Risk of the Cross-Sectional Returns in Foreign Exchange Markets

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The cross-section of foreign exchange returns has substantial exposure to the risk captured by the market-wide moments. We investigate if the foreign exchange market risks are appropriately priced in exchange rates of individual countries. We use cross-sectional analysis to explore the correlation between the market-wide risks and risk premiums of foreign currencies. The results from analysis with the Fama and MacBeth regressions indicate that, while the market beta is negatively associated with the cross-sectional returns in foreign exchange markets, higher exposures to market-wide volatility, skewness, and kurtosis are positively related to individual countries' exchange-rate risk premiums. These results are robust in the empirical setup.

Keywords: cross-section, volatility, skewness, kurtosis, foreign exchange markets, market-wide moments

INTRODUCTION

In 1971, the collapse of pegged exchange rate system under the Bretton Woods agreement made many countries switch over to the free-rate exchange system, which in turn triggered the fluctuation and volatility of foreign exchange rates. To eliminate exchange risks associated with the exchange rate fluctuation, the U.S. Chicago Mercantile Exchange (CME) adopted the foreign currency futures transaction in May 1972. Despite this newly adopted transaction, the global foreign exchange market has witnessed ever-increasing volatility of foreign exchange rates, resulting in high exchange risks.

The exchange rate volatility has attracted a lot of attention from many areas. Real exchange depreciation is often found to precede sustained economic growth accelerations (Hausmann et al., 2005). The depreciation of the currency of a host country makes foreign companies acquire more firms in the host country (Blonigen, 1997) and attracts foreign direct investment (Kiyota and Urata, 2004). The financial effect of exchange rate fluctuations has been witnessed in stock price movements (Ma and Kao, 1990; Pan et al., 2007; Tsai, 2012; Wong, 2017). The agriculture industry is no exception. The sensitivity of agricultural prices to exchange rate movements is reported (Chambers and Just, 1981; Abbott et al., 2008; Gilbert, 2010). Economic agents are also subject to the influence of exchange rate movements. Flood and Lessard (1986) argue that the value of firms' assets has great exposure to exchange rate fluctuations. Firms engaged in international businesses are vulnerable to exchange rate risks – transaction risk, translation risk, and economic risk (Papaioannou, 2009).

Another group of economic agents largely affected by foreign currency volatility is international investors. An investment denominated in a strong currency is more likely to deliver a higher rate of return (Ma and Kao, 1990). Mun (2008) argues that the volatility of U.S. stock markets partially results from the exchange rate fluctuations and shows a positive correlation between the U.S. market returns and local currency values. Using data from Turkish banks, Kasman, Vardar, and Tunç (2011) find that the exchange rate volatility significantly and negatively affects stock returns.

Given that exchange rate movements have a tremendous impact on many areas, it is natural that exchange rate forecasting has been a popular research subject in international finance. Researchers have made many attempts to forecast future spot exchange rates. One of these attempts is related to the unbiased forward rate hypothesis (UFRH) that is under the assumption of rational expectation and risk neutrality. However, the attempt has produced mixed results. This disagreement suggests that, in estimating future exchange rates, researchers need to consider a risk premium whose nature is in effect an ex post facto variable. Therefore, scholars explore historical exchange rate returns to estimate the risk premium. But, the returns are widely known to be asymmetrically distributed.

While many scholars examine the relationship between market-wide risks and stock performances, there are few studies on how foreign exchange market-wide risks affect cross-sectional returns of individual foreign currencies. Hence, our study aims to investigate if the market-wide volatility, skewness, and kurtosis would be risk factors in the cross-section of foreign exchange returns, rather than to forecast future exchange rates. Applying the methodology of Chang, Christoffersen, and Jacobs (2013), we analyze relations between individual countries' exchange rate risk premium and moments of market returns. Our empirical results show that currencies with high exposure to volatility, skewness, and kurtosis exhibit higher returns on average. Excess returns on the market are negatively related to the excess returns on foreign currencies. The relationship is statistically significant. These findings suggest that economic agents such as multinational corporations and international investors should consider market-wide risk to reduce the exposure to exchange rate fluctuations.

Our work contributes to the literature focusing on the cross-sectional relationships between higher moments capturing market-wide risks and exchange returns. To our best knowledge, the present study is the first empirical research using the Capital Asset Pricing Model with additional risk factors to investigate if the risk factors are priced. Additionally, given that the forward exchange rate is the best prediction of future exchange rates, the present study incorporates the forward rates into our empirical research application.

The remainder of this paper is structured as follows: In section 2, we provide a brief review of some related literature, followed by Section 3 on the data sources and research design. The economic relevance of our results is tested in Section 4. And, Section 5 concludes this paper.

LITERATURE REVIEW

There is substantial empirical research investigating if the forward exchange rate has explanatory power in forecasting future rates. To do so, earlier studies in international finance literature use many theoretical models based on the UFRH. This hypothesis is under the assumption that rational expectation and risk neutrality must be held in the efficient market hypothesis. The earliest study (Cornell, 1977) using the UFRH argues that the forward rate is an unbiased predictor of the future spot rates because all the available information related to the future exchange rate is captured in the forward rate (Kohlhagen, 1979; Levich, 1979; Frenkel, 1980). However, other studies (Bilson, 1980; Fama, 1984; Chiang and Chiang, 1987) reject the UFRH, saying that the forward rate has little power to predict future rates. The mixed results are suggestive that the economic agents are risk-averse, not risk-neutral. Because of the risk-averse tendency, researchers need to consider risk premiums when estimating unbiased future spot rates.

In the finance discipline, research on the relation between stock market risks (or volatility) and equity risk premiums is an integral part of various asset pricing theories such as the Capital Asset Pricing Model (henceforth CAPM) and Intertemporal CAPM (henceforth ICAPM). Due to the nature of a risk premium, which is in effect an ex post facto variable, scholars explore historical returns to identify variables capturing the risk and to measure the risk premium. According to the ICAPM (Merton, 1973), risks and risk premiums are expected to have a positive association. However, many prior studies document conflicting results. For instance, some scholars (French *et al.*, 1987; Campbell and Hentschel, 1992) present empirical findings that the predictable volatility of stock returns is positively associated with the expected market risk premium while others (Fama and Schwert, 1977; Campbell, 1987; Breen *et al.*, 1989; Turner *et al.*, 1989; Glosten *et al.*, 1993) report the negative relationship between the risk and the risk premium.

The correlation between risk and return in the foreign exchange markets has also been rigorously studied. However, the presence of the time-dependent risk premium makes the task to unweave the link between investor rationality and equilibrium price harder. Yet, many scholars tried to accomplish this difficult task with the unbiased estimate hypothesis, which later results in disagreement among many academic researchers and practitioners. Perhaps, the major attribution to the mixed results is the assumption of normal distribution. From a statistical perspective, the normality assumption even with the presence of non-normality might lead to inefficient parameter estimates. The asymmetric distribution has been reported in many studies and is known to be related to currency returns. Bakshi et al. (2008) and Johnson (2002) report that the distribution of currency returns exhibits skewness, which is highly related to the risk premium (Carr and Wu, 2007). Furthermore, Khademalomoom and Narayan (2019) present the evidence that the other type of significant deviation from the return normality (i.e. kurtosis) plays an important role in understanding exchange rate behavior and its return.

DATA AND ANALYTICAL FRAMEWORK

This study aims to investigate the influence of market risks on individual countries' nominal exchange rates. To this end, we collect 20 countries' daily spot rates and one-month forward rates from Bloomberg. The selection of 20 nations is based on the exchange rate regime, which is a free-floating exchange rate system. Our study also uses the broad US dollar nominal effective exchange rate (NEER) collected from the Bank for International Settlements (bis.org). Our sample period starts from 2005 to 2019.

Following Chang, Christoffersen, and Jacobs (2013), we employ the CAPM with additional variables as the market-wide risk proxies. To be specific, the risk premiums are individual countries' daily returns, using daily spot exchange rates, minus risk-free interests (R_i - R_f). Likewise, we find the market beta values with the US NEER rate monthly returns minus its risk-free interests (R_m - R_f). To maintain the consistency of risk-free interests, our study uses the USD one-month T-bill rates. As the market-wide risks, Chang, Christoffersen, and Jacobs (2013) use prices of the Standard and Poor's 500 index options with 30 days maturity and the underlying asset at time t to compute daily volatility, skewness, and kurtosis. To imitate their approach, we use daily spot rates and one-month forward rates reported on the same date when spot rates are available because 20 countries' daily currency options are not available to us. The present study uses forward returns, that is $FR_t = \ln(Forward\ rate_t) - \ln\ (Spot\ rate_t)$, on each date for each country and finds daily volatility, skewness, and kurtosis using twenty forward returns on each date across twenty foreign currencies.

To test expected returns with the moments of foreign exchange market returns, namely, volatility, skewness, and kurtosis, we use two strategies. The first strategy is based on univariate sort using each model of the following:

$$R_{i,t} - R_{f,t} = \beta_0^i + \beta_{MKT}^i\left(R_{m,t} - R_{f,t}\right) + \beta_{\Delta VOL}^i \Delta VOL_t + \varepsilon_{i,t} \quad (1)$$

$$R_{i,t} - R_{f,t} = \beta_0^i + \beta_{MKT}^i\left(R_{m,t} - R_{f,t}\right) + \beta_{\Delta SKE}^i \Delta SKE_t + \varepsilon_{i,t} \quad (2)$$

$$R_{i,t} - R_{f,t} = \beta_0^i + \beta_{MKT}^i\left(R_{m,t} - R_{f,t}\right) + \beta_{\Delta KUR}^i \Delta KUR_t + \varepsilon_{i,t} \quad (3)$$

where $R_{i,t}$, $R_{m,t}$, and $R_{f,t}$ are the rates of return on the currency of *i* country at date *t*, the rates on the SDR at date *t*, and the one-month risk-free rate, respectively. At the end of each month, we run one of the above economic models on the daily returns of each foreign currency during that month to estimate its exposure to ΔVOL, ΔSKW, or ΔKUR. Then, we sort the foreign currencies into quintiles based on their regression coefficients, $\beta_{\Delta VOL}$, $\beta_{\Delta SKW}$, or $\beta_{\Delta KUR}$. For example, Quintiles 1 and 5 contain foreign currencies with the lowest factor loading and the highest factor loading, respectively. Additionally, ΔVOL_t, ΔSKE_t, and ΔKUR_t are the residuals from fitting an ARMA to the time series of moments.

The second strategy is based on multivariate sorts using each model of the following:

$$R_{i,t} - R_{f,t} = \beta_0^i + \beta_{MKT}^i(R_{m,t} - R_{f,t}) + \beta_{\Delta VOL}^i \Delta VOL_t + \beta_{\Delta SKE}^i \Delta SKE_t + \beta_{\Delta KUR}^i \Delta KUR_t + \varepsilon_{i,t} \quad (4)$$

At the end of each month, we run Equation (4) on the daily returns of each foreign currency during that month to estimate its exposure to ΔVOL, ΔSKW, and ΔKUR. Then, we sort the foreign currencies into quintiles based on their regression coefficients, β_{MKT}, $\beta_{\Delta VOL}$, $\beta_{\Delta SKW}$, and $\beta_{\Delta KUR}$.

A widely known relationship between volatility and returns in the equity market is that stock returns are negatively related to volatility. On the other hand, the relation between volatility and the foreign exchange market currencies returns is not clearly supported by previous studies. While Theodossiou (1994) argues that the impact of volatility on the returns is insignificant, others (McKenzie, 2002; Wang and Yang, 2009) show a negative relationship. Additionally, Jiang and Chiang (2010) argue that excess returns from foreign currencies are compensation for taking additional risk, that is volatility, implying a positive correlation. Therefore, our expectation relies on an empirical result.

The foreign exchange market has unique characteristics. It usually has huge volumes with low transaction costs (Menkhoff et al., 2012a), and its participants are usually sophisticated institutional investors. Furthermore, unlike equity markets, trading currencies in the foreign exchange market has two sides: buying a currency is selling another currency. Jiang, Han, and Yin (2018) argue that skewness and a currency's returns are positively related because investors in the foreign exchange market have value functions. Overvalued currencies with positive skewness tend to decline in the future, resulting in appreciation. Hence, investors will realize gains from buying these currencies, and gains will increase. Therefore, our study expects to find a positive relationship between the market-wide skewness and currencies' returns.

Lastly, when using kurtosis as the market-wide pricing factor, theory and past studies don't provide much guidance regarding the relationship between returns and kurtosis. Therefore, we rely on our empirical analysis.

EMPIRICAL RESULTS

In this section, we provide descriptive statistics along with results from the autoregressive moving average model. Using the risk factors, we examine how individual countries' exchange rate risk premiums $(R_{i,t} - R_{f,t})$ are related to the independent variables: market risk premium $(R_{m,t} - R_{f,t})$, ΔVOL_t, ΔSKE_t, and ΔKUR_t.

Time-Series Data

Table 1 provides descriptive statistics by country used in our study and by year from our sample period. Based on the information in Table 1, average returns from each foreign currency are very close to zero, while minimum and maximum returns are significantly low or high compared to the average. During our sample period, exchange rate returns with Turkey currency are highest (0.0383%), and the U.K. has the lowest average returns (-0.0126%).

TABLE 1
RETURNS BY COUNTRY AND BY YEAR

Panel A. Statistic by country

Nation	Mean	Median	Minimum	Maximum
Australia	-0.002	0	-3.254	3.9981
Canada	-0.0043	0.0102	-19.3834	9.0889
Denmark	-0.0049	0	-2.4339	3.4506
European Nation	0.0095	0.0066	-3.0009	8.3955
Hungary	-0.0058	-0.008	-2.678	2.9979
Israel	0.0015	0.0086	-3.782	5.5043
Japan	0.0028	-0.0058	-13.2361	10.2588
Mexico	0.0095	0.007	-4.971	4.8683
New Zealand	0.0016	-0.0145	-4.3243	6.7398
Norway	-0.0027	-0.0066	-1.8057	1.6778
Philippines	0.006	-0.0158	-6.5492	5.1655
Poland	0.0207	0.0004	-9.7707	9.7315
Russia	-0.0027	0.0257	-7.2937	8.2766
South Africa	0.0233	-0.0168	-6.6299	15.4965
South Korea	0.0136	-0.0188	-6.6527	7.9766
Sweden	0.0088	0.0023	-4.9791	4.2227
Switzerland	0.005	-0.0021	-3.4991	2.4358
Thailand	-0.007	-0.0058	-3.174	3.8132
Turkey	0.0383	-0.0056	-8.0685	14.7426
U.K.	-0.0126	0	-6.8649	5.4984

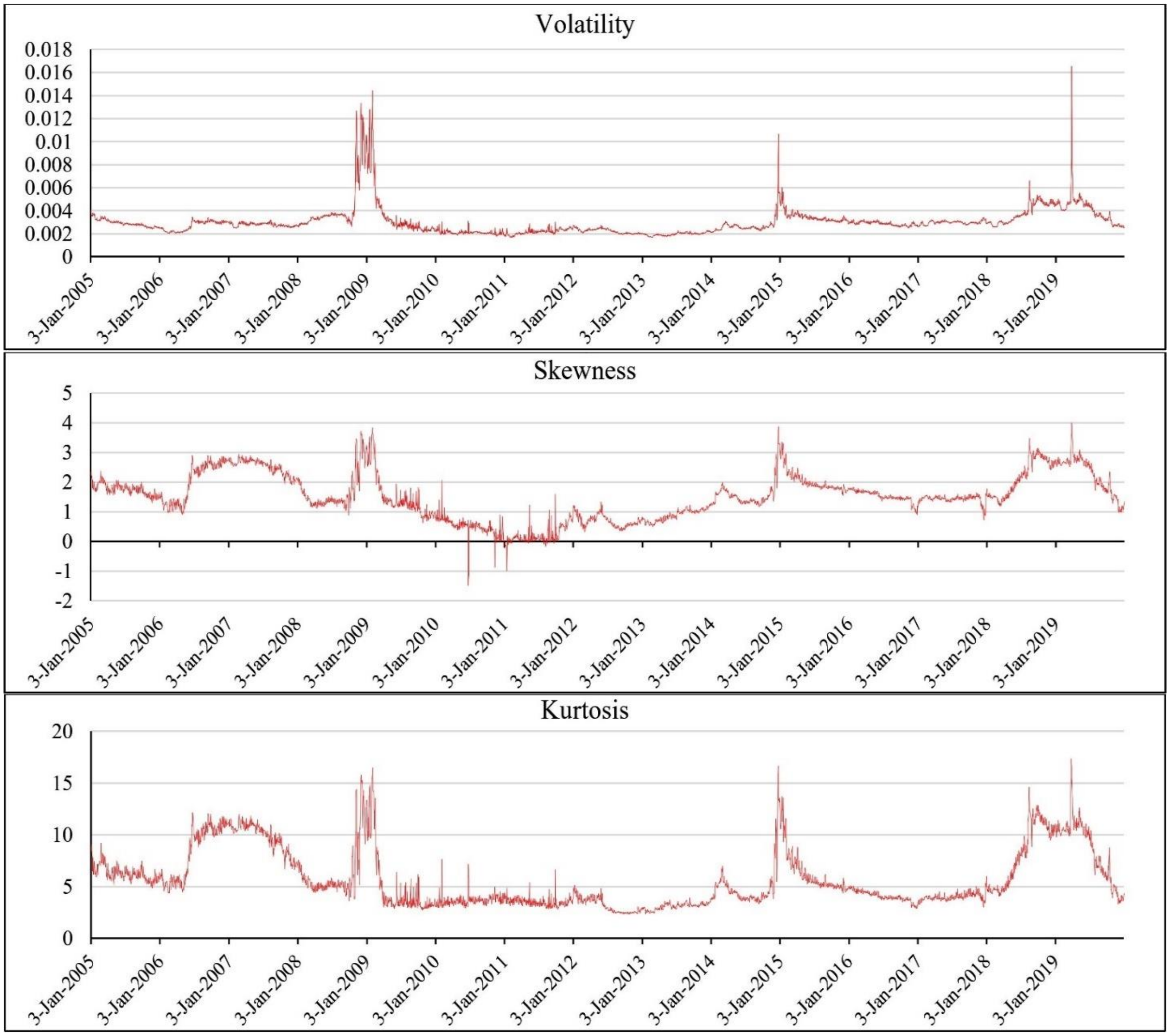
Panel B. Statistic by year

Year	Mean	Median	Minimum	Maximum
2005	0.0143	0.0114	-2.8258	3.362
2006	-0.0132	-0.0129	-3.3374	4.7015
2007	-0.0167	-0.0174	-4.0059	4.4116
2008	0.0369	0.0183	-13.2361	15.4965
2009	-0.0133	-0.0176	-4.4486	5.1854
2010	-0.0116	-0.0323	-4.2426	4.2799
2011	0.0135	-0.0124	-4.6217	9.0889
2012	-0.0086	-0.0077	-2.9297	3.2841
2013	0.0108	0	-2.8032	3.8234
2014	0.0303	0.0178	-9.7707	9.7315
2015	0.0242	0.0247	-19.3834	7.1881
2016	0.0083	0	-5.4012	8.3955
2017	-0.0139	-0.0222	-3.0997	2.4415
2018	0.0164	0	-8.0685	14.7426
2019	-0.0039	0	-4.0914	5.2379

This table presents average, median, minimum, and maximum of returns. Panel A provides the statistics by country in our sample and Panel B provides the statistics by year. Returns are calculated daily using $R_t = \ln(Spot\ rate_t) - \ln\ (Spot\ rate_{t-1})$. Values are in %.

Figure 1 shows daily volatility, skewness, and kurtosis values computed using daily forward returns during our sample period. Based on the volatility graph, it is noticed that the Global Financial Crisis (2008-2009) greatly affects foreign exchange markets. Also, skewness and kurtosis graphs inform us that, during our sample period, most of the currencies used in our sample face lower returns than the average. Furthermore, the distribution of exchange returns shows heavier tails and sharper peaks.

FIGURE 1
DAILY VOLATILITY, SKEWNESS, AND KURTOSIS



The volatility, skewness, and kurtosis are the daily values calculated based on daily forward returns $(FR_t = \ln(Forward\ rate_t) - \ln\ (Spot\ rate_t)$. Each exchange rate has the USD currency as a base currency.

Table 2 summarizes the results from an appropriate model, ARMA(1,1), to the time series for volatility, skewness, and kurtosis. Due to the nature of the time series data, we conduct the Dickey and Fuller (1979) test to find if the data has a unit root. Based on the MacKinnon p-values which are all equal to zero, we reject the null hypothesis and conclude that the moments are generated by a stationary process. The choice of lag order (p = 1, q = 1) in the model is based on the autocorrelation functions of the original moments data presented in Figure 2.

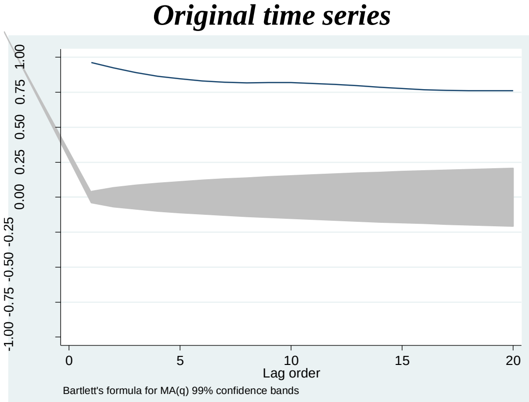
TABLE 2
DAILY RISK FACTORS

	Constant Parameter	AR(1) Parameter	MA(1) Parameter	Sigma Parameter	Correlation	ΔVOL	ΔSKE	ΔKUR
Volatility	0.003	0.966	-0.0036	0.0003	ΔVOL			
Skewness	1.529	0.992	-0.336	0.143	ΔSKE	0.4894		
Kurtosis	5.695	0.986	-0.119	0.532	ΔKUR	0.6185	0.7672	
					R_m - R_f	-0.0151	-0.0103	-0.0298

This table presents results from ARMA(1,1) and correlations between main risk factors.

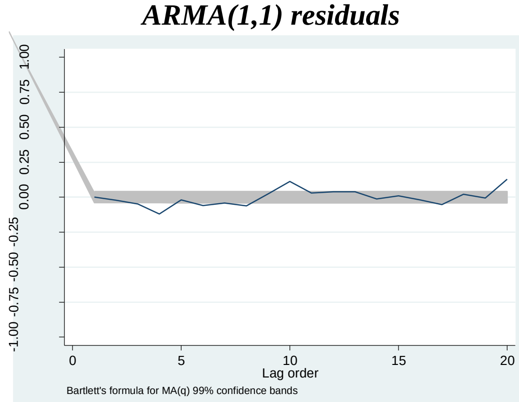
FIGURE 2
CORRELOGRAM OF AUTOCORRELATION

Original time series



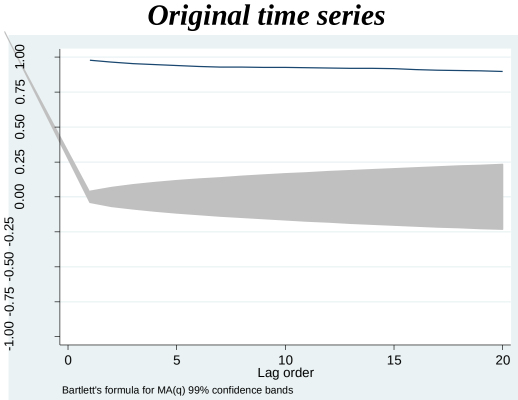
Volatility

ARMA(1,1) residuals



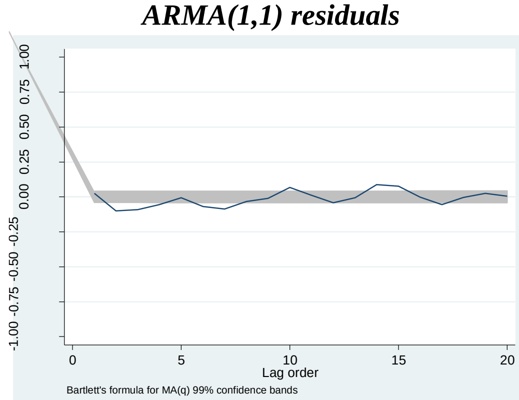
Volatility

Original time series



Skewness

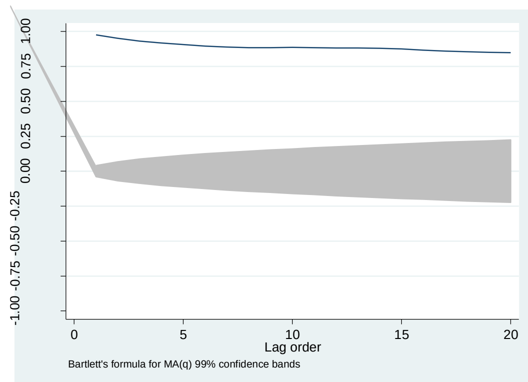
ARMA(1,1) residuals



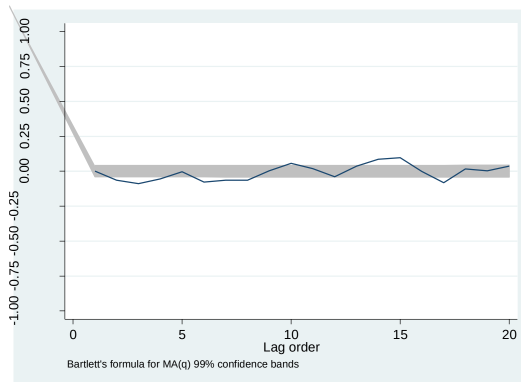
Skewness

Original time series

ARMA(1,1) residuals



Kurtosis



Kurtosis

This figure provides sample autocorrelations of the original time series.

Portfolios Sorted on Each Loading

Table 3 presents averages of alpha, returns, and coefficients of market-wide risk factors. We run Equation (1) – (3) on the daily returns of individual foreign currency at the end of each rolling one-month to estimate betas. Then, at the end of the beta estimation period, we sort the individual foreign currencies into quintiles based on their regression coefficients on ΔVOL, ΔSKE, or ΔKUR. We build an equally weighted quintile portfolio. After forming quintile portfolios, we compute daily post-ranking returns for each quintile portfolio during the one-month period following the estimation period.

TABLE 3
PORTFOLIOS SORTED ON EACH HOLDING: UNIVARIATE

Sorting statistic		Quintile portfolio				
		1	2	3	4	5
Sorting on ΔVOL	Average Alpha	-0.1166***	-0.0986***	-0.0974***	-0.0896***	-0.0911***
		(-7.2471)	(-9.2782)	(-8.9837)	(-7.6486)	(-5.4231)
	Average Return	-0.1371***	-0.1418***	-0.1352***	-0.1320***	-0.1188***
		(-8.7349)	(-9.7044)	(-9.9127)	(-9.5551)	(-9.4137)
	Average $\beta_{\Delta VOL}$	-0.2924***	-0.1087***	-0.0169***	0.0637***	0.2041***
		(-17.7443)	(-14.0147)	(-2.8479)	(8.7569)	(17.2202)
Sorting on ΔSKE	Average Alpha	-0.1129***	-0.0981***	-0.0947***	-0.0874***	-0.1025***
		(-7.0384)	(-8.5513)	(-9.0873)	(-7.2343)	(-6.8091)
	Average Return	-0.1367***	-0.1217***	-0.1327***	-0.1320***	-0.1416***
		(-9.1856)	(-8.3194)	(-10.0543)	(-9.029)	(-9.9147)
	Average $\beta_{\Delta SKE}$	-0.0279***	-0.0109***	-0.0014**	0.0067***	0.0208***
		(-14.6336)	(-12.0026)	(-2.1277)	(8.6762)	(16.4963)
Sorting on ΔKURL	Average Alpha	-0.1230***	-0.1043***	-0.0921***	-0.0833***	-0.0813***
		(-8.2705)	(-9.5726)	(-8.6829)	(-6.4357)	(-5.1044)
	Average Return	-0.1395***	-0.1298***	-0.1320***	-0.1228***	-0.1407***
		(-8.9538)	(-9.4169)	(-9.6506)	(-8.3884)	(-10.0194)
	Average $\beta_{\Delta KUR}$	-0.0075***	-0.0023***	0.0003	0.0027***	0.0078***
		(-15.1661)	(-9.895)	(1.2996)	(9.7413)	(13.823)

At the end of each rolling one-month, we run the following regressions on the daily return of spot rate: $R_{i,t} - R_{f,t} = \beta_0^i + \beta_{MKT}^i(R_{m,t} - R_{f,t}) + \beta_{\Delta K}^i \Delta K_t + \varepsilon_{i,t}$ where ΔK is ΔVOL, ΔSKE, or ΔKUR. Then, at the end of the beta estimation period, we sort the individual foreign currencies into quintiles based on their regression coefficients on ΔVOL, ΔSKE, or ΔKUR. We build an equally weighted quintile portfolio. After forming quintile portfolios, we compute daily post-ranking returns for each quintile portfolio during the one-month period following the estimation period. The table provides the average alphas (monthly alpha in %), pre-ranking βs, and post-ranking return (monthly return in %). The *t*-statistics are reported in parenthesis. The ***, **, and * refer to statistical significance at 1%, 5%, and 10%, respectively.

Even though we don't detect the monotonic pattern across quintiles, extreme quintiles (1 and 5) show that excess returns in Quintile 5 (-0.1188%) are greater than Quintile 1 (-0.1371%) with ΔVOL. On the other hand, a comparison between extreme quintiles (1 and 5) of portfolios with univariate sort on ΔSKE or ΔKUR shows that portfolios with larger betas have lower returns. While Quintile 1 portfolios sorted on $\beta_{\Delta SKE}$ and $\beta_{\Delta KUE}$ have -0.1367% and -0.1395%, Quintile 5 portfolios have -0.1416% and -0.1407%, respectively. All the estimations are significant at a 90% confidence level, at least.

Next, we use the multivariate regression model, Equation (4), to estimate loadings on ΔVOL, ΔSKE, and ΔKUR. But, portfolios are sorted on each coefficient on ΔVOL, ΔSKE, or ΔKUR. We follow the same portfolio formation described earlier. The results are provided in Table 4. Like univariate investigations provided in Table 3, Multivariate regression results don't show any monotonic pattern across quintiles. Nonetheless, we conclude that, based on the comparison of extreme quintiles with both univariate and multivariate economic models, the excess returns ($R_{i,t} - R_{f,t}$) of foreign currencies in portfolios sorted on $\beta_{\Delta VOL}$ are negatively associated with the market-wide volatility (ΔVOL). And, those in portfolios sorted on $\beta_{\Delta SKE}$ and $\beta_{\Delta KUR}$ appear to have negative relationships with the market-wide risks (ΔSKE and ΔKUR).

TABLE 4
PORTFOLIOS SORTED ON EACH LOADING: MULTIVARIATE

Sorting statistic		Quintile portfolio 1	2	3	4	5
Sorting on ΔVOL	Average Alpha	-0.1181***	-0.0980***	-0.1088***	-0.0865***	-0.0861***
		(-6.3114)	(-7.5236)	(-7.9723)	(-6.6258)	(-4.461)
	Average Return	-0.1387***	-0.1269***	-0.1203***	-0.1169***	-0.1199***
		(-9.4557)	(-9.1039)	(-8.8203)	(-8.6736)	(-8.3381)
	Average $\beta_{\Delta \text{VOL}}$	-0.4305***	-0.1632***	-0.0085	0.1491***	0.4038***
		(-15.5859)	(-11.467)	(-0.7731)	(11.0256)	(17.2815)
Sorting on ΔSKE	Average Alpha	-0.0784***	-0.0945***	-0.1131***	-0.1039***	-0.1381***
		(-3.8564)	(-7.1183)	(-8.7042)	(-7.5818)	(-7.739)
	Average Return	-0.1082***	-0.1247***	-0.1337***	-0.1305***	-0.1386***
		(-7.406)	(-8.9528)	(-10.0736)	(-9.7824)	(-8.9237)
	Average $\beta_{\Delta \text{SKE}}$	-0.0705***	-0.0229***	0.0054***	0.0386***	0.0943***
		(-10.6135)	(-7.5718)	(2.6075)	(11.7762)	(13.6544)
Sorting on ΔKURL	Average Alpha	-0.1476***	-0.1141***	-0.0945***	-0.0800***	-0.0522***
		(-9.4454)	(-8.9129)	(-7.1927)	(-5.0931)	(-2.4432)
	Average Return	-0.1399***	-0.1295***	-0.1291***	-0.1149***	-0.1180***
		(-9.3613)	(-9.8414)	(-9.2978)	(-8.1311)	(-7.3067)
	Average $\beta_{\Delta \text{KUR}}$	-0.0185***	-0.0054***	0.0019***	0.0095***	0.0256***
		(-16.6632)	(-9.5465)	(3.32)	(12.0679)	(13.7566)

At the end of each rolling one-month, we run the following regressions on the daily return of spot rate: $R_{i,t} - R_{i,t} - R_{f,t} = \beta_0^i + \beta_{MKT}^i(R_{m,t} - R_{f,t}) + \beta_{\Delta VOL}^i \Delta VOL_t + \beta_{\Delta SKE}^i \Delta SKE_t + \beta_{\Delta KUR}^i \Delta KUR_t + \varepsilon_{i,t}$.

Then, at the end of the beta estimation period, we sort the individual foreign currencies into quintiles based on their regression coefficients on ΔVOL, ΔSKE, or ΔKUR. We build an equally weighted quintile portfolio. After forming quintile portfolios, we compute daily post-ranking returns for each quintile portfolio during the one-month period following the estimation period. The table provides the average alphas (monthly alpha in %), pre-ranking βs, and post-ranking return (monthly return in %). The *t*-statistics are reported in parenthesis. The ***, **, and * refer to statistical significance at 1%, 5%, and 10%, respectively.

Portfolios Sorted on Multiple Loadings

Based on the results in Table 4, we conclude that the cross-sectional risks, which are the market-wide volatility, skewness, and kurtosis, are priced risk factors. To investigate further, we apply the two-pass regressions of Fama and MacBeth (1973). In the first stage, we run Equation (4) on the daily returns of individual foreign currency at the end of each rolling one-month to estimate betas. Then, at the end of the beta estimation period, the individual foreign currencies are included in 16 portfolios based on their regression coefficients on $R_{m,t} - R_{f,t}$, ΔVOL, ΔSKE, and ΔKUR, quadruple sorting (2×2×2×2). In the second stage, we run the cross-sectional regression of excess returns on the 16 portfolios on the estimated betas by using the following:

$$R_{i,t} - R_{f,t} = \lambda_0 + \widehat{\beta_i}\lambda_t + \alpha_{i,t} \tag{5}$$

where $\widehat{\beta_i}$ is a vector of the coefficients estimated on the first step, $\widehat{\beta_i} \equiv [\beta_{MKT}^i, \beta_{\Delta VOL}^i, \beta_{\Delta SKE}^i, \beta_{\Delta KUR}^i]'$. In the second stage, we estimate the vector of $\widehat{\lambda_t} \equiv [\lambda_{t,MKT}, \lambda_{t,\Delta VOL}, \lambda_{t,\Delta SKE}, \lambda_{t,\Delta KUR}]'$. We repeat the procedure by rolling the best estimation window by one month.

We consider several different specifications controlling for pricing factors: $R_{m,t} - R_{f,t}$, ΔVOL, ΔSKE, and ΔKUR. We compare the performance of models including (1) $R_{m,t} - R_{f,t}$, (2) $R_{m,t} - R_{f,t}$ and ΔVOL, (3) $R_{m,t} - R_{f,t}$ and ΔSKE, (4) $R_{m,t} - R_{f,t}$ and ΔKUR, (5) $R_{m,t} - R_{f,t}$, ΔVOL, and ΔSKE, (6) $R_{m,t} - R_{f,t}$, ΔVOL, and ΔKUR, (7) $R_{m,t} - R_{f,t}$, ΔSKE, and ΔKUR, and (8) $R_{m,t} - R_{f,t}$, ΔVOL, ΔSKE, and ΔKUR. Table 5 summarizes our empirical results.

TABLE 5
PORTFOLIOS SORTED ON MULTIPLE LOADINGS: QUADRUPLE SORTING

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Constant	0.0014***	0.0014**	0.0015**	-0.0014**	-0.0013**	-0.0005	0.0013**	-0.001**
	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.00052)	(0.0009)	(0.0005)	(0.0004)
β_{MKT}	-0.0002**	0.0005**	-0.0003	-0.0002	-0.00007	-0.0004	0.0006**	0.0012**
	(0.0001)	(0.0002)	(0.0002)	(0.0001)	(0.0005)	(0.0003)	(0.0003)	(0.0005)
$\beta_{\Delta\text{VOL}}$		0.0011*			.00593*	0.0099		0.0106**
		(0.0005)			(0.00354)	(0.0064)		(0.0052)
$\beta_{\Delta\text{SKE}}$			0.0069*		0.03264		0.0064	0.0406*
			(0.0035)		(0.02322)		(0.0068)	(0.0204)
$\beta_{\Delta\text{KUR}}$				-0.0152*		-0.1876	-0.0001	0.1293*
				(-0.0089)		(0.1345)	(0.0118)	(0.0771)
Observations	388	388	388	388	388	388	388	388
Adj R^2	0.0207	0.1309	0.0478	0.0523	0.1633	0.2017	0.1848	0.2627

For each model considered, we estimate the prices of risk βs by applying the two-pass regression procedure of Fama and MacBeth (1973) to the post-ranking returns of portfolios sorted on exposures to $R_{m,t} - R_{f,t}$, ΔVOL, ΔSKE, and ΔKUR. In the first stage, we estimate betas by running a time series regression of one month of daily returns on the factor of $R_{m,t} - R_{f,t}$, ΔVOL, ΔSKE, and ΔKUR by using $R_{i,t} - R_{f,t} = \beta_0^i + \beta_{MKT}^i(R_{m,t} - R_{f,t}) + \beta_{\Delta VOL}^i \Delta VOL_t + \beta_{\Delta SKE}^i \Delta SKE_t + \beta_{\Delta KUR}^i \Delta KUR_t + \varepsilon_{i,t}$. We then run the cross-sectional regression on next month's returns by using $R_{i,t} - R_{f,t} = \lambda_0 + \widehat{\beta_\iota}\lambda_t + \alpha_{i,t}$ where $\widehat{\beta_\iota} \equiv [\beta_{MKT}^i, \beta_{\Delta VOL}^i, \beta_{\Delta SKE}^i, \beta_{\Delta KUR}^i]'$ and $\widehat{\lambda_t} \equiv [\lambda_{t,MKT}, \lambda_{t,\Delta VOL}, \lambda_{t,\Delta SKE}, \lambda_{t,\Delta KUR}]'$. We repeat the procedure by rolling the beta estimation window by one month. The Newey and West *t*-statistics with 22 lags are reported in parenthesis. The ***, **, and * refer to statistical significance at 1%, 5%, and 10%, respectively.

Even though not all the estimates from the Fama and MacBeth regressions are significant, the results show consistent signs regarding the prices of market-wide risks; $\beta_{\Delta VOL}$, $\beta_{\Delta VOL}$, and $\beta_{\Delta VOL}$. The signs are sharply contrasted with the results from Tables 3 and 4. Models 1 ~ 8 in Table 5 show that all the market-wide risks are positively priced. The signs remain even with including different pricing factors.

CONCLUSIONS

The present study analyzes relations between individual countries' exchange rate risk premium, ($R_{i,t} - R_{f,t}$), and market risk premium, ($R_{m,t} - R_{f,t}$), with other cross-sectional risks. We use moments of forward-looking market performance that are computed using daily forward returns across twenty nations, $FR_t = \ln(Forward\ rate_t) - \ln(Spot\ rate_t)$. Because of the time-series characteristics of the market-wide moments, we use an autoregressive moving average model to estimate innovations in the moments, which are the residuals of volatility, skewness, and kurtosis from fitting an ARMA(1,1).

Using the Fama and MacBeth regression as our main investigation, we study the market-wide risks on cross-sectional returns in foreign exchange markets. The present study presents evidence that foreign currencies with higher exposure to innovations in market volatility exhibit low returns. On the other hand, foreign currencies with higher exposure to innovations in market skewness and kurtosis provide higher returns on average. These findings are statistically significant, and the directions of correlations are robust.

To summarize, our findings suggest that foreign exchange markets reward investors for having additional risk across the market. And market participants appear to realize higher returns by utilizing value functions. The present paper uses one-month forward rates to mimic the approach used in equity markets because we are constrained by the data availability. With a better database, we could exploit major currencies with their foreign exchange option information, which will enable us to study in more detail the impact of market-wide risks on cross-sectional returns.

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