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

# Cash Flow, Currency Risk, and the Cost of Capital

**Working Paper Series—11-12 | October 2011**

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

Ou Hu
Department of Economics
Youngstown State University
Youngstown, OH 44555

ohu@ysu.edu

(330) 941-2061

# Cash Flow, Currency Risk, and the Cost of Capital

## 1. Introduction

Firms are impacted by currency fluctuations. Hung (1992) finds that the loss due to currency fluctuations for U.S. manufacturing firms is about 10% per year of gross profits in the 1980s. A Philadelphia Federal Reserve Bank survey cited by Francis, Hasan, and Hunter (2008) finds that "over 45% of U.S. firms reported that they are affected by currency movements (p. 177). Nucci and Pozzolo (2010) "document a statistically significant effect of exchange rate variations on employment, hours worked and wages in a representative panel of Italian manufacturing firms." (p.121)

A voluminous literature has developed assessing currency risk. Most theoretical models of currency risk emphasize the impact of currency fluctuations on firms' cash flows (e.g. Stulz, 1984; Smith and Stulz, 1985; and Froot, Sharfstein, and Stein, 1993). However, the common empirical approach is to focus on stock returns instead (e.g., Adler and Dumas, 1983). This approach, in general, finds that currency risk is not priced (e.g., Jorion, 1990, 1991).[1] Despite the weak results from this common approach, few studies have attempted to examine currency risk from a cash flow perspective. This paper intends to fill this gap. Our focus on cash flows is also motivated by Hou, Karolyi and Kho (2011) who recently find robust evidence that cash flow is related to a covariance risk factor in global stock markets. Specifically, Hou, Karolyi and Kho (2011) find that the cash flow mimicking portfolio always carries an economically and statistically significant risk premium even after controlling for variation in the cash flow characteristic.

In terms of empirical implementation, we use the mimicking portfolio approach that is consistent with domestic asset-pricing models of Fama and French (1992, 1993) and utilized by Kolari, Moorman, and Sorescu (2008) to examine currency risk.[2] Consistent with Kolari, Moorman, and Sorescu (2008), we first estimate the sensitivity of each firm's operating cash flows to currency movements in a rolling fashion (to allow for time-variation in currency exposure); then we construct a zero-investment portfolio that takes long positions in stocks whose operating cash flows have positive sensitivity to currency movements and short positions in stocks whose operating cash flows have negative currency sensitivity. We refer to it as PMN (or positive minus negative).

Since the return of the PMN portfolio is driven by currency movements, PMN is the factor-mimicking portfolio of currency risk and its average return represents the risk premium on currency risk. PMN is based on firms' fundamentals (i.e. operating cash flows). Therefore, if it is significant in the standard asset-pricing tests, it is unlikely due to possible spurious correlation discussed by Lewellen, Nagel and Shanken (2010).[3] This is one major advantage of our approach.

Our approach has two more advantages. First, previous studies (see Footnote 1) typically use raw exchange rate changes, which, as macroeconomic variables (not returns), contain information that is irrelevant to asset pricing and may also have measurement errors. In contrast, our mimicking factor portfolio captures only the information in currency movements that is pertinent to stock returns, and therefore should reduce the noise in estimations. See Chan, Karceski and Lakonishok (1998, 1999), Kolari, Moorman, and Sorescu (2008), and Hou, Karolyi and Kho (2011) for more discussion and applications of the mimicking portfolio approach. Second, previous studies usually do not allow for time variation in currency exposure, which as Francis, Hasan, and Hunter (2008), among others, point out is a

[1] See also Khoo (1994), Bartov and Bodnar (1994), Allayannis (1997), Chow, Lee and Solt (1997), Vassalou (2000), Griffin (2002), Bodnar and Wong (2003), Bartram (2004), Bartram and Bodnar (2005), and Bartram (2007). Although Bartram (2008) and Bartram, Brown, and Minton (2010) argue that firms use hedges to greatly reduce currency exposures, their arguments do not seem to be consistent with the firm-level evidence in Hung (1992), Francis, Hasan, and Hunter (2008) and Nucci and Pozzolo (2010).

[2] The major difference between this paper and Kolari, Moorman, and Sorescu (2008) is that we focus on cash flows which is well motivated by theories, where Kolari, Moorman, and Sorescu (2008) center on stock returns.

[3] This observation motives Da (2009) to focus on cash flows to test consumption risk.

major methodological weakness. In contrast, our approach estimates firms' currency sensitivities in a rolling regression fashion, which takes into account time variation in exposure in a non-structural framework. See Doidge, Griffin, and Williamson (2006) for more discussion.

More specifically, we first construct 25 size and cash-flow-sensitivity portfolios as our test assets in line with Fama and French (1993) and Kolari, Moorman, and Sorescu (2008). Cash-flow sensitivity refers to the sensitivity of firms' operating cash flows to currency movements. We then compare the standard Fama-French three-factor model (as well as the four-factor model that employs exchange rate changes as the currency risk proxy) with our new four-factor model that includes PMN as the currency risk factor from pole to pole in standard time-series and cross-sectional asset pricing tests. We find that our new four-factor model including PMN outperforms both the Fama-French three-factor model and the standard four-factor model. Taken all the evidence together, our findings suggest that currency risk is relevant for asset pricing if we focus on its impact on firms' cash flows. Our results are robust regardless of whether we use a different set of testing assets or whether we use real or nominal exchange rates.

Based on our four-factor model including PMN, we find that the impact of currency risk on the cost of capital is not only statistically but also economically significant. With the average currency beta being around 0.22 in absolute value and the average currency risk premium being about 6% per year, our estimates suggest that the impact of currency risk on the cost of capital is about 1.3% per year (or 11.4% of the average risk premium). Over time, the impact of currency risk on the cost of capital does not decrease but increases.

The remainder of the paper is organized as follows: Section 2 discusses the data and how we construct the currency risk factor PMN. Section 3 presents the empirical methodology and results. Section 4 is robustness check. Section 5 concludes the paper with a brief summary.

## 2. Motivation and Currency Risk Factor

### *2.1 Data*

A firm's value depends on cash flows generated from its operations or operating cash flows (OCFs). Therefore, we focus on operating cash flows in this paper. We use the OCF measure that is commonly used in the literature (e.g., Hirshleifer, Hou and Teoh, 2009). More specifically, we define operating cash flow as earnings after depreciation less accruals, where accruals is the change in non-cash current assets less the change in current liabilities excluding the change in short-term debt and the change in taxes payable, minus depreciation and amortization expense. Following Huang (2009), we standardize OCF by sales. As Huang (2009) points out, using sales as the scalar has the advantage of removing seasonality from cash flows. The quarterly accounting data are obtained from the Compustat database.

To be consistent with relevant literature (e.g., Francis, Hasan, and Hunter, 2008), we focus on all NYSE, AMEX, and NASDAQ stocks in the 36 industries that are most likely to be affected by currency risk.[4] The monthly stock returns data are obtained from CRSP. The Fama-French factors data are from Kenneth French's website. Our sample covers July 1980 to December 2008.

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 in St. Louis. The Major Currency Index includes the Euro Area, Canada, Japan, United Kingdom, Switzerland, Australia, and Sweden. Panel A of Figure 1 shows the raw MCI over our sample period. As we can see, the value of the trade-weighted dollar changes substantially over our sample period.[5]

---

[4] They are made up of 31 traded-goods (manufacturing) industries and five nontraded-goods industries (Entertainment, Construction, Meals, Retail Goods and Banking).

[5] MCI is a nominal exchange rate series. However, in the robustness check section, we show that using real exchange rates would yield qualitatively similar results.

*2.2 Currency Risk Factor PMN*

Since theory emphasizes the impact of currency movements on firms' cash flows, we construct the currency factor portfolio based on the sensitivity of firms' cash flows to currency movements. Essentially, we construct a zero-investment portfolio that takes long positions in stocks whose OCFs have positive sensitivity to currency movements and short positions in stocks whose OCFs have negative currency sensitivity. Since the currency factor portfolio is based on firms' fundamentals (i.e. OCFs), it is unlikely to be a spurious factor in the Lewellen, Nagel and Shanken (2010) sense.

In line with Fama and French (1993), we form our currency factor portfolio in two steps. The first step is to form six value-weighted size and cash-flow-sensitivity portfolios with all stocks in the 36 industries for which we have appropriate accounting data. The portfolios, which are constructed at the end of each June, are the intersections of two portfolios formed on size (market equity) and three portfolios formed on cash-flow sensitivity. The size breakpoint for year t is the median NYSE market equity at the end of June of year t. The cash-flow sensitivity for June of year t is estimated with the prior five years' quarterly data (i.e. from the third quarter of year t-5 to the second quarter of t) in a regression with the quarterly standardized OCF as the dependent variable and the quarterly exchange rate change as the independent variable. That is,

$$\frac{OCF_{it}}{Sales_{it}} = a_i + b_i \Delta MCI_t + e_{it} \qquad (1)$$

where $OCF_{it}$ is the quarterly operating cash flow defined as Hirshleifer, Hou and Teoh (2009), $Sales_{it}$ is the quarterly sales, and $\Delta MCI_t$ is the percentage change in quarterly MCI. $b_i$ is the cash-flow sensitivity of firm i. The cash-flow sensitivity breakpoints are the 30th and 70th percentiles.

These portfolios are held for one year (from July of year t to June of year t+1) and rebalanced at the end of June of year t+1. That is, at the end of June of year t+1, we reclassify stocks based on their size at the end of June of year t+1 and their cash-flow sensitivity based on the coefficient estimate over the prior five years (i.e. from the third quarter of year t-4 to the second quarter of t+1). By rebalancing the portfolios on an annual basis in a conditional fashion, we allow currency exposure of firms' OCFs to be time varying, which as Francis, Hasan, and Hunter (2008) suggest is important for studying currency risk.

Table 1 shows the annual mean returns and other relevant summary statistics of the six size and cash-flow-sensitivity portfolios. Consistent with the literature (e.g. Fama and French, 1993), small firms in our sample have higher average returns than large firms. However, what is new is that the mean return generally increases monotonically with the cash-flow sensitivity within a size group. For instance, within small stocks, the mean returns for the firms with negative, neutral and positive cash-flow sensitivity are 15.57% per year, 17.25% per year and 20.62% per year, respectively. A similar pattern is also found in large stocks. These results therefore suggest a positive linear risk premium on the currency risk factor, which is consistent with general perception. For instance, Starks and Wei (2005) argue that currency fluctuations can push a firm into financial distress. Therefore, currency risk may be a distress risk much like the value factor in the three-factor model of Fama and French (1993). Given the risk premium of the value factor is linear and positive, the risk premium on the currency risk factor should be linear and positive too.

**Table 1 Mean Returns of Six Size and Cash-Flow Sensitivity Portfolios**

| Size | CF Sensitivity | Number of firm months | Cash Flow Sensitivity: Estimate | Percent Positive | Percent significant at 10% level | Size | Average annual raw return |
|---|---|---|---|---|---|---|---|
| **Small** | Negative | 24510 | -26.67 | 0.00 | 0.19 | 167050 | 15.57 |
| | Neutral | 28264 | -0.04 | 0.46 | 0.01 | 232680 | 17.25 |
| | Positive | 24095 | 20.64 | 1.00 | 0.18 | 183470 | 20.62 |
| **Big** | Negative | 7473 | -2.50 | 0.00 | 0.24 | 8249400 | 13.44 |
| | Neutral | 14471 | -0.05 | 0.44 | 0.03 | 8440800 | 13.44 |
| | Positive | 7940 | 1.42 | 1.00 | 0.24 | 6340000 | 19.62 |

Table 1 shows the annual mean returns of the six size and cash-flow sensitivity portfolios. The sensitivity to cash flow is estimated over a five-year period. Size is calculated as the price times the number of shares outstanding in June of year t. The table shows portfolio averages for size, the cash-flow sensitivity, and returns. Firm months used in each portfolio are shown also, along with the percentage of firm months for which cash-flow sensitivity is positive or significant at the 10% level over the formation period.]

Again, in line with Fama and French (1993), the second step is to define the currency risk factor as the average return on the two positive sensitivity portfolios minus the average return on the two negative sensitivity portfolios. That is, our currency risk factor, $PMN_t$, is

$$PMN_t = \left(\frac{BP_t + SP_t}{2}\right) - \left[\frac{BN_t + SN_t}{2}\right] \tag{2}$$

where $BP_t$, $SP_t$, $BN_t$ and $SN_t$ are the returns on large and positive sensitivity, small and positive sensitivity, large and negative sensitivity, and small and negative sensitivity portfolios, respectively. Since the return of the PMN portfolio is driven by currency movements, PMN is the mimicking-factor portfolio of currency risk and its average return represents the risk premium on the currency risk.

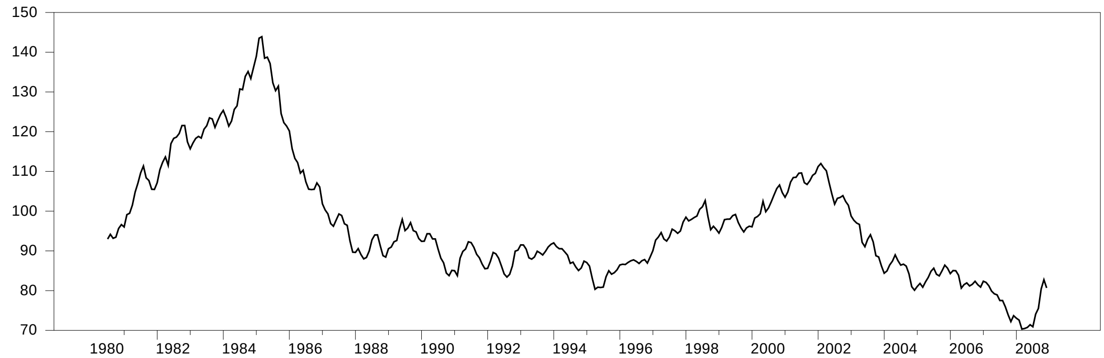
**Table 2 Correlation Matrix of the Relevant Variables**

| | MMR | SMB | HML | PMN |
|---|---|---|---|---|
| **MMR** | 1.00 | 0.20 | -0.48 | 0.00 |
| **SMB** | 0.20 | 1.00 | -0.38 | -0.06 |
| **HML** | -0.48 | -0.38 | 1.00 | -0.01 |
| **PMN** | 0.00 | -0.06 | -0.01 | 1.00 |

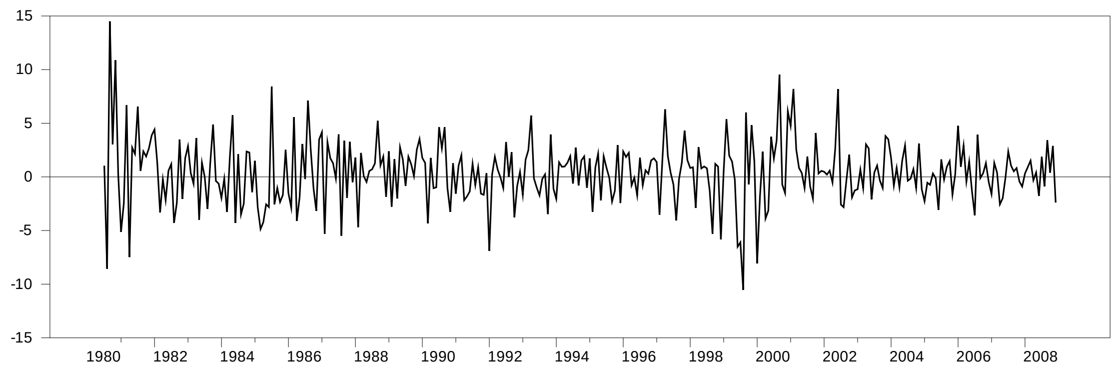
Panel B of Figure 1 shows the currency risk factor (PMN) over our sample period. In Table 2, we report the correlations of PMN with the Fama-French three factors. As we can see, the currency risk factor PMN is orthogonal to the Fama-French three factors. The correlations are all very close to zero, ranging from 0.00 with the market factor to -0.06 with the size factor. Therefore, if PMN is significant in our empirical tests, it cannot be due to its spurious correlation with the Fama-French factors. That is, PMN must be a relevant risk factor for asset pricing.

**Figure 1 MCI and Currency Risk Factor**

Panel A Trade -Weighted Value of the U.S. Dollar




Panel B Currency Risk Factor PMN




Panel A shows the raw MCI over our sample period, while Panel B depicts the currency risk factor PMN.

If PMN is a relevant risk factor, its mean return is an estimate of its risk premium. The mean return of the currency risk factor PMN is 0.40% per month or about 5% per year, which is not only statistically but also economically significant.

## 3. Empirical Methodology and Results

Empirically, in line with Fama and French (1993), we construct 25 size and cash-flow-sensitivity portfolios as our testing assets. Cash-flow sensitivity again refers to the sensitivity of firms' operating cash flows to currency movements. These 25 portfolios are constructed in a similar way as the six size and cash-flow-sensitivity portfolios in Section 2.2. Table 3 shows the annual mean returns and other relevant summary statistics of these portfolios. Again, the same patterns emerge: the mean return increases monotonically with cash flow sensitivity (and decreases monotonically with size), suggesting a positive linear risk premium on currency risk.

We take into account firm size, because the size-based analysis may offer some insight on the role of hedging in currency exposure. Large firms may be more exposed to currency risk due to the fact that they tend to be operating more globally. As a result, they may have more incentive to engage in hedging. Clearly, large firms may also have more resources for professional risk management. Thus, if hedging plays a critical role in currency exposure as Bartram (2008) and Bartram, Brown, and Minton (2010) suggest, we expect that large firms have significantly smaller exposure than do small firms. On the other hand, if hedging does not tell the full story of the exposure puzzle as Francis, Hasan, and Hunter (2008) suggest, we expect that large firms have significantly larger exposure to currency risk.

**Table 3 Mean Returns of 25 Size and Cash-Flow Sensitivity Portfolios**

| | | | Sensitivity | | | | |
|---|---|---|---|---|---|---|---|
| **Size** | **CF Sensitivity** | **Number of firm months** | **Estimate** | **Percent Positive** | **Percent significant at 10% level** | **Size** | **Average annual raw return** |
| **Small** | Negative | 3943 | -81.03 | 0.00 | 0.26 | 18174 | 23.08 |
| | 2 | 3986 | -0.82 | 0.03 | 0.07 | 17575 | 19.12 |
| | 3 | 4008 | -0.18 | 0.29 | 0.00 | 21889 | 29.37 |
| | 4 | 4032 | 0.40 | 0.89 | 0.01 | 20106 | 22.53 |
| | Positive | 4692 | 11.80 | 0.99 | 0.17 | 17721 | 26.75 |
| **2** | Negative | 4105 | -55.17 | 0.00 | 0.24 | 81841 | 10.46 |
| | 2 | 4124 | -0.72 | 0.00 | 0.06 | 85603 | 23.18 |
| | 3 | 4064 | -0.14 | 0.27 | 0.00 | 82754 | 18.65 |
| | 4 | 4091 | 0.38 | 0.91 | 0.04 | 86298 | 22.46 |
| | Positive | 4885 | 47.82 | 0.99 | 0.22 | 82693 | 25.19 |
| **3** | Negative | 4115 | -16.35 | 0.00 | 0.29 | 279390 | 14.02 |
| | 2 | 4126 | -0.50 | 0.06 | 0.07 | 270790 | 14.93 |
| | 3 | 4073 | -0.04 | 0.47 | 0.02 | 285730 | 14.71 |
| | 4 | 4121 | 0.38 | 0.85 | 0.05 | 288010 | 14.56 |
| | Positive | 4877 | 43.25 | 0.99 | 0.23 | 263390 | 15.88 |
| **4** | Negative | 4116 | -12.82 | 0.00 | 0.26 | 858130 | 10.69 |
| | 2 | 4100 | -0.46 | 0.01 | 0.08 | 827610 | 14.25 |
| | 3 | 4099 | -0.07 | 0.37 | 0.00 | 868030 | 13.90 |
| | 4 | 4123 | 0.27 | 0.84 | 0.03 | 857430 | 17.07 |
| | Positive | 4905 | 7.27 | 0.98 | 0.28 | 888710 | 14.57 |
| **5** | Negative | 4285 | -1.48 | 0.00 | 0.26 | 9628900 | 9.05 |
| | 2 | 4293 | -0.47 | 0.01 | 0.15 | 11352000 | 18.66 |
| | 3 | 4293 | -0.11 | 0.28 | 0.02 | 10223000 | 13.46 |
| | 4 | 4263 | 0.20 | 0.80 | 0.01 | 10461000 | 14.54 |
| | Positive | 5034 | 1.56 | 0.99 | 0.21 | 8678000 | 20.46 |

We form 25 value-weighted size and cash-flow sensitivity portfolios as our testing assets. Table 4 shows the annual mean returns of these portfolios. Cash-flow sensitivity is estimated over a five-year period. Size is calculated as the price times the number of shares outstanding in June of year t. The table shows portfolio averages for size, cash-flow sensitivity, and returns. Firm months used in each portfolio are shown also, along with the percentage of firm months for which cash-flow sensitivity is positive or significant at the 10% level over the formation period.

Next, we compare the standard three-factor model (as well as the four-factor model that employs the exchange rate change as the currency risk proxy) with our new four-factor model that includes PMN as the currency risk factor from pole to pole in standard time-series and cross-sectional asset pricing tests.

*3.1 Time-Invariant Currency Exposure and Risk Premium*

*Currency Exposure*

To test our hypothesis, we consider three asset-pricing models. The first one is the standard Fama-French three factor model:

$$\text{Model 1: } r_{it} = \alpha_i + \beta_{i,M} M_t + \beta_{i,SMB} SMB_t + \beta_{i,HML} HML_{tt} + \varepsilon_{it} \qquad (3)$$

where $r_{it}$ is the excess return on asset *i* in period *t*, $M_t, SMB_t$ and $HML_t$ are the returns on the market, the size, the book-to-market factors. The $\beta$'s are the associated factor loadings, and $\varepsilon_{it}$ is the disturbance.

The second one is the standard four-factor model in the exchange rate literature that includes the Fama-French three factors and changes in MCI. As we have emphasized, exchange rate changes, as macroeconomic variables (not returns), contain information that is irrelevant to asset pricing and may also have measurement errors. As a result, using exchange rate changes may introduce noise and mask the true underlying relationship.

$$\text{Model 2: } r_{it} = \alpha_i + \beta_{i,M} M_t + \beta_{i,SMB} SMB_t + \beta_{i,HML} HML_t + \beta_{i,MCI} \Delta MCI_t + \varepsilon_{it} \quad (4)$$

The third model is our new four-factor model that includes the Fama-French three factors and the currency risk factor PMN (which reflects the impact of currency movements on firms' cash flows).

$$\text{Model 3: } r_{it} = \alpha_i + \beta_{i,M} M_t + \beta_{i,SMB} SMB_t + \beta_{i,HML} HML_t + \beta_{i,PMN} PMN_t + \varepsilon_{it} \quad (5)$$

We run time-series regressions portfolio by portfolio to estimate currency exposure. If as we conjecture currency risk is relevant but the change in exchange rate is a noisy proxy of currency risk, we expect that Model 2 will not outperform Model 1, but our Model 3 will outperform both Model 1 and Model 2.

The currency exposure results for the 25 size and cash-flow-sensitivity portfolios based on Eqs. (3), (4) and (5) are reported in Table 4 for the whole sample period from 1980:7 to 2008:12. To save space, we only report Alphas, currency exposure estimates and adjusted-$R^2$s. The t-ratios are based on Newey-West HAC standard errors with the lag parameter set equal to 12, and the significant estimates (at the 10% level for two-sided tests) are in bold. As we can see, Model 2 does not outperform Model 1 or the Fama-French three-factor model: the average of the absolute values of Alphas of Model 2 is 0.35 which is equal to that of Model 1; the average of the adjusted-$R^2$s of 0.54 is also equal to that of Model 1; furthermore, there are only three portfolios that have significant exposure to the change in MCI and the loadings do not change accordingly with the cash flow sensitivity. Note that 25 size and cash-flow-sensitivity portfolios are constructed based on the sensitivity of firms' operating cash flows to currency movements.

In contrast, Model 3 seems to marginally outperform both Model 1 and Model 2. The average of the absolute values of Alphas of Model 3 is 0.33 which is slightly smaller than those of Model 1 and Model 2. The average of the adjusted-$R^2$s of 0.55 is also slightly higher than those of Model 1 and Model 2. More importantly, 11 out of 25 or 44% of the size and cash-flow-sensitivity portfolios have statistically significant exposure to the currency risk PMN, and negative/positive cash-flow sensitivity portfolios generally have negative/positive loadings on the PMN factor. Therefore, our results indicate that stocks are exposed to currency risk if we focus on the impact of currency fluctuations on cash flows.

As we can also see from Table 4, large firms do not have smaller exposure to currency risk than do small firms. For instance, four out of five portfolios with the largest size have significant exposure to the currency risk PMN, where none of five portfolios with the smallest size has significant exposure to PMN. The results therefore suggest that hedging may not tell the full story of the exposure puzzle. Large firms have more incentive to engage in hedging because they tend to be operating more globally. Large firms may also have more resources for professional risk management. Thus, if hedging plays a critical role in currency exposure as Bartram (2008) and Bartram, Brown, and Minton (2010) suggest, we would expect that large firms have smaller exposure than do small firms (not the opposite as we find in Table 4).

*Currency Risk Premium*

To estimate the risk premium on the currency risk factor, 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 those to obtain risk premium 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 (MIS) robust standard errors.[6]

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

## Table 4 Currency Exposure based on Nominal MCI over 1980-2008

| | OCF | Model 1 | | Model 2 | | | Model 3 | | |
|---|---|---|---|---|---|---|---|---|---|
| **Size** | **Sensitivity** | $\alpha_i$ | **Adj-$R^2$** | $\alpha_i$ | $\beta_{i,\ MCI}$ | **Adj-$R^2$** | $\alpha_i$ | $\beta_{i,\ PMN}$ | **Adj-$R^2$** |
| **Small** | Negative | 0.54 | 0.34 | 0.54 | -0.16 | 0.34 | 0.67 | -0.30 | 0.34 |
| | | ( 1.26 ) | | ( 1.25 ) | ( -0.79 ) | | ( 1.52 ) | ( -1.51 ) | |
| | 2 | 0.34 | 0.34 | 0.35 | 0.30 | 0.34 | 0.30 | 0.09 | 0.34 |
| | | ( 0.94 ) | | ( 0.98 ) | ( 1.44 ) | | ( 0.96 ) | ( 0.38 ) | |
| | 3 | **1.20** | 0.35 | **1.22** | **0.58** | 0.36 | **1.18** | 0.06 | 0.35 |
| | | ( 3.11 ) | | ( 3.20 ) | ( 2.21 ) | | ( 3.09 ) | ( 0.54 ) | |
| | 4 | **0.61** | 0.29 | **0.62** | 0.22 | 0.30 | **0.63** | -0.04 | 0.29 |
| | | ( 1.92 ) | | ( 1.97 ) | ( 1.19 ) | | ( 1.92 ) | ( -0.35 ) | |
| | Positive | **0.99** | 0.30 | **0.99** | -0.11 | 0.30 | **0.92** | 0.16 | 0.30 |
| | | ( 2.46 ) | | ( 2.46 ) | ( -0.51 ) | | ( 2.22 ) | ( 1.32 ) | |
| **2** | Negative | -0.35 | 0.53 | -0.34 | 0.18 | 0.51 | -0.12 | **-0.53** | 0.53 |
| | | ( -0.91 ) | | ( -0.89 ) | ( 0.93 ) | | ( -0.33 ) | ( -2.95 ) | |
| | 2 | **0.71** | 0.54 | **0.70** | -0.17 | 0.53 | **0.77** | **-0.14** | 0.54 |
| | | ( 2.44 ) | | ( 2.48 ) | ( -1.36 ) | | ( 2.51 ) | ( -2.00 ) | |
| | 3 | 0.21 | 0.48 | 0.22 | 0.10 | 0.48 | 0.22 | -0.01 | 0.48 |
| | | ( 0.79 ) | | ( 0.79 ) | ( 0.62 ) | | ( 0.78 ) | ( -0.08 ) | |
| | 4 | **0.57** | 0.50 | **0.57** | -0.10 | 0.50 | **0.61** | -0.08 | 0.50 |
| | | ( 2.15 ) | | ( 2.17 ) | ( -0.68 ) | | ( 2.15 ) | ( -0.74 ) | |
| | Positive | **0.73** | 0.46 | **0.74** | 0.12 | 0.44 | **0.56** | **0.41** | 0.46 |
| | | ( 2.04 ) | | ( 2.06 ) | ( 0.69 ) | | ( 1.74 ) | ( 2.61 ) | |
| **3** | Negative | 0.01 | 0.62 | 0.00 | -0.14 | 0.61 | 0.13 | **-0.30** | 0.62 |
| | | ( 0.01 ) | | ( 0.00 ) | ( -0.79 ) | | ( 0.32 ) | ( -1.79 ) | |
| | 2 | -0.02 | 0.54 | -0.02 | -0.06 | 0.54 | 0.02 | -0.09 | 0.54 |
| | | ( -0.08 ) | | ( -0.09 ) | ( -0.35 ) | | ( 0.07 ) | ( -1.01 ) | |
| | 3 | 0.00 | 0.57 | 0.00 | -0.05 | 0.57 | 0.00 | -0.01 | 0.57 |
| | | ( 0.01 ) | | ( 0.00 ) | ( -0.36 ) | | ( 0.02 ) | ( -0.09 ) | |
| | 4 | -0.01 | 0.56 | -0.01 | -0.04 | 0.55 | -0.06 | 0.10 | 0.56 |
| | | ( -0.05 ) | | ( -0.05 ) | ( -0.31 ) | | ( -0.23 ) | ( 1.19 ) | |
| | Positive | 0.05 | 0.72 | 0.05 | 0.04 | 0.69 | -0.13 | **0.41** | 0.72 |
| | | ( 0.21 ) | | ( 0.21 ) | ( 0.41 ) | | ( -0.62 ) | ( 4.99 ) | |
| **4** | Negative | -0.38 | 0.61 | -0.38 | -0.02 | 0.60 | -0.27 | **-0.25** | 0.61 |
| | | ( -1.15 ) | | ( -1.15 ) | ( -0.13 ) | | ( -0.86 ) | ( -3.05 ) | |
| | 2 | -0.08 | 0.67 | -0.08 | 0.09 | 0.67 | -0.07 | -0.03 | 0.67 |
| | | ( -0.48 ) | | ( -0.46 ) | ( 1.04 ) | | ( -0.40 ) | ( -0.49 ) | |
| | 3 | -0.12 | 0.62 | -0.11 | **0.16** | 0.62 | -0.11 | -0.02 | 0.62 |
| | | ( -0.65 ) | | ( -0.61 ) | ( 1.76 ) | | ( -0.62 ) | ( -0.25 ) | |
| | 4 | 0.07 | 0.59 | 0.07 | 0.02 | 0.59 | 0.09 | -0.04 | 0.59 |
| | | ( 0.32 ) | | ( 0.32 ) | ( 0.16 ) | | ( 0.43 ) | ( -0.41 ) | |
| | Positive | 0.04 | 0.69 | 0.04 | 0.08 | 0.69 | -0.02 | **0.14** | 0.69 |
| | | ( 0.18 ) | | ( 0.19 ) | ( 0.68 ) | | ( -0.11 ) | ( 1.72 ) | |
| **Big** | Negative | -0.19 | 0.66 | -0.18 | **0.37** | 0.62 | 0.03 | **-0.51** | 0.66 |
| | | ( -0.99 ) | | ( -0.89 ) | ( 3.57 ) | | ( 0.15 ) | ( -4.31 ) | |
| | 2 | **0.40** | 0.64 | **0.40** | -0.10 | 0.61 | **0.53** | **-0.30** | 0.64 |
| | | ( 2.14 ) | | ( 2.16 ) | ( -1.29 ) | | ( 2.79 ) | ( -3.64 ) | |
| | 3 | 0.22 | 0.64 | 0.22 | 0.04 | 0.64 | 0.27 | -0.12 | 0.64 |
| | | ( 1.09 ) | | ( 1.08 ) | ( 0.27 ) | | ( 1.43 ) | ( -1.27 ) | |
| | 4 | 0.18 | 0.64 | 0.19 | 0.08 | 0.63 | 0.11 | **0.17** | 0.64 |
| | | ( 1.09 ) | | ( 1.12 ) | ( 0.69 ) | | ( 0.67 ) | ( 2.33 ) | |
| | Positive | **0.69** | 0.74 | **0.69** | -0.08 | 0.71 | **0.55** | **0.32** | 0.74 |
| | | ( 3.94 ) | | ( 3.90 ) | ( -0.82 ) | | ( 3.33 ) | ( 3.27 ) | |

Model 1: $r_{it} = \alpha_i + \beta_{i,M} M_t + \beta_{i,SMB} SMB_t + \beta_{i,HML} HML_{tt} + \varepsilon_{it}$

Model 2: $r_{it} = \alpha_i + \beta_{i,M} M_t + \beta_{i,SMB} SMB_t + \beta_{i,HML} HML_t + \beta_{i,MCI} \Delta MCI_t + \varepsilon_{it}$

Model 3: $r_{it} = \alpha_i + \beta_{i,M} M_t + \beta_{i,SMB} SMB_t + \beta_{i,HML} HML_t + \beta_{i,PMN} PMN_t + \varepsilon_{it}$

where $r_{it}$ is the excess return on asset *i* in period *t*, $M_t$, $SMB_t$, $HML_t$, $PMN_t$ and $\Delta MCI_t$ are the market, the size, the book-to-market, the currency risk, and the contemporaneous change in exchange rate.

Consistent with previous analysis, we employ the following three cross-sectional regression models in the second pass. The first one is the Fama-French three factor model:

$$\text{Model 1: } \bar{r}_i = \gamma_0 + \gamma_M \hat{\beta}_{i,M} + \gamma_{SMB} \hat{\beta}_{i,SMB} + \gamma_{HML} \hat{\beta}_{i,HML} + \eta_i \tag{6}$$

The second one is the standard four-factor model that includes the Fama-French three factors and the change in MCI.

$$\text{Model 2: } \bar{r}_i = \gamma_0 + \gamma_M \hat{\beta}_{i,M} + \gamma_{SMB} \hat{\beta}_{i,SMB} + \gamma_{HML} \hat{\beta}_{i,HML} + \gamma_{MCI} \hat{\beta}_{i,MCI} + \eta_i \tag{7}$$

The third model is our new four-factor model that includes the Fama-French three factors and the currency risk factor PMN (which reflects the impact of currency movements on firms' cash flows).

$$\text{Model 3: } \bar{r}_i = \gamma_0 + \gamma_M \hat{\beta}_{i,M} + \gamma_{SMB} \hat{\beta}_{i,SMB} + \gamma_{HML} \hat{\beta}_{i,HML} + \gamma_{PMN} \hat{\beta}_{i,PMN} + \eta_i \tag{8}$$

where the $\hat{\beta}$ s are the factor loadings (jointly estimated for all the factors) from the first-pass time-series regression, and $\gamma$ s are the associated risk premiums. Again, if as we conjecture currency risk is relevant but the change in exchange rate is a noisy proxy of currency risk, we expect that Model 2 will not outperform Model 1, but our Model 3 will outperform both Model 1 and Model 2.

The results are reported in Table 5. As we can see, Model 2 does not outperform Model 1 in terms of explaining the cross-sectional differences in the returns of the 25 size and cash-flow-sensitivity portfolios. First, the change in MCI is not priced regardless of whether we use OLS or GLS. This is consistent with previous findings (i.e. Jorion, 1991). Second, adding the change in MCI decreases adjusted $R^2$. Note again that 25 size and cash-flow-sensitivity portfolios are constructed based on the sensitivity of firms' operating cash flows to currency movements.

In contrast, Model 3 significantly outperforms both Model 1 and Model 2. Regardless of whether we use OLS or GLS, the adjusted-$R^2$ improves substantially: based on OLS it increases from 0.55 in Model 1 to 0.70, and based on GLS it increases from 0.48 in Model 1 to 0.62! Thus, the currency risk factor PMN helps explain cross-sectional returns. More importantly, the currency risk factor is priced. Based on OLS, the premium associated with this factor is 0.61 percent per month with an EIV-robust t-statistic of 2.25 and a MIS-robust t-statistic of 2.21. The estimate is quite close to the mean return of the currency risk factor series PMN (0.40 percent per month), which is what we expect for a factor portfolio. The GLS estimate is similar and also significant even after we take into account the EIV problem and potential model misspecifications. Therefore, our results further confirm that currency risk matters if we focus on the impact of currency fluctuations on cash flows.

### *3.3Time Varying Currency Exposure and Risk Premium*

*Currency Exposure*

Currency exposure of testing assets can be time varying. To allow currency exposure to change over time, we repeat the previous exercise with rolling samples. Currency exposure is estimated with 10 years of data to obtain meaningful estimates. Consequently, the test period starts in 1990:7. We update estimates monthly by dropping the earliest observation and adding the latest observation. We report the average currency exposure in Table 6. Since we use overlapping data, the t-ratios are based on Newey-West HAC standard errors with the lag parameter set equal to 12.[7] Evidence suggests that 19 out of 25 (or 76%) size and cash-flow-sensitivity portfolios have significant currency exposure if we allow time variation in currency exposure, which further confirms that stocks are exposed to currency risk if we focus on the impact of currency fluctuations on cash flows. We report the average currency beta in absolute value for all 25 portfolios over time in Panel A of Figure 2. The average currency beta is around 0.22 in absolute value and never below 0.18, suggesting that currency risk is relevant.

[7] The results are robust for different lag parameters.

**Table 5 Risk Premium Estimates based on 25 Size and Cash-Flow Sensitivity Portfolios over 1980 to 2008**

| | | **Model 1** | |
|---|---|---|---|
| **OLS** | **Coefficient** | **EIV-robust t-ratio** | **MIS-robust t-ratio** |
| Alpha | **2.79** | 4.26 | 4.11 |
| M | **-1.87** | -2.90 | -2.83 |
| SMB | 0.03 | 0.12 | 0.12 |
| HML | 0.05 | 0.12 | 0.12 |
| Adj-$R^2$ | 0.55 | | |
| **GLS** | **Coefficient** | **EIV-robust t-ratio** | **MIS-robust t-ratio** |
| Alpha | **2.38** | 4.69 | 4.01 |
| M | **-1.46** | -2.76 | -2.42 |
| SMB | -0.04 | -0.16 | -0.15 |
| HML | 0.04 | 0.12 | 0.11 |
| Adj-$R^2$ | 0.48 | | |
| | | **Model 2** | |
| **OLS** | **Coefficient** | **EIV-robust t-ratio** | **MIS-robust t-ratio** |
| Alpha | **2.86** | 4.46 | 4.25 |
| M | **-1.92** | -3.03 | -2.94 |
| SMB | 0.02 | 0.06 | 0.06 |
| HML | 0.05 | 0.13 | 0.13 |
| ΔMCI | -0.09 | -0.21 | -0.18 |
| Adj-$R^2$ | 0.53 | | |
| **GLS** | **Coefficient** | **EIV-robust t-ratio** | **MIS-robust t-ratio** |
| Alpha | **2.33** | 4.41 | 3.85 |
| M | **-1.38** | -2.53 | -2.24 |
| SMB | -0.06 | -0.25 | -0.24 |
| HML | 0.05 | 0.14 | 0.13 |
| ΔMCI | -0.50 | -1.38 | -1.06 |
| Adj-$R^2$ | 0.37 | | |
| | | **Model 3** | |
| **OLS** | **Coefficient** | **EIV-robust t-ratio** | **MIS-robust t-ratio** |
| Alpha | **2.69** | 4.10 | 4.01 |
| M | **-1.76** | -2.73 | -2.69 |
| SMB | 0.07 | 0.25 | 0.25 |
| HML | 0.02 | 0.05 | 0.05 |
| PMN | **0.61** | **2.25** | **2.21** |
| Adj-$R^2$ | 0.70 | | |
| **GLS** | **Coefficient** | **EIV-robust t-ratio** | **MIS-robust t-ratio** |
| Alpha | **2.40** | 4.64 | 4.17 |
| M | **-1.45** | -2.70 | -2.47 |
| SMB | -0.07 | -0.30 | -0.29 |
| HML | 0.11 | 0.35 | 0.33 |
| PMN | **0.66** | **3.09** | **3.03** |
| Adj-$R^2$ | 0.62 | | |

Model 1: $\bar{r}_i = \gamma_0 + \gamma_M \hat{\beta}_{i,M} + \gamma_{SMB}\hat{\beta}_{i,SMB} + \gamma_{HML}\hat{\beta}_{i,HML} + \eta_i$

Model 2: $\bar{r}_i = \gamma_0 + \gamma_M \hat{\beta}_{i,M} + \gamma_{SMB}\hat{\beta}_{i,SMB} + \gamma_{HML}\hat{\beta}_{i,HML} + \gamma_{MCI}\hat{\beta}_{i,MCI} + \eta_i$

Model 3: $\bar{r}_i = \gamma_0 + \gamma_M \hat{\beta}_{i,M} + \gamma_{SMB}\hat{\beta}_{i,SMB} + \gamma_{HML}\hat{\beta}_{i,HML} + \gamma_{PMN}\hat{\beta}_{i,PMN} + \eta_i$

where the $\hat{\beta}$s are the factor loadings (jointly estimated for all the factors) from the first-pass time-series regression, and $\gamma$s are the associated risk premiums. EIV is the Shanken (1992)'s errors-in-variables robust t-ratios, and MIS is the Shanken and Zhou (2007)'s misspecification robust t-ratios.

**Figure 2 Time varying Currency Exposure and Risk Premium**

**Table 6 Time-Varying Currency Exposure**

| | | Mean Exposure | | | | |
|---|---|---|---|---|---|---|
| | | Cash Flow Sensitivity | | | | |
| | | **Negative** | **2** | **3** | **4** | **Positive** |
| | Small | **-0.37** | **-0.08** | 0.06 | **-0.25** | **0.18** |
| | 2 | **-0.41** | -0.03 | **-0.11** | **-0.15** | **0.16** |
| **Size** | 3 | **-0.46** | -0.04 | -0.06 | 0.08 | **0.33** |
| | 4 | **-0.30** | -0.03 | **0.10** | **0.18** | **0.25** |
| | Big | **-0.57** | **-0.30** | **-0.07** | **0.25** | **0.40** |
| | | **T-statistic $H_0$: Mean exposure = 0** | | | | |
| | | **Cash Flow Sensitivity** | | | | |
| | | **Negative** | **2** | **3** | **4** | **Positive** |
| | Small | -4.39 | -1.92 | 1.41 | -2.75 | 3.14 |
| | 2 | -6.98 | -0.71 | -2.57 | -4.60 | 2.86 |
| **Size** | 3 | -8.55 | -1.15 | -1.43 | 1.13 | 8.21 |
| | 4 | -7.02 | -0.85 | 3.40 | 7.96 | 7.09 |
| | Big | -12.69 | -8.40 | -2.34 | 9.46 | 20.95 |

To allow currency exposure to change over time, we repeat the currency exposure regressions with a rolling sample. Currency exposure is estimated with 10 years of data to obtain meaningful estimates. Consequently, the test period starts in 1990:7. We update estimates monthly by dropping the earliest observation and adding the latest observation. We report the average currency exposure in Table 7. Since we use overlapping data, the t-ratios are based on Newey-West HAC standard errors with the lag parameter set equal to 12.

*Currency Risk Premium*

The currency risk premium may also change over time. To obtain more information about the path of the currency risk premium over time, we repeat the previous exercise with rolling samples. The risk premium at each time is estimated with 10 years of data to obtain meaningful estimates. Consequently the test period starts in July 1990. We update estimates monthly by dropping the earliest observation and adding the latest observation. The results are displayed in Panel B of Figure 2. The average risk premium is 0.49% per month or about 6% per year, which is not only statistically but also economically significant. The evidence further confirms that the currency risk factor is relevant for asset pricing.

We also report the associated adjusted-$R^2$s from the above regressions in Panel C of Figure 2. As we can see, currency risk becomes more relevant in recent years for explaining cross-sectional returns. This trend is plausible given the tremendous growth in international trade. According to our calculations, U.S. imports and exports have increased from about 20% in 1980 to about 30% in 2008 as a percentage of U.S. GDP. It also suggests that hedging does not tell the full story of the exposure puzzle, because if it did we would expect that currency risk would become less relevant in explaining cross-sectional returns over time.

*Impact of Currency Risk on the Cost of Capital*

The impact of currency risk on the cost of capital can be measured by the product of risk premium and currency exposure in absolute value. We focus on the average estimates from the rolling regressions in this section since they allow time variation in currency exposure and currency risk premium. The results are reported in Panel D of Figure 2. As we can see, the impact of currency risk on the cost of capital varies substantially over time. The average impact is about 1.32% per year (or 11.4% of the average risk premium). More importantly, the impact of currency risk increases over time. This again suggests that hedging does not explain the full story of the exposure puzzle.

## 4 Robustness Check

### *4.1 Using 25 Cash-Flow Sensitivity Portfolios as Testing Assets*

Lewellen, Nagel and Shanken (2010) point out that a spurious factor can be statistically significant in standard asset pricing tests if test assets are the portfolios formed on size and book-to-market ratio. We emphasize that our currency risk factor PMN is based on firms' fundamentals (i.e. OCFs), and therefore is unlikely to be a spurious factor. However, for a robustness check, we use a different set of test assets to repeat the previous tests. More specifically, in line with Kolari, Moorman, and Sorescu (2008), we construct 25 portfolios based solely on cash-flow sensitivity as our test assets. Cash-flow sensitivity again refers to the sensitivity of firms' operating cash flows to currency movements. These 25 portfolios are constructed in a similar fashion as the 25 size and cash-flow-sensitivity portfolios in Section 3.

The currency exposure results are reported in Table 7 for the entire sample period from 1980 to 2008 in the same fashion as Table 4. As we can see, Model 2 (the standard four-factor model using the change in exchange rates as the currency risk proxy) does not outperform Model 1 (the Fama-French three-factor model): the average of the absolute values of Alphas of Model 2 is 0.36 which is equal to that of Model 1; the average of the adjusted-$R^2$s of 0.43 is also equal to that of Model 1; furthermore, there are eight portfolios that have significant exposure to the change in MCI, but their loadings do not change accordingly with the cash-flow sensitivity. Note again that 25 cash-flow-sensitivity portfolios are constructed based on the sensitivity of firms' operating cash flows to currency movements.

In contrast, Model 3 including PMN marginally outperforms both Model 1 and Model 2. The average of the absolute values of Alphas of Model 3 is 0.35 which is slightly smaller than those of Model 1 and Model 2. The average of the adjusted-$R^2$s of 0.44 is also slightly higher than those of Model 1 and Model 2. Furthermore, 13 out of 25 cash-flow-sensitivity portfolios have statistically significant exposure to the currency risk PMN, and negative/positive cash-flow-sensitivity portfolios generally have negative/positive loadings on the PMN factor.

The risk premium results are reported in Table 8 for the entire sample period from 1980 to 2008. As we can see, Model 2 does not outperform Model 1 in terms of explaining the cross-sectional differences in the returns of the 25 cash-flow sensitivity portfolios. First, the change in MCI is not priced. Second, adding the change in MCI decreases adjusted $R^2$. In contrast, Model 3 significantly outperforms both Model 1 and Model 2. Regardless of whether we use OLS or GLS, the adjusted-$R^2$ improves substantially. More importantly, the currency risk factor is priced, and the estimated premium of 0.72 percent per month (based on OLS) is very close to the estimate based on the 25 size and cash-flow sensitivity portfolios. Therefore, our results further confirm that currency risk matters for asset pricing if we focus on the impact of currency movements on firms' cash flows.

### *4.2 Using Real Exchange Rates*

Previous studies usually find that using either nominal or real exchange rates is not crucial for currency risk research (i.e. Jorion, 1990; Starks and Wei, 2005). For robustness, we repeat the previous tests with real MCI series from the Board of Governors of the Federal Reserve System. That is, we construct the PMN factor and the 25 size and cash-flow-sensitivity portfolios in the same way as in Sections 2 and 3 except that we use real MCI. We then redo all the tests in Section 3 with the new PMN and 25 size and cash-flow-sensitivity portfolios. When we retest Model 2 (the standard four-factor model), we also use the real MCI change.[8] In general, consistent with previous studies, we find that the results based on real exchange rates are qualitatively similar as those based on nominal exchange rates. In our case, the four-factor model including PMN again outperforms both the three-factor model and the four-factor model including the change in real MCI, which again suggests that currency risk matters for asset pricing if we focus on the impact of currency movements on firms' cash flows.

[8] To save space, we do not report the results. But they are available upon request.

**Table 7 Currency Exposure based on the 25 Cash-Flow Sensitivity Portfolios over 1980-2008**

| | Model 1 | | Model 2 | | | Model 3 | | |
|---|---|---|---|---|---|---|---|---|
| **Cash Flow Sensitivity** | $\alpha_i$ | **Adj-$R^2$** | $\alpha_i$ | $\beta_{i, MCI}$ | **Adj-$R^2$** | $\alpha_i$ | $\beta_{i, PMN}$ | **Adj-$R^2$** |
| **Negative 1** | 0.23 | 0.41 | 0.22 | -0.25 | 0.41 | 0.30 | -0.17 | 0.41 |
| | ( 0.56 ) | | ( 0.53 ) | ( -1.18 ) | | ( 0.73 ) | ( -1.19 ) | |
| **2** | 0.06 | 0.39 | 0.05 | -0.19 | 0.39 | 0.24 | **-0.42** | 0.40 |
| | ( 0.13 ) | | ( 0.12 ) | ( -0.91 ) | | ( 0.60 ) | ( -3.39 ) | |
| **3** | **-0.64** | 0.39 | **-0.63** | **0.35** | 0.39 | -0.46 | **-0.41** | 0.40 |
| | ( -2.15 ) | | ( -2.01 ) | ( 1.66 ) | | ( -1.60 ) | ( -3.28 ) | |
| **4** | -0.33 | 0.40 | -0.34 | -0.24 | 0.40 | -0.08 | **-0.59** | 0.45 |
| | ( -1.09 ) | | ( -1.14 ) | ( -1.12 ) | | ( -0.27 ) | ( -2.82 ) | |
| **5** | 0.26 | 0.42 | 0.27 | **0.31** | 0.42 | 0.42 | **-0.37** | 0.44 |
| | ( 0.84 ) | | ( 0.85 ) | ( 2.52 ) | | ( 1.35 ) | ( -2.64 ) | |
| **6** | -0.13 | 0.39 | -0.12 | **0.31** | 0.40 | 0.05 | **-0.43** | 0.42 |
| | ( -0.46 ) | | ( -0.43 ) | ( 1.83 ) | | ( 0.18 ) | ( -3.25 ) | |
| **7** | 0.19 | 0.48 | 0.19 | 0.06 | 0.48 | 0.30 | **-0.26** | 0.49 |
| | ( 0.52 ) | | ( 0.52 ) | ( 0.31 ) | | ( 0.85 ) | ( -2.04 ) | |
| **8** | **0.48** | 0.39 | **0.48** | -0.06 | 0.39 | **0.67** | **-0.44** | 0.43 |
| | ( 1.74 ) | | ( 1.74 ) | ( -0.37 ) | | ( 2.43 ) | ( -3.69 ) | |
| **9** | 0.05 | 0.45 | 0.05 | 0.04 | 0.45 | 0.13 | **-0.18** | 0.46 |
| | ( 0.18 ) | | ( 0.18 ) | ( 0.35 ) | | ( 0.41 ) | ( -1.83 ) | |
| **10** | 0.25 | 0.44 | 0.25 | 0.03 | 0.44 | 0.33 | **-0.20** | 0.45 |
| | ( 0.88 ) | | ( 0.88 ) | ( 0.19 ) | | ( 1.23 ) | ( -2.44 ) | |
| **11** | 0.13 | 0.43 | 0.12 | -0.06 | 0.43 | 0.18 | -0.13 | 0.44 |
| | ( 0.53 ) | | ( 0.52 ) | ( -0.46 ) | | ( 0.77 ) | ( -0.84 ) | |
| **12** | -0.10 | 0.49 | -0.10 | -0.05 | 0.49 | -0.08 | -0.04 | 0.49 |
| | ( -0.45 ) | | ( -0.47 ) | ( -0.36 ) | | ( -0.36 ) | ( -0.44 ) | |
| **13** | 0.38 | 0.47 | 0.39 | **0.35** | 0.47 | **0.48** | **-0.24** | 0.48 |
| | ( 1.62 ) | | ( 1.62 ) | ( 2.82 ) | | ( 2.10 ) | ( -2.49 ) | |
| **14** | **0.81** | 0.38 | **0.82** | 0.11 | 0.38 | **0.77** | 0.09 | 0.38 |
| | ( 1.91 ) | | ( 1.92 ) | ( 0.60 ) | | ( 1.92 ) | ( 0.65 ) | |
| **15** | -0.09 | 0.43 | -0.10 | -0.17 | 0.43 | -0.10 | 0.02 | 0.42 |
| | ( -0.27 ) | | ( -0.30 ) | ( -1.15 ) | | ( -0.29 ) | ( 0.18 ) | |
| **16** | **0.68** | 0.30 | **0.68** | 0.09 | 0.30 | **0.59** | 0.20 | 0.30 |
| | ( 1.88 ) | | ( 1.90 ) | ( 0.55 ) | | ( 1.83 ) | ( 1.04 ) | |
| **17** | **0.61** | 0.44 | **0.62** | **0.26** | 0.45 | **0.58** | 0.07 | 0.44 |
| | ( 2.02 ) | | ( 2.09 ) | ( 2.11 ) | | ( 1.98 ) | ( 0.64 ) | |
| **18** | -0.06 | 0.43 | -0.05 | **0.35** | 0.44 | -0.11 | 0.12 | 0.43 |
| | ( -0.24 ) | | ( -0.19 ) | ( 2.02 ) | | ( -0.45 ) | ( 1.35 ) | |
| **19** | 0.38 | 0.50 | 0.39 | **0.23** | 0.50 | 0.31 | **0.16** | 0.50 |
| | ( 1.52 ) | | ( 1.59 ) | ( 1.70 ) | | ( 1.27 ) | ( 2.23 ) | |
| **20** | 0.36 | 0.46 | 0.36 | -0.11 | 0.46 | 0.31 | 0.11 | 0.46 |
| | ( 1.47 ) | | ( 1.46 ) | ( -0.70 ) | | ( 1.33 ) | ( 1.05 ) | |
| **21** | **0.58** | 0.41 | **0.58** | -0.01 | 0.41 | 0.52 | 0.14 | 0.41 |
| | ( 1.83 ) | | ( 1.83 ) | ( -0.05 ) | | ( 1.60 ) | ( 1.15 ) | |
| **22** | 0.42 | 0.40 | 0.43 | **0.20** | 0.40 | 0.38 | 0.10 | 0.40 |
| | ( 1.51 ) | | ( 1.58 ) | ( 1.67 ) | | ( 1.40 ) | ( 0.73 ) | |
| **23** | **0.76** | 0.47 | **0.76** | 0.11 | 0.47 | **0.70** | 0.14 | 0.47 |
| | ( 2.92 ) | | ( 2.91 ) | ( 0.68 ) | | ( 2.85 ) | ( 1.13 ) | |
| **24** | **0.77** | 0.40 | **0.76** | -0.29 | 0.40 | **0.61** | **0.38** | 0.41 |
| | ( 2.25 ) | | ( 2.30 ) | ( -1.55 ) | | ( 1.86 ) | ( 2.28 ) | |
| **Positive 25** | 0.31 | 0.55 | 0.31 | -0.09 | 0.55 | 0.13 | **0.42** | 0.58 |
| | ( 1.19 ) | | ( 1.17 ) | ( -0.48 ) | | ( 0.50 ) | ( 3.79 ) | |

Model 1: $r_{it} = \alpha_i + \beta_{i,M} M_t + \beta_{i,SMB} SMB_t + \beta_{i,HML} HML_{tt} + \varepsilon_{it}$

Model 2: $r_{it} = \alpha_i + \beta_{i,M} M_t + \beta_{i,SMB} SMB_t + \beta_{i,HML} HML_t + \beta_{i,MCI} \Delta MCI_t + \varepsilon_{it}$

Model 3: $r_{it} = \alpha_i + \beta_{i,M} M_t + \beta_{i,SMB} SMB_t + \beta_{i,HML} HML_t + \beta_{i,PMN} PMN_t + \varepsilon_{it}$

where $r_{it}$ is the excess return on asset *i* in period *t*, $M_t, SMB_t$, $HML_t$, $PMN_t$ and $\Delta MCI_t$ are the market, the size, the book-to-market, the currency risk, and the contemporaneous change in exchange rate.

**Table 8 Risk Premium Estimates based on the 25 Cash-Flow Sensitivity Portfolios over 1980-2008**

| | | Model 1 | |
|---|---|---|---|
| **OLS** | **Coefficient** | **EIV-robust t-ratio** | **MIS-robust t-ratio** |
| Alpha | **2.06** | 2.46 | 1.96 |
| M | -1.15 | -1.42 | -1.15 |
| SMB | -0.08 | -0.18 | -0.17 |
| HML | 0.22 | 0.55 | 0.49 |
| Adj-$R^2$ | -0.04 | | |
| **GLS** | **Coefficient** | **EIV-robust t-ratio** | **MIS-robust t-ratio** |
| Alpha | **1.60** | 2.13 | 1.59 |
| M | -0.74 | -1.01 | -0.77 |
| SMB | 0.01 | 0.02 | 0.02 |
| HML | 0.43 | 1.18 | 1.03 |
| Adj-$R^2$ | -0.10 | | |
| | | **Model 2** | |
| **OLS** | **Coefficient** | **EIV-robust t-ratio** | **MIS-robust t-ratio** |
| Alpha | **2.06** | 2.45 | 1.96 |
| M | -1.13 | -1.40 | -1.13 |
| SMB | -0.18 | -0.39 | -0.34 |
| HML | 0.22 | 0.55 | 0.48 |
| ΔMCI | -0.15 | -0.43 | -0.30 |
| Adj-$R^2$ | -0.08 | | |
| **GLS** | **Coefficient** | **EIV-robust t-ratio** | **MIS-robust t-ratio** |
| Alpha | **1.58** | 2.08 | 1.55 |
| M | -0.73 | -0.99 | -0.75 |
| SMB | 0.02 | 0.06 | 0.05 |
| HML | 0.42 | 1.15 | 0.99 |
| ΔMCI | 0.09 | 0.29 | 0.21 |
| Adj-$R^2$ | -0.16 | | |
| | | **Model 3** | |
| **OLS** | **Coefficient** | **EIV-robust t-ratio** | **MIS-robust t-ratio** |
| Alpha | **2.06** | 2.39 | 2.13 |
| M | -1.14 | -1.37 | -1.23 |
| SMB | 0.12 | 0.27 | 0.26 |
| HML | 0.44 | 1.10 | 1.02 |
| PMN | **0.72** | 2.83 | 2.75 |
| Adj-$R^2$ | 0.33 | | |
| **GLS** | **Coefficient** | **EIV-robust t-ratio** | **MIS-robust t-ratio** |
| Alpha | **1.75** | 2.24 | 1.81 |
| M | -0.83 | -1.10 | -0.90 |
| SMB | 0.12 | 0.31 | 0.27 |
| HML | 0.52 | 1.38 | 1.25 |
| PMN | **0.64** | 2.63 | 2.54 |
| Adj-$R^2$ | 0.30 | | |

Model 1: $\bar{r}_i = \gamma_0 + \gamma_M \hat{\beta}_{i,M} + \gamma_{SMB}\hat{\beta}_{i,SMB} + \gamma_{HML}\hat{\beta}_{i,HML} + \eta_i$

Model 2: $\bar{r}_i = \gamma_0 + \gamma_M \hat{\beta}_{i,M} + \gamma_{SMB}\hat{\beta}_{i,SMB} + \gamma_{HML}\hat{\beta}_{i,HML} + \gamma_{MCI}\hat{\beta}_{i,MCI} + \eta_i$

Model 3: $\bar{r}_i = \gamma_0 + \gamma_M \hat{\beta}_{i,M} + \gamma_{SMB}\hat{\beta}_{i,SMB} + \gamma_{HML}\hat{\beta}_{i,HML} + \gamma_{PMN}\hat{\beta}_{i,PMN} + \eta_i$

where the $\hat{\beta}$ s are the factor loadings (jointly estimated for all the factors) from the first-pass time-series regression, and $\gamma$ s are the associated risk premiums. EIV is the Shanken (1992)'s errors-in-variables robust t-ratios, and MIS is the Shanken and Zhou (2007)'s misspecification robust t-ratios.

## 5. Conclusion

Although most theoretical models of currency risk emphasize the impact of currency fluctuations on firms' cash flows, the standard empirical approach is to focus on stock returns instead. This approach, in general, finds that currency risk is not priced. Despite the weak results from this standard approach, few studies have attempted to examine currency risk from a cash flow perspective. This paper intends to fill this gap.

In terms of empirical implementation, we use the mimicking portfolio approach that is in line with domestic asset-pricing models of Fama and French (1992, 1993) and utilized by Kolari, Moorman, and Sorescu (2008) to examine currency risk. Essentially, we construct a currency risk factor portfolio (PMN) that reflects the impact of currency movements on firms' cash flows. This factor is shown to be orthogonal to the Fama-French three factors. To test our conjecture, we focus on the comparison between the standard three-factor model (as well as the standard four-factor model that employs the exchange rate change as the currency risk proxy) and our new four-factor model that includes PMN. We show that, in both time series exposure regressions and cross-sectional premium regressions, the standard four-factor model does not outperform the Fama-French three-factor model, but our new four-factor model that takes into account the impact of currency movements on firms' cash flows outperforms both the standard four-factor model and the Fama-French three-factor model. Our results are robust regardless of whether we use a different set of testing assets or whether we use real or nominal exchange rates, which suggests that currency risk matters for asset pricing if we focus on the impact of currency movements on firms' cash flows.

**References**


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

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

Bartov, E., and G.M. Bodnar 1994. Firm Valuation, Earnings Expectations, and the Exchange Rate Exposure Effect, Journal of Finance 44:5: 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, Sohnke M., 2007, "Corporate Cash Flow and Stock Price Exposures to Foreign Exchange Rate Risk," Journal of Corporate Finance, 13, 981-994.

Bartram, Sohnke M., 2008, "What Lies Beneath: Foreign Exchange Rate Exposure, Hedging and Cash Flows," Journal of Banking and Finance, 32, 1508-1521.

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

Bartram, Sohnke M., G.W. Brown and B. Minton, 2010, "Resolving the Exposure Puzzle: The Many Facets of Exchange Rate Exposure," Journal of Financial Economics, 95, 148-173.

Black, F., M. C. Jensen, and M. Scholes, 1972, The Capital Asset Pricing Model: Some Empirical Findings; in Michael C. Jensen, ed.: (Praeger, New York). Studies in the Theory of Capital Markets

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

Chan, L. K. C., J. Karceski, and J. Lakonishok, 1998, The risk and return from factors, Journal of Financial and Quantitative Analysis 33, 159-188.

Chan, L. K. C., J. Karceski, and J. Lakonishok, 1999, On portfolio optimization: Forecasting covariances and choosing the risk model, The Review of Financial Studies 12, 937-974.

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.

Da, Zhi, 2009, Cash Flow, Consumption Risk, and the Cross-section of Stock Returns, Journal of Finance 64, 923-956.

Fama, E.F., 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 J. D. MacBeth, 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.

Francis, B., I Hasan, and D. Hunter, 2008, Can hedging tell the full story? Reconciling differences in U.S. aggregate- and industry-level exchange rate risk premium, Journal of Financial Economics, 90, 169-196.

Griffin, J.M., 2002. Are the Fama and French factors global or country specific? Review of Financial Studies 15, 783-803.

Hirshleifer, D., Hou, K., and Teoh, S. H., 2009. Accruals, cash flows, and aggregate stock returns, Journal of Financial Economics 91, 389-406.

Hou, K., A. Karolyi and B. Kho, 2011, What Factors Drive Global Stock Returns?, Review of Financial Studies, forthcoming.

Huang, A. G., 2009, The cross section of cash flow volatility and expected stock returns, Journal of Empirical Finance 16, 409–429.

Jagannathan, R., and Z. Wang, 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

Jorion, P. 1991. The Pricing of Exchange Rate Risk in the Stock Market, Journal of Financial and Quantitative Analysis 26:3: 363-376.

Khoo, A., 1994. Estimation of foreign exchange rate exposure: an application to mining companies 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.

Lewellen, J. W., Nagel, S., and Shanken, J. A., 2010. A Skeptical Appraisal of Asset Pricing Tests, Journal of Financial Economics 96, 175-194.

Nucci, F., and A. F. Pozzolo, 2010, The exchange rate, employment and hours: What firm-level data say", Journal of International Economics, 82, 112-123.

Shanken, J., 1992, On the Estimation of Beta-Pricing Models, Review of Financial Studies 5, 1-33.

Shanken, J., and G. Zhou, 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

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.