NORTHERN ARIZONA UNIVERSITY
The W. A. Franke College of Business

Does Exchange Rate Risk Matter for Asset Pricing?

Working Paper Series—10-01 | January 2010

Ding Du
Northern Arizona University
The W. A. Franke College of Business

PO Box 15066
Flagstaff, AZ 86011.5066

ding.du@nau.edu

(928) 523-7274
Fax: (928) 523-7331

Does Exchange Rate Risk Matter for Asset Pricing?

1. Introduction

Financial economists generally believe that exchange rate risk should matter for asset pricing. That is, stock returns should be sensitive to exchange rate movements, and exchange rate risk should be a priced factor. Adler and Dumas (1984) argue that "U.S. corporations, including those with no foreign operations and no foreign currency assets, liabilities, or transactions, are generally exposed to foreign currency risk." (p 41) Foreign exchange exposure can be due to direct effects of exchange rate movements on firms' cash flows (through its influence on the demand for firms' goods/services or the cost of imported capital and other imported inputs), and its indirect effects (through foreign competition and competition for factors of production between traded and non-traded sectors).[1] Solnik (1974), Sercu (1980), and Adler and Dumas (1983) develop the International Capital Asset Pricing Model (ICAPM) in which exchange rate risk is a priced factor.

Nevertheless, empirical studies usually find that only low proportions of U.S. firms have significant exchange rate exposure, and exchange rate risk is not priced. For instance, Choi and Prasad (1995) find that only 14.9% of the individual firms and 10% of the industry portfolios in the U.S. have significant foreign exchange exposure at the 10% level![2] Jorion (1990) finds that exchange rate risk does not carry a significant risk premium.[3] This anomaly is called the "exposure puzzle" in the exchange rate literature.

Considerable research has been devoted to solving the exposure puzzle. For instance, Khoo (1994) uses bilateral exchange rates instead of the popular trade-weighted multilateral exchange rate; Bartov and Bodnar (1994) look at lagged instead of contemporaneous exchange rate changes; Bodnar and Wong (2003) and Chow, Lee and Solt (1997) examine different time horizons; Allayannis (1997) investigates time-varying exchange exposure; and Bartram (2004) studies nonlinear exchange exposure.[4] However, as Bartram and Bodnar (2005) point out, in general these studies are not able to satisfactorily explain the exposure puzzle, because "a majority of these studies still find significant exposures in just 10–25% of the cases" (p. 2).

---

[1] See Stulz (1984), Smith and Stulz (1985), Froot, Sharfstein, and Stein (1993), Dominguez and Tesar (2001), Bartram (2007), and Landona and Smith (2009) for more discussion.

[2] See also Bodnar and Gentry (1993), Amihud (1994), and Griffin and Stulz (2001) for more U.S. evidence, and He and Ng (1998), Bartram and Karolyi (2006), and Doidge, Griffinb, and Williamsonet (2006) for international evidence.

[3] Vassalou (2000) finds that exchange rate risk is priced in some international stock markets, but its premium can be positive or negative. Kolari, Moorman, and Sorescu (2008) find a non-linear premium for foreign exchange risk in the U.S. However, as they acknowledge, their results are not consistent with any standard asset pricing theory.

[4] See Bartram and Bodnar (2005) for a comprehensive review.

It is important to note that previous studies focus on *contemporaneous* (or lagged) exchange rate changes. We argue in this paper, if exchange rate fluctuations affect cash flows and future not current cash flows matter for asset pricing (e.g. Merton, 1973), we should focus on *future* (more precisely news about future) not *contemporaneous* (or lagged) exchange rate changes. This is especially important given a lot of evidence suggesting that exchange rates follow a random walk (e.g. Meese and Rogoff, 1988), meaning contemporaneous changes in exchange rates have little correlation with future exchange rate movements. Therefore, we conjecture in this paper that the exposure puzzle might be at least partly due to the fact that previous studies usually focus on current not future exchange rate movements.

Furthermore, if exchange rate fluctuations can push a firm into financial distress as Starks and Wei (2005) argue, exchange rate risk is a distress risk much like the value factor in the three-factor model of Fama and French (1992, 1993, 1996). Given the risk premium of the value factor is positive and growth firms have lower loadings on this factor, we expect that the risk premium of the exchange rate factor be positive, and growth firms have lower loadings on this factor.

To test our conjectures, we first use the economic tracking portfolio approach proposed by Breeden, Gibbons, and Litzenberger (1989) and Lamont (2001), and recently applied by Vassalou (2003) to construct the exchange rate mimicking portfolio (or the exchange rate news). This approach allows us to also estimate the risk premium of the exchange rate factor without imposing a particular model of asset pricing. Additionally, we employ a second, more structural approach to estimate the risk premium of the exchange rate factor - the two-pass regression methodology proposed by Black, Jensen, and Scholes (1972) and Fama and MacBeth (1973), as amended by Shanken (1992), Lewellen, Nagel and Shanken (2006), and Shanken and Zhou (2007). This approach allows us to examine further the exposure to this factor.

Consistent with our conjectures, we find evidence suggesting that the risk premium of the exchange rate factor is significantly positive, and growth firms generally have lower loadings on this factor in the post Plaza-Accord period. Based on the Carhart (1997) four-factor model, about 80% of the size-BM portfolios and 57% of the industry portfolios have significant exposure to foreign exchange risk, and the premium on the exchange rate factor is about 0.15% per month or 1.8% per year. Our results, therefore, suggest that exchange rate risk does matter for asset pricing if we focus on future not contemporaneous exchange rate changes.

Given the positive risk premium on the exchange rate factor, our results have different implications from previous studies such as Kolari, Moorman, and Sorescu (2008). They find that the risk premium on the exchange rate factor is negative and therefore suggest that firms do not need to hedge the exchange rate risk. Our results instead imply whether firms need to hedge the currency risk depends on whether currency exposure is positive or negative. That is, firms with positive exposure should hedge the risk to reduce the cost of capital, while firms with negative exposure should not.

The remainder of the paper is organized as follows: Section 2 briefly discusses the data. Section 3 presents the premium estimate based on a non-structural approach – the tracking portfolio approach. Section 4 estimates the premium in a structural context – applying the two-pass regression methodology. Section 5 examines foreign exchange exposure of U.S. stock portfolios. Section 6 concludes the paper with a brief summary.

2. Data

Following relevant literature (e.g. Kolari, Moorman, and Sorescu, 2008), we focus on the Federal Reserve's Major Currencies Index (MCI) based on foreign exchange values of the dollar against currencies of major industrial countries from the Federal Reserve Bank - St. Louis. The data series is available from 1973:1 to 2008:6. As Figure 1 shows, the value of the trade-weighted dollar changes substantially over our sample period. Since there is considerable evidence suggesting that exchange risk exposure can be varying over time,[5] we mainly focus on two sub-sample periods. One is from 1973:1 to 1985:9, and the other is from 1985:10 to 2008:6. This division of the sample is based on our consideration of the Plaza Accord in 1985:9. As Priestley and Ødegaard (2007) suggest, exchange exposure may depend on the exchange rate regime. However, we also present the results based on rolling samples. The other macroeconomic variables used in empirical tests are also from the Federal Reserve Bank - St. Louis. The stock portfolio returns and the factors data are from Kenneth French's website.[6]

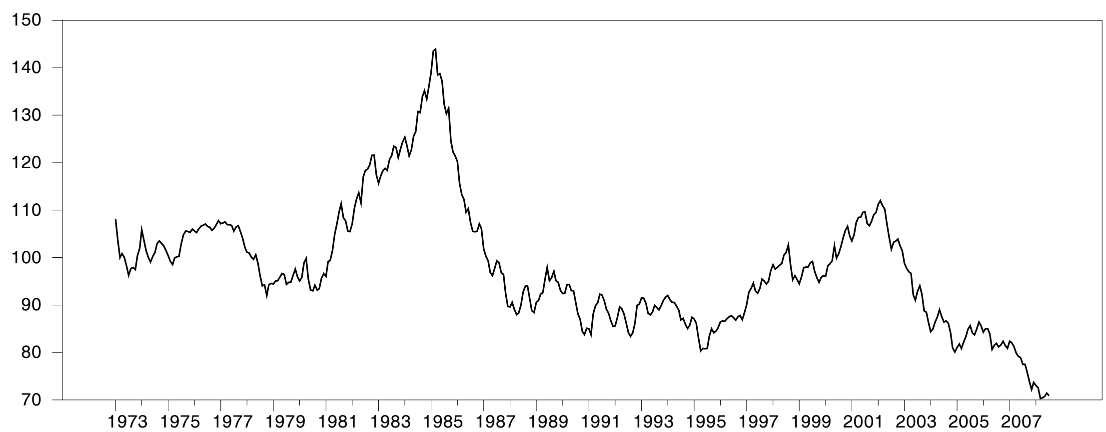

Figure 1 Trade -Weighted Value of the U.S. Dollar. This figure plots the weighted average of the foreign exchange values of the U.S. dollar against the currencies of major U.S. trade partners for the period of January 1973 to June 2008.

[5] See Allayannis (1997), Bodnar, Dumas, and Marston (2002) and Allayannis and Ihrig (2001).

[6] http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/.

3. Economic Tracking Portfolios: A Non-Structural Approach

Asset returns are driven by changing information, "news", about future cash flows and discount rates. Stulz (1984), Smith and Stulz (1985), and Froot, Sharfstein, and Stein (1993), among others, suggest that exchange rate movements can affect firms' cash flows. Therefore, news concerning future exchange rate movements should be relevant for asset pricing. We could use a structural model to estimate the news concerning future exchange rate fluctuations. But doing so results in a joint test of the validity of the model for what constitutes news and the validity of our hypothesis that exchange rate fluctuations matter for asset pricing. To circumvent this issue, we use the economic tracking portfolio approach proposed by Breeden, Gibbons, and Litzenberger (1989) and Lamont (2001), and recently applied by Vassalou (2003). Importantly, this a-theoretical approach further allows us to estimate the risk premium of the exchange rate risk without imposing a particular model of asset pricing.

3.1 An Economic Tracking Portfolio for Exchange Rate Fluctuations

Let CEX_{t+12} be the cumulative percentage change in the exchange rate over the next year, and define $\Delta E_t(CEX_{t+12}) = E_t(CEX_{t+12}) - E_{t-1}(CEX_{t+12})$ as the news component in month *t*. Then we have the tautology

$$CEX_{t+12} \equiv E_{t-1}(CEX_{t+12}) + \Delta E_t(CEX_{t+12}) + \omega_{t+12}\,, \tag{1}$$

which decomposes the future annual change in the exchange rate in a previously expected component, a news component, and a noise component.

If exchange rate risk affects firms' cash flows and matters for asset pricing, innovations in excess returns of base assets should reflect innovations in expectations about future exchange rate fluctuations. That is,

$$\Delta E_t(CEX_{t+12}) = b\tilde{R}_t + \eta_t\ , \tag{2}$$

where $\tilde{R}_t$ represents a column vector of unexpected returns $\tilde{R}_t = R_t - E_{t-1}(R_t)$, with R_t a column vector of excess returns of base assets in month *t*, and η_t the component of news that is orthogonal to the unexpected returns of the base assets.

Assume that the base asset return in month t is a linear function of Z_{t-1}, a vector of conditioning economic variables known at period t-1, and that $E_{t-1}(CEX_{t+12})$ is a linear function of Z_{t-1} and Z'_{t-1}, where Z'_{t-1} is a vector of conditioning variables known at period t-1 that may help predict the exchange rate. That is, $E_{t-1}(R_t) = dZ_{t-1}$ and $E_{t-1}(CEX_{t+12}) = fZ_{t-1} + gZ'_{t-1}$ Then, we have from equations (1) and (2) that

$$CEX_{t+12} = E_{t-1}(CEX_{t+12}) + \Delta E_t(CEX_{t+12}) + \omega_{t+12}$$
$$= fZ_{t-1} + gZ'_{t-1} + b(R_t - dZ_{t-1}) + \eta_t + \omega_{t+12},$$

or

$$CEX_{t+12} = gZ'_{t-1} + bR_t + eZ_{t-1} + \varepsilon_{t+12} \quad , \tag{3}$$

with $e = - bd + f$, and $\varepsilon_{t+12} = \eta_t + \omega_{t+12}$.

Tracking portfolio returns are defined here as the "factor mimicking" portfolios of excess returns $r_t = bR_t$. The OLS regression given by equation (3) can be used to estimate the portfolio weights *b* so as to obtain bR_t, the tracking portfolio returns of expectations about exchange rate fluctuations, the exchange rate factor.

The unconditional mean of the tracking portfolio returns $bE(R_t)$ represents the risk premium of the exchange rate factor (see Lamont, 2001 and Vassalou, 2003). The intuition is that the estimated coefficients *b* represent the base asset loadings on the exchange rate news. The portfolio with weights *b* on the base assets has a mean excess return $bE(R_t)$ that reflects the risk due to exchange rate news and can be interpreted as the risk premium on the exchange rate factor. If exchange rate risk is economically important, the risk premium associated with it should be significantly different from zero. Furthermore, if exchange rate risk is a distress risk as Starks and Wei (2005) suggest, we expect that it carries a positive risk premium as the value factor does in the three-factor model.

We focus on news concerning next year's cumulative change in the exchange rate (CEX_{t+12}). The implicit assumption is that asset returns are affected by news regarding exchange rate fluctuations over the upcoming one-year period. This is a reasonable simplifying assumption because, even if asset returns are affected by exchange rate news over a longer horizon, we would expect that much of this news pertains also to next year's exchange rate movements.

We follow Vassalou (2003) and use the six Fama-French size/book-to-market portfolios as the base assets. As conditioning variables – the Z_{t-1} in equation (3) – we again basically follow Vassalou (2003) and use some macro variables which are known to predict equity returns. They are the risk-free rate (RF), the term premium (TERM), the default premium (DEF), and a detrended wealth variable, cay, computed by Lettau and Ludvigson (2001). We use the lagged change in the exchange rate over the past year as the control variable in Z'.[7]

[7] Although Vassalou (2003) also includes the term premium and the default premium as her base assets in R, we do not do so for two reasons. First, with our monthly data we find strong first-order autocorrelation in these two time series. As a result, including them as base assets will introduce strong multicollinearity into Eq. (3). Note that the one-month lagged term and default premium are used as the conditioning variables in Z. The resulting tracking

3.2 Empirical Results

Table 1 presents the construction and diagnostic tests of the exchange rate tracking portfolios based on equation (3) with the six Fama-French size-BM portfolios as the base assets and the macro variables used also by Vassalou (2003) as conditioning variables. The t-ratios are based on Newey-West HAC standard errors with the lag parameter set equal to 12. Since we require one year of data to compute CEX_{t+12} (the cumulative percentage change in the exchange rate over the next year), our sample ends in June 2007.

Table 1. Tracking Portfolios and Diagnostic Tests

Panel A presents the results for the regression of eq. (3), $CEX_{t+12} = gZ'_{t-1} + bR_t + eZ_{t-1} + \varepsilon_{t+12}$, where CEX_{t+12} represents the cumulative percentage change in the exchange rate over the next one year, R_t = (SL_t, SM_t, SH_t, BL_t, BM_t, BH_t)', Z_{t-1} = (RF_t, DEF_{t-1},$TERM_{t-1}$ Cay_{t-1})', which are, respectively, risk free rate, lagged default risk premium, lagged term premium, the lagged Cay factor from Lettau and Ludvigson. Z'_{t-1} = (Constant, CEX_{t-12}). Panel B provides the R-square of the regression in eq. (5). Panel C shows the average return on portfolio bR_t with the weights given by the coefficient estimates in Panel A.

	1985:10-2007:6		1973:1-1985:9	
Panel A. Tracking portfolio regressions				
	Coeff	t-ratio	Coeff	t-ratio
SL_t	-0.13	-0.79	0.34	1.60
SM_t	0.39	1.45	-1.68	-1.92
SH_t	0.11	0.29	0.96	1.46
BL_t	-0.05	-0.32	-0.06	-0.42
BM_t	-0.17	-0.61	0.23	0.92
BH_t	0.03	0.13	0.09	0.36
Constant	5.60	1.29	-19.51	-3.41
CEX_{t-12}	-0.05	-0.53	-0.58	-2.74
RF_t	1.71	0.22	10.87	1.39
DEF_{t-1}	-19.12	-6.36	8.80	3.67
$TERM_{t-1}$	1.53	1.63	0.29	0.22
Cay_{t-1}	-67.65	-1.08	-182.24	-1.14
Adj-R^2	0.382		0.387	
Chi-square tests of the hypothesis that the coefficients on the base assets are jointly zero.				
χ^2 p-value	0.01		0.42	
Panel B. Lowers bounds of explanatory power of the tracking portfolio				
Lower Bound	0.041		0.027	
Panel C. The mean of the tracking portfolio returns				
Mean	0.289	3.49	-0.049	-0.29

portfolio will be dominated by time-series variation in the default premium, and have little value for tracking the variation in exchange rate. The results are available upon request. Second, in theory, we want to extract the news about future exchange-rate movements that the stock market perceives and then estimate its risk premium on stocks. Therefore, the bond portfolio returns are not necessary as base assets. They are still useful as the conditioning variables because the literature shows that they can predict equity returns (see Fama and French, 1988).

The columns labeled “1985:10-2007:6” represent the results for the post Plaza-Accord period. The chi-square test rejects the hypothesis that the coefficients on the base assets are jointly zero at the 1% level, indicating that the base assets have some tracking ability. We next evaluate the ability of the tracking portfolio to forecast exchange rate changes for the upcoming year, with the following regression suggested by Lamont (2001):

$$CEX_{t+12} - E_{t-1}(CEX_{t+12}) = h \cdot [bR_t - E(bR_t \mid Z_{t-1})] + u_{t+12} \quad (4)$$

The R-square from this regression provides an indication of the tracking ability of the factor mimicking portfolio. It gives a *lower bound* for the tracking ability because from equation (1) the left-hand side of equation (4) is only a noisy measure of the news component. The R-square in Panel B is 4.1%. So it appears that our tracking portfolio has some ability for tracking exchange rate movements. In comparison, the ability of the tracking portfolios to track news related to future GDP growth in Vassalou (2003) varies between 3% and 8%. Therefore, the exchange rate tracking ability of the mimicking portfolios appears to be reasonable. Panel C provides the mean of the tracking portfolio return, which is 0.29% per month or 3.5% per year with a t-statistic of 3.49. Therefore, consistent with our conjecture, the risk premium on the exchange rate factor is significantly positive. Figure 2 Panel A shows the raw annual exchange rate change series CEX_{t+12}, as well as the exchange rate mimicking portfolio return series for the period from 1985:10 to 2007:6.

We also repeat the above exercise for the pre Plaza-Accord period of 1973:1 to 1985:9. The results are reported in Table 1 in the columns labeled “1973:1-1985:9”. Exchange rate risk seems to be irrelevant for asset pricing in this period. The tracking portfolio has little ability to track future exchange rate movements: the chi-square test cannot reject the hypothesis that the coefficients on the base assets are jointly zero, even at the 10% level; the lower bound of the tracking ability of the tracking portfolio is only 2.7%; and the premium on the exchange rate factor is also not significant. Figure 2 Panel B shows the raw annual exchange rate change series CEX_{t+12}, as well as the exchange-rate mimicking portfolio return series for the period from 1973:1 to 1985:9.[8]

[8] What explains the irrelevance of exchange rate risk in this particular exchange rate regime may be an interesting topic for future research.

Figure 2A. 1985:10-2007:6

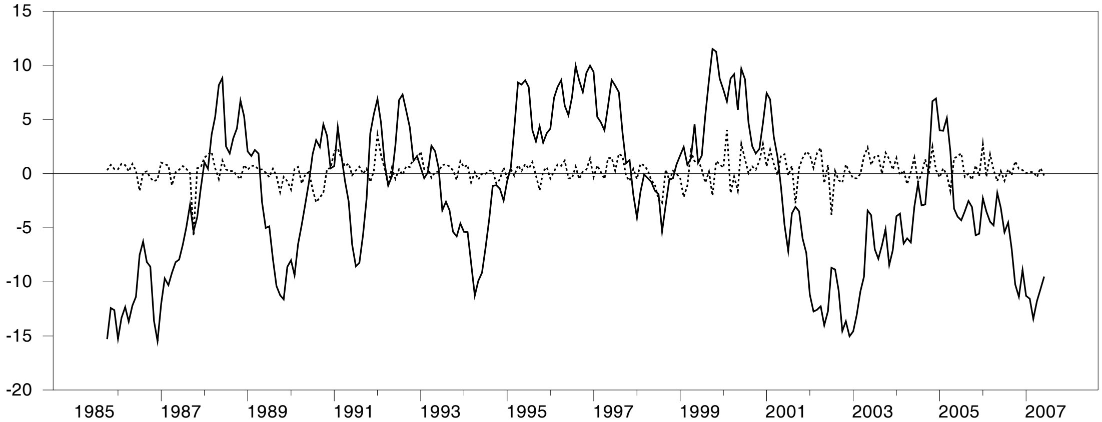

Figure 2B 1973:1-1985:9

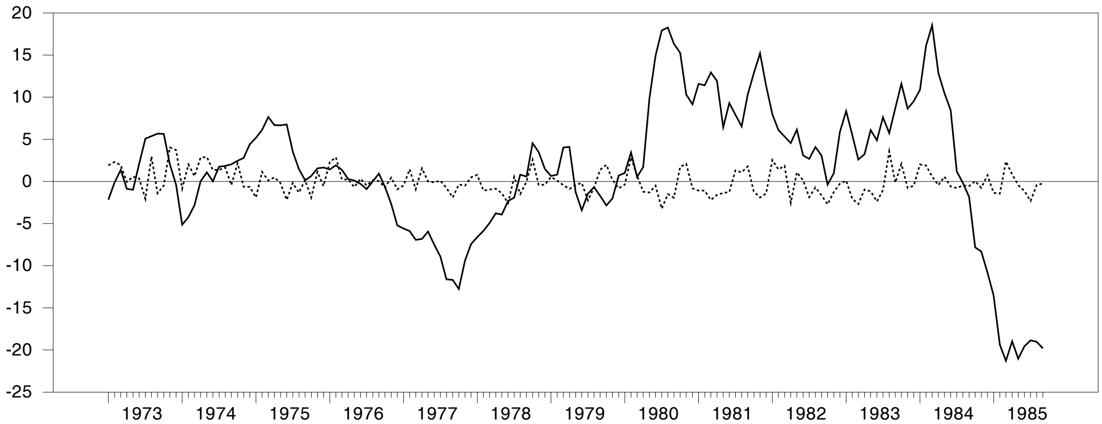

Figure 2. Exchange Rate and Exchange Rate Rate Factor. The cumulative percentage change in the exchange rate in solid line over the next one year and the corresponding exchange rate mimicking portfolio returns in dashed line are shown in Figure 2.

3.3 Time Path of the Risk Premium

To obtain more information about the path of the exchange rate risk premium over time, we repeat the above exercise with a rolling sample. The risk premium at each time is estimated with 10 years of data to obtain meaningful estimates. Consequently the test period starts in 1983:1. We update estimates monthly by dropping the earliest observation and adding the latest observation. The results are displayed in Figure 3. The evidence further confirms that the risk premium of the exchange rate factor is significantly positive since 1985.

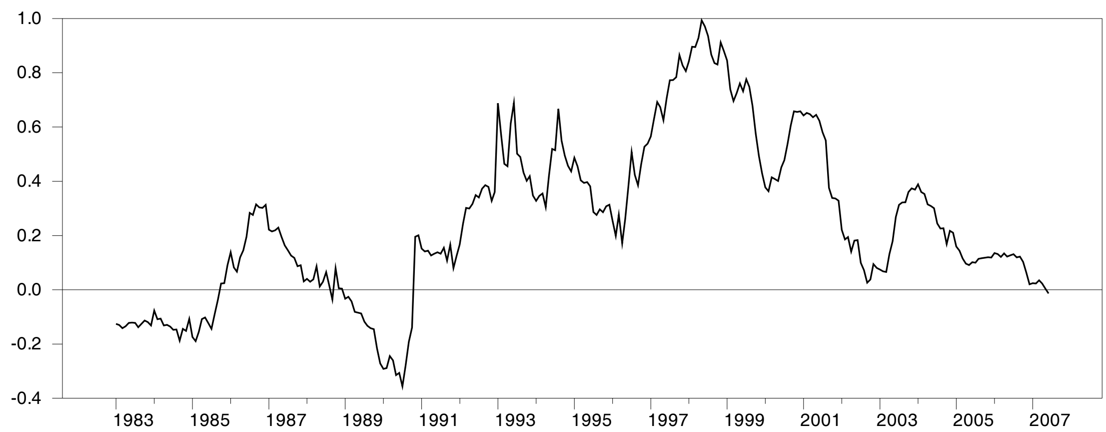

Figure 3. Rolling Estimates of the Exchange Rate Factor Risk Premium. The risk premium is estimated for the entire 1973:1-2007:8 sample using 10 years of data for each estimate. Thus, the first period starts in 1983:1. We update the estimates every month by dropping the earliest observation and adding the latest observation.

3.4 Contemporaneous Exchange Rate Changes and News about Future Exchange Rate Changes

Following Adler and Dumas (1983), it is a common practice in the exchange rate literature to use the contemporaneous exchange rate change as the relevant risk factor to estimate the risk exposure and risk premium. However, if exchange rate fluctuations affect cash flows of firms and future not current cash flows matter for asset pricing, what matters for stock returns should be future not contemporaneous exchange rate movements. Contemporaneous changes in exchange rates would be useful only if they contain information about future exchange rate movements, or they are related with the news about future exchange rate fluctuations.

To examine the relationship between the contemporaneous exchange rate change and the news about the future exchange rate movements, we run the following regression:

$$CEX_{t+12} - E_{t-1}(CEX_{t+12}) = m + nEX_t + e_{t+12}, \qquad (5)$$

where $CEX_{t+12} - E_{t-1}(CEX_{t+12})$ represents the news about future exchange rate movements (although a noisy proxy, recall Equation 1), and EX_t is the contemporaneous change in the exchange rate. The results for the both sub-sample periods are reported in Table 2. The t-ratios are based on Newey-West HAC standard errors with the lag parameter set equal to 12. As we can see, in neither sub-sample period, the contemporaneous exchange rate change is a good proxy for the news about future exchange rate fluctuations: the coefficient is not significant and the adjusted-R^2 is close to zero in every period. This is not surprising given that there is evidence suggesting that exchange rates follow a random walk (e.g. Meese and Rogoff, 1988). Therefore, we conjecture that the exposure puzzle might be at least partly due to that previous studies focus on the contemporaneous exchange rate change which is not a good proxy for the future exchange rate change. We examine exchange rate exposure in Section 5 for U.S. stock portfolios.

Table 2. The Contemporaneous Change in the Exchange Rate and the News about Future Movements in the Exchange Rate

To test the relationship between the contemporaneous exchange rate change and the news about the future exchange-rate movements, we run the following regression:

$$CEX_{t+12} - E_{t-1}(CEX_{t+12}) = h \cdot EX_t + u_{t+12}$$

The t-statistics are HAC-robust (Newey-West) t-statistics.

	Coefficient	t-ratio
	1985:10-2007:6	
Constant	0.04	0.06
EX	0.25	1.21
Adj-R^2	0.002	
	1973:1-1985:9	
Constant	0.25	0.19
EX	0.02	0.06
Adj-R^2	-0.007	

4. Standard Asset Pricing Models: A Structural Approach

The tracking portfolio approach of Lamont (2001) in Section 3 estimates the risk premium of the exchange rate factor without specifying an equilibrium asset pricing model. In this section, we supplement these results by estimating the risk premium of the exchange rate factor within a multi-factor model. This approach also enables us to obtain the sensitivities to the exchange rate factor, exchange rate exposure.

For our asset pricing specifications we focus on the Fama-French (1992, 1993, and 1996) three-factor model and the Carhart (1997) four-factor model. They are the most common systematic risk models used in the literature (e.g. Kolari, Moorman, and Sorescu, 2008). The exchange rate factor is added to these models as an additional factor affecting investment opportunities over time.

We use the Black, Jensen, and Scholes (1972) and Fama and MacBeth (1973) two-pass methodology – estimating factor sensitivities in the first pass, and using these to obtain risk premia in the second pass – with standard refinements: the Shanken (1992) correction to obtain errors-in-variables (EIV) robust standard errors, accounting for the fact that factor sensitivities are estimated, and the Shanken and Zhou (2007) correction to generate misspecification-robust standard errors.[9]

Lewellen, Nagel and Shanken (2009) argue that using as test assets only size–BM portfolios, as is common in the literature, can be highly misleading due to the strong factor structure of these portfolios. They propose to expand the set of test assets to include other portfolios, such as industry portfolios. Lewellen, Nagel and Shanken (2009) further argue, since the problems are exacerbated by the fact that

[9] See also Kim (1995) and Jagannathan and Wang (1998).

empirical tests often ignore restrictions on the cross-sectional slopes, that researchers take the predicted magnitudes of the slopes seriously. For example, the risk premium on a factor portfolio should be close to its average excess return.

We take their advice and use 55 size-BM and industry portfolios (25 size-BM portfolios and 30 industry portfolios) instead of just 25 size-BM portfolios as test assets, and force the premium on the Fama-French and the momentum factors equal to their average excess returns as the risk adjustment in the second pass. That is, we employ the following CSR models in the second pass:

$$\bar{r}_i - (\hat{\beta}_{i,M}\bar{r}_M + \hat{\beta}_{i,SMB}\bar{r}_{SMB} + \hat{\beta}_{i,HML}\bar{r}_{HML}) = \gamma_0 + \gamma_{EX}\hat{\beta}_{i,EX} + e_i \quad (5a)$$

$$\bar{r}_i - (\hat{\beta}_{i,M}\bar{r}_M + \hat{\beta}_{i,SMB}\bar{r}_{SMB} + \hat{\beta}_{i,HML}\bar{r}_{HML} + \hat{\beta}_{i,MOM}\bar{r}_{MOM}) = \gamma_0 + \gamma_{EX}\hat{\beta}_{i,EX} + e_i \quad (5b)$$

where the $\hat{\beta}$ s are the factor loadings (jointly estimated for all the factors) from the first-pass time series regression, $\bar{r}_i$ is the mean excess return of asset *i*, and $\bar{r}_M$, $\bar{r}_{SMB}$, $\bar{r}_{HML}$ and $\bar{r}_{MOM}$ are the mean excess returns of the Fama-French factors and the momentum factor. We use the economic tracking portfolio for future exchange rate movements as the exchange rate factor.

We focus on the 1985:10 to 2007:6 period or the post Plaza-Accord period.[10] The results are reported in Table 3. The top panel reports the results based on the Fama-French three-factor model. The intercept in equation (5a), (γ_0) is not significant suggesting no model misspecification. More interestingly, again we see that the exchange rate factor is priced. The premium associated with this factor (γ_{EX}) is 0.18 percent per month with an EIV-robust t-statistic of 2.4318 and a misspecification-robust t-statistic of 2.4317.

Table 3. Risk Premium of the Exchange Rate Factor for Risk-Adjusted Returns: 1985:10-2007:6

The risk premium on the exchange rate risk factor for the sample period 1985:10-2007:6 is γ_{EX} obtained from $\bar{r}_i - (\hat{\beta}_{i,M}\bar{r}_M + \hat{\beta}_{i,SMB}\bar{r}_{SMB} + \hat{\beta}_{i,HML}\bar{r}_{HML}) = \gamma_0 + \gamma_{EX}\hat{\beta}_{i,EX} + e_i$, or $\bar{r}_i - (\hat{\beta}_{i,M}\bar{r}_M + \hat{\beta}_{i,SMB}\bar{r}_{SMB} + \hat{\beta}_{i,HML}\bar{r}_{HML} + \hat{\beta}_{i,MOM}\bar{r}_{MOM}) = \gamma_0 + \gamma_{EX}\hat{\beta}_{i,EX} + e_i$, where $\bar{r}_i$ is the mean excess return of asset *i*, the $\hat{\beta}$ s are the estimated factor loadings from the first-pass time-series regressions, and $\bar{r}_M$, $\bar{r}_{SMB}$, $\bar{r}_{HML}$ and $\bar{r}_{MOM}$ are the mean excess returns of the Fama-French and the momentum factors.

Errors-in-variables (EIV) robust standard errors are based on Shanken (1992), and misspecification (MS) robust standard errors are based on Shanken and Zhou (2007).

	Coefficient	EIV-robust t-ratio	MS-robust t-ratio
Three-Factor Model Risk Adjustment			
γ_0	-0.0674	-0.7984	-0.7981
γ_{EX}	0.1832	2.4318	2.4317
Four-Factor Model Risk Adjustment			
γ_0	0.1326	1.7957	1.7961
γ_{EX}	0.1511	2.0060	2.0051

[10] Section 3 shows that due to low international integration, exchange rate risk seems to be irrelevant for asset pricing before 1985.

The lower panel presents the results based on the Carhart (1997) four-factor model, which are largely consistent with those based on the three-factor model. The risk premium associated with the exchange rate factor is again significantly positive, 0.15% per month, even after we control the error-in–the-variable problem and the potential model misspecification. Our results therefore confirm that the risk premium on the exchange rate factor is significantly positive as Starks and Wei (2005) suggest, and exchange rate risk is indeed priced.

5. Foreign Exchange Exposure

The previous two sections estimate the risk premium on the exchange rate factor using two different approaches. As we have seen, regardless whether we assume an asset pricing model or not and regardless what asset pricing model we use, the premium on the exchange rate factor is always significantly positive. The results therefore suggest that exchange rate risk is indeed priced.

In this section, we look at exchange rate exposure. Recall that previous studies usually find that only low proportions of U.S. firms have significant exchange rate exposure. For instance, Choi and Prasad (1995) find that only 10% of the industry portfolios in the U.S. have significant foreign exchange exposure at the 10% level. As we argue in the previous sections, this may be due to that researchers use the contemporaneous exchange rate change, not news about future exchange rate changes (which is what matters for asset pricing). Therefore, we re-examine exchange rate exposure in this section with our exchange rate tracking portfolio returns.

Specifically, to estimate exchange rate exposure, we estimate the factor loadings of the 25 Size-BM portfolios and the 30 industry portfolios with the following four-factor model and the five-factor model which are based on the Fama-French three-factor model and the Carhart four-factor model:

$$r_{it} = \alpha_i + \beta_{i,M} M_t + \beta_{i,SMB} SMB_t + \beta_{i,HML} HML_t + \beta_{i,EXF} EXF_t + \varepsilon_{it} \qquad (6a)$$

$$r_{it} = \alpha_i + \beta_{i,M} M_t + \beta_{i,SMB} SMB_t + \beta_{i,HML} HML_t + \beta_{i,MOM} MOM_t + \beta_{i,EXF} EXF_t + \varepsilon_{it} \qquad (6b)$$

where EXF_t is the exchange rate factor measured by the economic tracking portfolio for future exchange rate movements. If exchange rate risk is a distress risk as Starks and Wei (2005) suggest, we expect to see that growth firms have lower loadings on the exchange rate factor.

The results for the 25 size-BM portfolios based on Eq. (6a) or the four-factor model are reported in Table 4 for the sample period from 1985:10 to 2007:6. Again we focus on the post Plaza-Accord period, because Section 3 shows that exchange rate risk appears to be irrelevant for asset pricing before 1985. The t-ratios are based on Newey-West HAC standard errors with the lag parameter set equal to 12. We focus on the exposure to the exchange rate risk, and the significant factor loadings (at the 10% level for two-sided tests) are in bold. As we can see, 16 out of 25 or 64% of the size-BM portfolios have statistically significant exposure to the exchange rate risk. Furthermore, growth firms or low BM portfolios do generally tend to have lower loadings on the exchange rate factor.

Table 4. Factor Loadings of the Size-BM Portfolios based on the Four-Factor Model: 1985:10-2007:6

The factor loadings of the Size-BM portfolios over the sample period 1985:10-2007:6 are inferred from:

$$r_{it} = \alpha_i + \beta_{i,M} M_t + \beta_{i,SMB} SMB_t + \beta_{i,HML} HML_t + \beta_{i,EXF} EXF_t + \varepsilon_{it},$$

where r_{it} is the excess return on asset *i* in period *t*, M_t, SMB_t, HML_t, EXF_t are the excess returns on the market, the size, the book-to-market, and the exchange rate risk factor. The β s are the associated factor loadings, and ε_{it} is the disturbance. The t-statistics are HAC-robust (Newey-West) t-statistics.

Size	**BM**	α_i	$\beta_{i,M}$	$\beta_{i,SMB}$	$\beta_{i,HML}$	$\beta_{i,EX}$	**Adj-R²**
Small	Low	-0.01	1.90	2.98	1.09	**-5.64**	0.74
	t-stat	-0.03	8.04	5.78	3.32	-3.62	
	2	0.36	1.45	1.96	0.85	**-2.90**	0.79
		1.86	9.31	5.92	3.97	-2.90	
	3	0.46	1.05	1.27	0.59	**-1.13**	0.81
		2.89	10.03	5.68	4.04	-1.74	
	4	0.51	0.91	1.06	0.58	-0.62	0.80
		3.23	9.31	4.73	3.59	-0.90	
	High	0.85	1.18	1.60	1.05	**-2.00**	0.75
		5.11	9.93	6.18	5.58	-2.46	
2	Low	-0.16	1.62	1.73	0.29	**-2.66**	0.90
	t-stat	-0.85	11.23	5.03	1.42	-2.99	
	2	-0.27	0.98	0.47	0.04	**1.01**	0.90
		-1.91	10.95	1.76	0.29	1.70	
	3	-0.10	0.65	-0.07	-0.07	**2.49**	0.92
		-0.88	9.99	-0.35	-0.64	6.17	
	4	-0.14	0.77	0.20	0.31	**1.65**	0.91
		-1.07	12.72	1.53	2.83	5.57	
	High	-0.32	1.11	0.67	0.81	0.55	0.91
		-2.66	12.86	3.92	6.43	1.33	
3	Low	0.13	1.47	1.28	0.02	**-2.14**	0.88
	t-stat	0.62	8.96	3.19	0.07	-2.01	
	2	-0.24	0.88	-0.05	-0.10	**1.76**	0.87
		-1.74	9.50	-0.21	-0.77	2.95	
	3	-0.34	0.69	-0.34	0.00	**2.55**	0.88
		-3.06	9.33	-2.06	-0.02	6.24	
	4	-0.19	0.84	-0.05	0.43	**1.57**	0.87
		-1.47	11.32	-0.29	3.70	3.52	
	High	-0.04	1.10	0.34	0.79	0.38	0.83
		-0.29	12.29	1.52	7.03	0.77	
4	Low	0.27	1.33	0.70	-0.08	**-1.35**	0.90
	t-stat	1.67	10.58	2.57	-0.51	-1.97	
	2	-0.22	0.96	-0.28	0.16	**1.50**	0.86
		-1.61	10.20	-1.09	1.01	2.29	
	3	-0.24	0.91	-0.32	0.22	**1.70**	0.86
		-1.72	11.34	-1.45	1.58	3.16	
	4	0.01	1.02	0.03	0.59	0.43	0.84
		0.05	10.83	0.19	4.40	0.88	
	High	-0.20	1.08	0.02	0.69	0.47	0.83
		-1.84	8.55	0.09	4.37	0.88	
Big	Low	0.14	1.04	-0.22	-0.39	0.16	0.93
	t-stat	1.40	9.11	-1.03	-2.69	0.25	
	2	-0.18	0.93	-0.56	0.03	**1.46**	0.89
		-1.86	13.63	-3.79	0.20	3.57	
	3	-0.13	1.07	-0.23	0.46	0.37	0.87
		-1.41	11.54	-1.39	3.47	0.70	
	4	-0.09	0.93	-0.25	0.59	0.49	0.86
		-1.09	13.35	-1.57	5.27	1.07	
	High	-0.12	1.09	-0.06	0.87	-0.13	0.81
		-1.05	8.14	-0.33	5.28	-0.21	

Table 5 presents the results for the 30 industry portfolios based on the four-factor model (Eq. 6). The t-ratios are based on Newey-West HAC standard errors with the lag parameter set equal to 12. We again focus on the exposure to the exchange rate risk, and the significant factor loadings (at the 10% level for two-sided tests) are in bold. As we can see, 10 out of 30 or 33% of the industry portfolios have significant currency exposure. This is much higher than that in Choi and Prasad (1995) (10% of the industry portfolios). Four industries have positive exposure to the exchange rate risk, while six industries have negative currency exposure. The results in Tables 5 and 6 therefore suggest that as soon as we focus on the future exchange rate change, the exchange exposure is much higher than previous studies find. Therefore, the results are consistent with our conjecture: the exposure puzzle may be at least partly due to the fact that previous studies focus on the contemporaneous not the future exchange rate change.

The four-factor model of Eq. (6a) does not take into account the momentum factor, which may cause misspecification. Therefore, we repeat the above exercises with the five-factor model of Eq. (6b). The results are reported in Tables 6 and 7 in the same fashion as in Tables 4 and 5. Again, the t-ratios are based on Newey-West HAC standard errors with the lag parameter set equal to 12, and we focus on the exposure to the exchange rate risk with the significant factor loadings (at the 10% level for two-sided tests) in bold. When we take into account the momentum factor, our results become stronger. For instance, Table 6 shows that 20 out of 25 or 80% of the size-BM portfolios have significant exchange rate exposure (with growth firms having lower loadings), while Table 7 shows that 17 out of 30 or 57% of the industry portfolios have significant foreign exchange exposure. Therefore, the results further confirm that U.S. firms are in general exposed to exchange rate risk if we focus on future not current exchange rate changes.

Table 5. Factor Loadings of the Industry Portfolios based on the Four-Factor Model: 1985:10-2007:6

$$r_{it} = \alpha_i + \beta_{i,M} M_t + \beta_{i,SMB} SMB_t + \beta_{i,HML} HML_t + \beta_{i,EXF} EXF_t + \varepsilon_{it}$$

Size	α_i	$\beta_{i,M}$	$\beta_{i,SMB}$	$\beta_{i,HML}$	$\beta_{i,EX}$	**Adj-R^2**
Food	-0.20	0.56	0.12	0.15	**1.31**	0.68
	-1.07	6.09	0.60	0.90	2.02	
Beer	0.22	0.51	-0.23	-0.04	1.27	0.34
	0.89	3.00	-0.78	-0.12	1.36	
Smoke	0.53	0.56	-0.47	-0.18	**2.37**	0.16
	1.04	2.00	-1.04	-0.40	1.70	
Games	-0.33	1.21	1.29	0.70	-1.45	0.62
	-1.08	5.92	2.93	2.54	-1.04	
Books	-0.19	1.08	0.79	0.57	-0.84	0.73
	-1.14	9.04	2.75	2.83	-1.00	
Hshld	-0.37	0.88	0.61	0.36	0.46	0.73
	-1.73	7.32	2.33	1.72	0.59	
Clths	-0.42	0.84	0.45	0.34	1.07	0.63
	-1.38	5.82	1.32	1.48	1.20	
Hlth	0.66	1.28	1.87	0.33	**-2.07**	0.76
	1.98	9.61	8.35	1.45	-2.92	
Chems	-0.22	0.85	0.19	0.31	**1.19**	0.75
	-1.19	8.66	0.80	1.55	1.85	
Txtls	-0.84	0.96	0.57	0.60	0.48	0.49
	-2.54	3.90	1.17	1.48	0.32	
Cnstr	-0.31	1.03	0.73	0.67	0.35	0.74
	-1.51	6.77	2.27	3.28	0.38	
Steel	-0.17	1.52	1.31	1.21	-1.42	0.68
	-0.61	7.07	3.38	4.39	-1.09	
FabPr	0.04	1.14	1.00	0.52	-0.48	0.81
	0.26	10.53	4.51	3.27	-0.74	
ElcEq	-0.04	1.33	1.50	0.79	**-1.88**	0.77
	-0.21	9.57	6.39	3.96	-2.51	
Autos	-0.56	1.19	0.88	0.86	-0.38	0.68
	-1.91	5.83	2.16	3.21	-0.30	
Carry	-0.20	0.86	0.30	0.52	1.28	0.61
	-0.85	5.44	0.90	2.57	1.33	
Mines	0.06	0.89	1.31	1.10	-1.18	0.25
	0.14	3.99	2.92	2.72	-0.82	
Coal	-0.61	0.46	-0.34	0.17	3.06	0.17
	-1.05	1.02	-0.41	0.26	1.09	
Oil	0.34	1.38	1.45	1.55	**-2.72**	0.34
	0.71	6.35	3.41	4.27	-1.93	
Util	0.14	0.61	0.05	0.63	0.02	0.52
	0.95	5.92	0.24	3.94	0.04	
Telcm	0.68	2.18	2.74	1.22	**-6.47**	0.73
	1.90	9.57	6.08	4.23	-4.93	
Servs	0.64	1.85	2.46	0.85	**-4.80**	0.82
	3.06	10.01	5.82	3.58	-4.06	
BusEq	0.80	1.94	2.73	0.83	**-4.91**	0.82
	2.68	9.07	6.83	3.11	-4.09	
Paper	-0.38	0.79	0.15	0.26	**1.14**	0.76
	-1.90	8.02	0.66	1.42	1.81	
Trans	-0.29	1.05	0.61	0.61	0.25	0.74
	-1.63	8.70	1.96	3.64	0.31	
Whlsl	-0.04	1.12	1.13	0.63	-0.84	0.77
	-0.20	7.61	3.75	3.16	-0.90	
Rtail	-0.37	1.01	0.54	0.29	0.60	0.66
	-1.09	4.96	1.15	1.05	0.45	
Meals	-0.49	0.74	0.56	0.42	0.72	0.60
	-2.19	5.81	1.76	2.00	0.80	
Fin	0.06	0.73	0.31	0.55	0.59	0.74
	0.23	6.88	1.63	3.38	1.02	
Other	-0.12	1.07	0.90	0.55	-0.40	0.73
	-0.61	7.65	2.75	2.45	-0.40	

Table 6. Factor Loadings of the Size-BM Portfolios based on the Five-Factor Model: 1985:10-2007:6

The factor loadings of the Size-BM portfolios over the sample period 1985:10-2007:6 are inferred from:

$$r_{it} = \alpha_i + \beta_{i,M} M_t + \beta_{i,SMB} SMB_t + \beta_{i,HML} HML_t + \beta_{i,MOM} MOM_t + \beta_{i,EXF} EXF_t + \varepsilon_{it},$$

where r_{it} is the excess return on asset *i* in period *t*, $M_t, SMB_t, HML_t, MOM_t, EXF_t$ are the excess returns on the market, the size, the book-to-market, the momentum, and the exchange rate risk factor. The β s are the associated factor loadings, and ε_{it} is the disturbance. The t-statistics are HAC-robust (Newey-West) t-statistics.

Size	**BM**	α_i	$\beta_{i, M}$	$\beta_{i, SMB}$	$\beta_{i, HML}$	$\beta_{i, MOM}$	$\beta_{i, EX}$	**Adj-R^2**
Small	Low	0.29	1.66	2.68	0.74	-0.42	**-4.49**	0.78
	t-stat	0.77	13.68	8.63	3.69	-3.00	-5.24	
	2	0.58	1.27	1.75	0.60	-0.31	**-2.06**	0.83
		2.75	16.78	9.32	4.85	-3.88	-3.87	
	3	0.62	0.92	1.11	0.40	-0.23	-0.50	0.84
		3.48	10.58	7.32	3.34	-4.61	-1.10	
	4	0.60	0.84	0.97	0.47	-0.13	-0.26	0.82
		3.58	11.43	5.67	4.07	-2.46	-0.51	
	High	0.97	1.08	1.48	0.90	-0.18	**-1.51**	0.77
		5.54	11.69	7.02	5.90	-3.37	-2.40	
2	Low	0.10	1.40	1.47	-0.02	-0.37	**-1.64**	0.94
	t-stat	0.65	23.04	8.44	-0.17	-5.31	-4.02	
	2	-0.10	0.84	0.29	-0.17	-0.25	**1.69**	0.93
		-0.97	9.30	1.40	-1.39	-5.51	2.83	
	3	0.02	0.55	-0.18	-0.21	-0.17	**2.95**	0.94
		0.25	12.45	-1.36	-2.52	-5.66	9.91	
	4	-0.03	0.68	0.09	0.18	-0.15	**2.07**	0.92
		-0.29	13.07	0.89	2.20	-3.59	6.73	
	High	-0.21	1.02	0.56	0.68	-0.16	**0.98**	0.92
		-2.32	16.33	4.47	6.79	-5.09	3.07	
3	Low	0.36	1.28	1.05	-0.25	-0.32	**-1.25**	0.92
	t-stat	1.90	14.97	4.18	-2.11	-3.25	-2.05	
	2	-0.10	0.77	-0.19	-0.26	-0.20	**2.29**	0.90
		-0.91	10.79	-0.95	-2.46	-4.09	4.52	
	3	-0.22	0.59	-0.45	-0.13	-0.16	**3.00**	0.91
		-2.55	10.95	-3.65	-1.94	-4.48	8.56	
	4	-0.09	0.76	-0.15	0.32	-0.14	**1.96**	0.88
		-0.71	13.01	-0.98	3.50	-2.89	4.76	
	High	0.13	0.96	0.18	0.60	-0.24	**1.03**	0.87
		1.01	12.33	1.15	6.83	-4.99	2.46	
4	Low	0.42	1.21	0.55	-0.25	-0.21	**-0.77**	0.92
	t-stat	2.56	17.52	3.15	-2.31	-4.81	-1.78	
	2	-0.11	0.87	-0.39	0.03	-0.16	**1.93**	0.87
		-0.85	10.76	-1.67	0.20	-3.81	2.93	
	3	-0.11	0.80	-0.45	0.07	-0.18	**2.20**	0.88
		-0.89	11.61	-2.40	0.59	-4.64	4.38	
	4	0.08	0.96	-0.04	0.50	-0.10	**0.71**	0.85
		0.60	13.68	-0.26	4.76	-2.74	1.76	
	High	-0.11	1.01	-0.08	0.58	-0.13	**0.84**	0.84
		-0.97	10.52	-0.54	4.93	-3.43	1.94	
Big	Low	0.25	0.96	-0.32	-0.51	-0.15	0.56	0.95
	t-stat	2.65	13.60	-2.36	-5.16	-3.68	1.45	
	2	-0.10	0.86	-0.64	-0.06	-0.11	**1.77**	0.90
		-1.20	14.76	-4.88	-0.53	-3.15	4.55	
	3	-0.08	1.03	-0.28	0.40	-0.08	0.58	0.88
		-0.84	12.60	-1.84	3.47	-2.02	1.14	
	4	-0.02	0.87	-0.32	0.51	-0.10	**0.76**	0.87
		-0.27	12.26	-2.19	5.46	-2.51	1.70	
	High	-0.03	1.02	-0.15	0.77	-0.12	0.20	0.82
		-0.26	8.67	-0.84	5.50	-2.98	0.35	

Table 7. Factor Loadings of the Industry Portfolios based on the Five-Factor Model: 1985:10-2007:6

$$r_{it} = \alpha_i + \beta_{i,M} M_t + \beta_{i,SMB} SMB_t + \beta_{i,HML} HML_t + \beta_{i,MOM} MOM_t + \beta_{i,EXF} EXF_t + \varepsilon_{it}$$

Size	α_i	$\beta_{i,M}$	$\beta_{i,SMB}$	$\beta_{i,HML}$	$\beta_{i,MOM}$	$\beta_{i,EX}$	Adj-R^2
Food	-0.13	0.51	0.06	0.07	-0.10	**1.57**	0.69
	-0.68	5.79	0.32	0.53	-1.41	2.91	
Beer	0.26	0.48	-0.27	-0.08	-0.06	1.43	0.34
	1.05	2.88	-0.90	-0.27	-0.72	1.51	
Smoke	0.62	0.49	-0.56	-0.29	-0.13	**2.73**	0.16
	1.27	1.73	-1.27	-0.68	-0.88	1.91	
Games	-0.14	1.06	1.10	0.48	-0.27	-0.70	0.65
	-0.45	6.00	3.07	2.10	-2.58	-0.62	
Books	-0.06	0.98	0.67	0.43	-0.18	-0.35	0.75
	-0.38	11.40	2.87	2.60	-3.30	-0.49	
Hshld	-0.23	0.77	0.47	0.20	-0.19	**1.00**	0.75
	-1.26	7.98	2.29	1.25	-3.07	1.66	
Clths	-0.24	0.70	0.27	0.13	-0.25	**1.76**	0.66
	-0.96	5.93	1.07	0.81	-3.07	2.62	
Hlth	0.76	1.21	1.78	0.22	-0.14	**-1.69**	0.77
	2.24	9.95	7.94	1.07	-2.58	-2.52	
Chems	-0.10	0.76	0.07	0.18	-0.16	**1.64**	0.77
	-0.57	9.39	0.36	1.02	-2.98	2.85	
Txtls	-0.66	0.81	0.39	0.38	-0.26	1.19	0.52
	-2.10	4.39	1.00	1.08	-2.09	1.04	
Cnstr	-0.14	0.89	0.57	0.48	-0.23	0.99	0.77
	-0.79	7.39	2.26	2.96	-3.71	1.36	
Steel	0.03	1.36	1.12	0.98	-0.28	-0.65	0.70
	0.12	8.67	4.00	4.51	-3.85	-0.66	
FabPr	0.21	1.01	0.84	0.33	-0.23	0.17	0.84
	1.39	11.29	5.04	2.34	-4.69	0.36	
ElcEq	0.07	1.24	1.39	0.66	-0.16	**-1.45**	0.78
	0.34	10.36	6.92	3.59	-3.95	-2.25	
Autos	-0.33	1.01	0.66	0.59	-0.32	0.51	0.73
	-1.27	6.89	2.20	2.95	-3.39	0.56	
Carry	-0.06	0.75	0.17	0.36	-0.19	**1.81**	0.63
	-0.26	5.57	0.59	2.22	-2.26	2.31	
Mines	0.05	0.90	1.32	1.11	0.01	-1.21	0.24
	0.13	3.83	2.87	2.62	0.10	-0.83	
Coal	-0.66	0.50	-0.30	0.22	0.06	2.89	0.17
	-1.11	1.07	-0.36	0.31	0.44	1.03	
Oil	0.36	1.36	1.43	1.53	-0.03	**-2.64**	0.34
	0.77	5.29	3.04	3.66	-0.24	-1.67	
Util	0.11	0.63	0.07	0.66	0.04	-0.08	0.52
	0.76	6.44	0.42	4.34	0.79	-0.17	
Telcm	0.95	1.96	2.48	0.91	-0.38	**-5.42**	0.77
	2.67	12.27	8.06	3.25	-2.80	-6.16	
Servs	0.89	1.64	2.21	0.57	-0.35	**-3.83**	0.86
	4.16	19.35	9.01	3.75	-3.25	-6.00	
BusEq	1.07	1.72	2.46	0.52	-0.38	**-3.86**	0.85
	3.31	15.69	10.52	2.70	-4.64	-6.13	
Paper	-0.25	0.68	0.02	0.11	-0.18	**1.65**	0.79
	-1.56	8.30	0.09	0.74	-3.26	3.09	
Trans	-0.08	0.88	0.40	0.37	-0.29	**1.06**	0.79
	-0.53	10.81	1.98	3.06	-4.45	1.94	
Whlsl	0.11	1.00	0.98	0.46	-0.20	-0.28	0.79
	0.59	9.22	4.32	3.35	-2.21	-0.42	
Rtail	-0.10	0.79	0.28	-0.02	-0.37	**1.63**	0.73
	-0.37	5.49	0.87	-0.11	-3.80	1.73	
Meals	-0.33	0.62	0.40	0.24	-0.22	**1.33**	0.63
	-1.54	5.29	1.53	1.38	-2.34	1.80	
Fin	0.11	0.68	0.26	0.48	-0.08	**0.81**	0.74
	0.51	7.29	1.53	3.50	-1.35	1.65	
Other	0.00	0.97	0.78	0.41	-0.17	0.08	0.75
	0.02	9.38	2.99	2.25	-2.17	0.09	

6. Conclusion

Following Adler and Dumas (1983), it is a common practice in the exchange rate literature to use the contemporaneous exchange rate change as the relevant risk factor to estimate the risk exposure and risk premium. However, if exchange rate movements affect cash flows of firms and future not current cash flows matter for asset pricing, what matters for stock returns should be future exchange rate movements (or more feasibly the news about future movements) not contemporaneous exchange rate changes. This is especially important given a lot of evidence suggesting that exchange rates follow a random walk (meaning contemporaneous changes in exchange rates have little correlation with future exchange rate movements). Therefore, we conjecture in this paper that the exposure puzzle might be at least partly due to the fact that previous studies usually focus on current not future exchange rate movements.

Previous studies find that the risk premium on the exchange rate factor can be positive or negative. If as Starks and Wei (2005) suggest exchange rate fluctuations can push a firm into financial distress, exchange rate risk is a distress factor and should behave like the value factor in the three-factor model and carry a positive risk premium.

We test these two conjectures in this paper. We first use the tracking portfolio approach proposed by Breeden, Gibbons, and Litzenberger (1989) and Lamont (2001), and recently applied by Vassalou (2003), to construct the news about future exchange rate movements. Then, we estimate the risk premium of this factor and the exposure of stock portfolios to this factor. Consistent with our conjectures, we find evidence suggesting that the premium of the exchange rate factor is positive, and U.S. firms are generally exposed to this risk in the post Plaza-Accord period.

Given the positive risk premium on the exchange rate factor, our results imply whether firms need to hedge the currency risk depends on whether currency exposure is positive or negative. Firms with positive exposure should hedge the risk to reduce the cost of capital, while firms with negative exposure should not.

References

Adler, M., and Dumas, B., 1983. International portfolio choice and corporate finance: a synthesis. *Journal of Finance* 38, 925-984.

Adler, M., and Dumas, B., 1984. Exposure to currency risk: definition and measurement. *Financial Management* 13, 41-50.

Allayannis, G., 1997. The time-variation of the exchange rate exposure: An industry analysis, Working paper, Darden Graduate School of Business, University of Virginia

Allayannis, G., and Ihrig, J., 2001. Exposures and markups, *Review of Financial Studies* 14, 805-835

Amihud, Y., 1994. Exchange rates and the valuation of equity shares, in Yakov Amihud and Richard M. Levich, ed.: Exchange Rates and Corporate Performance (Irwin, New York).

Bartov, E., Bodnar, G. M., 1994. Firm valuation, earnings expectations, and the exchange rate exposure effect. *Journal of Finance* 49, 1755–1785.

Bartram, S. M., 2004. Linear and nonlinear foreign exchange rate exposures of German nonfinancial corporations, *Journal of International Money and Finance* 23. 673-699.

Bartram, S. M., 2007. Corporate cash flow and stock price exposures to foreign exchange rate risk, *Journal of Corporate Finance* 13, 981-994.

Bartram, S. M., and Bodnar, G. M., 2005. The foreign exchange exposure puzzle. Working paper, John Hopkins University and Lancaster University.

Bartram, S. M. and Karolyi, G.A., 2006. The impact of the introduction of the Euro on foreign exchange rate risk exposures, *Journal of Empirical Finance* 13, 519-549.

Black, F., Jensen, M. C., and Scholes, M., 1972. The capital asset pricing model: Some empirical findings; in Michael C. Jensen, ed.: Studies in the Theory of Capital Markets (Praeger, New York).

Bodnar, G. M., Dumas, B., and Marston, R. C., 2002. Pass-though and exposure. *Journal of Finance* 57, 199-232.

Bodnar, G. M. and Gentry, W. M., 1993. Exchange rate exposure and industry characteristics: Evidence from Canada, Japan, and the USA, *Journal of International Money and Finance* 12, 29-45

Bodnar, G.M., and Wong, M. H. F., 2003. Estimating exchange rate exposures: issues in model structure. *Financial Management* 32, 35-67.

Breeden, D. T., Gibbons, M. R., and Litzenberger, R. H., 1989. Empirical Test of the Consumption-Oriented CAPM, *Journal of Finance* 44, 231-262.

Carhart, M. M., 1997. On persistence in mutual fund performance. *Journal of Finance* 52, 57-82.

Choi, J. J., and Prasad, A. M., 1995. Exchange risk sensitivity and its determinants: a firm and industry analysis of U.S. multinationals. *Financial Management* 24, 77–88.

Chow, E.H., Lee, W.Y., and Solt, M.E., 1997. The exchange-rate risk exposure of asset returns. *Journal of Business* 70, 105-123.

Doidge, C., Griffin, J., and Williamson, R., 2006. Measuring the economic importance of exchange rate exposure?. *Journal of Empirical Finance* 13, 550-576.

Dominguez, K. M. E., and Tesar, L. L., 2001. A re-examination of exchange rate exposure. *American Economic Review* 91, 396–399.

Fama, E. F., and French, K. R., 1988. Dividend Yields and Expected Stock Returns, *Journal of Financial Economics* 22, 3-25.

Fama, E.F., and French, K. R., 1992. The cross-section of expected stock returns. *Journal of Finance* 47, 427-465.

Fama, E.F., and French, K. R., 1993. Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics* 33, 3-56.

Fama, E. F., and French, K. R., 1996. Multifactor explanations of asset pricing anomalies. *Journal of Finance* 51, 55-84.

Fama, E. F., and MacBeth, J. D., 1973. Risk, return and equilibrium: Empirical tests, *Journal of Political Economy* 81, 607-636.

Froot, K., Sharfstein, D. and Stein, J., 1993. Risk management: Coordinating corporate investment and financing decisions. *Journal of Finance* 48, 1629-1648.

Griffin, J. M. and Stulz, R. M., 2001. International competition and exchange rate shocks: A cross-county industry analysis of stock returns, *Review of Financial Studies* 14, 215-241

He, J., and Ng, L. K., 1998. The foreign exchange exposure of Japanese multinational corporations. *Journal of Finance* 53, 733-753.

Jagannathan, R., and Wang, Z., 1998, An asymptotic theory for estimating beta-pricing models using cross-sectional regression, *Journal of Finance* 53, 1285-1309.

Jorion, P., 1990. The exchange-rate exposure of U.S. multinationals. *Journal of Business* 63, 331-345

Khoo, A., 1994. Estimation of foreign exchange rate exposure: an application to mining com-panies in Australia. *Journal of International Money and Finance* 13, 342-363.

Kim, D., 1995. The errors in the variables problem in the cross-section of expected stock returns, *Journal of Finance* 50, 1605-1634.

Kolari, J., Moorman, T., and Sorescu, S. M.., 2008. Foreign Exchange Risk and the Cross-Section of Stock Returns. *Journal of International Money and Finance* 27, 1074-1097.

Lamont, O. A., 2001. Economic tracking portfolios, *Journal of Econometrics*, 105, 161-184.

Landona, S., and Smith, C. E., 2009 Investment and the exchange rate: Short run and long run aggregate and sector-level estimates, *Journal of International Money and Finance* 28, 813-835.

Lettau, M., and Ludvigson, S., 2001. Consumption, Aggregate Wealth, and Expected Stock Returns, *Journal of Finance* 56, 815-849.

Lewellen, J. W., Nagel, S., and Shanken, J. A., 2009. A Skeptical Appraisal of Asset Pricing Tests, *Journal of Financial Economics*, forthcoming.

Meese, R. A., and Rogoff, K., 1988. Was It Real? The Exchange Rate-Interest Differential Relation over the Modern Floating Period. *Journal of Finance* 43, 923-948.

Merton, R. C., 1973, An intertemporal capital asset pricing model, *Econometrica* 41, 867-887.

Priestley, R., and Ødegaard, B. A., 2007. Linear and nonlinear exchange rate exposure, *Journal of International Money and Finance* 26, 1016-1037.

Sercu, P., 1980. A generalization of the international asset pricing model. *Revue de l'Association Française de Finance* 1, 91-135.

Shanken, J., 1992. On the estimation of beta-pricing models, *Review of Financial Studies* 5, 1-33.

Shanken, J., and Zhou, G., 2007. Estimating and Testing Beta Pricing Models: Alternative Methods and Their Performance in Simulations, *Journal of Financial Economics* 84, 40--86.

Smith, C. W., and Stulz, R., 1985. The determinants of firms' hedging policies, *Journal of Financial and Quantitative Analysis* 20, 391-405

Solnik, B., 1974. An equilibrium model of the international capital market. *Journal of Economic Theory* 8, 500-524.

Starks, L. T., and Wei, K. D., 2005. Foreign exchange exposure and short-term cash flow sensitivity. Working paper, University of Texas, Austin, TX.

Stulz, R., 1984. Optimal hedging policies, *Journal of Financial and Quantitative Analysis* 19, 127-140.

Vassalou, M., 2000. Exchange rate and foreign inflation risk premiums in global equity returns. *Journal of International Money and Finance* 19, 433-475.

Vassalou, M., 2003. News Related to Future GDP Growth as a Risk Factor in Equity Returns. *Journal of Financial Economics*, 68, 47-73.