rate Variance. Note: The graph on the left is the plot of stock return and exchange rate variance; the one on the right is the plot of stock return and standardized exchange rate variance.

Table 3
Descriptive Statistics – Exchange Rate Skewness, Exchange Rate Kurtosis.

VARIABLES	Exchange Rate Skewness	Exchange Rate Skewness (z)	Exchange Rate Kurtosis	Exchange Rate Kurtosis (z)
Mean	0.1334395	0	−0.056949	0
Median	0.2314975	0.1659511	−0.3575232	−0.2412555
Standard Deviation	0.5908847	1	1.245875	1
Skewness	−0.0733261	−0.0733261	0.9204662	0.9204662
Kurtosis	3.025059	3.025059	3.271826	3.271826
Max	1.580441	2.448872	3.166804	2.587541
Min	−1.217805	−2.286816	−1.808751	−1.406081
N	24,683	24,683	24,683	24,683

where δ_t is a vector of time fixed effect, η_i is a vector of company fixed effect, $u_{i,t}$ is the random error term. The slope coefficient of interest is γ, which measures the effect of exchange rate volatility on stock returns. Firm fixed effects are included to allow for the effects of those omitted variables that are specific to each firm but stay constant over time, and time fixed effects are included to account for the omitted variables that affect all cross-section over time.

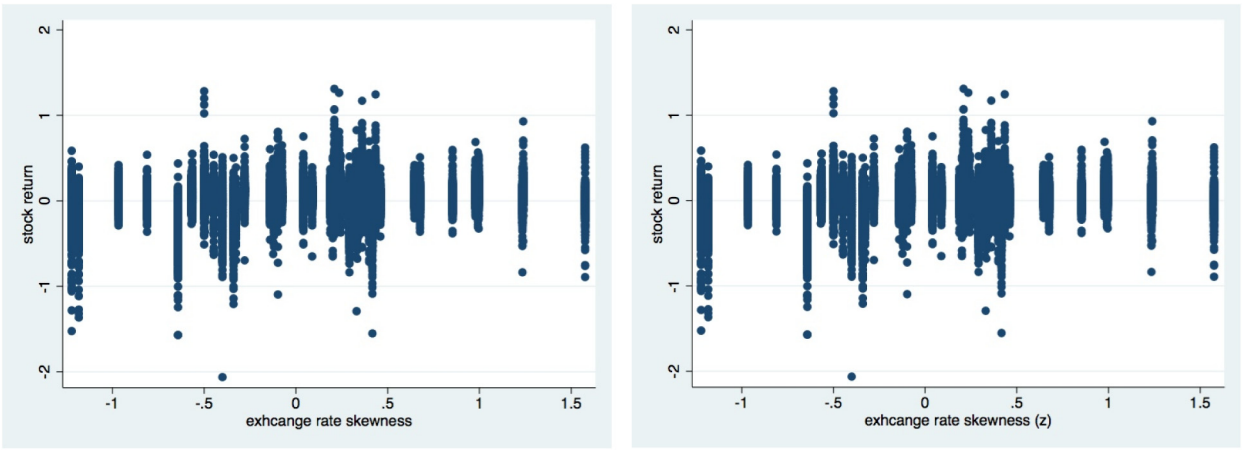


Fig. 4. Scatter Plots of Stock Return and Exchange Rate Skewness. Note: The graph on the left is the plot of stock return and exchange rate skewness; the one on the right is the plot of stock return and standardized exchange rate skewness.

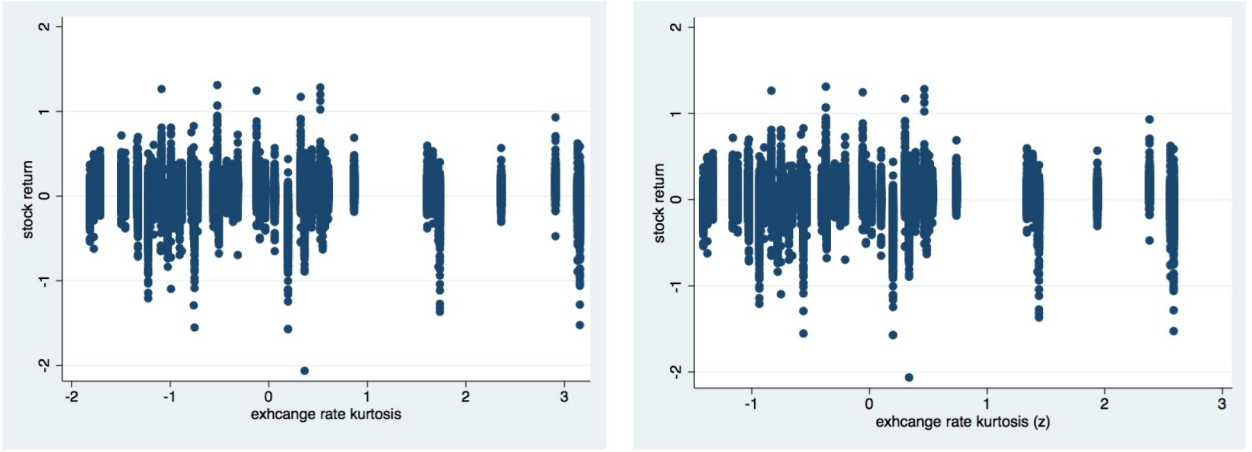


Fig. 5. Scatter Plots of Stock Return and Exchange Rate Kurtosis. Note: The graph on the left is the plot of stock return and exchange rate kurtosis; the one on the right is the plot of stock return and standardized exchange rate kurtosis.

The second estimation strategy is the standard conditional heteroskedasticiy method using the panel. The conditional heteroskedasticiy method includes the GARCH formulation for conditional heteroskedasticity and an autoregressive moving average components variance equation. It is specified as Eq. (3) above together with the evolution of volatility:

$$h_{it} = \alpha_o + \gamma_1 h_{i,t-1} + \alpha_1 u^2_{i,t-1} \tag{4}$$

where $h_{i,t}$is the variance of $u_{i,t}$.

4.1. Volatility exposure of the S&P500 companies

This section presents the empirical results of the effects of foreign exchange volatility on the returns of the S&P500 companies.

4.1.1. Fixed effects approach

Table 4 shows two alternative estimations of the effect of exchange rate volatility on S&P500 returns using the fixed effect method specified in expression (3). Column 1 is the simple specification that includes only exchange rate volatilities and market returns. Column 2 includes exchange rate volatilities, market returns and the company-specific factors. As shown in both columns, the effect of exchange rate volatility on stock returns is negative and statistically significant. When the variance of dollar index increases one standard deviation from its mean, stock returns decrease about 1.1% in column (1) and

Table 4
Fixed Effect Estimate of S&P500 Volatility Exposure.

Variables	(1) Stock return	(2) Stock return
Exchange rate variance (z)	−0.0111***	−0.0175***
	(0.0023)	(0.0014)
Russell 3000 return	1.0794***	0.9939***
	(0.0403)	(0.0428)
EPS		(+)***
PE Ratio		(−)***
Account receivable turnover		(+)
Price-to-book ratio		(+)***
Long-term debt to equity		(+)*
Current ratio		(−)
Constant	0.0241***	0.0210***
	(0.0051)	(0.0063)
Company fixed effect	Y	Y
Time fixed effect	Y	Y
Cluster on	Sector	Sector
Observations	22,817	17,298
Overall R-squared[a]	0.3274	0.3343
Number of tick	497	414

Robust standard errors in parentheses.
Qualitative signs in parenthesis for controls.
***p < 0.01, **p < 0.05, *p < 0.1.
[a]The marginal gains in overall R-squared, AIC and BIC from a simple market and constant only are: For column (1): R-squared 0.001622; AIC -55.94; BIC -55.95; For Column (2): R-squared 0.00652932; AIC 3179.86; BIC 3177.38. While these changes are marginal, here we emphasize that the t-stat of the slope of the exchange rate variance is statistically significant.

1.8% in column (2). In addition, the coefficient of the Russell 3000 returns is close to one indicating, as one might expect, that variability of the S&P500 companies is comparable to the Russell 3000.

4.1.2. Conditional heteroskedasticity approach

Table 5 shows two estimations of the effect of exchange rate volatility on the returns of the S&P500 portfolio using the conditional heteroskedasticity approach method specified in expression 3 and 4. Column 1 is the simple specification that includes exchange rate volatility and market returns. Column 2 includes exchange rate volatility, market returns and the company-specific factors. As shown in the table, the ARCH and GARCH effects are both statistically significant. Also, similar to the estimates using constant variance, both columns 1 and 2 show that the exchange rate volatility has a statistically significant negative effect on stock returns.

4.1.3. Robustness check

The negative effect of exchange rate volatility is robust to both fixed effects and conditional heteroskedasticity methods. In this section, we examine the effect of exchange rate volatility using a different measure of exchange rate volatility – the JP Morgan exchange rate volatility index, a measure of that the market looks at as a timely measure of exchange rate volatility. We examine the effect on returns of the S&P500 portfolio using both fixed effect approach and conditional heteroskedasticity approach as in expressions (3) and (3–4) substituting the FX volatility variable.

Table 6 presents the results. Column 1 shows the estimation results using fixed effect approach and column 2 shows the estimation results using conditional heteroskedasticity approach. Exchange rate volatility still has a significant negative effect on returns of the S&P500 portfolio after changing the measure of exchange rate volatility to JP Morgan exchange rate volatility index. Table 7 compares the results between the fixed effect estimation results of using different exchange rate volatility measures including all fixed effects of Table 4. Column 1 shows the estimation of the realized exchange rate variance and column 2 shows the results of the JP Morgan exchange rate volatility index. The exchange rate variance and the JP Morgan exchange rate volatility index are standardized in order to make the results comparable. The estimated effects of both measures are similar in terms of significance level and magnitude, but the standard errors are smaller when we use the JP Morgan foreign exchange volatility index.

4.1.4. Volatility exposure by sector

This section further examines the exchange rate volatility exposure by sector. The purpose of measuring each sector's exchange rate volatility exposure is to examine whether or not exchange rate exposure is related to industry characteristics. Sectors that are more involved in international trade should have more exposure to exchange rate volatility.

Table 5
Conditional Heteroskedasticity Estimate of S&P500 Volatility Exposure.

Variables	(1) Stock return	(2) Stock return
Exchange rate variance (z)	−0.0105***	−0.0081***
	(0.0009)	(0.0011)
Russell 3000 return	0.9032***	0.8781***
	(0.0122)	(0.0140)
EPS		(+)***
PE Ratio		(−)
Account receivable turnover		(−)
Price-to-book ratio		(+)
Long-term debt to equity		(+)**
Current ratio		(+)
arch	0.2934***	0.2266***
	(0.0070)	(0.0074)
garch	0.6388***	0.7126***
	(0.0070)	(0.0084)
Constant	0.0017***	0.0012***
	(0.0001)	(0.0001)
Company fixed effect	Y	Y
Time fixed effect	Y	Y
Observations	22,817	17,298

Robust standard errors in parentheses.
Qualitative signs in parenthesis for controls.
***p < 0.01, **p < 0.05, *p < 0.1.

Table 6
Estimates using JP Morgan FX Volatility Index.

Variables	(1) Panel fixed Effect Stock return	(2) Conditional Heteroskedasticity Stock return
JP Morgan FX Volatility Index	−0.0064***	−0.00492***
	(0.0010)	(0.0010)
ret_RU_3000	1.0630***	0.902***
	(0.0383)	(0.0790)
Constant	0.0991***	0.00175***
	(0.0098)	(0.0024)
Observations	22,321	22,321
Overall R-squared	0.3246	0.3343
Number of tick	496	416

Robust standard errors in parentheses.
***p < 0.01, **p < 0.05, *p < 0.1.

Table 7
Comparison of Exchange Rate Variance and JP Morgan FX Volatility Index.

Variables	Realized Exchange rate Variance (z) Stock return	JPM FX Volatility (z) Stock return
Exchange rate volatility variable	−0.0111***	−0.0175***
	(0.0023)	(0.0014)
Russell 3000 return	1.0794***	1.0630***
	(0.0403)	(0. 0.0383)
Constant	0.0241***	0.0317***
	(0.0051)	(0. 0043)
Observations	22,817	22,321
Overall R-squared	0.3274	0.3246
Number of tick	497	496

Robust standard errors in parentheses.
***p < 0.01, **p < 0.05, *p < 0.1.

Table 8a presents the panel fixed effect estimates of the effects of exchange rate volatility on the ten sectors of the S&P500 portfolio. As shown in the columns, exchange rate exposure does vary across sectors. The effect of exchange rate volatility is most significant for the consumer staples sector, and then the consumer discretionary sector. Exchange rate volatility also has a significant effects on the healthcare, industrial and information technology sectors. It does not have significant effects

Table 8a
Fixed Effect Estimate of Sector Volatility Exposure.

Variables	(1) Consumer discretionary Stock return	(2) Consumer staples Stock return	(3) Energy Stock return	(4) Financials Stock return	(5) Healthcare Stock return
z-Exchange rate variance	−0.0129**	−0.0159***	−0.0089	−0.0043	−0.0085*
	(0.0055)	(0.0045)	(0.0099)	(0.0063)	(0.0048)
Russell 3000 return	0.9956***	0.9115***	1.1710***	0.8157***	0.9108***
	(0.0742)	(0.0639)	(0.1404)	(0.0922)	(0.0631)
EPS	(+)	(+)*	(−)	(+)**	(+)*
PE Ratio	(+)	(+)	(+)	(+)	(−)
Account receivable turnover	(+)**	(+)	(−)	(−)	(−)***
Price-to-book ratio	(+)***	(+)	(+)*	(+)*	(−)
Long-term debt to equity	(+)	(+)	(+)	(+)	(+)**
Current ratio	(+)	(−)	(−)	(−)	(−)**
Constant	0.0295*	−0.0007	−0.0143	0.0455	0.0178
	(0.0164)	(0.0172)	(0.0391)	(0.0283)	(0.0136)
Company fixed effect	Y	Y	Y	Y	Y
Time fixed effect	Y	Y	Y	Y	Y
Cluster on	Firm	Firm	Firm	Firm	Firm
Observations	2174	2765	1231	1859	2497
Overall R-squared	0.3238	0.3397	0.3854	0.2932	0.3110
Number of tick	53	68	28	40	61

Variables	(6) Industrials Stock return	(7) Information technology Stock return	(8) Materials Stock return	(9) Tele-communication services Stock return	(10) Utilities Stock return
Exchange rate variance (z)	−0.0101*	−0.0090*	−0.0069	−0.0225	−0.0091
	(0.0056)	(0.0050)	(0.0089)	(0.0162)	(0.0076)
Russell 3000 return	1.1019***	1.1813***	1.0496***	0.7313***	0.9554***
	(0.0861)	(0.0788)	(0.1158)	(0.1058)	(0.1271)
EPS	(+)***	(+)***	(+)	(−)	(+)
PE Ratio	(−)***	(+)	(+)*	(+)	(+)*
Account receivable turnover	(−)	(+)	(+)	(+)***	(−)**
Price-to-book ratio	(+)	(+)***	(+)	(+)	(+)**
Long-term debt to equity	(+)	(−)	(−)**	(−)	(−)*
Current ratio	(−)	(+)***	(+)	(−)	(−)
2008_year	(+)	(−)	(+)	(−)	(+)
Constant	0.0061	0.0044	−0.0269	0.0189	−0.0658
	(0.0242)	(0.0170)	(0.0385)	(0.0314)	(0.0603)
Company fixed effect	Y	Y	Y	Y	Y
Time fixed effect	Y	Y	Y	Y	Y
Cluster on	Firm	Firm	Firm	Firm	Firm
Observations	2179	2052	1036	608	897
Overall R-squared	0.3919	0.4079	0.3576	0.2606	0.3842
Number of tick	48	51	25	17	23

Robust standard errors in parentheses.
Qualitative signs in parenthesis for controls.
***p < 0.01, **p < 0.05, *p < 0.1.

on the energy, financials, materials, telecommunication and utilities sector. In terms of magnitude, exchange rate volatility has the largest effects on the consumer staples sector, second on the consumer discretionary sector, and then on the industrial, information technology, and healthcare sector. Table 8b provides a summary of the significance levels and magnitudes of the effects.

Table 9a presents the conditional heteroskedasticity estimates of the effects of exchange rate volatility on the ten S&P500 sectors. The conditional heteroskedasticity estimates of exchange rate exposure do vary across sectors as well. The effect of exchange rate volatility is most significant on the consumer staples sector. Exchange rate volatility also has statistically significant effects on the energy, healthcare, information technology, consumer discretionary, industrial and material sectors as well. It does not have significant effect on financials, materials, telecommunication and utilities sectors. In terms of magnitude, exchange rate volatility has the largest effects on the energy sector, second on the consumer staple sector, and then on the materials, healthcare, industrial and consumer discretionary sectors. Table 9b provides a summary of the significance levels and magnitudes.

Accounting for conditional heteroskedasticity makes the energy sector more vulnerable to exchange rate volatility exposure potentially due to currency mismatch of revenues and liabilities.[9]

[9] See e.g. Bianconi and Yoshino (2014) for evidence of currency mismatches in the nonrenewable energy sector.

Table 8b
Significance Levels and Magnitudes of Volatility Exposure (Fixed Effects).

Significance levels:
Consumer staples > consumer discretionary > information technology ∼ industrial∼healthcare
Magnitudes:
Consumer staples > consumer discretionary > industrials>information technology > healthcare

4.1.5. International trade and sector exposure

Using both methods the consumer discretionary and the consumer staple sectors have more significant negative exposure to exchange rate volatility than the other sectors. Their exposure is larger than that of other sectors' as well as in terms of scale. Companies in those sectors are more engaged in international operations and international trade. We can also see that the exposure of the telecommunications sector and the utilities sector is not statistically significant. Companies in those alternative sectors are much less involved in international operations by nature since products and services of many firms in those two sectors are largely nontradable. The notable differences in exchange rate exposure between the consumer sectors and the telecommunications and the utilities sector supports the hypothesis that exchange rate volatility affects stock returns through the channel of international operations.

4.1.6. A closer look at the consumer sectors

We provide further insights into the exposure of the industries in the consumer staples and the consumer discretionary sectors. The two consumer sectors are intensively involved in international trade and it is reasonable that they have the largest and most significant exposure to exchange rate volatility. However, some industries in the consumer sectors are relatively closed, such as the broadcasting & cable TV industry, the restaurants industry to some extent, and the homebuilding industry. We look for evidence that their exposure to exchange rate volatility is relatively weak thus suggesting that operations in tradable activities results in more significant exchange rate volatility exposure.

Using the panel fixed effect method specified in expression (3), the exchange rate exposure of the broadcasting & cable TV, restaurants, homebuilding industry, household products, and the personal products industries is examined. Products and services of the broadcasting & cable TV, restaurants and the homebuilding industries are relatively nontradable as compared to the products and services of the household products and personal products industries and thus would have less exposure to exchange rate volatility. Table 10 provides the results. As expected, the broadcasting & cable TV, restaurants and the homebuilding industries do not have statistically significant exchange rate volatility exposure, whereas the household products, personal products industries have significant negative exposure.

4.1.7. The financial sector exposure puzzle

A puzzling observation is that the exchange rate exposure of the financial sector is not statistically significant and companies in the financial sector are active dealers of foreign exchange assets. But, at the same time, firms in the financial sectors are the biggest providers of currency derivatives. The more companies in other sectors use those derivatives the more the financial sector makes profits and their negative exposure could be potentially offset.

We evaluate the financial sector exchange rate exposure examining the exchange rate exposure of the five industries in the financial sector. Those industries are the insurance industries (including insurance broker, life & health insurance, multiline insurance, property and casualty insurance), consumer finance, real estate (REITs), banks, and diversified financial services industries. The estimation strategy used is the panel fixed effect model as specified in expression (3). Table 11 presents the results. As shown in the table, all but the banking industry have significant exposure to exchange rate volatility. The banking industry consists of firms like Bank of America, Citigroup, Wells Fargo, and JP Morgan Chase among others. The nation's commercial banks are the largest players in foreign currency trading, dealing and providers of currency derivatives. Companies in other sectors use their products and services to hedge against exchange rate risks. The more volatile exchange rate is the more companies use their products and services, thereby giving them a positive exposure to exchange rate volatility. Therefore their negative exposure to exchange rate volatility as a result of currency dealing business and hedging costs could be offset by the positive gains from providing currency services. We speculate that this provides support to the hypothesis that hedging activity can mitigate exposure to exchange rate volatility.

4.2. Exchange rate returns skewness and kurtosis

As mentioned above, skewness of exchange rate returns is an indicator of crash risk. The more negatively skewed the returns of a currency are, the higher the potential probability this currency depreciates sharply eventually. Kurtosis may be described as the degree to which a distribution is weighted towards its tails, and it is a unit-free measure scaled by the variance of the distribution.[10] Kurtosis measures the probability mass in the tails of the distribution and it captures the probability of outcomes farther from the mean. One key question is whether or not stock returns have exposure to skewness

[10] See DeCarlo (1997) for a clear exposition of kurtosis and its uses.

Table 9a
Conditional Heteroskedasticity Estimate of Sector Volatility Exposure.

Variables	(1) Consumer discretionary Stock return	(2) Consumer staples Stock return	(3) Energy Stock return	(4) Financials Stock return	(5) Healthcare Stock return
Exchange rate variance (z)	−0.0065*	−0.0131***	−0.0155***	−0.0042	−0.0090***
	(0.0033)	(0.0029)	(0.0054)	(0.0033)	(0.0033)
Russell 3000 return	0.8363***	0.8375***	0.9289***	0.7519***	0.8117***
	(0.0433)	(0.0326)	(0.0533)	(0.0424)	(0.0377)
EPS	(+)	(+)***	(−)*	(+)***	(−)
PE Ratio	(+)***	(+)	(+)	(+)	(−)
Account receivable turnover	(+)	(+)	(+)	(+)	(−)
Price-to-book ratio	(+)	(+)	(+)***	(+)***	(−)
Long-term debt to equity	(−)	(+)	(+)***	(+)	(+)**
Current ratio	(−)	(+)	(−)	(+)	(−)
Arch	0.2595***	0.2338***	0.4641***	0.2418***	0.1872***
	(0.0227)	(0.0221)	(0.0541)	(0.0275)	(0.0141)
garch	0.7065***	0.6309***	0.4606***	0.7067***	0.7628***
	(0.0225)	(0.0326)	(0.0461)	(0.0278)	(0.0175)
Constant	0.0011***	0.0021***	0.0026***	0.0009***	0.0009***
	(0.0002)	(0.0003)	(0.0005)	(0.0002)	(0.0002)
Company fixed effect	Y	Y	Y	Y	Y
Time fixed effect	Y	Y	Y	Y	Y
Observations	2174	2765	1231	1859	2497

Variables	(6) Industrials Stock return	(7) Information technology Stock return	(8) Materials Stock return	(9) Tele-communication services Stock return	(10) Utilities Stock return
Exchange rate variance	−0.0068*	−0.0106***	−0.0101*	−0.0028	−0.0013
	(0.0037)	(0.0034)	(0.0056)	(0.0057)	(0.0043)
Russell 3000 return	0.9994***	1.0905***	0.9171***	0.7001***	0.8422***
	(0.0395)	(0.0435)	(0.0633)	(0.0874)	(0.0511)
EPS	(+)***	(+)***	(+)*	(−)***	(+)**
PE Ratio	(+)*	(+)	(+)***	(+)	(+)***
Account receivable turnover	(+)	(−)	(−)	(+)	(−)*
Price-to-book ratio	(+)	(+)	(+)***	(−)	(+)
Long-term debt to equity	(+)**	(−)	(+)	(+)	(+)
Current ratio	(−)	(+)***	(−)	(+)	(+)***
arch	0.1618***	0.1840***	0.2852***	0.4045***	0.5364***
	(0.0170)	(0.0243)	(0.0382)	(0.0662)	(0.0643)
garch	0.7847***	0.7569***	0.6434***	0.4688***	0.4583***
	(0.0213)	(0.0320)	(0.0419)	(0.0749)	(0.0492)
Constant	0.0008***	0.0012***	0.0016***	0.0034***	0.0014***
	(0.0002)	(0.0004)	(0.0004)	(0.0010)	(0.0003)
Company fixed effect	Y	Y	Y	Y	Y
Time fixed effect	Y	Y	Y	Y	Y
Observations	2179	2052	1036	608	897

Robust standard errors in parentheses.
Qualitative signs in parenthesis for controls.
***p < 0.01, **p < 0.05, *p < 0.1.

Table 9b
Significance Levels and Magnitudes of Volatility Exposure (Conditional Heteroskedasticity).

Significance levels:
Consumer staples ∼ energy∼healthcare ∼ information technology > consumer discretionary ∼ industrial∼materials
Magnitudes:
Energy > Consumer staples > information technology > materials>healthcare > industrial>consumer discretionary

and kurtosis of exchange rate returns. We first examine the exposure of the S&P500 portfolio of companies and then whether or not the exposure varies across sectors.

We basically add to the model in expression (3), variables for skewness and kurtosis. The model is of the form:

$$stock\_return_{i,t} = \beta_o + \beta_1 Market\_return_t + \gamma_1 FX\_volatility_t + \gamma_2 FX\_skewness_t + \gamma_3 FX\_kurtosis_t + \boldsymbol{\alpha}' Company\_Specific\_Factors_{i,t} + \eta_i + \delta_t + u_{i,t} \quad (5)$$

Table 10
Volatility Exposure of Some Consumer Sector Industries.

Variables	(1) Broadcasting & Cable TV Stock return	(2) Restaurants Stock return	(3) Homebuilding Stock return	(4) Household Products Stock return	(5) Personal Products Stock return
Exchange rate variance	−0.00262	0.0250	−0.00495	−0.0250**	−0.0333**
	(0.0102)	(0.0192)	(0.0262)	(0.0119)	(0.0138)
Russell 3000 return	1.403***	2.059***	1.382***	0.748***	0.770***
	(0.112)	(0.211)	(0.271)	(0.127)	(0.143)
Constant	−0.0931**	0.0941	0.117	0.104**	0.0585
	(0.0400)	(0.0733)	(0.0826)	(0.0408)	(0.0436)
Company Fixed Effect	Y	Y	Y	Y	Y
Time Fixed Effect	Y	Y	Y	Y	Y
Observations	369	215	102	235	153
Overall R-squared	0.493	0.505	0.524	0.300	0.419
Number of tick	10	5	2	5	3

Standard errors in parentheses.
***p < 0.01, **p < 0.05, *p < 0.1.

where FX volatility is the exchange rate volatility variable; FX skewness is the skewness of exchange rate returns, and FX kurtosis is the kurtosis of exchange rate returns. The coefficients of interest are γ_1, γ_2 and γ_3 as they capture the exposure to exchange rate volatility, skewness and kurtosis respectively.

4.2.1. Evidence from S&P500 portfolio of companies

Table 12 presents the panel fixed effect estimates of the effects of exchange rate volatility, exchange rate skewness and kurtosis on returns of the S&P500 portfolio. Column 1 is the simple specification that includes exchange rate volatility, skewness, kurtosis and market return. Column 2 includes the company-specific factors. Returns of the S&P500 portfolio still have a significant negative exposure to exchange rate variance. However, exchange rate skewness has a negative effect only when using the estimation model with company-specific factors and the effect is significant only at the 10% level. Exchange rate kurtosis is not statistically significant.

4.2.2. Exposure by sector

Table 13 presents the panel fixed effect estimates of the exposure to exchange rate volatility, skewness and kurtosis by S&P500 sectors. Exchange rate skewness has negative effects on the financial sector and the information technology sector. Its effect on information technology sector is most significant. Exchange rate kurtosis also has an effect only on the information and technology sector. The effect is positive but significant only at the 10% level. As for exchange rate volatility, it still has a significant negative effect on the consumer discretionary and consumer staples sector after controlling for skewness and kurtosis. It also has significant negative effect on the healthcare, industrial, and information technology sector thus robust.

4.2.3. Kurtosis exposure conditional on volatility exposure

We found above that, at the portfolio level, exposure to kurtosis is weak. However, kurtosis is a measure of the probability of extreme deviation from the mean and it is reasonable to expect that exchange rate kurtosis has a significant effect on a

Table 11
Volatility Exposure of Financial Sector Industries.

Variables	(1) Insurance Stock return	(2) Consumer Finance Stock return	(3) REITs Stock return	(4) Banks Stock return	(5) Diversified Financial Services Stock return
Exchange rate variance	−0.0260***	−0.0281*	−0.0613***	−0.0126	−0.0237**
	(0.00839)	(0.0169)	(0.00742)	(0.00814)	(0.00978)
Russell 3000 return	1.179***	1.298***	0.985***	1.264***	1.247***
	(0.0881)	(0.181)	(0.0767)	(0.0841)	(0.100)
Constant	−0.0134	0.0178	−0.0538**	−0.0277	−0.0408
	(0.0277)	(0.0593)	(0.0236)	(0.0256)	(0.0310)
Company Fixed Effect	Y	Y	Y	Y	Y
Time Fixed Effect	Y	Y	Y	Y	Y
Observations	842	179	815	866	318
Overall R-squared	0.392	0.462	0.447	0.369	0.548
Number of tick	17	4	16	17	7

Standard errors in parentheses.
***p < 0.01, **p < 0.05, *p < 0.1.

Table 12
Higher Moments of Exchange Rate on the S&P500 Portfolio.

Variables	(1) Stock return	(2) Stock return
Exchange rate variance (z)	−0.0118***	−0.0120***
	(0.0021)	(0.0014)
Exchange rate skewness (z)	−0.0026	−0.0043*
	(0.0019)	(0.0014)
Exchange rate kurtosis (z)	0.0003	0.0014
	(0.0012)	(0.0014)
Russell 3000 return	1.0853***	1.0032***
	(0.0418)	(0.0443)
EPS		(+)***
PE Ratio		(−)***
Account receivable turnover		(−)
Price-to-book ratio		(+)***
Long-term debt to equity		(+)*
Current ratio		(−)
Constant	0.0225***	0.0179**
	(0.0050)	(0.0059)
Company fixed effect	Y	Y
Time fixed effect	Y	Y
Cluster on	Sector	Sector
Observations	22,817	17,298
Overall R-squared[b]	0.3276	0.3347
Number of tick	497	414

Robust standard errors in parentheses.
Qualitative signs in parenthesis for controls.
***p < 0.01, **p < 0.05, *p < 0.1.
[b]The marginal gains in overall R-squared, AIC and BIC from a simple market and constant only are: For column (1): R-squared 0.00169176; AIC -60.29; BIC -60.29; For Column (2): R-squared 0.00673919; AIC 3174.97; BIC 3172.48. While these changes are marginal, here we emphasize that the t-stat of the slopes of the exchange rate moments

sample with significant volatility exposure. We estimate the kurtosis exposure of a sample of companies with statistically significant exposure to exchange rate volatility and then compare with a sample of companies without statistically significant exchange rate volatility exposure.

First, we measure the volatility exposure of all companies, by industry, in the S&P500 portfolio using the panel fixed effects model of expression (3). We then select two samples of companies, one that has statistically significant volatility exposure and one that does not have statistically significant volatility exposure. We then estimate the panel fixed effects model of expression (5) for the two alternative selected samples.[11]

Results are presented in Table 14. Column 1 shows the results using the sample with statistically significant volatility exposure and column 2 shows the results using the sample without significant volatility exposure. Kurtosis has a statistically significant negative effect on stock returns of the firms with significant volatility exposure and has no effect on the firms without volatility exposure. It suggests that exchange rate kurtosis impacts returns of companies that are exposed to exchange rate volatility, implying that volatility of the volatility matters.

5. Summary and conclusions

We examined the exposure of S&P500 company returns to higher moments of exchange rate returns. Those higher moments are the variance, skewness and kurtosis of the percentage change of U.S. dollar exchange rates. They describe the most important aspects of the probability distribution of exchange rates and thus can be used to better estimate economic exposure, considering that economic exposure is related to unexpected fluctuations in exchange rates.

When the variance of the U.S. exchange rate increases by one standard deviation from its mean, stock returns decrease by about 1.1–1.8%. In addition, the coefficient of the Russell 3000 returns is close to one indicating, as one might expect, that variability of the S&P500 companies is comparable to the Russell 3000. The negative effect of exchange rate volatility is robust to conditional heteroskedasticity specifications, and an alternative measure of volatility – the JP Morgan exchange rate volatility index.

Exchange rate volatility exposure by sector shows that it is most statistically significant and largest in magnitude for the consumer staples sector, then the consumer discretionary sector. Exchange rate volatility also has a significant effect on the healthcare sector, the industrial sector and the information technology sector. It does not have statistically significant effects on the energy, financials, materials, telecommunication and utilities sectors. Accounting for conditional heteroskedasticity

[11] Tables of panel estimates for each industry are available upon request.

Table 13
Higher Moments Exposures by Sector.

Variables	(1) Consumer discretionary Stock return	(2) Consumer staples Stock return	(3) Energy Stock return	(4) Financials Stock return	(5) Healthcare Stock return
Exchange rate var (z)	−0.0145***	−0.0168***	−0.0074	−0.0063	−0.0091*
	(0.0053)	(0.0045)	(0.0106)	(0.0067)	(0.0048)
Exchange rate skew (z)	−0.0049	−0.0040	0.0045	−0.0069*	−0.0011
	(0.0047)	(0.0031)	(0.0055)	(0.0034)	(0.0036)
Exchange rate kurt (z)	0.0033	−0.0010	−0.0029	0.0009	0.0039
	(0.0049)	(0.0031)	(0.0044)	(0.0035)	(0.0028)
Russell 3000 return	1.0086***	0.9175***	1.1597***	0.8283***	0.9186***
	(0.0716)	(0.0642)	(0.1350)	(0.0926)	(0.0668)
EPS	(+)	(+)*	(−)	(+)**	(+)*
PE Ratio	(+)	(+)	(+)	(+)	(−)
Account receivable turnover	(+)**	(+)	(−)	(−)	(−)***
Price-to-book ratio	(+)***	(+)	(+)*	(+)*	(−)
Long-term debt to equity	(+)	(+)	(+)	(+)	(+)**
Current ratio	(+)	(−)	(−)	(−)	(−)**
Constant	0.0253	−0.0034	−0.0110	0.0410	0.0163
	(0.0158)	(0.0163)	(0.0398)	(0.0290)	(0.0139)
Company fixed effect	Y	Y	Y	Y	Y
Time fixed effect	Y	Y	Y	Y	Y
Cluster on	Industry	Industry	industry	industry	industry
Observations	2174	2765	1231	1859	2497
Overall R-squared	0.3243	0.3402	0.3858	0.2943	0.3114
Number of tick	53	68	28	40	61

Variables	(6) Industrials Stock return	(7) Information technology Stock return	(8) Materials Stock return	(9) Tele-communication services Stock return	(10) Utilities Stock return
Exchange rate var (z)	−0.0103*	−0.0144**	−0.0084	−0.0218	−0.0098
	(0.0057)	(0.0054)	(0.0087)	(0.0152)	(0.0086)
Exchange rate skew (z)	−0.0021	−0.0171***	−0.0048	0.0054	−0.0010
	(0.0043)	(0.0039)	(0.0063)	(0.0079)	(0.0056)
Exchange rate kurt (z)	−0.0045	0.0081*	0.0012	0.0030	0.0033
	(0.0037)	(0.0041)	(0.0052)	(0.0095)	(0.0059)
Russell 3000 return	1.0980***	1.2208***	1.0598***	0.7234***	0.9614***
	(0.0868)	(0.0805)	(0.1203)	(0.1004)	(0.1269)
EPS	(+)***	(+)***	(+)	(−)	(+)
PE Ratio	(−)***	(+)	(+)*	(+)	(+)*
Account receivable turnover	(−)	(+)	(+)	(+)***	(−)**
Price-to-book ratio	(+)	(+)***	(+)	(−)	(+)**
Long-term debt to equity	(+)	(−)	(−)**	(−)	(+)*
Current ratio	(−)	(+)**	(+)	(−)	(−)
Constant	0.0063	−0.0078	−0.0305	0.0224	−0.0683
	(0.0246)	(0.0176)	(0.0399)	(0.0276)	(0.0582)
Company fixed effect	Y	Y	Y	Y	Y
Time fixed effect	Y	Y	Y	Y	Y
Cluster on	Industry	Industry	Industry	Industry	Industry
Observations	2179	2052	1036	608	897
Overall R-squared	0.3926	0.4133	0.3581	0.2616	0.3845
Number of tick	48	51	25	17	23

Robust standard errors in parentheses.
Qualitative signs in parenthesis for controls.
***p < 0.01, **p < 0.05, *p < 0.1.

makes the energy sector more vulnerable to exchange rate volatility exposure potentially due to currency mismatch of revenues and liabilities.

We find robust evidence that the consumer discretionary and the consumer staple sectors have more significant negative exposure to exchange rate volatility than the other sectors, thus supporting the hypothesis that exchange rate volatility affects stock returns through the channel of international operations. In terms of industries, the household products and personal products industries have statistically significant negative exposure as well.

We evaluate the financial sector exchange rate volatility exposure examining the exchange rate exposure of the five industries in the financial sector. Those industries are the insurance industries, including insurance broker, life & health insurance, multi-line Insurance, property and casualty insurance; consumer finance, real estate (REITs), banks, and diversified financial services industries. Companies in other sectors use the financial sector to hedge against exchange rate risks. The more volatile exchange rate, the more companies use financial products and services, thereby giving the financial sector

Table 14
Kurtosis Exposure of Samples with and without Volatility Exposure.

Variables	(1) Sample with volatility exposure Stock return	(2) Sample without volatility exposure Stock return
Exchange rate variance (z)	−0.0293***	−0.0021
	(0.00293)	(0.00212)
Exchange rate skewness (z)	0.00316	−0.0046**
	(0.00244)	(0.00238)
Exchange rate kurtosis (z)	−0.00594***	0.00326
	(0.00221)	(0.00219)
Russell 3000 return	0.9950***	1.0387***
	(0.0304)	(0.0719)
Constant	0.0157*	−0.0247**
	(0.00942)	(0.01043)
Firm fixed effect	Y	Y
Time fixed effect	Y	Y
Observations	6324	11888
Number of tick	134	292
Overall R-squared	0.342	0.326

Standard errors in parentheses.
***p < 0.01, **p < 0.05, *p < 0.1.

positive exposure to exchange rate volatility. Therefore, their negative exposure to exchange rate volatility as a result of currency dealing business and hedging costs is potentially offset by the positive gains from providing currency services. This provides support to the hypothesis that hedging activity can mitigate exposure to exchange rate volatility.

We find weak evidence that exchange rate skewness has an effect on S&P500 stock returns. But, we find evidence that exchange rate kurtosis affects returns of companies that are more exposed to exchange rate volatility.

An important caveat of our empirical analysis is that it is carried out based on measuring average effects of higher moments on the S&P500 firm returns directly with panel data methods via linear regressions. An alternative would be to sort portfolios based on the higher moment measures and price the risk of the higher moments using, for example, the Fama and MacBeth (1973) approach.[12] We leave this alternative for future research. In addition, further research to include a more general portfolio of worldwide companies and other measures of higher moments of multilateral and bilateral exchange rates seem a fruitful avenue for future research.

Appendix

List of Sectors and Industries

Consumer Discretionary	Consumer Staples	Energy	Financials	Health Care
1. Auto Components	1. Beverages	1. Energy Equipment & Services	1. Banks	1. Biotechnology
2. Automobiles	2. Food & Staples	2. Oil, Gas & Consumable Fuels	2. Capital Markets	2. Health Care
3. Distributors	3. Retailing		3. Consumer Finance	3. Equipment & Supplies
4. Diversified Consumer Services	4. Food Products		4. Diversified	4. Health Care Providers & Services
Hotels, Restaurants & Leisure	5. Household Products		5. Financial Services	5. Health Care Technology
5. Household Durables	6. Personal Products		6. Insurance	6. Life Sciences Tools & Services

[12] Basically, we are estimating average betas across entities and time with panel fixed effects. Rafferty (2012) follows the alternative approach allowing for variable risk pricing for the impact of exchange rate skewness, but on currency portfolios. More recently, Bianconi and Sammon (2017) provide a full analysis of the risk pricing of the first moment of changes in the exchange rate in a larger sample of companies and time following the cross-sectional pricing method.

Appendix (*continued*)

Consumer Discretionary	Consumer Staples	Energy	Financials	Health Care
6. Internet & Catalog Retail	7. Tobacco		7. Real Estate Investment Trusts (REITs)	7. Pharmaceuticals
7. Leisure Products			8. Real Estate Management & Development	
8. Media			Thrifts & Mortgage Finance	
9. Multiline Retail				
10. Specialty Retail				
11. Textiles, Apparel & Luxury Goods				
Industrials	**Information Technology**	**Materials**	**Telecommunication Services**	**Utilities**
1. Aerospace & Defense	1. Communications Equipment	1. Chemicals	1. Diversified Telecommunication Services	1. Electric Utilities
2. Air Freight & Logistics	2. Electronic Equipment, Instruments & Components	2. Construction	2. Wireless Telecommunication Services	2. Gas Utilities
3.Airlines	3. IT Services	3. Materials		3. Independent Power and Renewable Electricity Producers
4. Building Products	4. Internet Software & Services	4. Containers & Packaging		
5. Commercial Services & Supplies	5. Semiconductors & Semiconductor Equipment	5. Metals & Mining		4. Multi-Utilities
6. Construction & Engineering	6. Software Technology	6. Paper & Forest Products		
7. Electrical Equipment	7. Hardware, Storage & Peripherals			
8. Industrial Conglomerates				
9. Machinery				
10. Marine				
11. Professional Services				
12. Road & Rail				
13. Trading Companies & Distributors				
14. Transportation Infrastructure				

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