Global Macro Risks in Currency Excess Returns

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Abstract

We identify country macroeconomic fundamentals, whose first and higher-ordered moments have predictive power for currency excess returns. Using this identification in conjunction with the carry trade, we form portfolios of profitable currency excess returns and study the determinants of their cross-sectional variation. We find that global macro factors are priced in currency excess returns. The high-minus-low conditional skewness of the unemployment gap is a factor consistently and significantly priced in these returns. Somewhat weaker evidence points to the high-minus-low volatility of the real exchange rate depreciation as a second global risk factor.

Keywords: Currency excess returns, prediction, beta-risk, carry trade, global macro risk factors.
JEL: E21, E43, F31, G12

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Introduction

In this paper we study the macroeconomic determinants of currency excess returns and the macroeconomic risk factors for which those returns compensate. We first identify several country macroeconomic fundamentals, whose first and higher-ordered moments have predictive power for currency excess returns. We then use this identification in conjunction with the carry trade, to form portfolios of profitable currency excess returns to serve as test returns in an investigation into their cross-sectional behavior. In the cross-sectional analysis, we find that *global* macroeconomic risk factors are priced in currency excess returns. The global aspect of risk arises because the excess returns are available to global investors and not only to those with a U.S. domicile. Importantly, global macro risks are not diversifiable. If currency excess returns are exposed to such risks, they should be priced. The global macro risk factor we find to be consistently and significantly priced in these returns is the 'high-minus-low' (HML) conditional skewness of the unemployment gap. We also find that the HML conditional volatility of the real exchange depreciation may constitute a second risk factor, but here the evidence is weaker. Evidence that a consumption-based utility model, where the intertemporal marginal rate of substitution serves as the stochastic discount factor (SDF), can adequately explain the data is not robust.

A large literature has sought to understand currency excess returns by trying to make sense of the forward premium puzzle–recognized as an empirical regularity since Bilson (1981), Hodrick and Hansen (1983) and Fama (1984). That is, in regressions of the future exchange rate depreciation on the interest rate differential, the slope coefficient is not equal to one as implied by the zero-profit uncovered interest rate parity condition, but is typically negative. Because the interest rate differential between the two countries is not fully offset by subsequent exchange rate movements, systematically positive excess returns can be generated by shorting the low interest rate country's currency and using the proceeds to take a long position in the high interest rate country's currency. Hodrick (1987), Engel (1996) and Lewis (1996) survey this early work, which viewed excess returns as risk premia and emphasized the time-series properties of individual currency excess returns. Whether through estimation or quantitative evaluation of asset pricing models, explanatory power was low and this body of work was unable to produce or identify mechanisms for risk-premia that were sufficiently large or acceptably correlated with the excess returns.

Although the forward premium puzzle implies non-zero currency excess returns, they are different and distinct phenomena (see Hassan and Mano (2014)). Recent research deemphasizes the forward premium puzzle, focuses directly at understanding currency excess returns and employs methods used in finance which has produced new insights. One important methodological adjustment, introduced by Lustig and Verdelhan (2007), has been to change the observational unit from individual returns to portfolios of returns. Identification of systematic risk in currency excess returns has posed a challenge to this research and the use of portfolios aids in this identification by averaging out idiosyncratic return fluctuations. A second methodological shift is to study the cross-sectional variation in average returns instead of the time-series properties of returns.

Much of this research studies returns implied by the carry trade. This is where investors short portfolios of low-interest rate currencies and go long portfolios of high-interest rate currencies (e.g., Lustig and Verdelhan (2007, 2011), Burnside et al. (2011), Jorda and Taylor (2012), Clarida et al. (2009), Christiansen et al. (2011), amongst others). In the first part of the paper, we show that there exist macro fundamentals, in addition to interest rates, that predict currency excess returns. Here, we consider higher-ordered conditional moments of macro fundamentals–an approach motivated by Backus et al. (2001). The macro variables we employ include consumption growth, inflation, the real exchange rate gap, and the change in the current account to GDP ratio. Sorting over these variables to form HML portfolios (to take long (short) positions in currencies associated with the high (low) criterion) give portfolios of currency excess returns and Sharpe ratios similar in magnitude to the carry trade. Menkhoff et al. (2013) is another paper that generates currency portfolios from macro-fundamentals. They sort on first moments of variables associated with the monetary approach to exchange rate determination, whereas we identify an alternative set of macroeconomic fundamentals, including countries' inflation rates, real exchange rate gap, and changes in the current-account to GDP ratio, that have predictive power for currency excess returns.

The second part of the paper employs a collection of these portfolio excess returns in the 'beta-risk' framework to study the determinants of their cross-sectional variation.[1] Our 'test' excess returns combine the carry trade with portfolios of currency excess returns formed by sorting on first and higher-order moments of countries' macroeconomic fundamentals for two-way sorting as in Fama and French (1996). Estimation follows the 'two-pass' procedure used in finance. In the first pass, portfolio excess returns are regressed on the macro risk factors in a time-series regression to obtain the betas. In the second pass, using a single cross-sectional regression, mean excess returns are regressed on the betas to estimate factor risk premia. Inference is drawn using generalized method of moments standard errors, as presented in Cochrane (2005), which take into account that the betas in the second stage are not data but are generated regressors.

The primary factor found to be priced in the currency excess returns is the HML unemployment gap skewness. This factor is shown to be robust to estimation across five alternative sets of test excess returns. The HML unemployment gap skewness factor is formed by computing the conditional skewness of each country's unemployment gap and subtracting the average value in the bottom quartile from the average in the top quartile. An increase in the HML unemployment gap skewness signals an increase in the inequality of fortunes across national economies. The high skew countries can be thought as being in the bad state, having had a recent history of unusually large realizations of unemployment, while the low skew countries (typically negative) can be thought as being in the good state. An increase in the HML unemployment gap skewness is associated with an increase in the excess currency return. Weak currencies tend to fall hard and strong or safe haven currencies tend to rise. Larger excess returns are available in those times by shorting the weak and going long the strong.

Our paper seeks to understand how currency excess returns are priced by macroeconomic risk factors, in particular, the HML unemployment gap skewness factor, which is related to Lustig and Verdelhan (2007), who ask whether carry trade currency returns can be explained by consumption-

[1]The beta is the slope coefficient in a regression of the excess return on the macro risk factor. In the beta-risk framework, a currency excess return is predicted to be proportional to a risk factor's beta.

based utility models of the stochastic discount factor (SDF) and Menkhoff et al. (2013), who focus on pricing currency returns with variables that appear prominently in the monetary approach to the exchange rate. Another strand of this literature looks at pricing carry trade excess returns relative to returns on other assets (e.g., Lustig et al. (2011), Daniel et al. (2014) and Ang and Chen (2010)). Our paper also makes contact with papers that study the role of higher-ordered moments. Menkhoff et al. (2012) find a relation between carry excess returns and global foreign exchange rate volatility, and Brunnermeier et al. (2009) investigate the relationship between carry excess returns and skewness of exchange rate changes. We consider the role of higher ordered moments (volatility and skewness) of countries' macroeconomic fundamentals in identification and pricing of currency excess returns.[2]

The remainder of the paper is organized as follows. The next section discusses our method for constructing portfolios of currency excess returns. Section 2 describes the data. Section 3 implements the portfolio selection procedures and discusses properties of the excess returns. Section 4 outlines the beta-risk framework. Section 5 reports the estimation results of the beta-risk model. Section 6 undertakes a closer examination of the HML unemployment gap skewness factor and Section 7 concludes.

1 Portfolios of Currency Excess Returns

Identification of systematic risk in currency returns has long posed a challenge in international finance. In early research on single-factor models (e.g., Mark (1988), Frankel and Engel (1984), Cumby (1988)), the observational unit was the excess U.S. dollar return against a single currency. An innovation to recent methodology, introduced by Lustig and Verdelhan (2007), is to work with portfolios of currency excess returns instead of returns for individual currencies. This is useful because organizing the data into portfolios of returns averages out noisy idiosyncratic and non-systematic variation and improves the ability to see systematic risk.

How to form portfolios of currency returns? One strategy, employed by Burnside et al. (2011), is the bilateral carry trade. Suppose there are n_t currencies available at time t. Let the nominal interest rate of country i be $r_{i,t}$ for $i = 1, ..., n_t$, and let the U.S. interest rate be $r_{0,t}$. Under the carry trade, if $r_{0,t} > r_{i,t}$, short currency i and go long the U.S. dollar (USD). The expected excess return is

$$E_t\left((1 + r_{0,t}) - (1 + r_{i,t})\,\frac{S_{i,t+1}}{S_{i,t}}\right) \simeq r_{0,t} - r_{i,t} - E_t\left(\Delta \ln\left(S_{i,t+1}\right)\right), \tag{1}$$

where $S_{i,t}$ is the USD price of currency i (an increase in $S_{i,t}$ means the USD depreciates relative to currency i). If $r_{0,t} < r_{i,t}$, short the USD and go long currency i. An equally weighted bilateral carry portfolio invests $1/n_t$ dollars in each of the n_t trades.

Lustig and Verdelhan (2007) extend the carry trade strategy to a multilateral setting. Instead of restricting the carry to be between the USD and the n_t other currencies, one is allowed to short any of the $n_t + 1$ currencies and to go long in the remaining n_t currencies. They rank the countries by

[2] Recent contributions, using alternative approaches to ours, include Burnside et al.'s (2011) peso problem explanation, Bansal and Shalistovich's (2012) and Colacito and Croce's (2011) long-run risk models, and Verdelhan's (2010) habit persistence model.

their interest rates from high to low, and use this ranking to create portfolios of carry trade currency returns. To be concrete, let us form 4 portfolios from the n_t currencies, which we call P_1, P_2, P_3, and P_4. Portfolios are arranged from low (P_1) to high (P_4) where P_4 is the equally weighted average return from the currencies in the highest quartile of interest rates, P_1 is the average return from the lowest quartile of interest rates, while P_2 and P_3 are from the inter-quartile range.

Having formed portfolios of returns, excess returns can be constructed in two ways. One way is by 'differencing' the portfolio return, as in Lustig et al. (2013) and Menkhoff et al. (2013). Application of the 'differencing' method to our example involves subtracting the P_1 return from P_2, P_3, and P_4, which gives three excess returns. If there are $n_{j,t}$ currencies in portfolio P_j, the USD ex post $P_4 - P_1$ excess return is

$$\frac{1}{n_{4,t}} \sum_{i \in P_4} (1 + r_{i,t}) \frac{S_{i,t+1}}{S_{i,t}} - \frac{1}{n_{1,t}} \sum_{k \in P_1} (1 + r_{k,t}) \frac{S_{k,t+1}}{S_{k,t}}. \tag{2}$$

The payoff results from taking a long position in P_4 and a short position in P_1. Notice that these portfolio excess returns are dollar neutral. At time t, the only unknown in the excess return is the cross-exchange rate depreciation between the P_4 currencies and the P_1 currencies.

An alternative way to form excess returns on the P_4 portfolio is to subtract the U.S. interest rate from portfolio returns,

$$\frac{1}{n_{4,t}} \sum_{i \in P_4} (1 + r_{i,t}) \frac{S_{i,t+1}}{S_{i,t}} - (1 + r_{0,t}), \tag{3}$$

as in Lustig and Verdelhan (2007). In this approach, the exchange rate components of the excess returns are relative to the USD.

Although the carry trade is profitable, the strategy does not seem to be grounded in any theory (that we are aware of). It is an empirical strategy based on observed patterns of violations of uncovered interest rate parity as reported, for example, in Fama's (1984) regressions of the home-currency depreciation on the home-foreign interest rate differential. The carry exploits this empirical regularity that the high minus low interest rate differential predicts that shorting the low interest currency and going long the high interest currency gives a positive payoff.

We draw motivation from theory developed in Backus et al. (2001) to generate portfolios of currency excess returns as alternatives to the carry trade. To simplify the exposition, consider just one bilateral excess return and use the '$*$' notation to denote foreign variables. The expected long the home currency and short the foreign currency return is,

$$E_t\left(r_{t+1}^e\right) = E_t \ln\left[\frac{(1+r_t)}{(1+r_t^*)} \frac{S_t}{S_{t+1}}\right] \simeq E_t\left(r_t - r_t^* - \Delta \ln\left(S_{t+1}\right)\right),$$

where S_t is the home currency price of foreign exchange.[3] In a complete markets environment, or in an

[3]This nominal excess return is the same as the real excess return. Let P_t be the price level, $\pi_{t+1} = P_{t+1}/P_t - 1$ be the inflation rate and $rr_t = (1 + r_t) / (1 + \pi_{t+1}) - 1$ be the real interest rate. Multiplying and dividing country returns by the gross inflation rate $(1 + \pi_{t+1})$ gives

$$E_t\left(r_{t+1}^e\right) = E_t\left(\ln\left[\frac{(1+rr_t)\,Q_t}{(1+rr_t^*)\,Q_{t+1}}\right]\right)$$

where $Q_t = \left(P_t^* S_t\right)/P_t$ is the real exchange rate.

incomplete markets setting with no arbitrage, it follows from investors' Euler equations,

$$E_t\left(r^e_{t+1}\right) = \ln\left(\frac{E_t M^*_{t+1}}{E_t M_{t+1}}\right) - \left[E_t\left(\ln\left(M^*_{t+1}\right)\right) - E_t\left(\ln\left(M_{t+1}\right)\right)\right], \tag{4}$$

where M_t is the real stochastic discount factor (SDF).[4] Backus et al. (2001) show that the difference between the log expected SDF and the expected log SDF maps into an expansion of the SDF's higher-ordered cumulants, to give the predictive relationship

$$E_t\left(r^e_{t+1}\right) = \sum_{j=2}^{\infty} \frac{\kappa^*_{j,t} - \kappa_{j,t}}{j!}, \tag{5}$$

where $\kappa_{j,t}$ is the $j-th$ conditional cumulant of the log SDF, $m_{t+1} = \ln\left(M_{t+1}\right)$. Cumulants correspond to the coefficients in the Taylor expansion of the log moment generating function of a random variable. Equation (**??**) says that higher-ordered conditional cumulants of the log SDF predict currency excess returns. The first three cumulants are the first three central moments of the distribution,

$$\begin{aligned}
\kappa_{1,t} &= \mu_t = E_t\left(m_{t+1}\right) (\text{1st central moment}), \\
\kappa_{2,t} &= \sigma^2_t = E_t\left(m_{t+1} - \mu_t\right)^2 \ \ (\text{2nd central moment}), \\
\kappa_{3,t} &= E_t\left(m_{t+1} - \mu_t\right)^3 \ \ (\text{3rd central moment}).
\end{aligned}$$

We exploit the implied predictive relationship in equation (**??**) to guide the sorting of currency returns into portfolios. The division of the $j-th$ cumulant by $!j$ in equation (**??**) diminishes the impact of successively higher-ordered cumulants, so we restrict our attention to those of third order and less,[5]

$$E_t\left(r^e_{t+1}\right) = \frac{\kappa^*_{2,t} - \kappa_{2,t}}{2} + \frac{\kappa^*_{3,t} - \kappa_{3,t}}{6}. \tag{6}$$

According to equation (**??**), the home country is 'risky' and pays a currency premium if its log SDF is less volatile than foreign's ($\kappa_2 < \kappa^*_2$) and/or is less positively skewed ($\kappa_3 < \kappa^*_3$). In the special case where the SDF is conditionally log normally distributed, the third cumulants are zero. When home residents live in relative stability ($\kappa_2 < \kappa^*_2$), the need for precautionary saving is low. Hence, bond prices at home will be relatively low. The relatively high returns this implies contributes to a higher excess currency return.

[4]The home and foreign investors' Euler equations give

$$1 = E_t\left(\left(\frac{1+r^*_t}{1+\pi_{t+1}}\right)\frac{S_{t+1}}{S_t}M_{t+1}\right) = E_t\left(\left(\frac{1+r^*_t}{1+\pi^*_{t+1}}\right)M^*_{t+1}\right).$$

Assuming complete markets, it follows that $Q_{t+1}/Q_{,t} = M^*_{t+1}/M_{t+1}$, where Q_t is the real exchange rate. From the definition of the real exchange rate and re-arranging gives,

$$\frac{S_{t+1}}{S_t} = \frac{M^*_{t+1}}{M_{t+1}}\frac{P_{t+1}}{P^*_{t+1}}\frac{P^*_t}{P_t} = \frac{M^*_{t+1}/\left(1+\pi^*_{t+1}\right)}{M_{t+1}/\left(1+\pi_{t+1}\right)}.$$

Using the Euler equations for pricing the real one-period bond, $\frac{1}{1+rr_t} = E_t\left(M_{t+1}\right)$ and $\frac{1}{1+rr^*_t} = E_t\left(M^*_{t+1}\right)$, and noting that the nominal excess return is equivalent to the real excess return, equation (**??**) follows.

[5]Fourth and higher-ordered cumulants are not the same as the central moments. e.g., $\kappa_{4,t} = E_t\left(m_{t+1} - \mu_t\right)^4 - 3\sigma^2_t$. Also, fourth order cumulants are divided by $4! = 24$, which are likely to make them empirically unimportant.

To summarize, equation (**??**) is a high-minus-low relation between country conditional cumulants and an excess currency return and we can use this insight to identify portfolios of currency excess returns. Instead of sorting on country interest rates to form portfolios of currency returns, equation (**??**) says to sort on country cumulants of the log SDF. The problem is, the log SDF is not observable. As a result, we investigate this aspect of the theory by taking a soft stand on what the log SDF really is and make modifications to empirically implement the theory. We discuss these adjustments below, but before doing so, we describe the data that we use to construct the portfolios of currency excess returns where we sort on higher-ordered moments of macroeconomic variables.

2 The Data

The raw data are quarterly. When available, observations are end-of-quarter and point sampled. Cross-sectional data availability varies by quarter. At the beginning of the sample, we have data for 10 countries. The sample expands to include additional countries as data become available and contracts when data vanishes (as when countries join the Euro). Our encompassing sample is for 41 countries plus the Euro area from 1973Q1 to 2014Q3. The countries are Australia, Austria, Belgium, Brazil, Canada, Chile, Colombia, Czech Republic, Denmark, Spain, Finland, France, United Kingdom, Greece, Germany, Hungary, Iceland, India, Indonesia, Ireland, Israel, Italy, Japan, South Korea, Malaysia, Mexico, Netherlands, Norway, New Zealand, Philippines, Poland, Portugal, Romania, South Africa, Singapore, Switzerland, Sweden, Thailand, Turkey, Taiwan, and the United States. Countries that adopt the Euro are dropped when they join the common currency. The data set consists of exchange rates, interest rates, consumption, gross domestic product (GDP), unemployment rates, consumer price index (CPI), share prices, and the current account. Details are elaborated below.

The data are *not* seasonally adjusted. Census seasonal adjustment procedures impound future information into today's seasonally adjusted observations. Since we will employ the data for prediction of currency excess returns, the presence of future information in the predictor is unwelcome. We remove the seasonality ourselves with a moving average of the current and three previous quarters of the variable in question.

The exchange rate $S_{j,t}$, is expressed as USD per foreign currency units so that a higher exchange rate represents an *appreciation* of the foreign currency relative to the USD. In the early part of the sample, exchange rates and interest rates for Australia, Belgium, Canada, France, Germany, Great Britain, Italy, Japan, the Netherlands, Switzerland, and the U.S. are from the Harris Bank *Weekly Review.* These are last Friday of the quarter observations from 1973Q1 to 1996Q1. These interest rates are 3-month Eurocurrency rates. All other exchange rate observations are from Bloomberg and all other interest rate observations are from *Datastream.* Here, when available, the interest rates are 3-month interbank rates. When interbank rates are not available, the interest rates are either 3-month T-bill rates or imputed rates from spot and forward exchange rates. Additional details on interest rate sampling are provided in the appendix.

Real consumption and GDP are from Haver Analytics. The unemployment rate, consumer price index ($P_{j,t}$), share prices, and the current account (valued in USD) are from the FRED database at the Federal Reserve Bank of St. Louis. To construct the current account to GDP ratio, we deflate the current account valued in USD into constant 2010 USD with the U.S. CPI and then divide by the country's real GDP valued in 2010 USD. The real exchange rate between the U.S. and Country j is defined as $Q_{j,t} \equiv (S_{j,t}P_{j,t})/P_{US,t}$.

In many cases, due to the relatively short time-span of the data, the real exchange rate and unemployment rate observations appear to be non-stationary. To induce stationarity in these variables, we work with their 'gap' versions. The gap variables are cyclical components from a recursively applied Hodrick-Prescott (1997) (HP) filter. The HP filter is applied recursively so as not to introduce future information into current observations.

3 Portfolios Formed by Sorting Cumulants of Macro Fundamentals

We draw on equation (**??**) to guide portfolio selection but are unable to follow the theory exactly. First, because we do not know the true log SDF, we employ empirical proxies based on countries' macroeconomic fundamentals, that might plausibly be correlated with the true log SDF. Second, computing the conditional variance and conditional skewness coefficients called for in equation (**??**) requires distributional assumptions that we are not prepared to make. Instead, we approximate the conditional moments with sample moments computed from a backward-looking moving 20-quarter window, but in an abuse of terminology, we continue to refer to these calculations as 'conditional' moments.[6] Third, as noted above, the theory in equation (**??**) says that the conditional means of countries' log SDFs are irrelevant for predicting excess currency returns. However, Menkhoff et al. (2013) find profitable currency excess returns by conditioning on and sorting over conditional mean values of GDP growth and real money. Motivated by their work, we also consider portfolios generated by sorting on conditional mean values of macro fundamentals.

The macro variables that we consider along with a brief rationale for why these variables make *a priori* contact with the log SDF are as follows.

Δc: Consumption growth rate. In utility-based models where people have time-separable constant relative risk aversion utility, the consumption growth rate is perfectly negatively correlated with the log SDF.

EZW$= -(\theta/\psi)\,\Delta c + (\theta - 1)\,r_c$: Log intertemporal marginal rate of substitution implied by Epstein-Zin (1989) and Weil (1989) utility. EZW is used to price assets in models of long-run risk (e.g., Bansal-Yaron (2004), Bansal-Shalistovich (2012)). In the theory, r_c is the return on a portfolio that pays the observed consumption flow as dividends. We take the country's ex-dividend stock return to proxy for the unobserved theoretical portfolio. Following from Bansal and Shalistovich

[6] We also considered using a 16-quarter and a 24-quarter window. The results are largely robust to these choices in window length, which we report in the appendix.

(2012), we set $\gamma = 20.9$ (risk aversion) and $\psi = 1.81$ (intertemporal elasticity of substitution), and therefore, $\theta = (1-\gamma)/(1-(1/\psi)) = -44.468$.

π: Inflation rate. Inflation, as a component of the real interest rate, should impact consumption growth. High inflation induces people to consume now, thereby depressing the consumption growth rate and increasing the log SDF.

q^{gap}: Real exchange rate gap. Consideration of the real exchange rate gap is motivated by the SDF approach to exchange rates (Lustig-Verdelhan (2012)), where the real depreciation is the foreign-home difference in log SDFs, $\Delta q = m^* - m$.

ΔCAY: Proportionate change in current account to GDP ratio. The current account is national saving and connects to the log SDF by inferring the saving rate from consumption growth. Periods of high consumption growth (low SDF) are periods of low current consumption and high saving.

For each country and each macro fundamental, we compute conditional means ($\kappa_{1,t}$), conditional variances ($\kappa_{2,t}$), and conditional skewness coefficients ($\kappa_{3,t}$) using a 20−quarter window.[7] We also sort by $\text{VS}_t = \kappa_{2,t} + \kappa_{3,t}/3$ (which follows from Backus et al. (2001)) for each country and each macro fundamental from high to low.[8] The rank ordering is divided into quartiles, into which the currency returns are assigned. P_4 is the portfolio of returns associated with the highest quartile, P_3 is from the next highest quartile and so on.

From this point onwards, we switch to more intuitive notation for the conditional cumulants of a variable x and write $\kappa_{1,t} = \mu_t(x), \kappa_{2,t} = \sigma_t^2(x), \kappa_{3,t} = S_t(x)$ and $\text{VS}_t(x) = \sigma_t^2(x) + S_t(x)/3$. Table **??** shows sample mean HML excess returns (in percent per annum) on the $P_4 - P_1$ portfolios (difference method), the Newey-West (1987) t-ratios on the mean returns and the associated Sharpe ratios for alternative sorting strategies. As a benchmark, we include the carry trade return. To construct the carry returns, we sort on point-sampled (as opposed to conditional means of) interest rates. Although not implied by theory, but in light of the findings in Menkhoff et al. (2013), we generate HML returns from portfolios sorted by conditional mean values of the macro variables ($\mu_t(x)$). We also generate HML returns from portfolios sorted by volatility ($\sigma_t(x)$) and skewness ($S_t(x)$) independently as well as VS_t.

Table 1 shows that the carry trade strategy generates a significant average excess return of 6.2% with a Sharpe ratio of 0.34. Sorting by consumption growth does not yield statistically significant excess returns, but point estimates from sorting by $VS_t(\Delta c)$ and $\sigma_t(\Delta c)$ have the correct sign. High consumption growth VS_t and volatility countries are safe and earn negative excess returns but the Sharpe ratios are unfavorable. Similarly, sorting EZW by VS_t, volatility and skewness yield the predicted sign of the excess returns. The skewness sort of EZW generates significant (5% level) excess returns.

[7]Since the real exchange rates are bilateral with respect to the U.S., there is no "U.S." value of these variables–only values for each of the other countries.

[8]VS_t stands for variance and skewness.

Sorting on the mean, volatility, skewness and VS_t of inflation (π) and the real exchange rate gap (q^{gap}) yield excess returns significant at the 10% level in each case. Similarly, sorting on the mean and volatility of the change in the current account to GDP ratio (ΔCAY) give excess returns significant at the 5% level and when sorting on skewness and VS_t is significant at the 10% level. For π and q^{gap}, sorting by the mean generates the highest excess returns (both at 4.5%). For ΔCAY, sorting by volatility gives the highest excess return (4.0%). Sharpe ratios for these returns are quite high (the Sharpe ratio for the S&P 500 over the same time period is 0.2).

The patterns of excess returns displayed in Table 1 tends to conform to economic intuition. Countries with high average inflation and high inflation volatility pay currency premia and typically high inflation is associated with a bad state of affairs. Countries with low average q^{gap} and ΔCAY and low skewness in EZW, q^{gap} and ΔCAY pay currency premia. Low average and low skewness q^{gap} countries have had realizations of real currency weakness and it is likely that these countries have experienced some economic distress. The SDF approach to the exchange rate says the SDF of the weak (strong) currency country is low (high) which would be the case when in the bad (good) state of nature. Similarly, countries with low realizations of ΔCAY (P_1 portfolios sorted by mean and skewness) pay the currency premium. These are countries that have experienced large relative declines in the national saving ratio. Countries in economic distress typically experience deteriorations in their current account positions. The HML returns obtained from sorting on the means of q^{gap} and ΔCAY tell a consistent story, even though the theory says conditioning on mean values should not help to predict currency excess returns.

The alternative sorting strategies create heterogeneous portfolios in the sense that the returns are drawn from different sets of countries. This is seen in Table **??**, which displays the average proportion of countries contained in both the P_4 portfolios that are sorted by interest rates (the Carry) and the particular sorting criteria considered. Countries with high interest rates are not necessarily countries with high consumption growth, real exchange rate gaps or changes in current account ratios. The P_4 and P_1 returns generated by sorting over q^{gap} and ΔCAY are generally from different countries than those in the *carry*. The average country overlap with the carry for these sorts ranges from 0.09 to 0.35. When sorting over average inflation and inflation volatility, the country overlap with the carry is relatively high. This makes sense because high inflation drives up nominal interest rates and average inflation is known to be correlated with inflation volatility. Interestingly, it is those countries with high volatility of π, q^{gap}, and ΔCAY that pay the currency premium.

Instead of subtracting P_1 returns from P_4 returns, excess returns can be formed by subtracting the U.S. nominal interest rate from the portfolio returns. Table **??** shows summary statistics when excess returns are formed in this alternative fashion. For $\Delta c, EZW$ and π sortings, we subtract the U.S. interest rate from P_4 returns. For q^{gap} and ΔCAY, P_1 returns are highest and P_4 returns are lowest when sorting on means, skewness and VS_t. In Table **??**, the excess returns for these variables subtract the U.S. interest rate from their P_1 returns. The table shows that the magnitude and significance of the excess returns relative to the U.S. are quite similar to those of the HML ($P_4 - P_1$) excess returns.

Figure **??** plots mean P_1 through P_4 returns in excess of the U.S. interest rate for sortings by the carry, the average inflation rate, the average real exchange rate gap and the volatility of the change in the current account to GDP ratio. We note that these mean excess returns exhibit substantial and systematic variation across the different portfolios.

An alternative visualization of the returns is given in Figure **??**, which displays the cumulated excess returns generated by sorting over $Carry$, $\mu_t(\pi)$, $\mu_t(q^{gap})$, $\mu_t(\Delta CAY)$ and $\sigma_t(\Delta CAY)$. Portfolio excess returns produced by the difference method ($P_4 - P_1$) are shown in Panel A and returns in excess of the U.S. interest rate are shown in Panel B. As can be seen, these portfolios can be profitable.

To summarize, through the Fama (1984) regression and the carry trade, it has been known for quite some time that interest rates are related to and can predict currency excess returns. The significant excess returns from the HML carry portfolio are not implied by any theory, but results from what seems to be an empirical anomaly. The analysis of Backus et al. (2001) suggests that currency excess returns are predictable from conditional higher-ordered cumulants of the log SDF. Using their analysis as a guide and exploiting various proxies for the log SDF, we find that going beyond interest rates and conditioning on first through third conditional moments of several macroeconomic variables have predictive power for portfolios of currency returns. These alternative sorting strategies are found to be distinct from the carry trade.

4 Pricing Currency Excess Returns with HML Macro Risk Factors

This section outlines the framework we use to study the cross-section of average currency excess returns. The actual selection of the test returns used in our analysis is described in the next section. At this point, take the collection of excess returns as given.

To motivate using global HML macro factors in the empirical work, we draw on Cochrane's (2005) treatment of the linear-factor model of the log SDF in investor's Euler equations and the connection to the beta-risk model. Consider pricing the vector of currency excess returns $\underline{r}_t^e = \left(r_{1,t}^e, ..., r_{N,t}^e\right)'$. Since this collection of returns is available to any investor, regardless of domicile, we can write the Euler equation

$$\underline{0} = E\left(\underline{r}_t^e M_{i,t}\right), \tag{7}$$

where $M_{i,t}$ is the SDF for country i, and where we have conditioned down to unconditional expectations in equation (**??**). The expectation is set to zero because the long/short excess return does not require an investment up front. Since equation (**??**) holds for every country, it holds as an average of those in P_4 and those in P_1 as well as the HML difference,

$$\underline{0} = E\left(\underline{r}_t^e\left(\frac{1}{n_{4,t}}\sum_{i\in P_{4,t}} M_{i,t} - \frac{1}{n_{1,t}}\sum_{j\in P_{1,t}} M_{j,t}\right)\right). \tag{8}$$

In utility-based models, $M_{i,t}$ is a parametric model of the investor's intertemporal marginal rate of substitution. It is typically found, in utility-based models, that investor risk aversion must be unreasonably high to fit the data (e.g., Mark (1985)). Instead of restricting our attention to parametric models of

$M_{i,t}$, we follow Cochrane (2005), who suggests taking a linear factor representation for the stochastic discount factor,

$$M_{i,t} = \sum_{k=1}^{K} b_k F_{k,i,t} \tag{9}$$

where $\mu_{k,i} = E\left(F_{k,i,t}\right)$ is the mean of factor k from country i. Substituting equation (**??**) into equation (**??**), using the decomposition of the covariance and re-arranging, gives the beta representation,

$$E\left(\underline{r}_t^e\right) = \mathbf{B}\underline{\lambda},$$

where $\mathbf{B}$ is the matrix of the HML factor betas and $\underline{\lambda}$ is the vector of the risk prices,[9]

$$\mathbf{B} = \begin{pmatrix} \beta_{1,1} & \cdots & \beta_{1,k} \\ \vdots & & \vdots \\ \beta_{N,1} & \cdots & \beta_{N,k} \end{pmatrix}, \ \underline{\lambda} = \begin{pmatrix} \lambda_1 \\ \vdots \\ \lambda_k \end{pmatrix}.$$

For estimation, we employ the two-pass regression method used in the finance literature. Inference is drawn using generalized method of moments (GMM) standard errors described in Cochrane (2005).

Two-pass regressions. Let $\left\{r_{i,t}^e\right\}$, $i = 1, ...N, t = 1, ..., T$, be our collection of $N = 16$ excess returns. Let $\left\{f_{k,t}^{HML}\right\}$, $k = 1, .., K$, be a collection of potential HML macro risk factors. In the first pass, we run $N = 16$ individual time-series regressions of the excess returns on the K factors to estimate the factor 'betas' (the slope coefficients on the risk factors),

$$r_{i,t}^e = a_i + \sum_{k=1}^{K} \beta_{i,k} f_{k,t}^{HML} + \epsilon_{i,t}. \tag{10}$$

Covariance is risk, and the betas measure the extent to which the excess return is exposed to, or covaries with, the $k-th$ risk factor (holding everything else constant). If this risk is systematic and undiversifiable, investors should be compensated for bearing it. The risk should explain why some excess returns are high while others are low. This implication is tested in the second pass, which is the single cross-sectional regression of the (time-series) mean excess returns on the estimated betas,

$$\bar{r}_i^e = \gamma + \sum_{k=1}^{K} \lambda_k \beta_{i,k} + \alpha_i. \tag{11}$$

[9] Let $\underline{f}_t^{HML} = \sum_{k=1}^{K} \left(\frac{1}{n_{4,t}} \sum_{i \in P_{4,t}} F_{k,i,t} - \frac{1}{n_{1,t}} \sum_{j \in P_{1,t}} F_{k,j,t} \right)$ be the vector of HML macro factors, $\underline{\mu}^{HML} = E\left(\underline{f}_t^{HML}\right)$, and $\underline{b} = (b_1, ..., b_k)'$. Substituting (**??**) into (**??**) gives,

$$\underline{0} = E\left(\underline{r}_t^e \left(\underline{f}_t^{HML\prime} \underline{b}\right)\right) = Cov\left(\underline{r}_t^e \underline{f}_t^{HML}\right) \underline{b} + E\left(\underline{r}_t^e\right) \underline{\mu}^{HML\prime} \underline{b}$$

which implies

$$E\left(\underline{r}_t^e\right) = \underbrace{\left(-Cov\left(\underline{r}_t^e \underline{f}_t^{HML}\right) \mathbf{\Sigma}_f^{-1}\right)}_{\mathbf{B}} \underbrace{\left(\frac{\mathbf{\Sigma}_f \underline{b}}{\underline{\mu}^{HML\prime} \underline{b}}\right)}_{\underline{\lambda}} = \mathbf{B}\underline{\lambda}$$

where $\mathbf{\Sigma}_f = E\left(\underline{f}_t^{HML} - \mu^{HML}\right)\left(\underline{f}_t^{HML} - \mu^{HML}\right)'$ is the HML factor covariance matrix.

where $\bar{r}_i^e = (1/T)\sum_{t=1}^{T} r_{it}^e$ and the slope coefficient λ_k is the risk premia associated with the $k-th$ risk factor. If the excess returns are adequately explained by this $K-$factor model, the intercept γ should be zero.

To draw inference about the $\lambda' s$, we recognize that the betas in equation (**??**) are not data, but are themselves estimated from the data. To do this, we compute the GMM standard errors, described in Cochrane (2005) and Burnside (2011b), that accounts for the generated regressors problem and for heteroskedasticity in the errors. Cochrane (2005) sets up a GMM estimation problem using a constant as the instrument, which produces the identical point estimates for $\beta_{i,k}$ and λ_k as in the two-pass regression. The GMM procedure automatically takes into account that the $\beta_{i,k}$ are not data, per se, but are estimated and are functions of the data. It also is robust to heteroskedasticity and autocorrelation in the errors. Also available, is the covariance matrix of the residuals α_i, which we use to test that they are jointly zero. The α_i are referred to as the 'pricing errors,' and should be zero if the model adequately describes the data. We get our point estimates by doing the two-pass regressions with least squares and get the standard errors by 'plugging in' the point estimates into the GMM formulae. Additional details are presented in the appendix.

5 Empirical Results

It should not matter whether excess returns are formed by the 'difference' method or by subtracting the U.S. interest rate, since as Burnside (2011a) points out, portfolios formed by one method are linear combinations of portfolios formed by the other. In the analysis that follows, portfolio returns are stated in excess of the U.S. interest rate as percent per annum.

Test returns sorted on the carry and average consumption growth. In our first set of test returns, the portfolios are based on two-way sorting on national interest rates (the carry trade) and mean consumption growth rates. The procedure is analogous to the two-way sorting of equity returns employed by Fama and French (1996).[10] We form four categories of currency returns by sorting over countries' interest rates and four categories of currency returns by sorting over countries' average consumption growth rates. This then gives us a two-way sorting of currency returns into 16 portfolios.

Panel A of Table **??** shows the mean excess returns and Sharpe ratios of the 16 currency excess returns. The point note is that the mean returns show systematic variation. Returns from countries with low consumption growth and countries with low interest rates tend to be low. Returns from high consumption growth and high interest rate countries tend to be high.

We next estimate a one-factor model with the two-pass procedure, for a variety of potential factors (see Panel B of Table **??**). The candidate factors (listed in the first column of the table) are HML values of the conditional moments of various macro fundamentals. They are the conditional means of consumption growth ($\mu_t(\Delta c)$), Epstein-Zin-Weil utility-based SDF ($\mu_t(EZW)$), GDP growth ($\mu_t(\Delta y)$) and inflation ($\mu_t(\pi)$), the conditional volatility of consumption growth ($\sigma_t(\Delta c)$), GDP growth

[10]By ranking stocks by book-to-market value into 5 bins and by firm size into 5 bins, they create a two-way sorting of stock returns into 25 categories.

($\sigma_t(\Delta y)$), inflation ($\sigma_t(\pi)$) and real exchange rate depreciation ($\sigma_t(\Delta q)$) and unemployment gap skewness ($S_t(UE^{gap})$).[11]

The estimated intercepts (γ) are insignificant (at the 5% level). Many of the HML factor candidates are found to be significantly priced into returns. R^2 values are quite high for many specifications, in particular, 0.88 for unemployment gap skewness. The single-factor model estimates support potentially many global HML macro factors. Among these, the HML unemployment gap skewness receives the strongest support with the largest t-ratio on the estimated price of risk and the largest R^2. Figure **??** is a scatter plot of the average excess currency portfolio returns against the predicted values from the HML unemployment gap skewness single-factor model. The variation in predicted returns follows from the variation in the betas.

To investigate robustness of the HML unemployment gap skewness factor, we estimate a two-factor model with the HML $S_t(UE^{gap})$ as the maintained (first) factor and the second factor is one of the following: $\mu_t(\Delta c)$, $\mu_t(\Delta y)$, $\mu_t(\pi)$, $\sigma_t(\Delta c)$, $\sigma_t(\Delta y)$, $\sigma_t(\pi)$ or $\sigma_t(\Delta q)$ (We drop $\mu_t(EZW)$ in the two-factor analysis because it is insignificant at the 10% level). Panel C of Table **??** shows the two-factor estimation results. Here, we find the constant and the Wald test on the pricing errors to be insignificant in all specifications. The HML unemployment gap skewness is significant at the 10% level in every case and at the 5% level in 5 cases. Except for HML volatility of the real exchange rate depreciation, none of the other factor candidates are significantly priced as a second factor. These results suggest that a two-factor model consisting of HML unemployment gap skewness and HML real exchange rate depreciation volatility adequately prices the cross-section of the returns. Figure **??** shows the average excess returns plotted against each of these betas and against the predicted average excess returns.

We have seen, in the single-factor model, that the HML unemployment gap skewness is a significantly priced factor which gives an R^2 of 0.88. It continues to be a significantly priced factor in the two-factor specification, while most of the other factor candidates become insignificant. To further investigate the robustness of the HML unemployment skewness factor, we conduct analogous estimations on alternative sets of currency excess returns.

Test returns sorted on the carry and average real exchange rate gap. Here, we conduct two-way sorting by combining the carry returns with returns formed by sorting over countries' average real exchange rate gaps. As seen in Figure **??**, returns sorted by the mean real exchange rate gap decline in rank (a high exchange rate gap indicates currency weakness). The two-way sort takes this into account by arranging the order of the mean real exchange rate gap portfolio returns from P_1 to P_4.

Panel A of Table **??**, shows the mean excess returns and Sharpe ratios of the 16 currency excess returns formed by the two-way sort on the average real exchange rate gap and the carry. In the one-factor specification (Panel B), the HML average GDP growth factor is significantly priced at the 10% level and all of the other candidate HML factors are significantly priced at the 5% level. The HML skewness of the unemployment gap factor is the most significant factor and gives the highest R^2. Panel C shows estimation from the two-factor specification where the HML skewness of the unemployment

[11] Lustig and Verdelhan's (2007) analysis focused heavily on the Euler equation for a U.S. representative investor and relied on U.S. consumption data. Menkhoff et al. (2013) include foreign monetary variables as well as U.S. variables.

gap factor is maintained as the first factor. None of the second factor candidates remain significant at the 5% level. Only the HML volatility of the real depreciation factor is significant at the 10% level. In all specifications, the constant is not significant, nor is the Wald statistic on the pricing errors. Also, R^2 ranges from 0.80 to 0.85.

Test returns sorted on the carry and real exchange rate gap volatility. We repeat the estimation on excess returns generated by sorting on the interest rate and the volatility of the real exchange rate gap. The results are shown in Table **??** and are similar to the previous results. The mean returns show substantial variation across the portfolios and all of the HML macro factors are significantly priced at the 10% level in the single-factor model. In the two-factor model, only the HML volatility of GDP growth factor survives as a second factor (significant at the 10% level) when the HML unemployment gap skewness factor is maintained as the first factor. Neither the constant nor the Wald statistic on the pricing errors are significant.

Test returns sorted on inflation volatility and real exchange rate gap volatility. We alter the sorting such that the test returns do not involve the carry. The results, reported in Table **??**, show that these excess returns vary and are increasing in both dimensions of the portfolio quartiles (Panel A). In the single-factor specification (Panel B), only the HML unemployment gap skewness factor is significant at the 5% level (HML inflation is significant at 10% level).

Factor candidates that were insignificant in estimation of the one-factor model are dropped from the two-factor analysis. In the two-factor model, the HML unemployment gap skewness factor is significant at the 10% level while the inflation factor is insignificant. The evidence here continues to support the HML unemployment gap skewness as the priced factor, although the strength of the evidence is weaker than when the previous test returns were considered.

Test returns based on one-way sorting. We present estimation results on one more set of test returns. Instead of performing a two-way sort, here we consider the portfolios sorted into quartiles based on interest rates (the carry), the average real exchange rate gap, skewness of EZW, and volatility of the change in the current account to GDP ratio.[12] The summary statistics for these portfolios, reported in Panel A of Table **??**, show that mean excess returns vary and are increasing in the portfolio.

In the single-factor specification (Panel B), all but HML $\mu_t(EZW)$ and $\mu_t(\Delta y)$ appear to be significantly priced factors. Skewness of the unemployment gap is the most significant and has the highest regression R^2. When the HML unemployment gap skewness factor is maintained as the first factor in the two-factor specification, it survives as a significantly priced factor, whereas only HML volatility of the real exchange rate depreciation is a significantly (at the 10% level) priced second factor.

[12] The low to high returns sorted by $S_t(EZW)$ and $\mu_t(q^{gap})$ run from P_4 to P_1 so we reversed the order of these portfolios in the empirical work for this table.

6 The HML Unemployment Gap Skewness Factor

The previous section showed the HML skewness of the unemployment gap to be a robust risk factor priced into a variety of currency excess returns. What is this factor? Which countries are used in its construction? How is it related to other macro fundamentals? In this section, we address these questions.

Which are the key countries in shaping the factor? Table **??** lists the top ten countries that appear most frequently in construction of the HML unemployment gap skewness factor. They are roughly a mix of developed and emerging economies.

A visual of the factor is presented in Figure **??**, which plots the high, low and high-minus low average values of skewness of the unemployment gap. Low skewness is typically negative. In these countries, unemployment is falling unusually fast. An increase in the HML skewness factor signifies an increase in the divergence between countries with rapidly growing unemployment and those with falling unemployment. These are times of growing short-run divergence or growing inequality across countries. To see how the HML unemployment gap skewness factor might be related to other measures of distress, the figure also shows European and U.S. business cycle dating. The high-skew quartile tends to rise and the low-skew quartile tends to fall after recession periods which combine to make the HML skewness factor rise after recessions and to fall during recessions. We see this in 1982, 1986, early 1990, 2001, and 2008. The lead-lag relationship follows because the HML skewness factor is backward looking by 20 quarters. The unemployment distress experienced during recessions shows up in the factor subsequent to the recession.

In Table **??** we show raw correlations between the factor and the cross-sectional average of the mean, the volatility and skewness of macro variables considered in the empirical work (see columns (1)-(3) of the table). The correlations with average real depreciation skewness (Δq) and average volatility of the change in the current account ratio (ΔCAY) are relatively large but not exceptionally high. The signs of the correlations tell a consistent story where an increase in the factor indicates rising distress in the world economy. A decrease in ΔCAY indicates more rapid current account deteriorations. An increase in average skewness of Δq suggests a preponderance of large real depreciations. Otherwise, the factor is very weakly correlated with global growth and inflation and global growth and inflation uncertainty (volatility). Column 4 of the table shows the correlation between the factor and HML skewness of alternative variables. There is only a slight correlation between the factor and HML skewness of GDP growth.

Table **??** looks at the relation between the factor and alternative news-based measures of economic uncertainty designed by Baker et al. (2015).[13] The uncertainty indices are largely based on the volume of news articles discussing economic policy uncertainty. We regress economic policy uncertainty indices for the US, Europe, the UK, and the log VIX on the HML unemployment gap skewness factor. The factor is negatively (and significantly) related to the policy uncertainty indices. Evidently, policy makers are in agreement about what to do during periods of global distress. The factor is (roughly) orthogonal

[13]The data is available at their website www.policyuncertainty.com.

to the VIX.

7 Conclusion

It has long been understood that systematic currency excess returns (deviations from uncovered interest parity) are available to investors. Less well understood is what are the risks being compensated for by the profitable excess returns.

This paper identifies macroeconomic fundamentals, beyond interest rates, that predict currency excess returns. The predictive variables include first, second and third moments of national inflation rates, real exchange rate gaps, and changes in current account ratios. We show that this identification can be used in conjunction with the carry trade to form portfolios that exhibit substantial variation in their mean returns.

Furthermore, we find that currency excess returns compensate for global macroeconomic risks. The primary risk factor is the high-minus-low skewness of the unemployment gap. There are three notable features of this factor. First, it is a macroeconomic fundamental variable. As Lustig and Verdelhan (2011) point out, the statistical link between asset returns and macroeconomic factors is always weaker than the link between asset returns and return based factors, so the high explanatory power provided by this factor and its significance is notable. Second, the factor is global in nature. It is constructed from averages of countries in the top and bottom quartiles of unemployment gap skewness. Third, the factor measures something different from standard measures of global uncertainty.

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Table 1: Alternative HML ($P_4 - P_1$) Excess Returns.

$z \downarrow$	Sort by→	z			
Carry	Avg. Excess Return	6.231			
	t-ratio	**3.890**			
	Sharpe Ratio	0.338			
$x \downarrow$	Sort by →	$\mu_t(x)$	$\sigma_t(x)$	$S_t(x)$	$VS_t(x)$
Δc	Avg. Excess Return	1.697	-1.708	0.483	-1.197
	t-ratio	1.033	-1.307	0.463	-1.026
	Sharpe Ratio	0.100	-0.114	0.039	-0.087
	P_4 Overlap w/Carry	0.167	0.189	0.123	0.189
	P_1 Overlap w/Carry	0.372	0.293	0.251	0.293
EZW	Avg. Excess Return	1.471	-0.208	-2.390	-0.759
	t-ratio	0.863	-0.131	**-2.039**	-0.468
	Sharpe ratio	0.090	-0.013	-0.182	-0.040
	P_4 Overlap w/Carry	0.083	0.189	0.105	0.141
	P_1 Overlap w/Carry	0.125	0.169	0.159	0.167
π	Avg. Excess Return	4.492	3.511	2.350	3.310
	t-ratio	**3.049**	**2.541**	1.701*	**2.230**
	Sharpe ratio	0.261	0.223	0.167	0.207
	P_4 Overlap w/Carry	0.691	0.553	0.287	0.553
	P_1 Overlap w/Carry	0.617	0.403	0.295	0.403
q^{gap}	Avg. Excess Return	-4.544	3.712	-2.432	-2.600
	t-ratio	**-3.148**	**2.403**	-1.736*	-1.736*
	Sharpe ratio	-0.245	0.199	-0.142	-0.136
	P_4 Overlap w/Carry	0.230	0.350	0.196	0.348
	P_1 Overlap w/Carry	0.252	0.267	0.142	0.223
ΔCAY	Avg. Excess Return	-3.764	3.031	-2.800	-4.963
	t-ratio	**-2.527**	**2.023**	**-2.052**	**-2.814**
	Sharpe ratio	-0.218	0.188	-0.184	-0.264
	P_4 Overlap w/Carry	0.092	0.105	0.101	0.235
	P_1 Overlap w/Carry	0.107	0.244	0.151	0.132

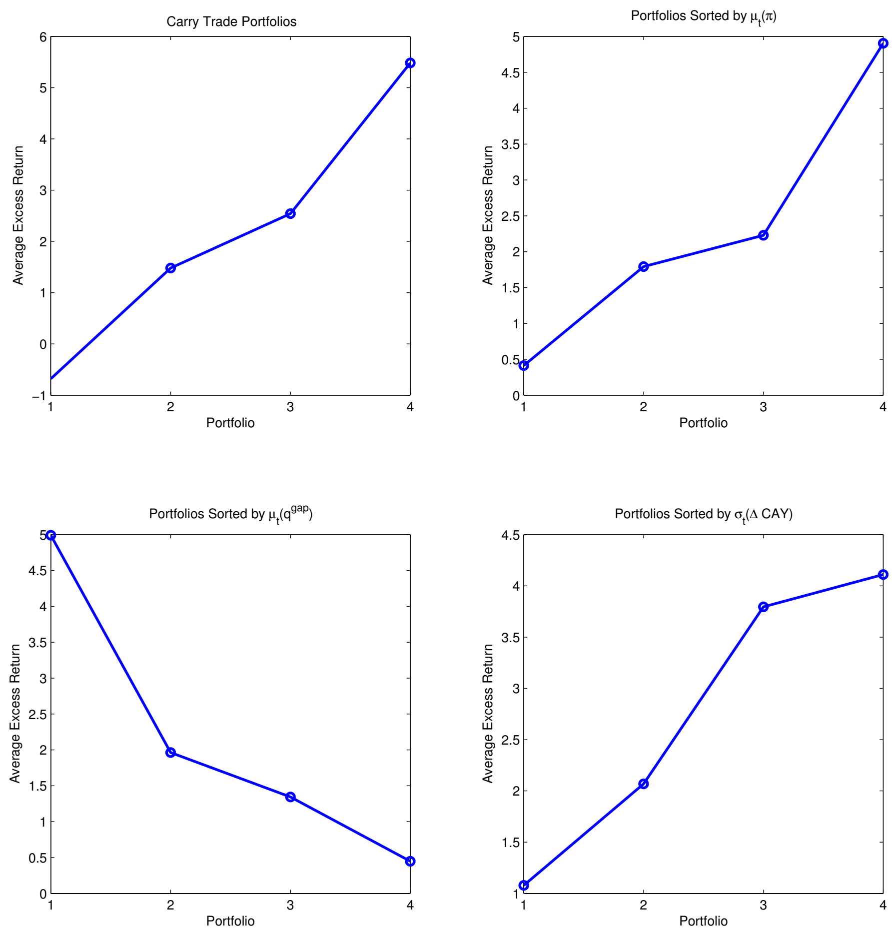
Notes: The raw data are quarterly (1973Q1 to 2014Q3) and when available are end-of-quarter and point sampled. *Carry*, Δc, EZW, π, q^{gap} and ΔCAY represent the nominal interest rate, consumption growth rate, intertemporal marginal rate of substitution implied by Epstein-Zin (1989) and Weil (1989) utility, inflation rate, real exchange rate gap and proportionate change in the current account to GDP ratio, respectively. For each country (41 countries plus the Euro area) and each macroeconomic variable (x), we compute the 'conditional' mean ($\mu_t(x)$), variance ($\sigma_t^2(x)$), and skewness ($S_t(x)$) using a 20-quarter window. To form the portfolio returns, we sort by *carry*, $\mu_t(x)$, $\sigma_t(x)$, $S_t(x)$ and $VS_t(x) = \sigma_t^2(x) + S_t(x)/3$ for each respective variable (x) and each country from high to low. The rank ordering is divided into quartiles, into which the currency returns are assigned. P_4 is the portfolio of returns associated with the highest quartile and P_1 is the portfolio of returns associated with the lowest quartile. The HML excess return is formed by subtracting the P_1 return from the P_4 return. For each HML (P_4 - P_1) excess return, the table shows the average (avg.) excess return (in percent per annum), the Newey-West (1987) t-ratio, the Sharpe ratio, and the P_4 (P_1) overlap with the carry, which is the average proportion of countries in both the P_4 (P_1) portfolios sorted by variable x and the *carry*. Bold indicates significance at the 5% level. '*' indicates significance at the 10% level.

Table 2: Alternative Excess Returns Relative to the U.S.

$z \downarrow$	Sort by $\rightarrow$	z			
$Carry$	Avg. Excess Return	5.483			
	t-ratio	**2.817**			
	Sharpe ratio	0.266			
$x \downarrow$	Sort by $\rightarrow$	$\mu_t(x)$	$\sigma_t(x)$	$S_t(x)$	$VS_t(x)$
Δc	Avg. Excess Return	2.282	1.893	2.205	1.749
	t-ratio	1.336	1.297	1.190	1.129
	Sharpe ratio	0.125	0.116	0.120	0.113
EZW	Avg. Excess Return	4.343	1.691	2.536	2.402
	t-ratio	**2.258**	1.063	1.658	1.386
	Sharpe ratio	0.229	0.090	0.143	0.124
π	Avg. Excess Return	4.905	4.495	3.728	4.100
	t-ratio	**2.398**	**2.259**	**2.134**	**2.251**
	Sharpe ratio	0.247	0.235	0.203	0.222
q^{gap}	Avg. Excess Return	4.991	4.218	3.812	4.209
	t-ratio	**2.749**	1.957	1.821	**2.020**
	Sharpe ratio	0.261	0.183	0.180	0.199
ΔCAY	Avg. Excess Return	6.340	4.110	4.514	6.314
	t-ratio	**3.730**	**2.724**	**2.594**	**3.454**
	Sharpe ratio	0.370	0.263	0.239	0.333

Notes: The raw data are quarterly (1973Q1 to 2014Q3) and when available are end-of-quarter and point sampled. $Carry$, Δc, EZW, π, q^{gap} and ΔCAY represent the nominal interest rate, consumption growth rate, intertemporal marginal rate of substitution implied by Epstein-Zin (1989) and Weil (1989) utility, inflation rate, real exchange rate gap and proportionate change in the current account to GDP ratio, respectively. For each country (41 countries plus the Euro area) and each macroeconomic variable (x), we compute the 'conditional' mean ($\mu_t(x)$), variance ($\sigma_t^2(x)$), and skewness ($S_t(x)$) using a 20-quarter window. To form the portfolio returns, we sort by $carry$, $\mu_t(x)$, $\sigma_t(x)$, $S_t(x)$ and $VS_t(x) = \sigma_t^2(x) + S_t(x)/3$ for each respective variable (x) and each country from high to low. The rank ordering is divided into quartiles, into which the currency returns are assigned. P_4 is the portfolio of returns associated with the highest quartile and P_1 is the portfolio of returns associated with the lowest quartile. For $\Delta c, EZW, \pi$, the excess return is formed by subtracting the U.S. nominal interest rate from the P_4 return. For q^{gap} and ΔCAY, the excess return is formed by subtracting the U.S. nominal interest rate from the P_1 return. For each excess return, the table shows the average (avg.) excess return (in percent per annum), the Newey-West (1987) t-ratio and the Sharpe ratio. Bold indicates significance at the 5% level. '*' indicates significance at the 10% level.

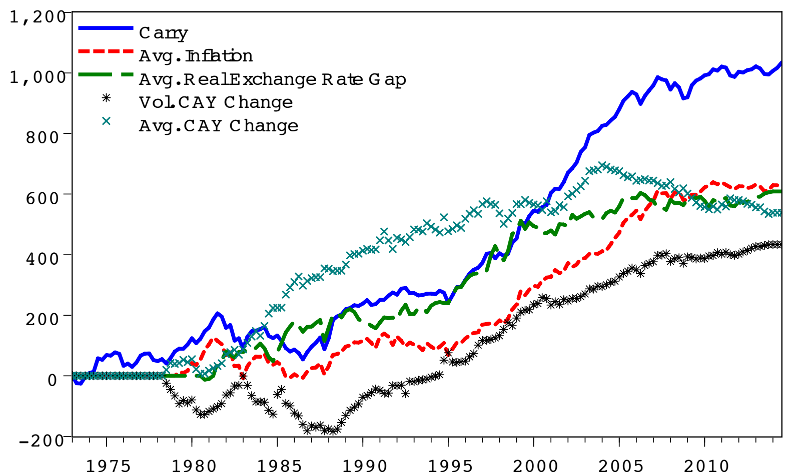
Figure 1: Average Portfolio Returns in Excess of the U.S. Interest Rate.



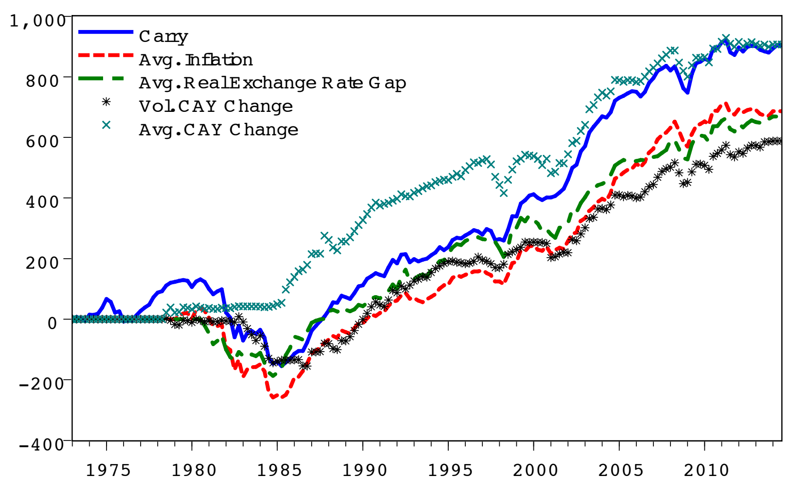
Notes: The raw data are quarterly (1973Q1 to 2014Q3) and when available are end-of-quarter and point sampled. $Carry$, π, q^{gap} and ΔCAY represent the nominal interest rate, inflation rate, real exchange rate gap and proportionate change in the current account to GDP ratio, respectively. For each country (41 countries plus the Euro area), we compute $\mu_t(\pi)$, $\mu_t(q^{gap})$ and $\sigma_t(\Delta CAY)$ using a 20-quarter window. To form the portfolio returns, we sort by $carry$, $\mu_t(\pi)$, $\mu_t(q^{gap})$ and $\sigma_t(\Delta CAY)$ for each country from high to low. The rank ordering is divided into quartiles, into which the currency returns are assigned. P_4 is the portfolio of returns associated with the highest quartile and P_1 is the portfolio of returns associated with the lowest quartile. The excess returns are formed by subtracting the U.S. nominal interest rate from the P_1, P_2, P_3 and P_4 returns. The figure plots average excess returns (in percent per annum).

Figure 2: Cumulated Currency Excess Returns.

Panel A: HML ($P_4 - P_1$) Excess Returns (Difference Method).



Panel B: Returns in Excess of the U.S. Interest Rate.



Notes: The raw data are quarterly (1973Q1 to 2014Q3) and when available are end-of-quarter and point sampled. $Carry$, π, q^{gap} and ΔCAY represent the nominal interest rate, inflation rate, real exchange rate gap and proportionate change in the current account to GDP ratio, respectively. For each country (41 countries plus the Euro area), we compute $\mu_t(\pi)$, $\mu_t(q^{gap})$, $\mu_t(\Delta CAY)$ and $\sigma_t(\Delta CAY)$ using a 20-quarter window. To form the portfolio returns, we sort by $carry$, $\mu_t(\pi)$, $\mu_t(q^{gap})$, $\mu_t(\Delta CAY)$ and $\sigma_t(\Delta CAY)$ for each country from high to low. The rank ordering is divided into quartiles, into which the currency returns are assigned. P_4 is the portfolio of returns associated with the highest quartile and P_1 is the portfolio of returns associated with the lowest quartile. In panels A and B, cumulated currency excess returns are plotted. In Panel A, the excess return is the P_4 minus P_1 return for $\Delta c, EZW$ and π and is the P_1 minus P_4 return for q^{gap} and ΔCAY. In Panel B, the excess return is formed by subtracting the U.S. nominal interest rate from the P_4 return for $\Delta c, EZW$ and π and subtracting the U.S. nominal interest rate from the P_1 return for q^{gap} and ΔCAY.

Table 3: Two-Pass Estimation of the Beta Model.

Returns Sorted on Carry and Average Consumption Growth.

Panel A: Test Excess Return Summary Statistics.

	Mean				Sharpe Ratio			
	$\mu_t(\Delta c)$				$\mu_t(\Delta c)$			
Carry	P_1	P_2	P_3	P_4	P_1	P_2	P_3	P_4
P_1	-0.059	0.148	0.794	1.609	-0.003	0.010	0.047	0.098
P_2	1.357	1.552	2.278	3.068	0.079	0.102	0.135	0.184
P_3	1.711	2.023	2.622	3.543	0.098	0.127	0.150	0.205
P_4	3.233	3.456	4.173	5.058	0.184	0.206	0.234	0.259

Panel B: Single-Factor Model.

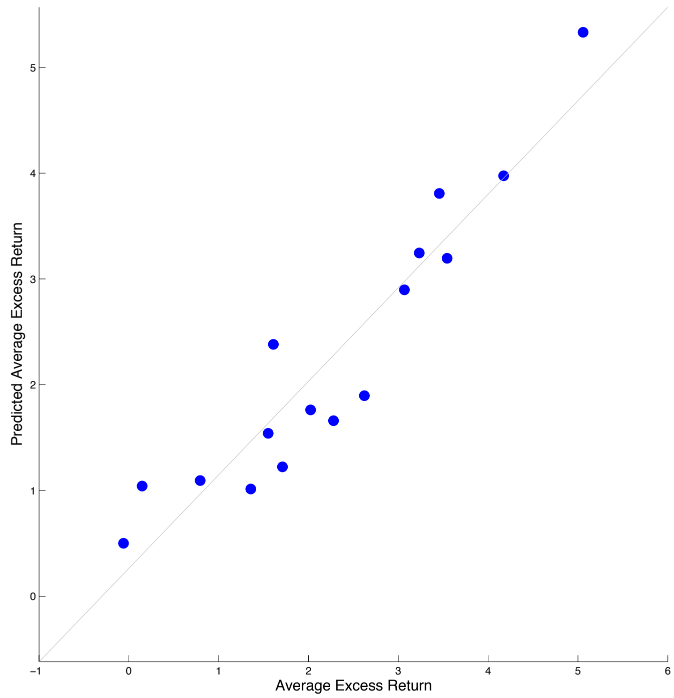
HML Factor	λ	t-ratio	γ	t-ratio	R^2	Test-stat	p-val.
$\mu_t(\Delta c)$	-2.014	-1.980*	4.245	1.119	0.412	8.656	0.895
$\mu_t(EZW)$	257.879	1.598	1.221	0.414	0.453	14.662	0.476
$\mu_t(\Delta y)$	-1.680	-1.706*	4.931	1.943	0.262	10.803	0.766
$\mu_t(\pi)$	6.302	**2.429**	1.925	0.925	0.674	10.072	0.815
$\sigma_t(\Delta c)$	1.125	**2.479**	-1.370	-0.489	0.773	14.391	0.496
$\sigma_t(\Delta y)$	1.190	**2.259**	-0.608	-0.255	0.692	11.700	0.702
$\sigma_t(\pi)$	2.490	**2.051**	0.349	0.151	0.511	11.847	0.691
$\sigma_t(\Delta q)$	11.576	**2.074**	6.277	1.536	0.882	6.284	0.975
$S_t(UE^{gap})$	0.437	**3.099**	1.771	0.894	0.884	10.150	0.810

Panel C: Two-Factor Model. First HML Factor is $S_t(UE^{gap})$.

λ_1	t-ratio	2^{nd} HML Factor	λ_2	t-ratio	γ	t-ratio	R^2	Test-stat	p-val.
0.412	**2.950**	$\mu_t(\Delta c)$	-1.117	-1.790*	2.553	1.032	0.878	8.175	0.917
0.415	**2.901**	$\mu_t(\Delta y)$	-0.931	-1.284	2.548	1.255	0.841	11.313	0.730
0.399	**2.260**	$\mu_t(\pi)$	1.774	0.494	1.363	0.531	0.820	12.948	0.606
0.439	1.857*	$\sigma_t(\Delta c)$	0.239	0.338	1.900	0.951	0.817	11.698	0.702
0.335	1.945*	$\sigma_t(\Delta y)$	0.535	0.977	0.750	0.281	0.821	12.191	0.664
0.409	**2.458**	$\sigma_t(\pi)$	0.283	0.258	2.299	1.168	0.851	14.385	0.497
0.268	**2.031**	$\sigma_t(\Delta q)$	8.366	**2.243**	4.539	1.493	0.934	7.214	0.951

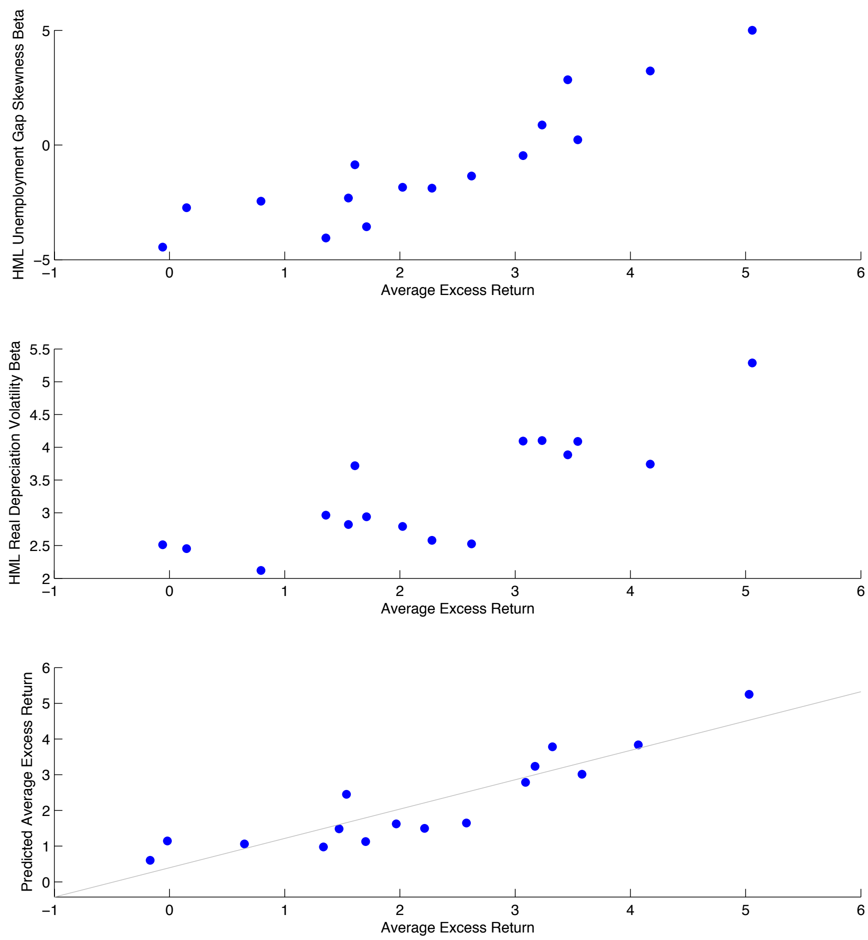
Notes: The raw data are quarterly (1973Q1 to 2014Q3) and when available are end-of-quarter and point sampled. *Carry*, Δc, EZW, Δy, π, Δq and UE^{gap} represent the nominal interest rate, consumption growth rate, intertemporal marginal rate of substitution implied by Epstein-Zin (1989) and Weil (1989) utility, GDP growth rate, inflation rate, real exchange rate depreciation and unemployment gap, respectively. For each country (41 countries plus the Euro area) and each macroeconomic variable (x), we compute the 'conditional' mean ($\mu_t(x)$), variance ($\sigma_t^2(x)$) and skewness ($S_t(x)$) using a 20-quarter window. To form the portfolio returns, we sort by *carry* and $\mu_t(\Delta c)$ for each country from high to low. The rank ordering is divided into quartiles, into which the currency returns are assigned. P_4 is the portfolio of returns associated with the highest quartile and P_1 is the portfolio of returns associated with the lowest quartile. Panel A lists the excess return summary statistics (mean and Sharpe ratio) for the two-way sorting (as in Fama and French (1996)) on nominal interest rates (*carry*) and 'conditional' mean consumption growth rates ($\mu_t(\Delta c)$). The excess returns are the average of the USD returns in each category minus the U.S. nominal interest rate and are stated in percent per annum. Panel B reports the two-pass procedure estimation results from a one-factor model. In the first pass, we run $N = 16$ individual time-series regressions of the excess returns on the K factors to estimate the factor 'betas,' $r_{i,t}^e = a_i + \sum_{k=1}^K \beta_{i,k} f_{k,t}^{HML} + \epsilon_{i,t}$, where $r_{i,t}^e$ is the excess return, $\beta_{i,k}$ is the factor beta and $f_{k,t}^{HML}$ is the HML macro risk factor. The factors considered include the high-minus-low (HML) values of $\mu_t(\Delta c)$, $\mu_t(EZW)$, $\mu_t(\Delta y)$, $\mu_t(\pi)$, $\sigma_t(\Delta c)$, $\sigma_t(\Delta y)$, $\sigma_t(\pi)$, $\sigma_t(\Delta q)$ and $S_t(UE^{gap})$. In the second pass, we run a single cross-sectional regression of the (time-series) mean excess returns on the estimated betas, $\bar{r}_i^e = \gamma + \sum_{k=1}^K \lambda_k \beta_{i,k} + \alpha_i$, where $\bar{r}_i^e$ is the average excess return, γ is the intercept, λ_k is the risk premia, and α_i is the pricing error. The table reports the price of risk (λ) and its associated t-ratio (using GMM standard errors), the estimated intercept (γ) and its associate t-ratio, R^2 and the Wald test on the pricing errors (Test-stat) and its associated p-value (p-val.). Panel C reports the two-pass procedure estimation results from a two-factor model where $S_t(UE^{gap})$ is the maintained first factor. Bold indicates significance at the 5% level. '*' indicates significance at the 10% level.

Figure 3: Actual and Predicted Average Excess Returns by HML Unemployment Gap Skewness Beta Model. Test Returns Sorted on the Carry and Average Consumption Growth.



Notes: The raw data are quarterly (1973Q1 to 2014Q3) and when available are end-of-quarter and point sampled. For each country (41 countries plus the Euro area), we compute the 'conditional' mean consumption growth rate and unemployment gap skewness using a 20-quarter window. To form the portfolio returns, we sort by the nominal interest rate and the 'conditional' mean consumption growth rate for each country from high to low. The rank ordering is divided into quartiles, into which the currency returns are assigned. P_4 is the portfolio of returns associated with the highest quartile and P_1 is the portfolio of returns associated with the lowest quartile. Excess returns are formed by two-way sorting (as in Fama and French (1996)) on nominal interest rates and 'conditional' mean consumption growth rates. The excess returns are the average of the USD returns in each category minus the U.S. nominal interest rate and are stated in percent per annum. The figure plots the actual versus the predicted average excess return. The two-pass procedure estimation results are from a one-factor model where the factor is the high-minus-low (HML) unemployment gap skewness.

Figure 4: HML Unemployment Gap Skewness and HML Real Exchange Rate Volatility Beta Model. Test Returns Sorted on the Carry and Average Consumption Growth.



Notes: The raw data are quarterly (1973Q1 to 2014Q3) and when available are end-of-quarter and point sampled. For each country (41 countries plus the Euro area), we compute the 'conditional' mean consumption growth rate, real exchange rate depreciation volatility and unemployment gap skewness using a 20-quarter window. To form the portfolio returns, we sort by the nominal interest rate and the 'conditional' mean consumption growth rate for each country from high to low. The rank ordering is divided into quartiles, into which the currency returns are assigned. P_4 is the portfolio of returns associated with the highest quartile and P_1 is the portfolio of returns associated with the lowest quartile. Excess returns are formed by two-way sorting (as in Fama and French (1996)) on nominal interest rates and 'conditional' mean consumption growth rates. The excess returns are the average of the USD returns in each category minus the U.S. nominal interest rate and are stated in percent per annum. The figure plots the average excess return versus the HML unemployment gap skewness beta, the average excess return versus the HML real exchange rate depreciation volatility beta and the actual versus the predicted average excess return. The two-pass procedure estimation results are from a two-factor model where the factors are the HML unemployment gap skewness and HML real exchange rate depreciation volatility.

Table 4: Two-Pass Estimation of the Beta Model.

Returns Sorted on Carry and Average Real Exchange Rate Gap.

Panel A: Test Excess Return Summary Statistics.

	Mean $\mu_t(q^{gap})$				Sharpe Ratio $\mu_t(q^{gap})$			
$Carry$	P_1	P_2	P_3	P_4	P_1	P_2	P_3	P_4
P_1	0.693	0.049	0.455	1.383	0.044	0.003	0.027	0.083
P_2	2.061	1.525	1.907	2.859	0.132	0.087	0.113	0.171
P_3	2.480	1.921	2.288	3.291	0.154	0.107	0.131	0.191
P_4	3.989	3.399	3.812	4.815	0.239	0.181	0.210	0.256

Panel B: Single-Factor Model.

HML Factor	λ	t-ratio	γ	t-ratio	R^2	Test-stat	p-val.
$\mu_t(\Delta c)$	-1.141	**-2.037**	3.351	1.438	0.242	14.812	0.465
$\mu_t(EZW)$	233.960	**2.068**	1.293	0.462	0.437	19.388	0.197
$\mu_t(\Delta y)$	-0.862	-1.781*	3.638	1.742	0.112	16.724	0.336
$\mu_t(\pi)$	6.150	**2.519**	1.950	0.936	0.605	12.456	0.644
$\sigma_t(\Delta c)$	1.119	**2.185**	-1.348	-0.509	0.550	16.918	0.324
$\sigma_t(\Delta y)$	1.265	**2.450**	-0.760	-0.312	0.638	15.484	0.417
$\sigma_t(\pi)$	1.974	**2.178**	0.761	0.356	0.362	17.503	0.290
$\sigma_t(\Delta q)$	8.686	**2.437**	5.269	1.755	0.569	7.821	0.931
$S_t(UE^{gap})$	0.451	**3.277**	1.771	0.869	0.875	14.045	0.522

Panel C: Two-Factor Model. First HML Factor is $S_t(UE^{gap})$.

λ_1	t-ratio	2^{nd} HML Factor	λ_2	t-ratio	γ	t-ratio	R^2	Test-stat	p-val.
0.416	**3.278**	$\mu_t(\Delta c)$	-0.658	-1.251	1.998	0.871	0.823	13.121	0.593
0.547	**2.340**	$\mu_t(EZW)$	-132.932	-0.748	1.827	0.665	0.846	10.474	0.789
0.426	**3.064**	$\mu_t(\Delta y)$	-0.682	-1.230	2.060	0.826	0.810	14.479	0.490
0.475	**2.279**	$\mu_t(\pi)$	-0.062	-0.016	1.138	0.368	0.826	13.031	0.600
0.632	**2.034**	$\sigma_t(\Delta c)$	-0.392	-0.397	3.552	1.011	0.834	12.548	0.637
0.434	**2.795**	$\sigma_t(\Delta y)$	0.220	0.401	1.891	0.746	0.799	14.764	0.469
0.422	**2.742**	$\sigma_t(\pi)$	0.539	0.583	2.119	0.871	0.826	15.454	0.419
0.348	**2.988**	$\sigma_t(\Delta q)$	5.215	1.713*	2.957	1.075	0.842	11.626	0.707

Notes: The raw data are quarterly (1973Q1 to 2014Q3) and when available are end-of-quarter and point sampled. $Carry$, Δc, EZW, Δy, π, Δq and UE^{gap} represent the nominal interest rate, consumption growth rate, intertemporal marginal rate of substitution implied by Epstein-Zin (1989) and Weil (1989) utility, GDP growth rate, inflation rate, real exchange rate depreciation and unemployment gap, respectively. For each country (41 countries plus the Euro area) and each macroeconomic variable (x), we compute the 'conditional' mean ($\mu_t(x)$), variance ($\sigma_t^2(x)$) and skewness ($S_t(x)$) using a 20-quarter window. To form the portfolio returns, we sort by $carry$ and $\mu_t(q^{gap})$ for each country from high to low. The rank ordering is divided into quartiles, into which the currency returns are assigned. P_4 is the portfolio of returns associated with the highest (lowest) quartile and P_1 is the portfolio of returns associated with the lowest (highest) quartile for the $carry$ ($\mu_t(q^{gap})$) sort. Panel A lists the excess return summary statistics (mean and Sharpe ratio) for the two-way sorting (as in Fama and French (1996)) on nominal interest rates ($carry$) and 'conditional' mean real exchange rate gap ($\mu_t(q^{gap})$). The excess returns are the average of the USD returns in each category minus the U.S. nominal interest rate and are stated in percent per annum. Panel B reports the two-pass procedure estimation results from a one-factor model. In the first pass, we run $N = 16$ individual time-series regressions of the excess returns on the K factors to estimate the factor 'betas,' $r_{i,t}^e = a_i + \sum_{k=1}^K \beta_{i,k} f_{k,t}^{HML} + \epsilon_{i,t}$, where $r_{i,t}^e$ is the excess return, $\beta_{i,k}$ is the factor beta and $f_{k,t}^{HML}$ is the HML macro risk factor. The factors considered include the high-minus-low (HML) values of $\mu_t(\Delta c)$, $\mu_t(EZW)$, $\mu_t(\Delta y)$, $\mu_t(\pi)$, $\sigma_t(\Delta c)$, $\sigma_t(\Delta y)$, $\sigma_t(\pi)$, $\sigma_t(\Delta q)$ and $S_t(UE^{gap})$. In the second pass, we run a single cross-sectional regression of the (time-series) mean excess returns on the estimated betas, $\bar{r}_i^e = \gamma + \sum_{k=1}^K \lambda_k \beta_{i,k} + \alpha_i$, where $\bar{r}_i^e$ is the average excess return, γ is the intercept, λ_k is the risk premia, and α_i is the pricing error. The table reports the price of risk (λ) and its associated t-ratio (using GMM standard errors), the estimated intercept (γ) and its associate t-ratio, R^2 and the Wald test on the pricing errors (Test-stat) and its associated p-value (p-val.). Panel C reports the two-pass procedure estimation results from a two-factor model where $S_t(UE^{gap})$ is the maintained first factor. Bold indicates significance at the 5% level. '*' indicates significance at the 10% level.

Table 5: Two-Pass Estimation of the Beta Model.

Returns Sorted on Carry and Real Exchange Rate Gap Volatility.

Panel A: Test Excess Return Summary Statistics.

	Mean $\sigma_t(q^{gap})$				Sharpe Ratio $\sigma_t(q^{gap})$			
$Carry$	P_1	P_2	P_3	P_4	P_1	P_2	P_3	P_4
P_1	0.029	0.264	0.674	1.511	0.002	0.015	0.038	0.088
P_2	1.463	1.741	2.114	2.941	0.109	0.097	0.117	0.168
P_3	1.784	2.132	2.497	3.427	0.125	0.116	0.135	0.188
P_4	3.338	3.616	3.996	4.910	0.223	0.196	0.211	0.236

Panel B: Single-Factor Model.

HML Factor	λ	t-ratio	γ	t-ratio	R^2	Test-stat	p-val.
$\mu_t(\Delta c)$	-1.029	**-1.972**	3.215	1.575	0.182	16.672	0.339
$\mu_t(EZW)$	197.677	1.655*	1.391	0.541	0.435	17.703	0.279
$\mu_t(\Delta y)$	-1.215	-1.716*	4.170	1.954	0.231	16.216	0.368
$\mu_t(\pi)$	5.361	**2.272**	1.966	0.983	0.522	14.676	0.475
$\sigma_t(\Delta c)$	1.179	**2.209**	-1.605	-0.574	0.837	14.724	0.472
$\sigma_t(\Delta y)$	1.220	**2.054**	-0.702	-0.288	0.738	13.904	0.533
$\sigma_t(\pi)$	2.074	1.870*	0.670	0.294	0.398	17.372	0.297
$\sigma_t(\Delta q)$	5.846	**2.146**	4.304	2.049	0.358	13.354	0.575
$S_t(UE^{gap})$	0.332	**2.560**	1.825	0.983	0.762	18.371	0.244

Panel C: Two-Factor Model. First HML Factor is $S_t(UE^{gap})$.

λ_1	t-ratio	2^{nd} HML Factor	λ_2	t-ratio	γ	t-ratio	R^2	Test-stat	p-val.
0.331	**2.870**	$\mu_t(\Delta c)$	-0.654	-1.462	2.112	1.108	0.778	15.970	0.384
0.344	**2.349**	$\mu_t(EZW)$	-14.751	-0.161	1.697	0.867	0.762	16.879	0.326
0.323	**2.564**	$\mu_t(\Delta y)$	-0.639	-1.240	2.248	1.161	0.761	16.983	0.320
0.340	**2.086**	$\mu_t(\pi)$	-0.345	-0.131	1.384	0.548	0.803	16.723	0.336
0.218	1.023	$\sigma_t(\Delta c)$	0.741	1.008	0.511	0.253	0.760	16.266	0.365
0.147	0.771	$\sigma_t(\Delta y)$	1.133	1.690*	-1.444	-0.519	0.837	13.666	0.551
0.342	**2.239**	$\sigma_t(\pi)$	-0.438	-0.422	2.787	1.129	0.846	15.567	0.411
0.297	**2.659**	$\sigma_t(\Delta q)$	3.127	1.447	2.288	1.262	0.775	14.855	0.462

Notes: The raw data are quarterly (1973Q1 to 2014Q3) and when available are end-of-quarter and point sampled. $Carry$, Δc, EZW, Δy, π, Δq and UE^{gap} represent the nominal interest rate, consumption growth rate, intertemporal marginal rate of substitution implied by Epstein-Zin (1989) and Weil (1989) utility, GDP growth rate, inflation rate, real exchange rate depreciation and unemployment gap, respectively. For each country (41 countries plus the Euro area) and each macroeconomic variable (x), we compute the 'conditional' mean ($\mu_t(x)$), variance ($\sigma_t^2(x)$) and skewness ($S_t(x)$) using a 20-quarter window. To form the portfolio returns, we sort by $carry$ and $\sigma_t(q^{gap})$ for each country from high to low. The rank ordering is divided into quartiles, into which the currency returns are assigned. P_4 is the portfolio of returns associated with the highest quartile and P_1 is the portfolio of returns associated with the lowest quartile. Panel A lists the excess return summary statistics (mean and Sharpe ratio) for the two-way sorting (as in Fama and French (1996)) on nominal interest rates ($carry$) and 'conditional' volatility of the real exchange rate gap ($\sigma_t(q^{gap})$). The excess returns are the average of the USD returns in each category minus the U.S. nominal interest rate and are stated in percent per annum. Panel B reports the two-pass procedure estimation results from a one-factor model. In the first pass, we run $N = 16$ individual time-series regressions of the excess returns on the K factors to estimate the factor 'betas,' $r_{i,t}^e = a_i + \sum_{k=1}^K \beta_{i,k} f_{k,t}^{HML} + \epsilon_{i,t}$, where $r_{i,t}^e$ is the excess return, $\beta_{i,k}$ is the factor beta and $f_{k,t}^{HML}$ is the HML macro risk factor. The factors considered include the high-minus-low (HML) values of $\mu_t(\Delta c)$, $\mu_t(EZW)$, $\mu_t(\Delta y)$, $\mu_t(\pi)$, $\sigma_t(\Delta c)$, $\sigma_t(\Delta y)$, $\sigma_t(\pi)$, $\sigma_t(\Delta q)$ and $S_t(UE^{gap})$. In the second pass, we run a single cross-sectional regression of the (time-series) mean excess returns on the estimated betas, $\bar{r}_i^e = \gamma + \sum_{k=1}^K \lambda_k \beta_{i,k} + \alpha_i$, where $\bar{r}_i^e$ is the average excess return, γ is the intercept, λ_k is the risk premia, and α_i is the pricing error. The table reports the price of risk (λ) and its associated t-ratio (using GMM standard errors), the estimated intercept (γ) and its associate t-ratio, R^2 and the Wald test on the pricing errors (Test-stat) and its associated p-value (p-val.). Panel C reports the two-pass procedure estimation results from a two-factor model where $S_t(UE^{gap})$ is the maintained first factor. Bold indicates significance at the 5% level. '*' indicates significance at the 10% level.

Table 6: Two-Pass Estimation of the Beta Model.

Returns Sorted on Inflation Volatility and Real Exchange Rate Gap Volatility.

Panel A: Test Excess Return Summary Statistics.

	Mean				Sharpe Ratio			
	$\sigma_t(q^{gap})$				$\sigma_t(q^{gap})$			
$\sigma_t(\pi)$	P_1	P_2	P_3	P_4	P_1	P_2	P_3	P_4
P_1	1.029	1.217	1.559	2.707	0.075	0.066	0.084	0.152
P_2	1.385	1.586	1.886	3.070	0.093	0.081	0.095	0.157
P_3	1.708	1.968	2.293	3.498	0.126	0.112	0.128	0.195
P_4	2.740	2.968	3.269	4.536	0.193	0.167	0.181	0.225

Panel B: Single-Factor Model.

HML Factor	λ	t-ratio	γ	t-ratio	R^2	Test-stat	p-val.
$\mu_t(\Delta c)$	0.823	1.302	1.609	0.695	0.158	16.787	0.332
$\mu_t(EZW)$	175.050	1.627	1.785	0.699	0.550	15.834	0.393
$\mu_t(\Delta y)$	0.067	0.127	2.237	1.699	0.001	16.567	0.345
$\mu_t(\pi)$	4.492	1.917*	2.251	1.163	0.500	15.082	0.446
$\sigma_t(\Delta c)$	1.128	1.636	-1.159	-0.395	0.725	11.373	0.726
$\sigma_t(\Delta y)$	1.254	1.551	-0.474	-0.200	0.772	13.449	0.568
$\sigma_t(\pi)$	1.976	1.594	0.939	0.414	0.537	15.908	0.388
$\sigma_t(\Delta q)$	1.551	0.603	2.891	1.923	0.031	15.596	0.409
$S_t(UE^{gap})$	0.268	**2.065**	1.891	0.987	0.869	11.394	0.724

Panel C: Two-Factor Model. First HML Factor is $S_t(UE^{gap})$.

λ_1	t-ratio	2^{nd} HML Factor	λ_2	t-ratio	γ	t-ratio	R^2	Test-stat	p-val.
0.266	1.958*	$\mu_t(\pi)$	1.222	0.588	1.778	0.860	0.913	10.757	0.770

Notes: The raw data are quarterly (1973Q1 to 2014Q3) and when available are end-of-quarter and point sampled. $Carry$, Δc, EZW, Δy, π, Δq and UE^{gap} represent the nominal interest rate, consumption growth rate, intertemporal marginal rate of substitution implied by Epstein-Zin (1989) and Weil (1989) utility, GDP growth rate, inflation rate, real exchange rate depreciation and unemployment gap, respectively. For each country (41 countries plus the Euro area) and each macroeconomic variable (x), we compute the 'conditional' mean ($\mu_t(x)$), variance ($\sigma_t^2(x)$) and skewness ($S_t(x)$) using a 20-quarter window. To form the portfolio returns, we sort by $\sigma_t(\pi)$ and $\sigma_t(q^{gap})$ for each country from high to low. The rank ordering is divided into quartiles, into which the currency returns are assigned. P_4 is the portfolio of returns associated with the highest quartile and P_1 is the portfolio of returns associated with the lowest quartile. Panel A lists the excess return summary statistics (mean and Sharpe ratio) for the two-way sorting (as in Fama and French (1996)) on 'conditional' volatility of inflation ($\sigma_t(\pi)$) and the real exchange rate gap ($\sigma_t(q^{gap})$). The excess returns are the average of the USD returns in each category minus the U.S. nominal interest rate and are stated in percent per annum. Panel B reports the two-pass procedure estimation results from a one-factor model. In the first pass, we run $N = 16$ individual time-series regressions of the excess returns on the K factors to estimate the factor 'betas,' $r_{i,t}^e = a_i + \sum_{k=1}^K \beta_{i,k} f_{k,t}^{HML} + \epsilon_{i,t}$, where $r_{i,t}^e$ is the excess return, $\beta_{i,k}$ is the factor beta and $f_{k,t}^{HML}$ is the HML macro risk factor. The factors considered include the high-minus-low (HML) values of $\mu_t(\Delta c)$, $\mu_t(EZW)$, $\mu_t(\Delta y)$, $\mu_t(\pi)$, $\sigma_t(\Delta c)$, $\sigma_t(\Delta y)$, $\sigma_t(\pi)$, $\sigma_t(\Delta q)$ and $S_t(UE^{gap})$. In the second pass, we run a single cross-sectional regression of the (time-series) mean excess returns on the estimated betas, $\bar{r}_i^e = \gamma + \sum_{k=1}^K \lambda_k \beta_{i,k} + \alpha_i$, where $\bar{r}_i^e$ is the average excess return, γ is the intercept, λ_k is the risk premia, and α_i is the pricing error. The table reports the price of risk (λ) and its associated t-ratio (using GMM standard errors), the estimated intercept (γ) and its associate t-ratio, R^2 and the Wald test on the pricing errors (Test-stat) and its associated p-value (p-val.). Panel C reports the two-pass procedure estimation results from a two-factor model where $S_t(UE^{gap})$ is the first factor and $\mu_t(\pi)$ is the second factor. Bold indicates significance at the 5% level. '*' indicates significance at the 10% level.

Table 7: Two-Pass Estimation of the Beta Model.

One-Way Sorted Returns.

Panel A: Test Excess Return Summary Statistics.

	Mean Excess Return				Sharpe Ratio			
	P_1	P_2	P_3	P_4	P_1	P_2	P_3	P_4
$Carry$	-0.680	1.481	2.543	5.483	-0.038	0.090	0.144	0.266
$\mu_t(q^{gap})$	0.448	1.344	1.962	4.991	0.024	0.066	0.107	0.261
$S_t(EZW)$	0.282	1.713	2.120	2.536	0.015	0.081	0.102	0.143
$\sigma_t(\Delta CAY)$	1.079	2.068	3.796	4.110	0.061	0.107	0.169	0.263

Panel B: Single-Factor Model.

HML Factor	λ	t-ratio	γ	t-ratio	R^2	Test-stat	p-val.
$\mu_t(\Delta c)$	-1.768	**-2.487**	3.531	1.112	0.512	11.807	0.694
$\mu_t(EZW)$	126.204	1.523	1.812	0.760	0.119	18.993	0.214
$\mu_t(\Delta y)$	-0.605	-1.470	3.049	1.792	0.097	16.602	0.343
$\mu_t(\pi)$	4.874	**3.024**	2.138	1.064	0.417	14.434	0.493
$\sigma_t(\Delta c)$	0.815	**2.688**	-0.558	-0.229	0.299	13.996	0.526
$\sigma_t(\Delta y)$	1.078	**2.566**	-0.373	-0.163	0.415	13.589	0.557
$\sigma_t(\pi)$	1.320	**2.254**	1.333	0.703	0.190	16.215	0.368
$\sigma_t(\Delta q)$	6.134	**2.636**	4.203	1.954	0.362	15.597	0.409
$S_t(UE^{gap})$	0.422	**3.363**	1.630	0.724	0.725	10.601	0.780

Panel C: Two-Factor Model. First HML Factor is $S_t(UE^{gap})$.

λ_1	t-ratio	2^{nd} HML Factor	λ_2	t-ratio	γ	t-ratio	R^2	Test-stat	p-val.
0.460	**3.322**	$\mu_t(\Delta c)$	-58.677	-0.690	1.769	0.743	0.760	11.810	0.693
0.415	**3.196**	$\mu_t(\pi)$	2.846	1.541	1.519	0.631	0.717	11.607	0.708
0.414	**3.213**	$\sigma_t(\pi)$	1.013	1.423	1.849	0.890	0.732	11.340	0.728
0.383	**3.222**	$\sigma_t(\Delta q)$	3.914	1.790*	2.285	0.900	0.738	11.538	0.714
0.476	**2.172**	$\sigma_t(\Delta c)$	0.105	0.144	2.292	1.267	0.737	8.899	0.883
0.508	**3.254**	$\sigma_t(\Delta y)$	-0.166	-0.419	3.355	1.279	0.776	9.804	0.832

Notes: The raw data are quarterly (1973Q1 to 2014Q3) and when available are end-of-quarter and point sampled. $Carry$, Δc, EZW, Δy, π, Δq UE^{gap}, and ΔCAY represent the nominal interest rate, consumption growth rate, intertemporal marginal rate of substitution implied by Epstein-Zin (1989) and Weil (1989) utility, GDP growth rate, inflation rate, real exchange rate depreciation, unemployment gap and proportional change in the current account to GDP ratio, respectively. For each country (41 countries plus the Euro area) and each macroeconomic variable (x), we compute the 'conditional' mean ($\mu_t(x)$), variance ($\sigma_t^2(x)$) and skewness ($S_t(x)$) using a 20-quarter window. To form the portfolio returns, we sort $Carry$ and $\sigma_t(\Delta CAY)$ for each country from high to low and sort $\mu_t(q^{gap})$ and $S_t(EZW)$ from low to high. Returns are then assigned into quartiles so that P_4 portfolios have the highest average return and P_1 portfolios have the lowest average return. Panel A lists the excess return summary statistics (mean and Sharpe ratio) for the one-way sort on $Carry$, $\mu_t(q^{gap})$, $S_t(EZW)$ and $\sigma_t(\Delta CAY)$. The excess returns are the average returns in each portfolio minus the U.S. nominal interest rate and are stated in percent per annum. Panel B reports the two-pass procedure estimation results from a one-factor model. In the first pass, we run $N = 16$ individual time-series regressions of the excess returns on the K factors to estimate the factor 'betas,' $r_{i,t}^e = a_i + \sum_{k=1}^K \beta_{i,k} f_{k,t}^{HML} + \epsilon_{i,t}$, where $r_{i,t}^e$ is the excess return, $\beta_{i,k}$ is the factor beta and $f_{k,t}^{HML}$ is the HML macro risk factor. The factors considered include the high-minus-low (HML) values of $\mu_t(\Delta c)$, $\mu_t(EZW)$, $\mu_t(\Delta y)$, $\mu_t(\pi)$, $\sigma_t(\Delta c)$, $\sigma_t(\Delta y)$, $\sigma_t(\pi)$, $\sigma_t(\Delta q)$ and $S_t(UE^{gap})$. In the second pass, we run a single cross-sectional regression of the (time-series) mean excess returns on the estimated betas, $\bar{r}_i^e = \gamma + \sum_{k=1}^K \lambda_k \beta_{i,k} + \alpha_i$, where $\bar{r}_i^e$ is the average excess return, γ is the intercept, λ_k is the risk premia, and α_i is the pricing error. The table reports the price of risk (λ) and its associated t-ratio (using GMM standard errors), the estimated intercept (γ) and its associate t-ratio, R^2 and the Wald test on the pricing errors (Test-stat) and its associated p-value (p-val.). Panel C reports the two-pass procedure estimation results from a two-factor model where $S_t(UE^{gap})$ is the maintained first factor. Bold indicates significance at the 5% level. '*' indicates significance at the 10% level.

Table 8: Top Ten Countries that Appear Most Frequently in the High and Low Unemployment Gap Skewness Categories

Country	Proportion of Times in High Group	Country	Proportion of Times in Low Group
Australia	0.473	Norway	0.390
Canada	0.404	USA	0.295
Taiwan	0.253	Denmark	0.281
Switzerland	0.247	Philippines	0.281
Singapore	0.240	Japan	0.247
USA	0.212	New Zealand	0.240
Sweden	0.192	Mexico	0.205
UK	0.185	Brazil	0.199
Mexico	0.185	Hungary	0.192
Poland	0.185	Canada	0.185

Table 9: Correlation between HML Unemployment Gap Skewness and Other Variables

Variable	(1) World Mean	(2) World Volatility	(3) World Skewness	(4) HML Skewness
Δc	0.106	-0.058	0.243	0.122
EZW	-0.166	-0.098	0.006	0.035
Δy	-0.018	-0.130	0.162	0.214
π	-0.036	0.117	-0.099	0.004
$\Delta DCAY$	0.035	-0.387	-0.188	0.096
Δq	0.008	-0.146	0.369	0.044

Notes: World Mean is the cross-sectional average across countries of the variable's mean value. World Volatility is the cross-sectional average across countries of the variable's volatility. World Skewness is the cross-sectional average across countries of the variables' skewness. HML Skewness is the high-minus-low value of the skewness of the variable.

Figure 5: High, Low, High-Minus-Low Unemployment Gap Skewness, U.S. and European Recessions

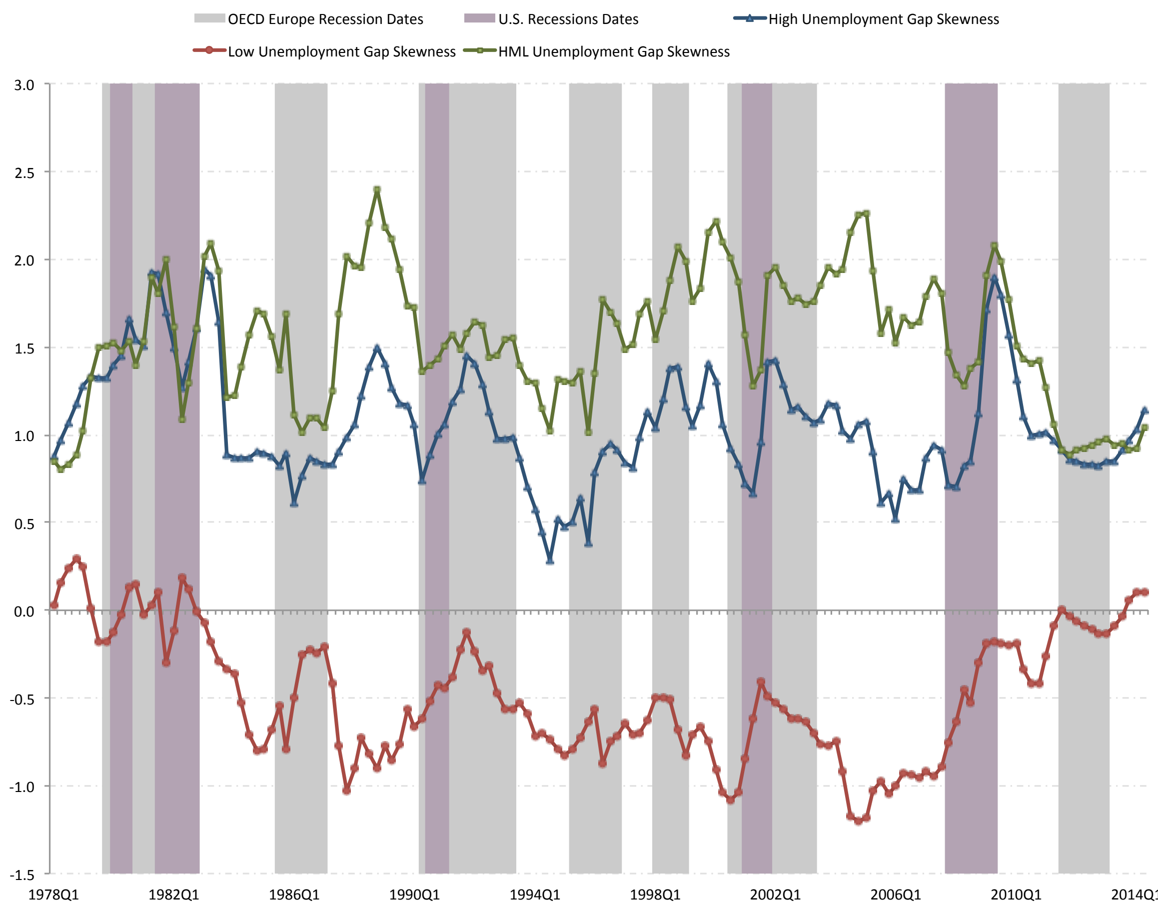


Table 10: Regressions of Alternative Uncertainty Measures on HML Unemployment Gap Skewness

Dependent Variable	Coeff.	t-ratio	R^2	Sample Begins
Log US Uncertainty	-0.239	**-3.412**	0.091	1985Q1
Log European Uncertainty	-0.818	**-7.997**	0.503	1997Q1
Log UK Uncertainty	-1.132	**-7.401**	0.538	1997Q1
Log VIX	0.075	1.296	0.032	1990Q1

Notes: Bold indicates significance at 5% level.

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Appendix

Additional notes on the data

All interest rates are for 3-months maturity.

Australia: 73.1-86.1, 3 month T-bill rate. 86.2-14.2, 3 month interbank rate.

Austria: 91.2-98.4, EIBOR (Emirates Interbank Offer Rate, *Datastream*).

Belgium: 73.1-89.4, 3 month eurocurrency (Harris). 90.1-98.4, EIBOR.

Brazil: 04.1-14.2, Imputed from spot and forward rates (*Datastream*).

Canada: 73.1-96.1, 3 month eurocurrency. 96.2-14.2, 3-month T-bill rate.

Chile: 04.1-13.2, Imputed from spot and forward rates.

Colombia: 04.1-13.2, Imputed from spot and forward rates.

Czech Republic: 92.2-14.2, Interbank rate.

Denmark: 84.4-88.1, imputed from spot and forward rates. 88.2-14.2, Interbank rate.

Spain: 88.3-98.4, Interbank.

Euro zone: 99.1-14.2, Interbank rate, Germany.

Finland: 87.1-98.4, EIBOR

France: 73.1-96.1, 3-month eurocurrency. 96.2-98.4, EIBOR.

Great Britain: 73.1-96.1, 3-month eurocurrency. 96.2-98.4, UK Interbank.

Greece: 94.2-98.4. Interbank.

Germany: 73.1-96.1, 3-month eurocurrency. 96.2-98.4, EIBOR.

Hungary: 95.3-14.2: Interbank

Iceland: 95.3-00.1, Interbank mid-rate. 00.2-14.2, Reykjavik interbank offer rate.

Indonesia: 96.1-14.2, Interbank rate.

India: 97.4-98.3, Imputed from spot and forward rates. 98.4-14.2 Interbank.

Ireland: 84.1-98.4. Interbank.

Israel: 94.4-99.3, T-bill. 99.4-14.2, Interbank.

Italy: 73.1-96.1, 3-month eurocurrency. 96.2-98.4, EIBOR.

Japan: 73.1-96.1, 3-month eurocurrency. 96.2-14.2, Interbank.

Korea: 92.1-14.2. Interbank.

Malaysia: 93.3-14.2, Interbank.

Mexico: 78.1-14.2, T-bill (FRED).

Netherlands: 73.1-96.1, 3-month eurocurrency. 96.2-98.4, EIBOR.

Norway: 86.1-14.2. Interbank

New Zealand: 74.1-13.4, Interbank (FRED).

Philippines: 87.1-14.2 T-bill

Poland: 94.4-14.2 Interbank

Portugal: 96.4-98.4, Imputed from spot and forward.

Romania: 95.3-14.2. Interbank.

Republic of South Africa: 73.1-14.3. T-bill.

Singapore: 84.4-87.2: Imputed from spot and forward rates. 87.3-13.4, Interbank.

Switzerland: 73.1-96.1, 3-month eurocurrency. 96.2-14.2, Interbank.

Sweden: 84.4-86.4, Imputed from spot and forward rates. 87.1-14.3, Interbank.

Thailand: 95.1-96.3, imputed from spot and forward rates. 96.5-14.2, Interbank.

Turkey: 96.4-06.4, imputed from spot and forward rates. 07.1-14.2, Interbank.

Taiwan: 82.2-14.2, Money market rates.

Two-pass regression procedure

We have k factors, T time-series observations and n excess returns (assets). Vectors are underlined. Matrices are bolded. Scalars have no special designation. The objective is to estimate the $k-$factor 'beta-risk' model

$$E\left(r_{i,t}^{e}\right) = \underline{\beta}_i'\underline{\lambda} + \alpha_i \tag{12}$$

where $\underline{\beta}_i$ is a $k-$dimensional vector of the factor betas for excess return i and $\underline{\lambda}$ is the $k-$dimensional vector of factor risk premia. The expectation is taken over t. The beta-risk model's answer to the question as to why average returns vary across assets is that returns with high betas (covariance with a factor) pay a high risk premiums ($\underline{\lambda}$). The cross-sectional test can be implemented with a two-pass procedure. Let $\underline{f}_t$ be the $k-$dimensional vector of the macro factors. In the first pass for each excess return $i = 1, ..., n$, estimate the factor betas in the time-series regression,

$$r_{i,t}^{e} = a_i + \underbrace{(\beta_{1,i}, ..., \beta_{k,i})}_{\underline{\beta}_i'} \begin{pmatrix} f_{1,t} \\ \vdots \\ f_{k,t} \end{pmatrix} + \epsilon_{i,t} = \underline{\tilde{\beta}}_i' \underline{F}_t + \epsilon_{i,t}$$

where

$$\underline{F}_t = \begin{pmatrix} 1 \\ \underline{f}_t \end{pmatrix}, \; \underline{f}_t = \begin{pmatrix} f_{1,t} \\ \vdots \\ f_{k,t} \end{pmatrix}, \; \underset{(k+1)\times 1}{\underline{\tilde{\beta}}_i} = \begin{pmatrix} a_i \\ \underline{\beta}_i \end{pmatrix}, \; \underset{(k\times 1)}{\underline{\beta}_i} = \begin{pmatrix} \beta_{1,i} \\ \vdots \\ \beta_{k,i} \end{pmatrix}.$$

In the second pass, we can run the cross-sectional regression of average returns $\bar{r}_i^e = (1/T)\sum_{t=1}^{T} r_{i,t}^e$, using the betas as data, to estimate the factor risk premia, $\underline{\lambda}$. If the excess return's covariance with the factor is systematic and undiversifiable, that covariance risk should be 'priced' into the return. The factor risk premium should not be zero. The second-pass regression run with a constant is,

$$\bar{r}_i^e = \gamma + \underbrace{(\lambda_1, ..., \lambda_k)}_{\underline{\lambda}} \begin{pmatrix} \beta_{1,i} \\ \vdots \\ \beta_{k,i} \end{pmatrix} + \alpha_i = \gamma + \underline{\lambda}'\underline{\beta}_i + \alpha_i$$

The α_i are the pricing errors. When the cross-sectional regression is run without a constant, set $\gamma = 0$.

$$\underline{\overline{r}}_i^e = \gamma + \underline{\beta}_i'\underline{\lambda} + \alpha_i.$$

OLS standard errors give asymptotically incorrect inference because the βs are not data but are generated regressors. Cochrane (2001) describes a procedure to obtain GMM standard errors that delivers asymptotically valid inference that is robust to the generated regressors problem and robust to heteroskedasticity and autocorrelation in the errors. Cochrane's strategy is to use the standard errors from a GMM estimation problem that exactly reproduces the two-stage regression point estimates. We will need the following notation

$$\underset{(k\times k)}{\mathbf{\Sigma}_f} = E\left(\underline{f}_t - \underline{\mu}_f\right)\left(\underline{f}_t - \underline{\mu}_f\right)',$$

$$\underline{\epsilon}_t = (\epsilon_{1,t}, \epsilon_{2,t}, ..., \epsilon_{n,t})'$$

$$\underset{n\times n}{\mathbf{\Sigma}} = E\left(\underline{\epsilon}_t\underline{\epsilon}_t'\right)$$

$$\underset{n\times k}{\mathbf{B}} = \begin{pmatrix} \underline{\beta}_1' \\ \vdots \\ \underline{\beta}_n' \end{pmatrix} = \begin{pmatrix} \beta_{1,1} & \cdots & \beta_{k,1} \\ \vdots & & \vdots \\ \beta_{1,n} & \cdots & \beta_{k,n} \end{pmatrix}$$

$$\underset{k\times n}{\mathbf{A}} = \underset{k\times k}{(\mathbf{B}'\mathbf{B})^{-1}}\underset{k\times n}{\mathbf{B}'}$$

$$\underset{n\times n}{\mathbf{M}_\beta} = \mathbf{I}_n - \underset{n\times k}{\mathbf{B}}\underset{k\times k}{(\mathbf{B}'\mathbf{B})^{-1}}\underset{k\times n}{\mathbf{B}}'$$

$$\underset{n\times(k+1)}{\mathbf{X}} = (\underline{\iota}_n\ \mathbf{B}'),\ \text{where } \underline{\iota}_n = \begin{pmatrix} 1 \\ \vdots \\ 1 \end{pmatrix} \leftarrow n'\text{th row}$$

$$\underset{(k+1)\times n}{\mathbf{C}} = \underset{(k+1)\times(k+1)}{(\mathbf{X}'\mathbf{X})}^{-1}\underset{(k+1)\times n}{\mathbf{X}'}$$

$$\underset{n\times n}{\mathbf{M}_X} = \mathbf{I}_n - \underset{n\times(k+1)}{\mathbf{X}}\underset{(k+1)\times(k+1)}{(\mathbf{X}'\mathbf{X})^{-1}}\underset{(k+1)\times n}{\mathbf{X}'}$$

$$\underset{(k+1)\times(k+1)}{\tilde{\mathbf{\Sigma}}_f} = \begin{pmatrix} \underset{\text{scalar}}{0} & \underset{1\times k}{\underline{0}} \\ \underset{k\times 1}{\underline{0}} & \underset{k\times k}{\mathbf{\Sigma}_f} \end{pmatrix}$$

Estimation without the constant. When estimating without the constant in the second-pass regression, the parameter vector is

$$\underset{[k(n+1)+k]\times 1}{\underline{\theta}} = \begin{pmatrix} \tilde{\underline{\beta}}_1 \\ \vdots \\ \tilde{\underline{\beta}}_n \\ \underline{\lambda} \end{pmatrix} = \begin{pmatrix} a_1 \\ \underline{\beta}_1 \\ \vdots \\ a_n \\ \underline{\beta}_n \\ \underline{\lambda} \end{pmatrix}$$

Let the second moment matrix of the factors be

$$\underset{(k+1)\times(k+1)}{\mathbf{M}_F} = \frac{1}{T}\sum_{t=1}^{T} \underline{F}_t \underline{F}_t'$$

The moment conditions are built off of the error vector,

$$\underset{n(k+2)\times 1}{\underline{u}_t(\theta)} = \begin{pmatrix} \underline{F}_t\left(r_{1,t}^e - \underline{F}_t'\underline{\tilde{\beta}}_1\right) \\ \vdots \\ \underline{F}_t\left(r_{n,t}^e - \underline{F}_t'\underline{\tilde{\beta}}_n\right) \\ r_{1,t}^e - \underline{\beta}_1'\underline{\lambda} \\ \vdots \\ r_{n,t}^e - \underline{\beta}_n'\underline{\lambda} \end{pmatrix} = \begin{pmatrix} \underline{F}_t\left(r_{1,t}^e - \underline{F}_t'\underline{\tilde{\beta}}_1\right) \\ \vdots \\ \underline{F}_t\left(r_{n,t}^e - \underline{F}_t'\underline{\tilde{\beta}}_n\right) \\ \underline{R}_t^e - \mathbf{B}\underline{\lambda} \end{pmatrix} \begin{matrix} \\ \\ \leftarrow \text{row } n(k+1) \\ \leftarrow (n\times 1) \end{matrix}$$

where

$$\underline{r}_t^e = \begin{pmatrix} r_{1,t}^e \\ \vdots \\ r_{n,t}^e \end{pmatrix}$$

Let

$$\underline{g}_T(\underline{\theta}) = \frac{1}{T}\sum_{t=1}^{T} \underline{u}_t(\theta)$$

$$\underset{[n(k+1)]\times[n(k+1)+k]}{\mathbf{d}_T} = \frac{\partial \mathbf{g}_T(\underline{\theta})}{\partial \underline{\theta}'} = \begin{pmatrix} \underset{[n(k+1)]\times[n(k+1)]}{-\mathbf{I}_n \otimes \mathbf{M}_F} & \underset{[n(k+1)]\times k}{\mathbf{0}} \\ \underset{n\times[n(k+1)]}{-\mathbf{I}_n \otimes \begin{pmatrix} \underset{\text{scalar}}{0} & \underline{\lambda}' \end{pmatrix}} & \underset{n\times k}{-\mathbf{B}} \end{pmatrix}$$

To replicate the estimates in the two-pass procedure, we need[14]

$$\underset{[n(k+1)+k]\times[n(k+2)]}{\mathbf{a}_T} = \begin{pmatrix} \mathbf{I}_{n(k+1)} & \underset{n(k+1)\times n}{\mathbf{0}} \\ \underset{k\times n(k+1)}{\mathbf{0}} & \underset{k\times n}{\mathbf{B}'} \end{pmatrix}, \tag{13}$$

not $\mathbf{d}_T\mathbf{S}_T^{-1}$. The coefficient covariance matrix we want is

$$\mathbf{V}_\theta = \frac{1}{T}\left(\mathbf{a}_T\mathbf{d}_T\right)^{-1}\left(\mathbf{a}_T\mathbf{S}_T\mathbf{a}_T'\right)\left[\left(\mathbf{a}_T\mathbf{d}_T\right)^{-1}\right]' \tag{14}$$

To test if the pricing errors are zero, use the covariance matrix of the moment conditions,

$$\mathbf{V}_g = \frac{1}{T}\left(\mathbf{I}_{(n(k+1))} - \mathbf{d}_T\left(\mathbf{a}_T\mathbf{d}_T\right)^{-1}\mathbf{a}_T\right)\mathbf{S}_T\left(\mathbf{I}_{(n(k+2))} - \mathbf{d}_T\left(\mathbf{a}_T\mathbf{d}_T\right)^{-1}\mathbf{a}_T\right) \tag{15}$$

We want to get $\mathbf{V}_\theta$ and $\mathbf{V}_g$ by plugging in.

GMM standard errors when estimating with a constant. The cross-sectional regression is now

$$\frac{1}{T}\sum_{t=1}^{T} r_{i,t}^e = \gamma + \underline{\beta}_i'\underline{\lambda} + \alpha_i$$

where γ is the constant. We have to add γ to the coefficient vector θ. Place it according to

$$\underset{(n+1)(k+1)\times 1}{\underline{\theta}} = \begin{pmatrix} a_1 \\ \underline{\beta}_1 \\ \vdots \\ a_n \\ \underline{\beta}_n \\ \gamma \\ \underline{\lambda} \end{pmatrix} = \begin{pmatrix} \underline{\tilde{\beta}}_1 \\ \vdots \\ \underline{\tilde{\beta}}_n \\ \gamma \\ \underline{\lambda} \end{pmatrix}$$

[14]In the usual GMM problem, we minimize

$$\underline{g}_T(\underline{\theta})'\mathbf{S}_T^{-1}\underline{g}_T(\underline{\theta})$$

where

$$\mathbf{S}_T \overset{a.s.}{\to} \mathbf{S} = \mathbf{E}\left(\sum_{j=-\infty}^{\infty}\underline{u}_t(\underline{\theta})\,\underline{u}_{t-j}(\theta)'\right)$$

We do Newey-West on $\underline{u}_t(\theta)$ to get $\mathbf{S}_T$. We will want to plug in our estimated λ and βs into $\mathbf{d}_T$. This problem chooses $\underline{\theta}$ to set

$$\mathbf{d}_T\mathbf{S}_T^{-1}\underline{g}_T(\underline{\theta}) = \underline{0}$$

and can be recast as having a weighting matrix on the moment conditions

$$\mathbf{a}_T\underline{g}_T(\underline{\theta}) = 0$$

where

$$\mathbf{a}_T = \mathbf{d}_T\mathbf{S}_T^{-1}$$

The covariance matrix of $\underline{\theta}$ for this problem is,

$$\mathbf{V}_\theta = \frac{1}{T}\left(\mathbf{d}_T\mathbf{S}_T\mathbf{d}_T\right)^{-1}$$

but this is not the covariance matrix for the two-pass estimation problem. The reason is that the last set of n moment conditions in $\underline{\mathbf{g}}_T(\underline{\theta})$ isn't the cross-sectional regression estimated by least squares (which is $\mathbf{B}'\left(\frac{1}{T}\sum_{t=1}^{T}\underline{R}_t^e - \mathbf{B}\underline{\lambda}\right)$).

Define

$$\mathbf{X} = \begin{pmatrix} \underset{n\times 1}{\underline{\iota}} & \underset{n\times k}{\mathbf{B}} \end{pmatrix}$$

The error vector that defines the model is

$$\underline{u}_t\left(\underline{\theta}\right) = \begin{pmatrix} \underline{F}_t\left(r^e_{1,t} - \underline{F}'_t\underline{\tilde{\beta}}_1\right) \\ \vdots \\ \underline{F}_t\left(r^e_{n,t} - \underline{F}'_t\underline{\tilde{\beta}}_n\right) \\ r^e_{1,t} - \gamma - \underline{\beta}'_1\underline{\lambda} \\ \vdots \\ r^e_{n,t} - \gamma - \underline{\beta}'_n\underline{\lambda} \end{pmatrix} = \begin{pmatrix} \underline{F}_t\left(r^e_{1,t} - \underline{F}'_t\underline{\tilde{\beta}}_1\right) \\ \vdots \\ \underline{F}_t\left(r^e_{n,t} - \underline{F}'_t\underline{\tilde{\beta}}_n\right) \\ \underline{R}^e_t - \mathbf{X}\begin{pmatrix} \gamma \\ \underline{\lambda} \end{pmatrix} \end{pmatrix}$$

Do Newey and West on $\underline{u}_t\left(\theta\right)$ to get $\mathbf{S}_T$. Use

$$\underset{[(n+1)(k+1)]\times[n(k+2)]}{\mathbf{a}_T} = \begin{pmatrix} \mathbf{I}_{n(k+1)} & \underset{[n(k+1)]\times n}{\mathbf{0}} \\ \underset{(k+1)\times[n(k+1)]}{\mathbf{0}} & \underset{(k+1)\times n}{\mathbf{X}'} \end{pmatrix}$$

$$\underset{[n(k+1)]\times[(k+1)(n+1)]}{\mathbf{d}_T} = \frac{\partial \mathbf{g}_T\left(\underline{\theta}\right)}{\partial \underline{\theta}'} = \begin{pmatrix} \underset{[n(k+1)]\times[n(k+1)]}{-\mathbf{I}_n \otimes \mathbf{M}_F} & \underset{[n(k+1)]\times(k+1)}{\mathbf{0}} \\ \underset{n\times[n(k+1)]}{-\mathbf{I}_n \otimes \begin{pmatrix} \underset{\text{scalar}}{0} & \underline{\lambda}' \end{pmatrix}} & \underset{n\times(k+1)}{-\mathbf{X}} \end{pmatrix}$$

to plug into (**??**) and (**??**).

We do not use GMM to estimate the model. We use the two-step procedure to get the point estimates for the betas and lambdas and plug those estimates into the GMM formulae to get standard errors.

Alternative Window Sizes

This section reports estimation of the beta model when the relevant moments are computed with windows of 16 and 24 quarters.

Table 11: Two-Pass Estimation of the Beta Model - Robustness.
Returns Sorted on Carry and Average Consumption Growth in Excess Over the U.S. Interest Rate.

Panel A: Two-Factor Model. Window-16. First HML Factor is $S_t(UE^{gap})$.									
λ_1	t-ratio	2^{nd} HML Factor	λ_2	t-ratio	γ	t-ratio	R^2	Test-stat	p-val.
0.629	**2.062**	$\mu_t(\Delta c)$	-266.297	-1.392	2.098	0.602	0.941	7.108	0.955
0.401	**2.870**	$\mu_t(EZW)$	-1.016	**-1.962**	2.482	1.078	0.866	8.949	0.880
0.421	**2.692**	$\mu_t(\Delta y)$	-1.162	-2.355	**2.984**	1.165	0.864	10.508	0.787
0.421	1.876	$\mu_t(\pi)$	-0.176	-0.042	1.234	0.405	0.815	13.440	0.568
0.265	1.211	$\sigma_t(\Delta c)$	0.812	1.038	-0.217	-0.067	0.807	12.387	0.650
0.495	1.468	$\sigma_t(\Delta y)$	-0.045	-0.041	**2.638**	1.094	0.800	11.335	0.728
0.396	**2.172**	$\sigma_t(\pi)$	-0.176	-0.141	**2.662**	1.196	0.849	14.421	0.494
0.288	**2.031**	$\sigma_t(\Delta q)$	8.015	2.452	**4.321**	1.440	0.932	8.588	0.898
Panel B: Two-Factor Model. Window-24. First HML Factor is $S_t(UE^{gap})$.									
λ_1	t-ratio	2^{nd} HML Factor	λ_2	t-ratio	γ	t-ratio	R^2	Test-stat	p-val.
0.623	**2.256**	$\mu_t(\Delta c)$	-266.965	-1.489	2.203	0.641	0.972	6.114	0.978
0.398	**3.015**	$\mu_t(EZW)$	-1.081	-1.944*	2.641	1.142	0.878	8.537	0.900
0.413	**2.932**	$\mu_t(\Delta y)$	-0.927	-1.387	2.640	1.266	0.839	10.613	0.780
0.399	**2.360**	$\mu_t(\pi)$	1.211	0.332	1.543	0.593	0.821	12.352	0.652
0.358	**2.251**	$\sigma_t(\Delta c)$	0.375	0.669	1.437	0.501	0.814	11.597	0.709
0.485	**2.038**	$\sigma_t(\Delta y)$	0.019	0.025	2.612	1.096	0.822	11.094	0.746
0.393	**2.678**	$\sigma_t(\pi)$	0.281	0.285	2.497	1.197	0.848	13.423	0.570
0.255	1.699	$\sigma_t(\Delta q)$	9.465	**2.184**	5.103	1.494	0.959	7.505	0.942

Notes: Significance at 10% level indicated by *. Bold indicates significance at 5% level.

Table 12: Two-Pass Estimation of the Beta Model - Robustness.
Returns Sorted on Carry and Real Exchange Rate Gap in Excess Over the U.S. Interest Rate.

Panel A: Two-Factor Model. Window-16. First HML Factor is $S_t(UE^{gap})$.									
λ_1	t-ratio	2^{nd} HML Factor	λ_2	t-ratio	γ	t-ratio	R^2	Test-stat	p-val.
0.639	1.922*	$\mu_t(\Delta c)$	-287.845	-1.218	2.210	0.602	0.967	5.822	0.983
0.402	**3.142**	$\mu_t(EZW)$	-0.755	-1.560	2.139	0.977	0.845	10.633	0.778
0.413	**2.492**	$\mu_t(\Delta y)$	-1.379	**-2.186**	3.406	1.189	0.909	9.066	0.874
0.445	1.763*	π_t	-1.538	-0.351	1.139	0.328	0.876	9.522	0.849
0.394	**2.193**	$\sigma_t(\Delta c)$	0.325	0.625	1.509	0.776	0.786	12.868	0.612
0.593	1.566	$\sigma_t(\Delta y)$	-0.384	-0.312	3.499	1.118	0.819	10.727	0.772
0.398	**2.294**	$\sigma_t(\pi)$	-0.089	-0.087	2.606	1.183	0.886	12.615	0.632
0.298	**2.841**	$\sigma_t(\Delta q)$	6.723	**2.214**	3.768	1.448	0.928	7.955	0.926
Panel B: Two-Factor Model. Window-24. First HML Factor is $S_t(UE^{gap})$.									
λ_1	t-ratio	2^{nd}HML Factor	λ_2	t-ratio	γ	t-ratio	R^2	Test-stat	p-val.
0.412	1.929*	$\mu_t(\Delta c)$	-38.902	-0.218	1.820	0.881	0.645	14.799	0.466
0.385	**2.685**	$\mu_t(EZW)$	-1.262	**-2.964**	2.806	1.233	0.871	10.606	0.780
0.377	**2.907**	$\mu_t(\Delta y)$	-0.411	-0.728	1.812	0.966	0.667	13.972	0.528
0.320	**2.581**	$\mu_t(\pi)$	4.469	1.682*	1.791	0.892	0.660	15.425	0.421
0.528	**2.770**	$\sigma_t(\Delta c)$	-0.405	-0.621	4.117	1.022	0.772	9.964	0.822
0.637	**3.328**	$\sigma_t(\Delta y)$	-0.707	-0.941	4.429	1.382	0.734	10.646	0.777
0.360	**2.662**	$\sigma_t(\pi)$	0.686	0.669	2.133	1.170	0.651	16.405	0.356
0.318	**2.834**	$\sigma_t(\Delta q)$	6.555	**2.458**	3.673	1.345	0.771	12.064	0.674

Notes: Significance at 10% level indicated by *. Bold indicates significance at 5% level.

Table 13: Two-Pass Estimation of the Beta Model - Robustness.
Returns Sorted on Carry and Real Exchange Rate Gap Volatility in Excess Over the U.S. Interest Rate.

Panel A: Two-Factor Model. Window-16. First HML Factor is $S_t(UE^{gap})$.									
λ_1	t-ratio	2^{nd} Factor	λ_2	t-ratio	γ	t-ratio	R^2	Test-stat	p-val.
0.487	**2.395**	$\mu_t(\Delta c)$	-205.224	-1.285	2.148	0.781	0.887	7.092	0.955
0.330	1.698*	$\mu_t(EZW)$	-1.988	-1.338	3.623	0.915	0.938	6.858	0.961
0.342	**2.389**	$\mu_t(\Delta y)$	-1.110	-1.355	3.050	1.665	0.839	14.659	0.476
0.350	**2.387**	$\mu_t(\pi)$	0.944	0.400	1.408	0.620	0.807	16.044	0.379
-0.095	-0.158	$\sigma_t(\Delta c)$	2.240	0.935	-5.320	-0.831	0.890	5.766	0.983
0.334	1.525	$\sigma_t(\Delta y)$	0.428	0.555	1.301	0.789	0.795	15.227	0.435
0.343	**2.488**	$\sigma_t(\pi)$	0.437	0.527	2.082	0.961	0.812	15.785	0.396
0.308	**2.847**	$\sigma_t(\Delta q)$	4.356	1.490	2.734	1.600	0.830	11.782	0.695
Panel B: Two-Factor Model. Window-24. First HML Factor is $S_t(UE^{gap})$.									
λ_1	t-ratio	2^{nd}HML Factor	λ_2	t-ratio	γ	t-ratio	R^2	Test-stat	p-val.
0.257	1.537	$\mu_t(\Delta c)$	41.143	0.338	1.773	0.956	0.589	16.004	0.382
0.337	**2.642**	$\mu_t(EZW)$	-0.917	**-2.172**	2.499	1.193	0.682	13.109	0.594
0.290	**2.204**	$\mu_t(\Delta y)$	-0.620	-0.941	2.413	1.262	0.598	15.182	0.438
0.268	**2.113**	$\mu_t(\pi)$	1.580	0.842	1.786	0.898	0.592	16.090	0.376
-0.052	-0.152	$\sigma_t(\Delta c)$	2.013	1.348	-4.320	-1.059	0.902	7.300	0.949
0.070	0.303	$\sigma_t(\Delta y)$	1.295	1.650*	-0.758	-0.311	0.672	13.315	0.578
0.287	1.889*	$\sigma_t(\pi)$	-0.735	-0.643	3.161	1.228	0.729	15.384	0.424
0.268	**2.524**	$\sigma_t(\Delta q)$	4.710	**2.130**	3.159	1.656	0.653	12.398	0.649

Notes: Significance at 10% level indicated by *. Bold indicates significance at 5% level.

Table 14: Two-Pass Estimation of the Beta Model - Robustness.
Returns Sorted on Inflation Volatility and Real Exchange Rate Gap Volatility in Excess Over the U.S. Interest Rate.

Panel A: Two-Factor Model. Window-16. First HML Factor is $S_t(UE^{gap})$.									
λ_1	t-ratio	2^{nd}HML Factor	λ_2	t-ratio	γ	t-ratio	R^2	Test-stat	p-val.
0.346	**2.269**	$\mu_t(\Delta c)$	-60.591	-0.613	1.874	0.975	0.840	12.643	0.630
0.376	**2.603**	$\mu_t(EZW)$	-1.367	-1.463	2.851	1.056	0.925	7.439	0.944
0.336	**2.151**	$\mu_t(\Delta y)$	-0.350	-0.469	1.698	1.226	0.791	11.423	0.722
0.349	**2.173**	$\mu_t(\pi)$	4.575	**1.996**	1.683	0.838	0.843	9.849	0.829
0.345	1.415	$\sigma_t(\Delta c)$	0.206	0.194	1.809	0.719	0.791	11.133	0.743
0.308	1.549	$\sigma_t(\Delta y)$	0.591	0.655	0.981	0.608	0.799	6.578	0.968
0.334	**2.081**	$\sigma_t(\pi)$	1.593	1.748*	1.230	0.575	0.812	10.993	0.753
0.320	**2.219**	$\sigma_t(\Delta q)$	2.406	0.794	1.950	1.397	0.802	9.500	0.850
Panel B: Two-Factor Model. Window-24. First HML Factor is $S(UE_t^{gap})$.									
λ_1	t-ratio	2^{nd} HML Factor	λ_2	t-ratio	γ	t-ratio	R^2	Test-stat	p-val.
0.124	0.632	$\mu_t(\Delta c)$	198.039	1.414	2.092	0.730	0.653	15.021	0.450
0.335	1.881*	$\mu_t(EZW)$	-0.669	-0.881	2.439	1.249	0.581	14.243	0.507
0.207	1.097	$\mu_t(\Delta y)$	0.564	0.716	1.123	0.528	0.633	14.526	0.486
0.255	1.854*	$\mu_t(\pi)$	2.358	1.046	2.226	1.137	0.576	16.582	0.344
0.174	0.770	$\sigma_t(\Delta c)$	1.452	1.002	-1.469	-0.455	0.735	9.017	0.877
0.097	0.387	$\sigma_t(\Delta y)$	1.689	1.154	-0.723	-0.203	0.688	12.082	0.673
0.236	1.454	$\sigma_t(\pi)$	-0.798	-0.441	3.267	1.113	0.654	13.176	0.589
0.250	1.680*	$\sigma_t(\Delta q)$	1.212	0.327	2.148	1.331	0.575	16.860	0.327

Notes: Significance at 10% level indicated by *. Bold indicates significance at 5% level.

Table 15: Two-Pass Estimation of the Beta Model - Robustness.
Original Sort Method in Excess Over the U.S. Interest Rate.

Panel A: Two-Factor Model. Window-16. First HML Factor is $S_t(UE^{gap})$.									
λ_1	t-ratio	2^{nd} Factor	λ_2	t-ratio	γ	t-ratio	R^2	Test-stat	p-val.
0.130	0.818	$\mu_t(\Delta c)$	214.839	**2.079**	2.102	0.889	0.612	10.653	0.777
0.344	**2.853**	$\mu_t(EZW)$	-0.864	**-3.651**	4.673	2.435	0.552	13.684	0.550
0.294	**2.258**	$\mu_t(\Delta y)$	-0.746	**-2.224**	3.830	2.329	0.420	14.833	0.463
0.313	**3.171**	$\mu_t(\pi)$	5.065	**2.967**	3.408	1.751	0.653	13.984	0.527
0.132	0.854	$\sigma_t(\Delta c)$	0.742	**2.382**	0.344	0.161	0.664	11.528	0.714
0.148	1.017	$\sigma_t(\Delta y)$	0.934	1.922*	1.683	0.827	0.576	10.936	0.757
0.285	**2.372**	$\sigma_t(\pi)$	1.546	**2.367**	3.211	1.704	0.514	15.014	0.450
0.315	**3.450**	$\sigma_t(\Delta q)$	7.495	**2.559**	4.865	2.343	0.542	12.736	0.623
Panel B: Two-Factor Model. Window-24. First HML Factor is $S_t(UE^{gap})$.									
λ_1	t-ratio	2^{nd}HML Factor	λ_2	t-ratio	γ	t-ratio	R^2	Test-stat	p-val.
0.347	1.740*	$\mu_t(\Delta c)$	132.841	1.375	1.862	0.704	0.379	18.581	0.233
0.308	**2.072**	$\mu_t(EZW)$	-0.532	-0.899	2.297	1.106	0.321	18.250	0.250
0.444	**2.032**	$\mu_t(\Delta y)$	0.118	0.340	1.531	0.614	0.394	16.909	0.324
0.192	1.110	$\mu_t(\pi)$	4.828	**3.005**	2.804	1.378	0.585	16.016	0.381
0.383	**2.043**	$\sigma_t(\Delta c)$	0.077	0.275	2.374	1.060	0.328	16.405	0.356
0.143	0.701	$\sigma_t(\Delta y)$	0.866	1.909	1.050	0.501	0.478	19.103	0.209
0.206	1.245	$\sigma_t(\pi)$	2.016	**2.508**	2.045	1.012	0.496	17.586	0.285
0.364	1.791	$\sigma_t(\Delta q)$	0.330	0.099	1.830	0.892	0.311	16.783	0.332

Notes: Significance at 10% level indicated by *. Bold indicates significance at 5% level.