Common Risk Factors in Currency Markets

Incomplete *

Hanno Lustig
UCLA and NBER

Nick Roussanov
Wharton

Adrien Verdelhan
Boston University

September 16, 2007

ABSTRACT

We build portfolios of one-month currency forward contracts on the basis of forward discounts. The spread between the lowest and highest interest rate currencies for a US investor is more than 5 percentage points per annum between 1983 and 2007 after taking into account bid ask spreads. The Sharpe ratio on a strategy that goes long in the highest and short in the lowest interest rate currencies is 0.6. We provide new evidence for a risk-based explanation of these currency returns. US dollar returns on these baskets of forward contracts are highly predictable over time and they are strongly counter-cyclical. In addition, we show that the cross-sectional variation in returns can be explained by a single aggregate risk factor. This risk factor (denoted HML_{FX}) is the return on a zero-cost strategy that goes long in the last portfolio and short in the first portfolio. This factor has a market beta that increases sharply in times of financial crisis.

*Lustig: Department of Economics, University of California at Los Angeles, Box 951477, Los Angeles, CA 90095; hlustig@econ.ucla.edu; Tel: (310) 825-8018; http://www.econ.ucla.edu/people/faculty/Lustig.html. Nick Roussanov: Wharton, University of Pennsylvania. Verdelhan: Department of Economics, Boston University, 270 Bay State Road, Boston, MA 02215; av@bu.edu; Tel: (617) 353-6324; http://people.bu.edu/av. The authors thank Andy Atkeson and Francis Longstaff for helpful comments.

A typical currency carry trade at the start of July 2007 was to borrow in yen and invest in Australian and New Zealand dollars. Figure 1 plots the percentage change in the dollar exchange rate for the yen (low interest rate currency) against the New Zealand and Australian dollar (high interest rate currencies). Each large drop in the S&P 500 was accompanied by a large appreciation of the yen of up to 1.7 % and a large depreciation of the New Zealand and Australian dollar of up to 2.3%.[1] Clearly, a US investor who was long in these high interest rate currencies and short in low interest rate currencies, was heavily exposed to US aggregate stock market risk during the recent mortgage crisis, and thus should be compensated by risk premia. In this paper, we demonstrate that currency risk premia are a robust feature of the data. Currency carry trades, which are defined generally as investing in high interest rate currencies and borrowing in low interest rate currencies, expose US investors to more US aggregate risk, especially during bad times in the US.

We find that, between 1983 and 2007, the annualized Sharpe ratio for a US investor, who goes long in high interest rate currencies and short in low interest rate currencies by taking positions in one-month forward and spot markets, is 60 percent. This is the risk-return trade-off after taking bid-ask spreads into account. Since forward contracts are not subject to sovereign default risk, these large excess returns must compensate the US investor for taking on aggregate US risk. In the cross-section, we find that a single aggregate US risk factor explains the difference in average excess returns between high and low interest rate currencies. After accounting for the covariance with this risk factor or β, there are no significant anomalous or unexplained excess returns (α) in the carry trade. In the time-series, we show that, for US investors, excess returns are highly predictable and counter-cyclical. These findings present a serious challenge to any non-risk-based explanation of the forward premium puzzle.

In this paper, we apply Fama and French (1993)'s technology for explaining stock and bond returns to currencies. As in Lustig and Verdelhan (2007), we sort currencies on their forward discount and we allocate them into six currency portfolios. The first portfolio contains the lowest interest rate currencies while the last portfolio contains the

[1] The 2.3% depreciation of the New Zealand dollar on July 26 is 3 times the size of the daily standard deviation in 2007. The 2 % drop in the Australian dollar is 3.5 times the size of the daily standard deviation in 2007 –the steepest one-day drop since it was allowed to trade freely in 1983.

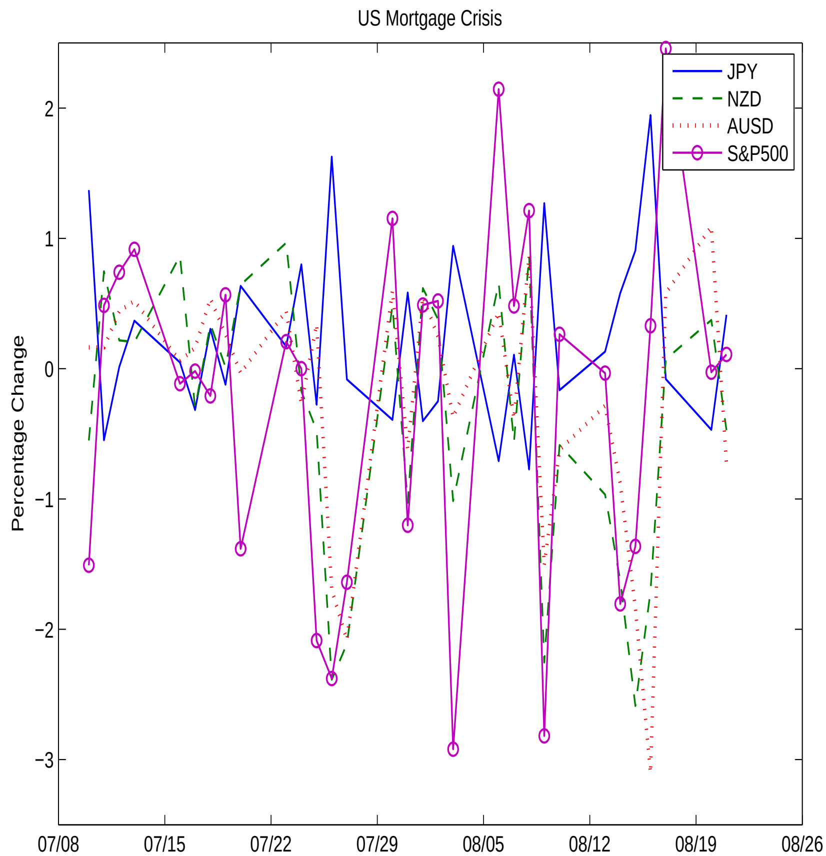

Figure 1. The Carry Trade and the US Stock Market during the Mortgage Crisis. This figure plots the percentage change in exchange rate for yen, New-Zealand dollar, the Australian dollar and the S&P 500 return.

highest interest rate currencies. Unlike Lustig and Verdelhan (2007), we only use spot and forward exchange rates. Our main sample comprises 37 currencies. Forward contracts are not subject to sovereign default risk and they are easily tradable. We account for bid-ask spreads that investors incur when they trade these portfolios of spot and forward contracts. By sorting currencies on their risk characteristics, we focus on sources of risk and we average out idiosyncratic variations.

For each portfolio, we compute the monthly foreign currency excess returns realized by buying or selling one-month forward contracts for all currencies in the portfolio, net of transaction costs. Between 1983 and 2007, US investors earn an annualized excess return of 5.3 percent by buying one-month forward contracts for currencies in the last portfolio and by selling forward contracts for currencies in the first portfolio. The annualized Sharpe ratio on a strategy that goes long in the last portfolio and short in the first portfolio is 0.6. These findings are robust. We find similar results when we limit the sample to developed currencies, and when we take the perspective of investors in other countries.

We show that a single risk factor explains about 80 percent of the variation in average excess returns on these portfolios of currency forward contracts. This risk factor is the return on a zero-cost strategy that goes long in the last portfolio and short in the first portfolio. We refer to it as HML_{FX} (high interest rate minus low interest rate). The estimated risk price of this factor is roughly equal to its sample mean of 5.3 percent per annum, as prescribed by Arbitrage Pricing Theory (APT). Low interest rate currencies provide US investors with insurance against HML_{FX} risk, while high interest rate currencies expose investors to more HML_{FX} risk.

The standard *CAPM* model also accounts for a large share of the cross-sectional variation at monthly frequency. Low discount currencies provide a hedge against US market risk, while high discount currencies expose investors to more risk. However, the estimated market risk premium is 40 percent, compared to an actual realized stock market excess return of 7.5 percent. This means the average market β of HML_{FX} is too small. We found evidence that this β varies over time; it tends to increase dramatically during crisis. For example, during the spring of 1998, the β increased to 1.2: high interest rates depreciated relative to low interest rate currencies by 1.2 percent when the market declined by 1 percent. This is consistent with the recent sub-prime mortgage crisis' effect on the carry trade (see figure 1).

In the time series, we document more predictability in these portfolio excess returns than in individual currency excess returns. These predictable excess returns are currency risk premia, because they go up for high interest rate currencies in bad times for US investors. Expected returns on portfolios with medium to high interest rates respond strongly to the US business cycle. For example, the (monthly) correlation between the one-month ahead forecast of excess returns on portfolios 2 through 4 and the change in the total US payroll varies between minus 50 and 70 %. The single best predictor other than forward rates is the change in US industrial production. At the 12-month horizon, a one percentage point decrease raises the risk premium on foreign currency between 100 and 200 basis points. US Industrial production forecasts currency returns with 20 to 40 % accuracy. Expected returns on the highest interest rate portfolios respond strongly to increases in US market uncertainty. The correlation of forecasted excess returns with the VIX index varies is 25 for the fifth and 50 % for the sixth portfolio. Since the forecasted excess return on high interest rate portfolios is strongly counter-cyclical and it increases in times of crisis for the highest interest rate portfolios, these forecastable excess returns are risk premia.

The literature on currency excess returns can broadly be divided into two different segments. The first segment of the literature pursues a standard risk-based analysis of exchange rates. This segment includes recent papers by Backus, Foresi and Telmer (2001), Harvey, Solnik and Zhou (2002), Verdelhan (2005), Campbell, de Medeiros and Viceira (2006), Lustig and Verdelhan (2007) and Bansal and Shaliastovich (2007). The second segment does not. This segment includes papers by Froot and Thaler (1990), Gourinchas and Tornell (2004), Lyons (2001), Bacchetta and van Wincoop (2006), Frankel and Poonawala (2007), Burnside, Eichenbaum, Kleshchelski and Rebelo (2006), Burnside, Eichenbaum and Rebelo (2007a) and Burnside, Eichenbaum and Rebelo (2007b). Our paper offers new evidence that time-series and cross-sectional variations in exchange rates are closely tied to risk factors. This evidence directly contradicts the findings of the last three papers which, using similar data, find no evidence that these returns are related to any risk factors. We show that building portfolios on the basis of forward discounts, instead of studying each country individually, explains the different findings.

Our paper is organized as follows. We start by describing the data, how we build the portfolios and the main characteristics of these portfolios in section I. Section II describes predictability results on these currency portfolios. In particular, we show that forecasted returns on high interest rate portfolios are strongly counter-cyclical. Section III shows that a single factor, HML_{FX} explains most of the cross-sectional variation in foreign currency excess returns. Section IV presents a series of robustness checks. Section V concludes.

I. Currency Portfolios and Risk Factors

We focus on investments in forward and spot currency markets. Compared to Treasury Bill markets, forward currency markets only exist for a limited set of currencies and shorter time-periods. However, forward currency markets offer two distinct advantages. First, the carry trade is easy to implement in these markets, and the data on bid-ask spreads for forward currency markets are readily available. This is not the case for most foreign fixed income markets. Second, these forward contracts are not subject to default risk, and counterparty risk is minimal. This section presents moments of monthly foreign currency excess returns from the perspective of a US investor. We consider currency portfolios that include developed and emerging countries for which forward contracts exist. We find that currency markets offer Sharpe ratios comparable to the ones measured on equity markets, even after controlling for bid-ask spreads. In section IV, we report several robustness checks considering only developed countries, non-US investors, and longer investment horizons.

A. Building Currency Portfolios

We briefly introduce some notations and describe our data and methodology for building currency portfolios.

Currency Excess Returns We use s to denote the log of the spot exchange rate in units of foreign currency per US dollar, and f for the log of the forward exchange rate, also in units of foreign currency per US dollar. The log excess return on buying a foreign currency in the forward market and then selling it in the spot market after one month is simply:

$$rx_{t+1} = f_t - s_{t+1}.$$

This excess return can also be stated as the log forward discount minus the change in the spot rate: $rx_{t+1} = -\Delta s_{t+1} + f_t - s_t$. In normal conditions, forward rates satisfy the covered interest rate parity condition: $f_t - s_t \approx i_t^\star - i_t$, where $i^\star$ and i denote the foreign and domestic nominal risk-free rates over the maturity of the contract. Hence, the log currency excess returns approximately equals the interest rate differential less the rate of depreciation:

$$rx_{t+1} \approx i_t^\star - i_t - \Delta s_{t+1}.$$

Transaction Costs Since we have bid-ask quotes for spot and forward contracts, we can compute the investor's actual realized excess return net of transaction costs. The *net* log currency excess returns for an investor who goes long in foreign currency is:

$$rx_{t+1}^l = f_t^a - s_{t+1}^b.$$

The investor buys the forward contract at the ask price (f^a), and sells the foreign currency at the bid price (s^b) in the spot market. Similarly, for an investor who shorts foreign currency, the net log currency excess return is given by:

$$rx_{t+1}^s = f_t^b - s_{t+1}^a.$$

To make our results comparable to Burnside et al. (2006), we adopt their rule-of-thumb and assume that the investor goes long (short) in the foreign currency when the forward discount $f - s$ is positive (negative).

Data We start from daily spot and forward exchange rates in US dollars. We build end-of-month series from November 1983 to April 2007.[2] Data are collected by Barclays and Reuters and available on Datastream. Our data set contains 37 currencies: Australia, Austria, Belgium, Canada, Hong Kong, Czech Republic, Denmark, Euro area, Finland, France, Germany, Greece, Hungary, India, Indonesia, Ireland, Italy, Japan, Kuwait, Malaysia, Mexico, Netherlands, New Zealand, Norway, Philippines, Poland, Portugal, Saudi Arabia, Singapore, South Africa, South Korea, Spain, Sweden, Switzerland, Taiwan, Thailand, United Kingdom. We leave out Turkey and United Arab Emirates, even if we have data for these countries, because their forward rates appear disconnected from their spot rates. The currency portfolios excess returns are available on our websites.

Currency Portfolios At the end of each period t, we allocate all currencies in the sample to six portfolios on the basis of the forward discount $f - s$ (the nominal interest

[2] When the last day of the month is Saturday or Sunday, we use the next business day.

rate difference between the foreign country and the US) observed at the end of period t. Portfolios are re-balanced at the end of every month. They are ranked from low to high interests rates; portfolio 1 contains the currencies with the lowest interest rate or smallest forward discount currencies, and portfolio 6 contains the currencies with the highest interest rates or largest forward discount. We compute the log currency excess return rx_{t+1}^j for each portfolio j by taking the average of the log currency excess returns in each portfolio j.

B. Returns to Currency Speculation for a US investor

Table I provides an overview of the properties of the six currency portfolios from the perspective of a US investor. For each portfolio j, we report average changes in the spot rate Δs^j (in units of foreign currency per dollar), the forward discounts $f^j - s^j$, the log currency excess returns $rx^j = -\Delta s^j + f^j - s^j$, and the log currency excess returns net of bid-ask spreads rx_{net}^j. Finally, we also report log currency excess returns on high-minus-low investment strategies that go long in portfolio $j = 2, 3 \ldots, 6$, and short in the first portfolio: $rx_{net}^j - rx_{net}^1$. All exchange rates and returns are reported in dollars and the moments of returns are annualized: we multiplied the mean of the monthly data by 12 and we multiplied the standard deviation by $\sqrt{12}$. The Sharpe ratio is the ratio of the annualized mean and the annualized standard deviation.

The first panel reports the average rate of depreciation for all the currencies in portfolio j. According to the standard uncovered interest rate parity (UIP) condition, the average rate of depreciation $E_T(\Delta s^j)$ of currencies in portfolio j should equal the average forward discount on these currencies $E_T(f^j - s^j)$, reported in the second panel.[3] Instead,

[3] A large body of empirical work starting with Hansen and Hodrick (1980) and Fama (1984) reports violations of the UIP condition. Hodrick (1987) and Lewis (1995) provide extensive surveys and updated regression results. UIP appears to be a reasonable description of the data only in four cases. First, Bansal and Dahlquist (2000) show that UIP is not rejected at high inflation levels, and likewise Huisman, Koedijk, Kool and Nissen (1998) find that UIP holds for very large forward premia. Second, Chaboud and Wright (2005) show that UIP is valid at very short horizons but is rejected for horizons above a few hours. Third, Meredith and Chinn (2005) find that UIP cannot be rejected at horizons above 5 years. Finally, Lothian and Wu (2005) find positive UIP slope coefficients for France/UK and US/UK on annual data over 1800-1999, because of the 1914-1949 sub-sample. Engel (1996) and Chinn (2006) provide recent surveys of the UIP tests. Such predictability regressions suffer from small sample bias and persistence in the right hand side variables, but Liu and Maynard (2005) and Maynard (2006) show that these biases

currencies in the first portfolio trade at an average forward discount of -390 basis points, but they appreciate on average only by 59 basis points over this sample. This adds up to a log currency excess return of minus 332 basis points on average, which is reported in the third panel. Currencies in the last portfolio trade at an average discount of 795 basis points but they depreciate only by 200 basis points on average. This adds up to a log currency excess return of 594 basis points on average.

The fourth panel reports average log currency excess returns net of transaction costs. Since we rebalance portfolios monthly, and transaction costs are incurred each month, these estimates of the net returns to currency speculation (rx_{net}) are conservative. After taking into account bid-ask spreads, the average return on the first portfolio drops to minus 218 basis points. The corresponding Sharpe ratio on this first portfolio is minus 0.26. The return on the sixth portfolio drops to 313 basis points. The corresponding Sharpe ratio on the last portfolio is 0.34.

The fifth panel reports returns on zero-cost strategies that go long in the high interest rate portfolios and short in the low interest rate portfolio. The spread between the net returns on the first and the last portfolio is 531 basis points. This high-minus-low strategy delivers a Sharpe ratio of 0.59. Equity returns provide a natural benchmark. Over the same sample, the (annualized) monthly log excess return on equity (the value-weighted CRSP index on NYSE, NASDQ and AMEX) is 6.85 percent, and the Sharpe ratio (ratio of annualized mean to annualized standard deviation) is 0.49. Note that this equity return does *not* reflect any transaction costs.

We have documented that a US investor with access to forward currency markets can realize large excess returns with annualized Sharpe ratios that are comparable to those in the US stock market. There is no evidence that time-varying bid-ask spreads can account for the failure of UIP in these data, as suggested by Burnside et al. (2006). In section IV, we conduct four robustness checks. We show that large currency excess returns obtain after accounting for bid-ask spreads even when (i) we restrict our sample to developed countries, (ii) we take the perspective of different foreign investors, (iii) we sort countries on past currency returns and (iv) we consider longer investment horizons. We turn now to the predictability of these currency excess returns.

can only explain a small part of the results.

II. Return Predictability in Currency Markets

The vast literature on the UIP condition considers country-by-country regressions of changes in exchange rates on forward discounts. Because the UIP condition fails in the data, forward discounts predict currency excess returns. In this section, we investigate the currency predictability implied by our portfolios. We show (i) that deviations from UIP are statistically even more significant for currency portfolios than for individual currencies, (ii) that time-variation in bid-ask spreads absorbs only a small fraction of the time variation in expected excess returns, and (iii) that these forecasted excess returns are clearly related to the US business cycle and to other events that affect US financial markets. Expected currency returns increase in downturns and decrease in expansions, as is the case in stock markets.

A. Forecasting Excess Returns at One-Month Horizon

For each portfolio j, we run a time series regression of average log currency excess returns on average log forward discounts for currencies in portfolio j:

$$rx_{t+1}^{j} = \gamma_0 + \gamma_1 (f_t^j - s_t^j) + \eta_t^j.$$

In the case of UIP, there is no predictability in currency excess returns, and the slope coefficient γ_1 is zero. Table II reports regression results in two panels. The left panel reports the results we obtained on returns without accounting for bid-ask spreads (rx_{t+1}^{j}) on the right-hand-side of the regression, while the left panel reports results on net returns ($rx_{net,t+1}^{j}$). We start by discussing the results in the left panel for gross returns. There is even stronger evidence against UIP in these portfolio returns than in individual currency returns. Looking across portfolios, from low to high interest rates, the slope coefficient γ_1 (column 3) increases from 102 basis points for currencies in the first portfolio to 370 basis points for currencies in the fourth portfolio. The slope coefficient decreases to 77 basis points for the sixth portfolio. The deviations from UIP are highest for currencies with medium to high forward discounts. The null of no predictability is rejected at the 1 percent significance level for all of these portfolios except for the third.[4]

Next, we turn to the predictability of the net returns in the right panel of Table II. There is some evidence that the time-variation in bid-ask spreads absorbs a small fraction of the predictability in currency returns: bid-ask spreads widen slightly when forward discounts increase, i.e. when expected returns increase in currency markets. Slope coefficients δ_1 in the net return predictability regressions tend to be between 40 and 55 basis points smaller for portfolios 2-5. Time variation in bid-ask spreads absorb a small fraction of the time variation in expected returns. This implies that a 100 basis point increase in the average forward discount on the fourth portfolio raises the net expected excess return by 315 basis points, compared to 370 basis points for the gross expected excess return. Clearly, time variation in the bid-ask spread does not eliminate the predictability of realized excess returns in currency markets.[5]

Since log excess returns are the difference between changes in spot rates at $t+1$ and forward discounts at t, these are predictability regressions for spot changes in exchange rates. At the one-month horizon, the R^2 on these predictability regressions varies between 2 and 6 percent. In other words, up to 6 percent of the variation in spot rates is predictable at one-month horizon.

Longer Horizons At longer horizons, the fraction of changes in spot rates explained by the forward discount is even higher. We use k-month maturity forward contracts to compute k-period horizon returns (where $k = 1,\ 2,\ 3,\ 6,\ 12.$). The log excess return on the k-month contract is:

$$rx_{t+1}^{k} = -\Delta s_{t\rightarrow t+k} + f_t^k - s_t.$$

Then we sort the currencies into portfolios based on the same longer maturity forward

[4]From γ_1, the slope coefficient in the return predictability regression, we can back out the implied slope coefficients δ_1 in the standard UIP regression:

$$-\Delta s_{t+1}^{i} = \delta_0 + \delta_1(f_t^i - s_t^i) + \eta_t^i$$

as $\delta_1 = 1 - \gamma_1$. The implied UIP coefficient on the fourth portfolio is -270 basis points: each 100 basis point increase in the forward discount reduces the rate of expected depreciation by 270 basis points.

[5]To make this point clearer, figure 6 in the Appendix plots one-month ahead forecasted excess returns with and without incurred transaction costs for the second portfolio.

rates.[6] Panel A of table III provides a summary of the results: it lists the R^2 we obtained for each portfolio (rows) and for each forecasting horizon (columns).[7] At longer horizons, the returns on the 1st portfolio are most predictable; the returns on the last portfolio are least predictable. On the first portfolio, more than a quarter of the variation in excess returns is accounted for by the forward rate at the 12-month horizon. On the last portfolio, 11 percent is accounted for by the forward rate.

Average Forward Discount There is even more predictability in these excess returns than the standard UIP regressions reveal, because the forward discounts on the other currency portfolios also help to forecast returns. A single return forecasting variable describes time variation in expected return on all the currency portfolios even better than the forward rates on the currency portfolios. This variable is the average of all the forward rates of the currency portfolios. We use ι to denote the 6×1 vector with elements $1/N$. For each portfolio j and maturity k, we run the following regression of log excess returns on the average forward rates:

$$rx^{j,k}_{net,t+1} = \gamma_0 + \gamma_1 \iota'(\mathbf{f}^k_t - \mathbf{s}^k_t) + \eta^j_t.$$

A summary of the results is reported in panel B of Table III.[8] This single factor explains between 3.3 and 8.8 percent of the variation at the one-month horizon and between 17 and 36 percent of the variation at the one-year horizon. This single factor mostly does as well and sometimes better than the forward discount of the specific portfolio in forecasting excess returns over the entire period. Clearly, the average forward discount contains additional information that is useful for forecasting excess returns on all currency portfolios, while little information is lost by aggregating all these forward discounts into a single number. The p-values on the slope coefficients are invariably lower than those for the forward rate regressions. This finding is similar to Cochrane and Piazzesi (2005)'s findings for the term structure. They show that a linear combination of forward rates outperforms the forward rate of that maturity. Cochrane and Piazzesi (2005) report R^2

[6]The returns from the long-short investment strategy are reported in Table XX in the separate appendix.

[7]The complete results are in the separate appendix in Table XXI.

[8]Table XXII in the separate appendix reports the complete results.

of up to 40 percent on one-year holding period returns for zero coupon bonds. Currency returns are *more predictable* than stock returns, and almost as predictable as bond returns.

B. Counter-Cyclical Forecasted Excess Returns at One-Month Horizon

Clearly, the excess returns that US investors expect in the carry trade vary over time. We show that this time variation has a large US business cycle component: the expected excess returns go up in US recessions and they go down in US expansions. The same counter-cyclical behavior has been documented for bond and stock excess returns.

We use $\widehat{E}_t rx^j_{t+1}$ to denote the forecast of the month-ahead excess return based on the forward discount:

$$\widehat{E}_t rx^j_{t+1} = \gamma^j_0 + \gamma^j_1 (f^j_t - s^j_t).$$

At high frequencies, forecasted returns on high interest rate currency portfolios – especially for the sixth portfolio – increase very strongly in response to events like the Asian crisis in 1997 and the LTCM crisis in 1998, but at lower frequencies, a big fraction of the variation in forecasted excess returns is driven by the US business cycle, especially for the third, fourth and fifth portfolios. To assess the cyclicality of these forecasted excess returns, we use three standard business cycle indicators and three financial variables: (i) the 12-month percentage change in US industrial production index, (ii) the 12-month percentage change in total US non-farm payroll, (iii) the 12-month percentage change in the Help Wanted index, (iv) the default spread – the difference between the 20-Year Government Bond Yield and the $S\&P$ 15-year BBB Utility Bond Yield – (v) the slope of the yield curve – the difference between the 5-year and the 1-year zero coupon yield, and (vi) the $S\&P$ 500 VIX volatility index.[9]

Table IV reports the contemporaneous correlation of the month-ahead forecasted excess returns with these macroeconomic and financial variables. As expected, forecasted

[9]Industrial production data are from the IMF International Financial Statistics. The payroll index is from the BEA. The Help Wanted Index is from the Conference Board. Zero coupon yields are computed from the Fama-Bliss series available from CRSP. These can be downloaded from `http://wrds.wharton.upenn.edu`. Payroll data can be downloaded from `http://www.bea.gov`. The VIX index, the corporate bond yield and the 20-year government bond yield are from `http://www.globalfinancialdata.com`.

excess returns for high interest rate portfolios are strongly counter-cyclical.

On the one hand, the monthly contemporaneous correlation between predicted excess returns and percentage changes in industrial production (first column), the non-farm payroll (second column) and the help wanted index (third column) are negative for all portfolios except the first one. For payroll changes, the correlations range from -.71 for the second portfolio to -.10. for the sixth. Figure 2 plots the forecasted excess return on portfolios 2 to 6 against the 12-month change in US payrolls. Vertical lines identify NBER recession dates. In our sample, NBER recessions cover the months of July 1990 to March 1991 and March 2001 to November 2001. Payroll changes alone explain between 19 percent and 51 percent of the variation in forecasted excess returns on high interest rate portfolios. Forecasted excess returns on the other portfolios have similar low frequency dynamics, but they also respond to other events, like the Russian default and LTCM crisis, the Asian currency crisis and the Argentine default.

On the other hand, monthly correlations of the high interest rate currency portfolio with the default spread (fourth column) and the term spread (fifth column) are, as expected, positive. Finally, the last column reports correlations with the implied volatility index. These correlations reveal a clear difference between the low interest rate currencies with negative correlations, and the high interest rate currencies, with positive correlations. In times of heightened market uncertainty in US financial markets, there is a flight to quality: US investors want a much higher risk premium for investing in high interest rate currencies, and they accept lower (or more negative) risk premia on low interest rate currencies.

Longer Horizons We found the same business cycle variation in expected returns over longer holding periods.[10] This is partly because the forward discounts are highly countercyclical. Table V reports the correlation of the currency risk factor (the average forward discount) with the business cycle variables. **Note to Hanno: what do you mean in the previous sentence?** However, these macro variables themselves help to forecast excess returns. In fact, the change in industrial production (IP) explains up to 37 percent of the variation in excess returns at the 12-month horizon. Table VI reports

[10]The complete list of correlations for all horizons considered is reported in Table XXIII in the separate appendix.

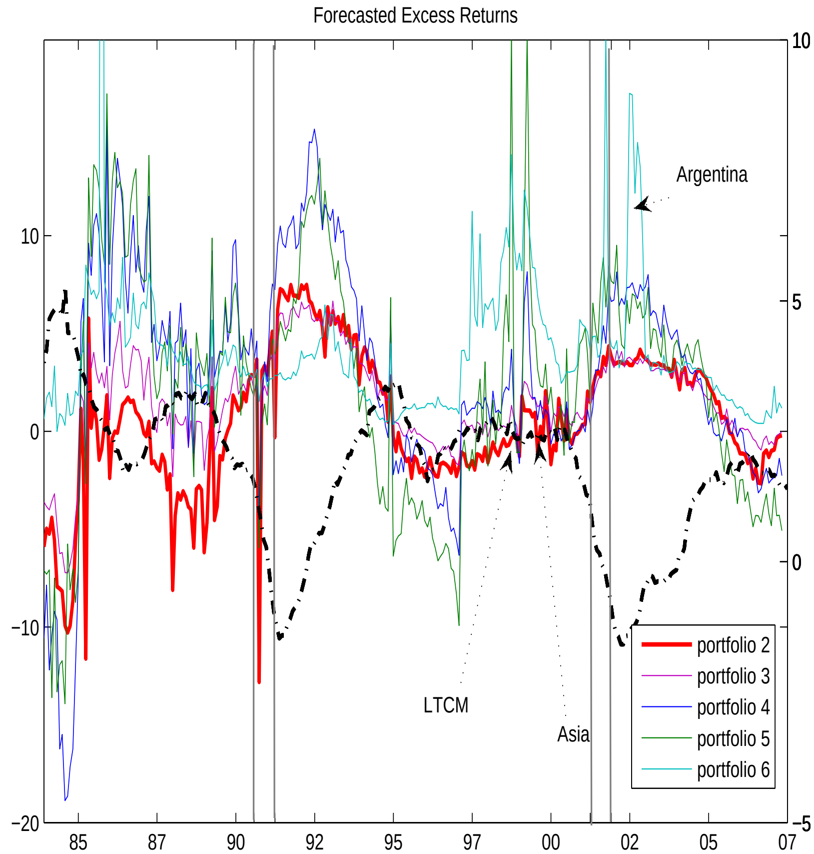

Figure 2. Forecasted Excess Return in Currency Markets and US Business Cycle. This figure plots forecasted excess returns on portfolios 2 to 6: $\widehat{E}_t rx^i_{t+1}, i = 2, \ldots, 6$. The dashed line is the year-on-year log change in US Non-Farm Payrolls (Seasonally adjusted). Vertical lines identify NBER recession dates. In our sample, NBER recessions cover the months from July 1990 to March 1991 and from March 2001 to November 2001. All returns are annualized.

regression results for :

$$rx^{j,k}_{net,t+1} = \gamma_0 + \gamma_{IP} \Delta \log IP_t + \eta^j_t.$$

Slope coefficients are negative at all horizons. At the 12-month horizon, a one percentage point drop in the annual change in industrial production raises the currency risk premium by 150 to 200 basis points per annum. At shorter horizons, this number is in the 100 to 150 basis point range. Except for the 1-month horizon forecasts, the Wald test for the slope coefficient has p-values that are smaller than 5 percent for all portfolios. The predictability is partly due to the countercyclical nature of the forward rates, but not entirely. The left panel in Table VII controls for the portfolio's average forward rates in that regression. The *p*-values (in percentage points) are for a t-test on the IP slope coefficient. The IP forecasting variable still enters significantly at the 5 percent level in all but the first two portfolios. The right panel controls for the average forward rate on all portfolios. Again, the IP forecasting variable enters significantly for all portfolios. The currency risk premium increase in response to a one percentage point drop in the growth rate of industrial production varies between 80 and 170 basis points. The strong response of currency excess returns to industrial production resembles results reported by Cooper and Priestley (2007) on stock market excess returns. Cooper and Priestley (2007) show that the output gap, defined using the deviation of industrial production from a trend, is a very robust predictor of excess returns on the stock market in all G-7 countries. This variable is highly correlated (.9) with the growth rate of industrial production in our sample.

We have documented in this section that returns in currency markets are highly predictable. The average forward discount rate accurately predicts up to 35 percent of the variation in annual excess returns. The time variation in expected returns has a clear business cycle pattern: the currency expected returns are strongly counter-cyclical. US macroeconomic variables are powerful predictors of these returns, especially at longer holding periods. We now turn to the estimation of the market prices of risk on the cross-section of these currency excess returns.

III. Common Risk Factors in Currency Markets

We show that the sizeable currency excess returns described in the previous sections are matched by covariances with risk factors. We propose two currency factors that are essentially the first two principal components of the portfolio returns. All portfolios load equivalently on the first factor, which is the average currency excess return. The second principal component, which is the difference in returns between the low and high interest rate currencies, explains a large share of the cross-section. Again, this results also holds for sub-samples of developed countries, foreign investors and longer investment horizons as reported in section IV. We first describe our methodology and then our results.

A. Methodology

A principal component analysis on our currency portfolios reveals that two factors explain more than three quarters of the variation in returns. The first principal component is indistinguishable from the average portfolio return.[11] We refer to this average currency excess return as RX_{FX}. The second principal component is essentially the difference between the return on the sixth portfolio and the first portfolio. We refer to this factor as HML_{FX}. HML_{FX} is computed as the difference between the net return on the last and the first portfolio. The correlation of the first principal component with RX_{FX} is .99. The correlation of the second principal component with HML_{FX} is .94. Both factors are computed from net returns, after bid-ask spreads. The first two principal components explain 82 percent of the variation in returns on these six portfolios.

These currency risk factors have a natural interpretation. HML_{FX} is the return in dollars on a zero-cost strategy that goes long in the highest interest rate currencies and short in the lowest interest rate currencies. This is the portfolio return of a US investor engaged in the usual currency carry trade. Hence, this is a natural candidate currency risk factor, and, as we are about to show, it explains much of the cross-sectional variation in average excess returns. RX_{FX} is the average portfolio return of a US investor who buys all foreign currencies available in the forward market. This second factor really is the currency "market" return in dollars.

Cross-sectional Asset Pricing We use Rx^j_{t+1} to denote the average excess return on portfolio j in period $t+1$.[12] In the absence of arbitrage opportunities, this excess return has a zero price:

$$E_t[M_{t+1} Rx^j_{t+1}] = 0.$$

[11]Table XXIV in the separate appendix reports the principal component coefficients.
[12]All asset pricing tests are run on excess returns and not log excess returns.

We assume that the stochastic discount m is linear in the pricing factors f:

$$m_{t+1} = 1 - b(f_{t+1} - \mu),$$

where b is the vector of factor loadings and μ is the vector of means of the factors. This linear factor model implies a beta pricing model: the expected excess return is equal to the factor price λ times the beta of each portfolio β^j:

$$E[Rx^j] = \lambda' \beta^j,$$

where $\lambda = \Sigma_{ff} b$ and $\Sigma_{ff} = E(f_t - \mu_f)(f_t - \mu_f)'$ is the variance-covariance matrix of the factors. To estimate the factor prices λ and the portfolio betas β, we use two different procedures: a Generalized Method of Moments estimation (GMM) applied to linear factor models, following Hansen (1982), and a 2-stage OLS estimation following Fama and MacBeth (1973) (henceforth FMB). We now briefly describe these two techniques, starting with GMM.

GMM The moment conditions are the sample analog of the population pricing errors:

$$g_T(b) = E_T(m_t Rx_t) = E_T(Rx_t) - E_T(Rx_t f_t')b,$$

where $Rx_t = [Rx_t^1 \; Rx_t^2 \; .. \; Rx_t^N]'$ bunches all N currency portfolios. In the first stage of the GMM estimation, we use the identity matrix as the weighting matrix, $W = I$, while in the second stage we use $W = S^{-1}$ where S is the spectral density matrix of the pricing errors in the first stage: $S = \sum_{-\infty}^{\infty} E[(m_t Rx_t)(m_{t-j} Rx_{t-j})']$.[13] Since we focus on linear factor models, the first stage is equivalent to an OLS-cross-sectional regression of average returns on the second moment of returns and factors. The second stage is a GLS cross-sectional regression of average excess returns on the second moment of returns and factors. We use demeaned factors.

[13]We use a Newey and West (1987) approximation of the spectral density matrix. The optimal number of lags is determined using Andrews (1991)'s criterium (with a maximum of 6 lags).

FMB In the first stage of the FMB procedure, for each portfolio j, we run a time-series regression of the currency returns Rx_{t+1}^j on a constant and the factors f_t, in order to estimate β^j. The difference with the first stage of the GMM procedure stems from the presence of a constant in the regressions. In the second stage, we run a cross-sectional regression of the average excess returns $E_T[Rx_t^j]$ on the betas that were estimated in the first stage, to estimate the factor prices λ. We do not include a constant in this regression. Finally, we can back out the factor loadings b and hence the structural parameters from the factor prices.

B. Results for US Investors

Table VIII reports the asset pricing results obtained using GMM and FMB on currency portfolios sorted on forward discounts. The table reports estimates of market prices of risk λ and factor loadings b, the adjusted R^2, square-root of mean-squared errors $RMSE$ and the p-values of χ^2 tests (in percentage points).

The first stage GMM estimates and the FMB point estimates are identical, because we do *not* include a constant in the second step of the FMB procedure. We focus on these results. The market price of HML_{FX} risk is 619 basis points *per annum*. This means that an asset with a beta of one earns a risk premium of 6.19 percent per annum. Since the factors are returns, no arbitrage implies that the risk prices of these factors should equal their average excess returns. The average excess return on the high-minus-low strategy (last row in Table VIII) is 648 basis points. So the estimated risk price is only 29 basis points removed from the point estimate implied by the theory. The GMM standard error of the risk price is 238 basis points. The FMB standard error is 188 basis points. In both cases, the risk price is more than 2.5 standard errors from zero. The second risk factor RX_{FX}, the average currency excess return, has an estimated risk price of 162 basis points, compared to a sample mean for the factor of 161 basis points. This is not surprising, because all the portfolios have a beta of close to one with respect to this second factor. As a result, the second factor explains none of the cross-sectional variation in portfolio returns, and the standard error on the risk price estimates are large: the GMM standard error is 170 basis points. Overall, pricing errors are small. The RMSE is around 75 basis points and the adjusted R^2 is 85 percent. The null that the pricing errors are zero cannot be rejected, regardless of the estimation procedure.

Figure 3 plots predicted against realized excess returns for all six currency portfolios. The predicted excess return is the OLS estimate of the betas times the sample mean of the factors. The top left panel shows the data for a US investor. The other panels plot asset pricing results obtained for foreign investors in the UK, Switzerland and Japan. The market prices of risk used in the figure are the sample means of the factors, not the estimated ones. Clearly, currency excess returns are priced from different investors' perspectives. We report precise estimates of the corresponding foreign prices of risk in our robustness section.

Alpha's in the Carry Trade? Another way of testing the model is by running time-series regressions of excess returns on the two factors. Table IX reports the constant (denoted α) and the slope coefficients (denoted β) obtained by running time-series regressions of the currency excess returns Rx_t^j on each portfolio on a constant and risk factors. Returns are in percentage points per annum. The first column reports estimates for α. These are annualized and in percentage points. The third portfolio has a large α of 142 basis points per annum, but is not statistically significant at the 5 percent level. The other α estimates are smaller than 50 basis points. These are not significantly different from zero. The null that all the α's are zero cannot be rejected. The p-value of the χ^2 statistic (reported on last row) is 45 percent.

The second column of Table IX reports the estimated β's for the HML_{FX} factor. These β's increase monotonically from -.40 for the first portfolio to .60 for the last currency portfolio, and they are estimated very precisely. The first three portfolios have betas that are negative and significantly different from zero. The last two have betas that are positive and significantly different from zero. The third column of Table IX shows that betas for the second factor are essentially all equal to one. Obviously, this second factor does not explain any of the variation in average excess returns across portfolios, but it helps to explain the average level of excess returns. To help us understand what HML risk is, we use the workhorse of modern finance, the standard CAPM.

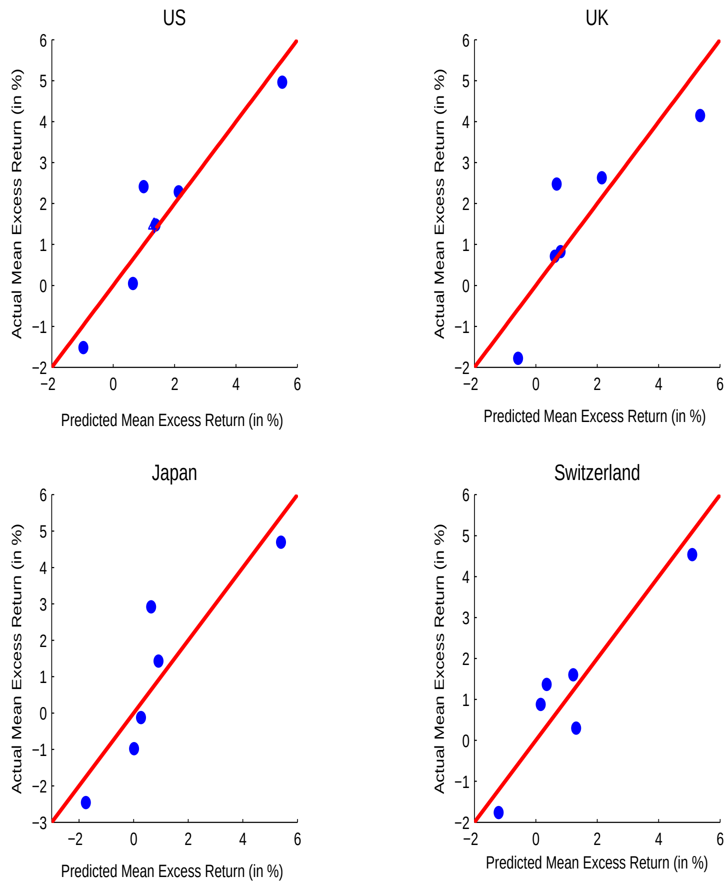

Figure 3. Predicted against Actual Excess Returns.
This figure plots the realized average excess return (vertical axis) against the predicted average excess return(horizontal axis). The predicted excess return is the OLS estimate of β times the sample mean of the factors. All returns are annualized.

C. CAPM

We now run the same asset pricing experiment using the US stock market excess return instead of HML_{FX}. We use the CRSP value-weighted return on the NYSE, AMEX and NASDAQ markets in excess of the one-month average Fama risk-free rate. In fact, the stock market excess return and the level factor RX can explain 78 percent of the variation in returns. However, the estimated price of US market risk is 43 percent, while the actual annualized excess return on the market was only 7 percent over this sample. The risk price is 6 times too large. The CAPM loadings are reported in Table XI. The loadings of these portfolios vary from -.05 for the first one to .07 for the last one. Low interest rate currencies provide a hedge, while high interest rate currencies expose US investors to more stock market risk. These betas increase almost monotonically, but they are too small to explain these excess returns. HML_{FX} has a market β of about .12 with a standard error of .06. While high interest rate currencies expose US investors to more stock market risk, and low interest rate currencies provide a hedge, the price of market risk is too high. In other words, the spread in market betas seems to small. We found evidence that this spread increases during times of crisis and high volatility in the stock markets.

Time Variation in Betas As it turns out, high interest rate currencies become more correlated with the stock market excess return during times of high volatility in financial markets. We computed 6-month rolling windows of these correlations on daily data. Figure 4 plots the difference between the correlation of the 6th and the 1st portfolio with the US market excess return:

$$Corr_\tau[R_t^m, rx_t^6] - Corr_\tau[R_t^m, rx_t^1],$$

where $Corr_\tau$ is the sample correlation over the previous 12 months $[\tau - 11, \tau]$ and R^m the stock market excess return. Vertical gray lines identify NBER recession dates. In our sample, NBER recessions cover the months from July 1990 to March 1991 and from March 2001 to November 2001. Red lines indicate key events: the 1987 market crash (October 1987), the Mexican crisis (December 1994), the Asian crisis (July 1997), the Russian debt crisis (August 1998) and the Brazilian devaluation (February 1999). In some cases, these events mark turning points at the end of a series of events rather than the start of the crisis. Clearly, market correlations are subject to enormous time variations. In times of crisis and during US recessions, the market correlation difference increases significantly. During the Mexican, Asian, Russian and Argentine crisis, the correlation difference jumps up by 50 to 120 basis points. This means high interest rate currencies become riskier than low interest rate currencies in bad times for US investors. In each of these episodes, whenever the US stock market falls, there is a *flight to quality* which puts downward pressure on high interest rate currencies and upward pressure on low interest rate currencies. Conversely, when the stock market recovers, the high interest rate currencies appreciate.

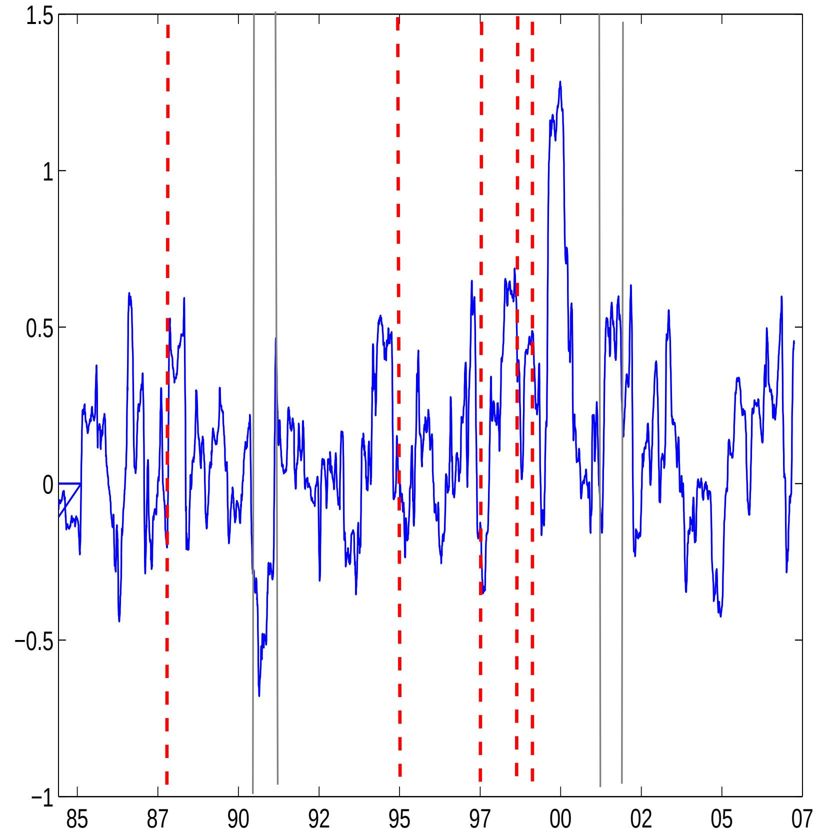

Figure 4. Market Correlation Spread of Currency Returns
This figure plots $Corr_\tau[R_t^m, rx_t^6] - Corr_\tau[R_t^m, rx_t^1]$, where $Corr_\tau$ is the sample correlation over the previous 6 months $[\tau - 128, \tau]$. We use monthly returns at daily frequency. Vertical gray lines identify NBER recession dates. In our sample, NBER recessions cover the months from July 1990 to March 1991 and from March 2001 to November 2001. All returns are annualized. The dotted lines indicate the 1987 market crash, the Mexican crisis, the Asian crisis, the Russian crisis and the Argentine crisis.

To examine this, we compute the market $\beta^m_{\tau,HML}$ of HML_{FX} over 12 month rolling

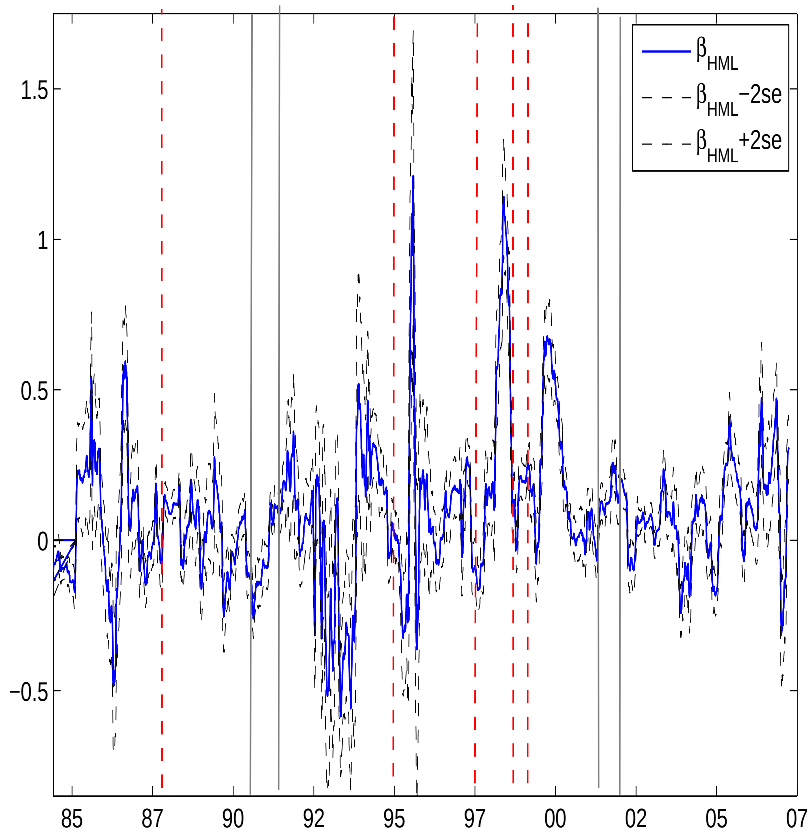

Figure 5. Time-Varying Market Betas of HML: $\beta^m_{\tau,HML}$
The full line plots $\beta^m_{\tau,HML} = \beta^6_\tau - \beta^1_\tau$ where the betas are computed over the previous 6 months ($t \in [\tau - 128, \tau]$). We use monthly returns at daily frequency. Vertical gray lines identify NBER recession dates. In our sample, NBER recessions cover the months from July 1990 to March 1991 and from March 2001 to November 2001. All returns are annualized. The dotted lines indicate the 1987 market crash, the Mexican crisis, the Asian crisis, the Russian crisis and the Argentine crisis.

windows. $\beta^m_{\tau,HML}$ is computed by regressing HML_{FX} on the market return on a sample where $t \in [\tau, \tau - 128]$:

$$HML_{FX} = \alpha_\tau + \beta^m_{\tau,HML} R^m_t + \eta_t.$$

As a result, $\beta^m_{\tau,HML}$ is the difference between the market betas of the corner portfolios:

$\beta^6_\tau - \beta^1_\tau$. In figure 5, we plot it against the major events in financial markets and the US recessions. The $\beta^m_{\tau,HML}$ varies between -.5 and 1.3 in 1998 during the Russian/LTCM crisis. On average, $\beta^m_{\tau,HML}$ is positive (with a mean of .10), but it is highly volatile: the standard deviation is 22 basis points. Invariably, in periods of high volatility during crises and during US recessions, $\beta^m_{\tau,HML}$ increases. The three episodes that stand out are the Spring of 1998, characterized by the run-up to the Russian debt crisis and the LTCM collapse, the Summer of 1995, known for the Mexican Tequila crisis and the Fall of 1999, leading to the Brazilian devaluation and the Argentine crisis. Table XII reports the market betas of the currency portfolios in each of these episodes. $\beta^m_{\tau,HML}$ increases to 1.14 in the run-up to the Russian default in 1998. This means high interest rate currencies depreciate on average by 1.14 percent relative to low interest rate currencies when the market goes down by percent. The β^j estimates increase quasi-monotonically from the first to the last portfolio. The same pattern appears in each of these episodes. Low interest rate currencies provide a hedge against market risk while high interest rate currencies expose US investors to more market risk. Overall, the distribution of $\beta^m_{\tau,HML}$ is skewed to the right (with a skewness of 1.09), and it has fat tails (with a kurtosis 6.8).

D. Foreign Equity

We end this cross-sectional asset pricing section by showing that our risk factors can shed some light above and beyond currency excess returns. US risk factors do not explain the cross-sectional variation in dollar returns on foreign equity portfolios. Our currency risk factors might explain part of this puzzle. To illustrate this, we construct six foreign equity portfolios using the same sorting procedure based on forward discounts. We use MSCI market indices for all countries in our sample. The US dollar excess returns on these portfolios increase from 9.86 percent to 13.46 percent on the fifth portfolio. The last portfolio has a much lower excess return of 7.89 percent, because of abnormally low returns (1.12 percent) in the stock market in some of these countries over this sample period.

We regress the US dollar excess returns on these equity portfolios on the US market excess return, HML_{FX} and RX_{FX}. The loadings on the currency risk factor are significantly different from zero for the first and the last two portfolios. The results are reported in Table XIII. The first four columns report the estimates for α and β. The 5th column reports the average excess returns in US dollars and the last column reports the currency risk premium:

$$CRP^j = \lambda_{HML}\beta^j_{HML} + \lambda_{RX}\beta^j_{RX}.$$

In the computation of this risk premium, we simply use the sample means of the factors for the risk prices. The 5th equity portfolio has roughly the same US market β as the first equity portfolio, but it yields an average excess return that is 3.50 percent higher. The CRP spread between the first and the fifth portfolio is 3.30 percent. Without the currency risk factors, this difference would have been absorbed by α.

IV. Robustness Checks

We perform four robustness checks. First, we limit our sample to developed countries. We redo our analysis on a smaller sample of 15 developed countries and on an even smaller sample of 10 developed countries that was used by Burnside et al. (2006). For these currencies, Burnside et al. (2006) conclude that there are no large exploitable excess returns that result from the failure of UIP because the difference between the forward discount and the rate of depreciation is absorbed largely by the bid-ask spreads. Burnside et al. (2006) also claim that these currency excess returns are not related to any risk factor. We find that large currency excess returns exist, even after taking into account bid-ask spreads. These currency excess returns are clearly explained by risk factors. Second, we consider different home countries. We take the perspective of the Swiss, UK and Japanese investors, and for each investor, we build currency portfolios, test their business cycle properties and we estimate the corresponding market prices of risk. Third, we consider different investment horizons because the US investor can buy not only one-month forward contracts, but also 2, 3, 6 and 12 month forward contracts. Fourth, we consider the longer sample of currency excess returns built using Treasury bills in Lustig and Verdelhan (2007).

A. Large and Small Sample of Developed Countries

We first consider developed countries, and then a sub-sample of developed countries.

Developed Countries Our main dataset comprises all forward and spot rates in US dollars collected from Reuters and Barclays and available on Datastream.[14] We now check the robustness of our results by excluding currencies of developing countries from the sample. This limited data set contains only 15 developed countries: Australia, Belgium, Canada, Denmark, Euro area, France, Germany, Italy, Japan, Netherlands, New Zealand, Norway, Sweden, Switzerland and United Kingdom. Note that we leave out Hong Kong, Malaysia, Singapore, South Africa, even if we have data for these countries, in order to be conservative in our definition of developed countries.[15]

Table XIV summarizes the results that we obtain for developed currencies. The fourth panel reports the moments of the net log currency excess returns realized over the sample in these five currency portfolios. Net excess returns vary between -111 basis points on the first portfolio and 336 basis points on the last portfolio. The fifth panel reports the moments for the returns on the long-short strategy. The average return on going long in the last and short in the first portfolio is 447 basis points. The annualized Sharpe ratio on this strategy is 0.54.

Burnside et al (2006)'s sample Burnside et al. (2006) consider an even smaller set of (at most) 10 developed countries: Belgium, Canada, Euro area, France, Germany, Italy, Japan, Netherlands, Switzerland, the United Kingdom and the United States.[16] Burnside et al. (2006) use spot and forward rates denominated in UK pounds, collected by Barclays and available on Datastream. The series denominated in pounds start in January 1976. We convert these series into dollars and start in 1976 as Burnside et al. (2006). Because of the small number of countries in the sample, we only consider 3 portfolios. Table XV

[14]In comparison to Burnside et al. (2007a) who use interest rates instead of forward contracts, we exclude Brazil, Bulgaria, Chile, Colombia, Croatia, Cyprus, Egypt, Estonia, Iceland, Israel, Kazakhstan, Kenya, Kuwait, Latvia, Lithuania, Malta, Morocco, Pakistan, Qatar, Romania, Russia, Slovakia, Slovenia, Tunisia, Turkey, United Arab Emirates, and Ukraine because neither Reuters nor Barclays report forward rates for these countries. Note that to use interest rates from these additional countries, one needs to check the financial openness of each country and correct for default events. See Lustig and Verdelhan (2007) for details.

[15]In comparison to the 10 countries in Burnside et al. (2006), we add Australia, Denmark, New Zealand, Norway, and Sweden.

[16]While we consider this sample too restrictive as it does not even encompass forward (or equivalent futures) contracts traded on large institutionalized currency markets as the Chicago Mercantile Exchange, we want to check our results on this sample.

below reports summary statistics on these currency portfolios. Even on this very limited sample and after taking into account bid-ask spreads, building portfolios delivers a cross-section of currency excess returns. The annualized gap between the third and the first portfolio is close to 290 basis points and the Sharpe ratio slightly below 0.40. Starting in 1983 (as for the other samples), the gap is even bigger (340 basis points) and the Sharpe ratio is above 0.40.

Cross-section This cross-section of excess returns reflects different exposures to risk factors. We use the risk factor HML_{FX} (built using our large sample of forward and spot rates) and the average return RX across the test assets. Because of the small number of test assets, we do not re-estimate market prices of risk; we simply use sample means. As a result, we only regress each excess return on HML_{FX} and RX to compute the corresponding betas. [17] The betas are highly significant. The loadings on HML_{FX} explain the cross-section of currency excess returns. The first portfolio has a negative beta, and the last portfolio a positive one. The loadings on the average market return do not vary much across portfolios.

What accounts for the difference with the results reported by Burnside et al. (2006)? They claim that currency excess returns are small and unrelated to any risk factor. Burnside et al. (2006) consider either country-by-country currency returns or an unique, equally-weighted currency market return. They do not consider the currency portfolios proposed by Lustig and Verdelhan (2007). Their market return has an annualized Sharpe ratio of 0.09 percent in our sample, compared to the Sharpe ratios we report in excess of 0.50.[18] Clearly, Burnside et al. (2006) focus on returns that seem to be well inside of the efficient frontier.

B. Other Home Countries

We now adopt the perspective of foreign investors and we consider currency excess returns denominated in foreign currency. We report summary statistics on these excess returns, test their business cycle properties and we estimate the market prices of risk.

[17] Table XXV in the separate appendix reports asset pricing results.

[18] The Burnside et al. (2006) currency market excess return has a monthly mean of 0.25 percent, a standard deviation of 2.6 percent and a Sharpe ratio of 0.0955 over the 11/1983-04/2007 period.

Summary Statistics We also adopt the perspective of a non-US investor. We consider the case of a UK investor, a Japanese investor and a Swiss investor. These are three countries with large and well-developed currency markets. We compute the excess returns that local investors would obtain if they had access to forward contracts in their own currency.[19] We obtained these excess returns by converting dollars into local currency at the midpoint rate. This way, investors are not hit twice by the bid-ask spread. The Sharpe ratios on the long-short strategy increase to 0.63, 0.64 and 0.77 for the UK, Japan and Switzerland respectively.

Business Cycle Properties Using employment data in each country, we show that foreign currency excess returns are predictable from the UK, Japan and Swiss perspectives. Table XVI reports these predictability results.

Asset Pricing Results for foreign investors Sofar, we have only considered the Euler equation of a US investor. This subsection checks the Euler equation of foreign investors in the UK, Japan and Switzerland. We construct the new asset pricing factors (HML_{FX} and RX_{FX}) in local currency and we use the local currency returns on our currency portfolios as test assets. We used returns converted back to local currency using midpoint quotes (see Table XXVII).

For all countries, the estimated market price of HML_{FX} risk is less than 100 basis points removed from the sample mean of the factor. The HML_{FX} risk price is estimated at 5.33 percent in the UK, 6.54 percent in Japan and 7.92 percent in Switzerland. These estimates are statistically different from zero in all three cases. The two currency factors explain between 47 and 73 percent of the variation (after adjusting for degrees of freedom). The mean squared pricing error is 140 basis points for the UK, 113 basis points for Japan and 106 basis points for Switzerland. The null that the underlying pricing errors are zero cannot be rejected except for the UK. In the case of the UK, the p-values are smaller than 5 percent.[20]

[19] These are reported in Table XXVII in the separate appendix.

[20] These results are reported in the separate appendix. The first panel in Table XXVIII reports results for the UK, the second panel for Japan and the third panel for Switzerland. Table XXIX reports results of time series regressions of portfolio excess returns on the two factors, for each country. The null that the pricing errors are zero can be rejected at the 10 % significance level for the UK, but not for Japan and

C. Longer Sample of Treasury Bill-based Portfolios

Lustig and Verdelhan (2007) built eight portfolios of foreign T-bills sorted on interest rates, from a panel of 81 currencies. The data are annual, and the sample spans 1953-2002. We check whether the currency risk factors can explain the cross-sectional variation in excess returns on these foreign T-bills. HML_{FX} is defined as the spread between the seventh and the first portfolio. The estimated risk price for HML varies between 4.10 percent on the whole sample and 6.20 percent on the post-Bretton-Woods subsample. This is very close to the estimate of 6.19 percent that we obtained on the basket of forward contracts. Also, these estimates are close to their respective sample means of 5.32 and 6.92 percentage points per annum. We also test whether the null that the α's are zero can be rejected. The results for both samples are reported in Table XVIII. The null cannot be rejected.

Using the HML_{FX} we constructed from the longer time series, we can explore the business cycle properties of HML_{FX}. We run a time series regression of HML_{FX} on US non-durable consumption growth and on durable consumption growth. Over the 1953-2002 sample, the consumption β of HML_{FX} is one; in the post-Bretton-Woods sample, it increases to 1.50. These estimates are statistically significant at the 5 percent level. The currency risk factor HML_{FX} is strongly pro-cyclical.

V. Conclusion

TO BE COMPLETED

Switzerland. The point estimate for α on the fourth UK portfolio is 250 basis points per annum. This is large and significantly different from zero. The estimated α's on the first and last portfolio of 160 basis points are also significant. In the case of Japan and Switzerland, the largest α's are smaller, 170 and minus 140 basis points respectively. For all of these countries, estimates of β_{HML} start at about minus .40 and increase monotonically to about .60 for the first portfolio. Estimates for β_{RX} are all around one.

Table I
Summary Statistics on Currency Portfolios - US Investor - Portfolios of Developed and Emerging Countries

Portfolio	1	2	3	4	5	6
			Spot change: Δs^j			
Mean	−0.59	−0.92	−1.19	−2.30	−0.67	2.02
Std	8.14	7.33	7.44	7.47	7.84	9.23
			Discount: $f^j - s^j$			
Mean	−3.91	−1.29	−0.12	0.98	2.61	7.95
Std	1.60	0.50	0.49	0.53	0.59	2.11
			Excess Return: rx^j(without bid-ask)			
Mean	−3.32	−0.37	1.07	3.28	3.28	5.94
Std	8.32	7.40	7.49	7.59	7.95	9.33
SR	−0.40	−0.05	0.14	0.43	0.41	0.64
			Excess Return: rx^j_{net} (with bid-ask)			
Mean	−2.18	0.15	1.11	2.44	1.99	3.13
Std	8.30	7.39	7.47	7.53	7.92	9.32
SR	−0.26	0.02	0.15	0.32	0.25	0.34
			High-minus-Low: $rx^j_{net} - rx^1_{net}$			
Mean		2.33	3.29	4.62	4.17	5.31
Std		5.39	5.56	6.66	6.40	8.99
SR		0.43	0.59	0.69	0.65	0.59

Notes: This table reports the moments in dollars for average changes in log of the spot exchange rate Δs^j in portfolio j, the average log forward discount $f^j - s^j$, the average log excess return rx^j without bid-ask spreads, and the average log excess return rx^j with bid-ask spreads, and, the average returns on the long short strategy $rx^j - rx^1$. The log currency excess returns are computed as $rx^j_{t+1} = -\Delta s^j_{t+1} + f^j_t - s^j_t$. All moments are annualized and reported in percentage points. For excess returns, the table also reports Sharpe ratios, computed as ratios of annualized means to annualized standard deviations. The portfolios are constructed by sorting currencies into six groups at time t based on the one-month forward discount (i.e nominal interest rate differential) at the end of period $t-1$. Portfolio 1 contains currencies with the lowest interest rates. Portfolio 6 contains currencies with the highest interest rates. Data are monthly, from Barclays and Reuters (Datastream). The sample period is 11/1983 - 04/2007.

Table II
Return Predictability: One-Month Ahead

Portfolio	*Constant*	*Slope*	$p(\%)$	R^2	*Constant*	*Slope*	$p(\%)$	R^2
	Panel I: without bid-ask spreads				**Panel II: with bid-ask spreads**			
	$rx^j_{t+1} = \gamma_0 + \gamma_1(f^j_t - s^j_t) + \eta^j_t$				$rx^j_{net,t+1} = \gamma_0 + \gamma_1(f^j_t - s^j_t) + \eta^j_t$			
1	0.82	1.07	0.10	4.34	1.68	1.00	0.17	3.78
	[1.93]	[0.33]			[1.92]	[0.32]		
2	2.58	2.57	0.90	3.05	2.63	2.20	2.81	2.25
	[1.57]	[0.98]			[1.58]	[1.00]		
3	1.15	2.16	4.12	1.96	1.13	1.60	13.64	1.08
	[1.57]	[1.06]			[1.56]	[1.07]		
4	−0.54	3.71	0.00	6.66	−0.90	3.18	0.02	4.96
	[1.55]	[0.88]			[1.54]	[0.84]		
5	−5.74	3.35	0.03	5.95	−6.06	2.98	0.15	4.76
	[2.61]	[0.94]			[2.59]	[0.94]		
6	−0.60	0.76	0.08	2.97	−2.25	0.62	0.27	1.95
	[2.53]	[0.23]			[2.38]	[0.21]		

Notes: This table reports summary statistics for return predictability regressions. In Panel I, we report the constant, the slope coefficient and the R^2 in the time-series regression the log currency excess return on the log forward discount: $rx^j_{t+1} = \gamma_0 + \gamma_1(f^j_t - s^j_t) + \eta^j_t$ for each portfolio j. In Panel II, we report the constant, the slope coefficient and the R^2 in the time-series regression the log currency excess return on the log forward discount: $rx^j_{net,t+1} = \gamma_0 + \gamma_1(f^j_t - s^j_t) + \eta^j_t$ for each portfolio j. The standard errors in brackets are Newey-West standard errors computed with the optimal number of lags. All the returns annualized and reported in percentage points. Data are monthly, from Barclays and Reuters (Datastream). The sample period is 11/1983 - 04/2007.

Table III
Return Predictability with Forward Discount

Portfolio	*1-month*	*2-month*	*3-month*	*6-month*	*12-month*
			Panel A: Forward Discount		
1	3.77	4.27	7.88	26.39	26.69
2	2.24	2.94	6.29	13.11	13.05
3	1.08	4.97	8.51	13.66	21.45
4	4.95	9.11	12.20	24.95	19.01
5	4.75	10.09	10.77	20.63	18.86
6	1.94	2.84	3.92	6.78	11.52
			Panel B: Average Forward Discount		
1	8.88	14.83	19.91	33.95	36.49
2	4.94	7.37	13.54	21.80	17.40
3	3.30	7.54	10.95	16.37	25.50
4	3.94	7.45	10.98	23.01	21.47
5	5.14	9.80	11.60	23.57	19.94
6	5.13	7.70	10.58	16.00	20.55

Notes: In Panel A, we report the R^2 in the time-series regressions of the log k-period currency excess return on the log forward discount for each portfolio j: $rx_{net,t+1}^{j,k} = \gamma_0 + \gamma_1(f_t^{j,k} - s_t^j) + \eta_t^j$. In Panel B, we report the R^2 in the time-series regression the log k-period currency excess return on the linear combination of log forward discounts for each portfolio j: $rx_{net,t+1}^{j,k} = \gamma_0 + \gamma_1 \iota'(\mathbf{f}_t^k - \mathbf{s}_t^k) + \eta_t^j$ for each portfolio j. Data are monthly, from Barclays and Reuters (Datastream). The sample period is 11/1983 - 04/2007.

Table IV
Business Cycle Properties of Expected Currency Returns

Portfolio	IP	Pay	$Help$	$spread$	$slope$	vol
1	0.18	0.02	0.15	−0.22	0.05	−0.18
	[0.04]	[0.02]	[0.11]	[0.03]	[0.04]	[0.03]
2	−0.58	−0.72	−0.52	0.34	0.42	−0.17
	[0.04]	[0.04]	[0.05]	[0.02]	[0.04]	[0.02]
3	−0.63	−0.67	−0.53	0.32	0.44	−0.10
	[0.05]	[0.05]	[0.06]	[0.02]	[0.04]	[0.02]
4	−0.59	−0.55	−0.48	0.24	0.37	0.03
	[0.06]	[0.05]	[0.06]	[0.02]	[0.04]	[0.02]
5	−0.54	−0.43	−0.41	0.26	0.31	0.25
	[0.05]	[0.05]	[0.04]	[0.02]	[0.03]	[0.02]
6	−0.15	−0.11	−0.14	0.16	0.09	0.51
	[0.04]	[0.05]	[0.05]	[0.02]	[0.05]	[0.02]

Notes: This table reports the contemporaneous correlation $Corr\left[\widehat{E}_t rx^j_{t+1}, x_t\right]$ of forecasted excess returns with different variables x_t: the 12-month percentage change in industrial production ($\Delta \log IP_t$), in the total US non-farm payroll ($\Delta \log Pay_t$), and of the Help-Wanted index ($\Delta \log Help_t$), the default spread ($spread_t$), the slope of the yield curve ($slope_t$) and the CBOE $S\&P$ 500 volatility index (vol_t). Data are monthly, from Datastream and Global Financial Data. The sample period is 11/1983 - 04/2007.

Table V
US Business Cycle and Risk Factor

Months	IP	Pay	$Help$	*spread*	*slope*	*vol*
			$Corr_t\left[\iota'(\mathbf{f}_t^k - \mathbf{s}_t), x_t\right]$			
1	−0.32	−0.37	−0.28	0.16	0.28	−0.18
	[0.05]	[0.05]	[0.07]	[0.02]	[0.04]	[0.03]
2	−0.48	−0.52	−0.43	0.24	0.34	−0.20
	[0.06]	[0.05]	[0.06]	[0.02]	[0.04]	[0.02]
3	−0.53	−0.57	−0.49	0.28	0.35	−0.20
	[0.06]	[0.05]	[0.05]	[0.02]	[0.03]	[0.02]
4	−0.57	−0.62	−0.56	0.31	0.33	−0.16
	[0.07]	[0.06]	[0.05]	[0.02]	[0.03]	[0.02]
5	−0.51	−0.62	−0.51	0.25	0.35	−0.17
	[0.06]	[0.05]	[0.05]	[0.02]	[0.03]	[0.02]

Notes: This table reports the contemporaneous correlation of forecasted excess returns with the percentage change in US Industrial Production ($\Delta \log IP_t$), Total US Non-farm Payroll ($\Delta \log Pay_t$), of the Help-Wanted-Index ($\Delta \log Help_t$), the default spread ($spread_t$), the slope of the yield curve ($slope_t$) and the CBOE $S\&P$ 500 Volatility Index (vol_t). Data are monthly, from Datastream and Global Financial Data. The sample period is 11/1983 - 04/2007.

Table VI
Forecasting Excess Returns with Industrial Production

Portfolios	γ_{IP}	$p(\%)$	R^2	γ_{IP}	$p(\%)$	R^2	γ_{IP}	$p(\%)$	R^2
	1-month			**2-month**			**3-month**		
1	−0.84	16.00	0.81	−1.40	1.81	4.77	−1.65	0.48	8.41
	[0.69]			[0.65]			[0.63]		
2	−1.04	4.36	1.60	−1.07	3.65	3.15	−1.25	1.46	6.84
	[0.58]			[0.57]			[0.56]		
3	−0.90	9.95	1.16	−1.14	2.45	3.58	−1.20	3.35	5.35
	[0.63]			[0.56]			[0.63]		
4	−1.42	1.04	2.78	−1.22	3.41	3.79	−1.37	1.49	6.48
	[0.60]			[0.64]			[0.61]		
5	−1.32	2.78	2.21	−1.76	0.29	6.70	−1.65	0.33	8.11
	[0.67]			[0.63]			[0.60]		
6	−1.45	3.62	1.93	−1.25	5.85	2.64	−1.32	3.65	4.16
	[0.77]			[0.75]			[0.70]		
	6-month			**12-month**					
1	−1.77	0.09	16.02	−1.68	0.00	23.12			
	[0.57]			[0.41]					
2	−1.36	0.66	14.23	−1.21	0.03	19.42			
	[0.54]			[0.35]					
3	−1.55	0.12	14.82	−1.56	0.00	28.19			
	[0.51]			[0.32]					
4	−1.86	0.00	22.58	−1.51	0.00	29.55			
	[0.46]			[0.31]					
5	−1.97	0.03	19.49	−1.99	0.00	37.18			
	[0.57]			[0.34]					
6	−1.70	0.31	12.49	−1.62	0.03	19.79			
	[0.61]			[0.46]					

Notes: This table reports the forecasted excess returns using the 12-month change in US Industrial Production. The standard errors in brackets are Newey-West standard errors computed with the optimal number of lags. The p-values (reported in percentage points) are for a Wald-test: $\gamma_{IP} = 0$. All the returns annualized and reported in percentage points. Data are monthly, from Datastream and Global Financial Data. The sample period is 11/1983 - 04/2007.

Table VII
Forecasting Excess Returns with Industrial Production and Forward Discounts

	γ_{IP}	γ_F	$p(\%)$	R^2	γ_{IP}	$\gamma_{\mathbf{F}}$	$p(\%)$	R^2
	$rx^j_{t+1} = \gamma_0 + \gamma_{IP} + \gamma_F(f^j_t - s^j_t) + \eta^j_t$				$rx^j_{t+1} = \gamma_0 + \gamma_{IP} + \gamma_{\mathbf{F}}\iota(\mathbf{f}_t - \mathbf{s}_t) + \eta^j_t$			
1	−0.91	2.28	10.19	30.86	−0.81	3.44	0.12	40.48
	[0.56]	[1.15]			[0.25]	[0.91]		
2	−0.94	0.85	5.92	20.30	−0.84	1.44	0.98	24.39
	[0.50]	[1.00]			[0.32]	[0.72]		
3	−1.12	1.35	0.16	31.00	−1.08	1.88	0.00	35.56
	[0.35]	[0.95]			[0.27]	[0.83]		
4	−1.19	1.02	0.00	32.14	−1.15	1.41	0.00	34.19
	[0.28]	[0.70]			[0.27]	[0.74]		
5	−1.68	1.35	0.00	41.55	−1.69	1.21	0.00	39.62
	[0.30]	[0.66]			[0.33]	[0.87]		
6	−1.54	1.21	0.00	29.55	−1.05	2.26	4.26	26.68
	[0.43]	[0.45]			[0.53]	[1.33]		

Notes: The left panel reports the forecasted excess returns using the 12-month change in Industrial Production and the forward discount. The right panel reports the forecasted excess returns using the 12-month change in Industrial Production and the average forward discount. The standard errors in brackets are Newey-West standard errors computed with the optimal number of lags. The p-values (reported in percentage points) are for a t-test: $\gamma_{IP} = 0$. All the returns annualized and reported in percentage points. Data are monthly, from Datastream and Global Financial Data. The sample period is 11/1983 - 04/2007.

Table VIII
Asset Pricing -US Investor

	λ_{HML}	λ_{RX}	b_{HML}	b_{RX}	R^2	$RMSE$	χ^2
GMM_1	6.19	1.62	0.64	0.25	84.97	0.70	
	[2.38]	[1.75]	[0.25]	0.32			36.55
GMM_2	5.88	1.42	0.61	0.21	83.42	0.74	
	[2.26]	[1.71]	[0.24]	[0.32]			36.91
FMB	6.19	1.62	0.64	0.25	84.97	0.70	
	[1.88]	[1.38]	[0.20]	[0.26]			35.20
	(1.88)	(1.38)	(0.20)	(0.26)			37.50
$Mean$	**6.48**	**1.61**					

Notes: This table reports results from GMM and Fama-McBeth asset pricing procedures. Market prices of risk λ, the adjusted R^2, the square-root of mean-squared errors $RMSE$ and the p-values of χ^2 tests are reported in percentage points. b_1 represents the factor loading. The portfolios are constructed by sorting currencies into six groups at time t based on the interest rate differential at the end of period $t-1$. Portfolio 1 contains currencies with the lowest interest rates. Portfolio 6 contains currencies with the highest interest rates. Data are monthly, from Barclays and Reuters in Datastream. The sample period is 11/1983 - 04/2007. Excess returns used as test assets take into account bid-ask spreads. All excess returns are multiplied by 12 (annualized). Standard errors are reported in brackets. Shanken-corrected standard errors are reported in parentheses. We do not include a constant in the second step of the FMB procedure.

Table IX
Factor Betas - US Investor

$Portfolio$	α_0^j	β_{HML}^j	β_{RX}^j	R^2	$\chi^2(\alpha)$	$p-value$
1	-0.542	-0.405	1.022	0.890		
	[0.585]	[0.023]	[0.032]			
2	-0.597	-0.150	0.999	0.791		
	[0.736]	[0.025]	[0.043]			
3	1.425	-0.114	1.071	0.768		
	[0.809]	[0.035]	[0.041]			
4	0.098	-0.003	0.869	0.661		
	[0.904]	[0.033]	[0.053]			
5	0.157	0.076	1.018	0.740		
	[0.875]	[0.039]	[0.054]			
6	-0.542	0.595	1.022	0.919		
	[0.585]	[0.023]	[0.032]			
					5.557	47.45

Notes: This table reports results OLS estimates of the factor betas. The intercept α_0 β, and the R^2 are reported in percentage points. The standard errors in brackets are Newey-West standard errors computed with the optimal number of lags. The χ^2 test statistic $\alpha' V_\alpha^{-1} \alpha$ tests the null that all intercepts are jointly zero. This statistic is constructed from the Newey-West variance-covariance matrix (1 lag) for the system of equations (Cochrane (2001), p. 234). The portfolios are constructed by sorting currencies into six groups at time t based on the interest rate differential at the end of period $t-1$. Portfolio 1 contains currencies with the lowest interest rates. Portfolio 6 contains currencies with the highest interest rates. Data are monthly, from Barclays and Reuters in Datastream. The sample period is 11/1983 - 04/2007. Excess returns used as test assets take into account bid-ask spreads. All excess returns are multiplied by 12. Standard errors are reported in parenthesis. Shanken-corrected standard errors are reported in brackets.

Table X
Asset Pricing - CAPM

	λ_{R^m}	λ_{RX}	b_{R^m}	b_{RX}	R^2	$RMSE$	χ^2
GMM_1	43.76	1.54	1.64	0.38	78.11	0.84	
	[20.84]	[2.18]	[0.78]	[0.39]			62.09
GMM_2	41.63	1.11	1.56	0.30	72.07	0.95	
	[19.42]	[2.02]	[0.72]	[0.36]			63.55
FMB	43.76	1.54	1.63	0.38	78.11	0.84	
	[13.99]	[1.40]	[0.52]	[0.26]			21.93
	(18.16)	(1.40)	(0.67)	(0.26)			50.28
$Mean$	**7.80**	**1.55**					

Notes: This table reports results from GMM and Fama-McBeth asset pricing procedures. Market prices of risk λ, the adjusted R^2, the square-root of mean-squared errors $RMSE$ and the p-values of χ^2 tests are reported in percentage points. b_1 represents the factor loading. The portfolios are constructed by sorting currencies into six groups at time t based on the interest rate differential at the end of period $t-1$. Portfolio 1 contains currencies with the lowest interest rates. Portfolio 6 contains currencies with the highest interest rates. Data are monthly, from Barclays and Reuters in Datastream. The sample period is 11/1983 - 04/2007. Excess returns used as test assets take into account bid-ask spreads. All excess returns are multiplied by 12 (annualized). Standard errors are reported in brackets. Shanken-corrected standard errors are reported in parentheses. We do not include a constant in the second step of the FMB procedure.

Table XI
Factor Betas - CAPM

Portfolio	α_0^i	β_m^i	β_{RX}^i	R^2	$\chi^2(\alpha)$	$p(\%)$
1	-2.638	-0.053	0.985	69.870		
	[1.073]	[0.016]	[0.062]			
2	-1.503	-0.015	0.984	76.181		
	[0.798]	[0.015]	[0.046]			
3	0.777	-0.009	1.060	75.280		
	[0.836]	[0.018]	[0.046]			
4	0.290	-0.023	0.868	66.335		
	[0.872]	[0.021]	[0.053]			
5	0.490	0.026	1.027	73.564		
	[0.865]	[0.016]	[0.056]			
6	2.584	0.074	1.075	61.006		
	[1.234]	[0.029]	[0.067]			
					5.557	47.45

Notes: This table reports results OLS estimates of the factor betas. The intercept α_0 β, and the R^2 are reported in percentage points. The standard errors in brackets are Newey-West standard errors computed with the optimal number of lags. The χ^2 test statistic $\alpha' V_\alpha^{-1} \alpha$ tests the null that all intercepts are jointly zero. This statistic is constructed from the Newey-West variance-covariance matrix (1 lag) for the system of equations (Cochrane (2001), p. 234). The portfolios are constructed by sorting currencies into six groups at time t based on the the currency excess return at the end of period $t-1$. Portfolio 1 contains currencies with the lowest previous excess return. Portfolio 6 contains currencies with the highest previous excess return. Data are monthly, from Barclays and Reuters in Datastream. The sample period is 11/1983 - 04/2007. Excess returns used as test assets take into account bid-ask spreads. All excess returns are multiplied by 12.

Table XII
Time-Varying Factor Betas - CAPM

Portfolio	β^i_m	$p(\%)$	R^2	β^i_m	$p(\%)$	R^2	β^i_m	$p(\%)$	R^2
				6-month window					
	26-May-1998			02-Aug-1995			10-Oct-1999		
HML	1.14	0.00	22.12	1.21	0.02	10.94	0.68	0.00	34.26
	[0.17]			[0.32]			[0.10]		
1	0.03	85.49	0.11	−1.21	0.08	18.05	−0.25	1.85	34.70
	[0.14]		[0.00]	[0.36]			[0.11]		
2	−0.05	75.45	0.60	−0.90	8.83	8.50	−0.08	35.93	5.36
	[0.16]			[0.53]			[0.09]		
3	0.21	11.08	10.95	−0.89	7.93	12.00	0.06	52.27	2.13
	[0.13]			[0.51]			[0.09]		
4	0.28	2.84	13.75	−0.48	5.70	11.86	−0.05	0.57	7.79
	[0.13]			[0.25]			[0.02]		
5	0.52	0.00	25.25	−0.55	5.35	10.23	−0.00	94.71	0.02
	[0.11]			[0.28]			[0.06]		
6	1.17	0.00	25.25	−0.00	99.96	10.23	0.42	0.00	0.02
	[0.28]			[0.14]			[0.08]		
				3-month window					
HML	1.41	0.00	6.28	1.22	0.00	32.95	0.60	0.00	56.55
	[0.23]			[0.25]			[0.13]		

Notes: This table reports results OLS estimates of the factor betas. The intercept α_0 β, and the R^2 are reported in percentage points. The standard errors in brackets are Newey-West standard errors computed with the optimal number of lags. The p-value is for a t-test on the slope coefficient. The portfolios are constructed by sorting currencies into six groups at time t based on the the currency excess return at the end of period $t-1$. Portfolio 1 contains currencies with the lowest previous excess return. Portfolio 6 contains currencies with the highest previous excess return. Data are daily, from Barclays and Reuters in Datastream. The returns are are 1-month returns. The sample period is 129 days (6 months) before and including date t. Excess returns used as test assets take into account bid-ask spreads. The second panel uses 63 days (3 months).

Table XIII
Factor Betas for Foreign Equity

$Portfolio$	α_0^j	β_m^j	β_{HML}^j	β_{RX}^j	R^2	$E_T[R^{e,j}]$	CRP
1	4.63	0.68	−0.27	0.85	40.88	9.86	−0.15
	[2.92]	[0.07]	[0.10]	[0.14]			
2	3.67	0.74	−0.05	0.83	43.87	10.51	1.06
	[2.82]	[0.06]	[0.09]	[0.12]			
3	2.90	0.89	−0.04	0.60	46.90	10.67	0.75
	[3.47]	[0.13]	[0.11]	[0.16]			
4	2.87	0.79	0.15	0.86	48.47	11.34	2.27
	[3.14]	[0.06]	[0.13]	[0.14]			
5	4.65	0.72	0.26	0.99	45.44	13.46	3.16
	[3.08]	[0.06]	[0.11]	[0.13]			
6	−3.81	0.86	0.57	1.03	56.82	7.98	5.04
	[3.96]	[0.08]	[0.14]	[0.15]			

Notes: This table reports results OLS estimates of the factor betas. The intercept α_0 β, and the R^2 are reported in percentage points. The standard errors in brackets are Newey-West standard errors computed with the optimal number of lags. The χ^2 test statistic $\alpha' V_\alpha^{-1} \alpha$ tests the null that all intercepts are jointly zero. This statistic is constructed from the Newey-West variance-covariance matrix (1 lag) for the system of equations (Cochrane (2001), p. 234). $E_T[R^{e,j}]$ is the average excess return in US dollars. The last column reports the currency risk premium (CRP) for each portfolio. The portfolios are constructed by sorting currencies into six groups at time t based on the the currency excess return at the end of period $t-1$. Portfolio 1 contains currencies with the lowest forward discount. Portfolio 6 contains currencies with the highest forward discount. Data are monthly, from Barclays and Reuters in Datastream. The sample period is 11/1983 - 04/2007. Excess returns used as test assets take into account bid-ask spreads. All excess returns are multiplied by 12.

Table XIV
US Investor - Portfolios of Developed Countries

Portfolio	1	2	3	4	5
			Spot change: Δs^j		
Mean	−1.13	−2.26	−3.63	−1.80	−0.84
Std	10.16	9.79	9.27	9.03	8.97
			Discount: $f^j - s^j$		
Mean	−3.08	−1.03	0.09	1.15	3.99
Std	0.79	0.65	0.66	0.68	0.77
			Excess Return: rx^j (without bid-ask)		
Mean	−1.95	1.23	3.72	2.95	4.83
SR	−0.19	0.13	0.40	0.32	0.53
			Excess Return: rx^j_{net} (with bid-ask)		
Mean	−1.11	1.59	3.75	2.54	3.36
SR	−0.11	0.16	0.40	0.28	0.37
			Long-Short: $rx^j_{net} - rx^1_{net}$		
Mean		2.69	4.86	3.65	4.47
SR		0.43	0.77	0.50	0.54

Notes: This table reports summary statistics for currencies sorted into portfolios. We report the moments in dollars for average changes in log of the spot exchange rate Δs^j in portfolio j, the average log forward discount $f^j - s^j$, the average log excess return rx^j without bid-ask spreads, and the average log excess return rx^j_{net} with bid-ask spreads, and, the average returns on the long short strategy $rx^j - rx^1$. Log currency excess returns are computed as $rx^j_{t+1} = -\Delta s^j_{t+1} + f^j_t - s^j_t$. All moments are annualized and reported in percentage points. For excess returns, the table also reports Sharpe ratios, computed as ratios of annualized means to annualized standard deviations. Averages and standard deviations are reported in percentage points. The portfolios are constructed by sorting currencies into five groups at time t based on the one-month forward discount at the end of period $t-1$. Portfolio 1 contains currencies with the lowest interest rates. Portfolio 5 contains currencies with the highest interest rates. Data are monthly, from Barclays (Datastream). The sample period is 11/1983 - 04/2007.

Table XV
US Investor - Portfolios of Countries in Burnside et al (2006)

Portfolio	1	2	3
		Spot change: Δs^j	
Mean	−0.98	−0.56	−0.46
Std	10.43	9.85	8.77
		Discount: $f^j - s^j$	
Mean	−3.36	−0.64	3.15
Std	0.81	0.72	0.94
		Excess Return: rx^j (without bid-ask)	
Mean	−1.72	0.47	4.17
SR	−0.16	0.05	0.47
		Excess Return: rx^j_{net} (with bid-ask)	
Mean	0.34	1.01	3.20
SR	0.03	0.10	0.36
		Long-Short: $rx^j_{net} - rx^1_{net}$	
Mean		0.66	2.86
SR		0.10	0.37

Notes: This table reports summary statistics for currencies sorted into portfolios. We report the moments in dollars for average changes in log of the spot exchange rate Δs^j in portfolio j, the average log forward discount $f^j - s^j$, the average log excess return rx^j without bid-ask spreads, and the average log excess return rx^j_{net} with bid-ask spreads, and, the average returns on the long short strategy $rx^j - rx^1$. Log currency excess returns are computed as $rx^j_{t+1} = -\Delta s^j_{t+1} + f^j_t - s^j_t$. All moments are annualized and reported in percentage points. For excess returns, the table also reports Sharpe ratios, computed as ratios of annualized means to annualized standard deviations. Averages and standard deviations are reported in percentage points. The portfolios are constructed by sorting currencies into five groups at time t based on the one-month forward discount at the end of period $t-1$. Portfolio 1 contains currencies with the lowest interest rates. Portfolio 3 contains currencies with the highest interest rates. Data are monthly, from Barclays (Datastream). The sample period is 01/1976 - 04/2007.

Table XVI
Forecasting Excess Returns with *EM*

Months	γ_{EM}	$p(\%)$	R^2	γ_{EM}	$p(\%)$	R^2	γ_{EM}	$p(\%)$	R^2
		US			**UK**			**Japan**	
1	−1.88	5.15	6.09	−2.88	0.10	17.93	−0.30	90.58	0.37
	[1.08]			[0.92]			[0.75]		
2	−0.81	23.21	1.85	−1.91	4.46	9.21	−0.73	42.75	1.64
	[0.79]			[1.06]			[1.01]		
3	−1.67	2.96	6.87	−1.33	5.44	5.36	−1.15	11.12	4.68
	[0.85]			[0.78]			[0.83]		
4	−1.72	3.82	8.09	−0.87	24.73	2.16	−1.51	4.26	7.62
	[0.92]			[0.88]			[0.83]		
5	−2.49	0.94	12.29	−1.40	3.38	4.74	−1.52	4.44	7.83
	[1.04]			[0.73]			[0.85]		
6	−2.12	2.11	7.17	−0.83	22.19	1.39	−2.13	1.20	11.46
	[1.01]			[0.80]			[0.92]		

Notes: This table reports the forecasted excess returns using the 12-month change in the level of employment for the US, UK and Japan. The standard errors in brackets are Newey-West standard errors computed with the optimal number of lags. The p-values (reported in percentage points) are for a Wald-test: $\gamma_{EM} = 0$. All the returns annualized and reported in percentage points. Data are monthly, from Datastream and Global Financial Data. The sample period is 11/1983 - 04/2007.

Table XVII
Asset Pricing - T-Bill portfolios

	λ_{HML}	λ_{RX}	b_{HML}	b_{RX}	R^2	$RMSE$	χ^2
				1953-2002			
GMM_1	4.10	0.25	8.39	-2.05	42.47	1.11	
	[1.25]	[1.10]	[2.76]	[3.60]			44.44
GMM_2	3.89	0.18	8.00	-2.13	42.09	1.11	
	[0.81]	[0.91]	[1.95]	[3.05]			45.47
FMB	4.10	0.25	8.22	-2.01	42.47	1.11	
	[1.17]	[0.84]	[2.34]	[2.54]			10.18
	(1.21)	(0.84)	(2.43)	(2.56)			24.16
$Mean$	**5.32**	0.128					
				1971-2002			
GMM_1	6.20	0.31	9.25	-2.48	72.50	0.92	
	[2.07]	[1.93]	[3.29]	[4.17]			78.19
GMM_2	5.80	0.30	8.65	-2.29	72.13	0.92	
	[1.09]	[1.18]	[1.96]	[2.73]			80.26
FMB	6.20	0.31	8.96	-2.41	72.50	0.92	
	[1.66]	[1.30]	[2.37]	[2.55]			68.36
	(1.73)	(1.30)	(2.49)	(2.57)			86.28
$Mean$	**6.92**	0.255					

Notes: This table reports results from GMM and Fama-McBeth asset pricing procedures. Market prices of risk λ, the adjusted R^2, the square-root of mean-squared errors $RMSE$ and the p-values of χ^2 tests are reported in percentage points. b_1 represents the factor loading. The portfolios are constructed by sorting currencies into six groups at time t based on the interest rate differential at the end of period $t-1$. Portfolio 1 contains currencies with the lowest interest rates. Portfolio 8 contains currencies with the highest interest rates. Data are annual, from Global Financial Data. The sample period is 11/1983 - 04/2007. Excess returns used as test assets take into account bid-ask spreads. All excess returns are multiplied by 12 (annualized). Standard errors are reported in brackets. Shanken-corrected standard errors are reported in parentheses. We do not include a constant in the second step of the FMB procedure.

Table XVIII
Factor Betas - US Investor

$Portfolio$	α_0^j	β_{HML}^j	β_{RX}^j	R^2	α_0^j	β_{HML}^j	β_{RX}^j	R^2
	1971-2002				**1953-2002**			
1	-0.02	-0.46	0.97	80.91	0.02	-0.47	0.95	79.28
	[0.71]	[0.06]	[0.10]		[0.44]	[0.06]	[0.09]	
2	0.07	-0.03	0.62	41.16	-1.16	0.04	0.64	32.92
	[0.92]	[0.07]	[0.16]		[0.96]	[0.10]	[0.18]	
3	-0.77	-0.04	0.99	74.28	-0.58	-0.05	0.97	72.11
	[0.86]	[0.09]	[0.12]		[0.52]	[0.08]	[0.12]	
4	0.40	0.06	1.20	78.00	-0.33	0.09	1.19	73.25
	[1.02]	[0.10]	[0.13]		[0.75]	[0.09]	[0.13]	
5	-0.32	-0.09	0.98	56.83	0.38	-0.12	0.98	55.44
	[1.15]	[0.11]	[0.12]		[0.72]	[0.11]	[0.12]	
6	-1.38	0.16	1.05	67.44	-1.12	0.15	1.05	64.26
	[1.21]	[0.10]	[0.14]		[0.78]	[0.09]	[0.14]	
7	-0.02	0.54	0.97	88.39	0.02	0.53	0.95	87.25
	[0.71]	[0.06]	[0.10]		[0.44]	[0.06]	[0.09]	
8	2.07	-0.13	1.22	34.31	2.76	-0.17	1.28	34.00
	[3.40]	[0.19]	[0.44]		[2.10]	[0.15]	[0.40]	
$\chi^2(\alpha)$	1.09				4.55			
$p-value$	99.06				80.33			

Notes: This table reports results OLS estimates of the factor betas. The intercept α_0 β, and the R^2 are reported in percentage points. The standard errors in brackets are Newey-West standard errors computed with the optimal number of lags. The χ^2 test statistic $\alpha' V_\alpha^{-1}\alpha$ tests the null that all intercepts are jointly zero. This statistic is constructed from the Newey-West variance-covariance matrix (1 lag) for the system of equations (Cochrane (2001), p. 234). The portfolios are constructed by sorting currencies into six groups at time t based on the interest rate differential at the end of period $t-1$. Portfolio 1 contains currencies with the lowest interest rates. Portfolio 6 contains currencies with the highest interest rates. Data are monthly, from Barclays and Reuters in Datastream. The sample period is 11/1983 - 04/2007. Excess returns used as test assets take into account bid-ask spreads. All excess returns are multiplied by 12. Standard errors are reported in parenthesis. Shanken-corrected standard errors are reported in brackets.

References

Andrews, Donald W.K., "Heteroskedasticity and Autocorrelation Consistent Covariance Matrix Estimation," *Econometrica*, 1991, *59* (1), 817–858.

Bacchetta, Philippe and Eric van Wincoop, "Incomplete Information Processing: A Solution to the Forward Discount Puzzle," September 2006. mimeo.

Backus, David, Silverio Foresi, and Chris Telmer, "Affine Models of Currency Pricing: Accounting for the Forward Premium Anomaly," *Journal of Finance*, 2001, *56.*

Bansal, Ravi and Ivan Shaliastovich, "Long-Run Risks Explanation of Forward Premium Puzzle," April 2007. working paper Duke University.

___ **and Magnus Dahlquist**, "The Forward Premium Puzzle: Different Tales from Developed and Emerging Economies," *Journal of International Economics*, 2000, *51*, 115–144.

Burnside, Craig, Martin Eichenbaum, and Sergio Rebelo, "The Returns to Currency Speculation in Emerging Markets," *American Economic Review*, May 2007, *97* (2), 333–338.

___ **,** ___ **, and** ___ , "Understanding the forward premium puzzle: A microstructure approach," 2007. working paper NBER No. 13278.

___ **,** ___ **, Isaac Kleshchelski, and Sergio Rebelo**, "The Returns to Currency Speculation," November 2006. working paper NBER No. 12489.

Campbell, John Y., Karine Serfaty de Medeiros, and Luis M. Viceira, "Global Currency Hedging," 2006. NBER Working Paper 13088.

Chaboud, Alain P. and Jonathan H. Wright, "Uncovered interest parity: it works, but not for long," *Journal of International Economics*, 2005, *66* (2), 349–362.

Chinn, Menzie D., "The (partial) rehabilitation of interest rate parity in the floating rate era: Longer horizons, alternative expectations, and emerging markets," *Journal of International Money and Finance*, 2006, *25*, 7–21.

Cochrane, John H., *Asset Pricing*, Princeton, N.J.: Princeton University Press, 2001.

___ **and Monika Piazzesi**, "Bond Risk Premia," *The American Economic Review,* forthcoming, 2005.

Cooper, Ilyan and Richard Priestley, "Time Varying Risk Premia and the Output Gap," 2007. Working Paper Norwegian School of Management.

Engel, Charles, "The forward discount anomaly and the risk premium: A survey of recent evidence," *Journal of Empirical Finance*, October 1996, *3*, 123–192.

Fama, Eugene, "Forward and Spot Exchange Rates," *Journal of Monetary Economics*, 1984, *14*, 319–338.

Fama, Eugene F. and James D. MacBeth, "Risk, Return, and Equilibrium: Empirical Tests," *Journal of Political Economy*, 3 1973, *81*, 607–636.

___ **and Kenneth R. French**, "Common Risk Factors in the Returns on Stocks and Bonds," *Journal of Financial Economics*, 1993, *33*, 3–56.

Frankel, Jeffrey and Jumana Poonawala, "The Forward Market in Emerging Currencies: Less Biased than in Major Currencies," 2007. working paper NBER No. 12496.

Froot, Kenneth and Richard Thaler, "Anomalies: Foreign Exchange," *The Journal of Economic Perspectives*, 3 1990, *4*, 179–192.

Gourinchas, Pierre-Olivier and Aaron Tornell, "Exchange Rate Puzzle and Distorted Beliefs," *Journal of International Economics*, 2004, *64* (2), 303–333.

Hansen, Lars Peter, "Large Sample Properties of Generalized Method of Moments Estimators," *Econometrica*, 1982, *50*, 1029–54.

——— **and Robert J. Hodrick**, "Forward Exchange Rates as Optimal Predictors of Future Spot Rates: An Econometric Analysis," *The Journal of Political Economy*, October 1980, *88* (5), 829–853.

Harvey, Campbell R., Bruno Solnik, and Guofu Zhou, "What Determines Expected International Asset Returns?," *Annals of Economics and Finance*, 2002, *3*, 249–298.

Hodrick, Robert, *The Empirical Evidence on the Efficiency of Forward and Futures Foreign Exchange Markets*, Chur, Switzerland: Harwood Academic Publishers, 1987.

Huisman, Ronald, Kees Koedijk, Clemens Kool, and Francois Nissen, "Extreme support for uncovered interest parity," *Journal of International Money and Finance*, 1998, *17*, 211–228.

Lewis, Karen K., "Puzzles in International Financial Markets," in G. Grossman and K. Rogoff, eds., *Handbook of International Economics*, Amsterdam: Elsevier Science B.V., 1995, pp. 1913–1971.

Liu, Wei and Alex Maynard, "Testing forward rate unbiasedness allowing for persistent regressors," *Journal of Empirical Finance*, 2005, *12*, 613–628.

Lothian, James R. and Liuren Wu, "Uncovered Interest-Rate Parity over the Past Two Centuries," June 2005. mimeo.

Lustig, Hanno and Adrien Verdelhan, "The Cross-Section of Foreign Currency Risk Premia and Consumption Growth Risk," *American Economic Review*, March 2007, *97* (1), 89–117.

Lyons, Richard K., *The Microstructure Approach to Exchange Rates*, M.I.T Press, 2001.

Maynard, Alex, "The forward premium anomaly: statistical artifact or economic puzzle? New evidence from robust tests," *Canadian Journal of Economics*, 2006, *forthcoming.*

Meredith, Guy and Menzie D. Chinn, "Testing Uncovered Interest Rate Parity at Short and Long Horizons during the Post-Bretton Woods Era," 2005. working paper NBER 11077.

Newey, Whitney K. and Kenneth D. West, "A Simple, Positive Semi-Definite, Heteroskedasticity and Autocorrelation Consistent Covariance Matrix," *Econometrica*, 1987, *55* (3), 703–708.

Verdelhan, Adrien, "A Habit Based Explanation of the Exchange Rate Risk Premium," 2005. Working Paper Boston University.

Appendix to 'Common Risk Factors in Currency Markets' by Lustig, Roussanov and Verdelhan (2007)

This Appendix reports the following tables:

- Summary statistics on currency portfolios for a US investor investing in developed countries: table XIV
- Summary statistics on currency portfolios for an US investor investing in the developed countries used in Burnside et al. (2006): table XV
- Summary statistics on currency portfolios for a US investor investing in developed countries at longer horizons: table XX
- Return predictability on longer horizons: table XXI
- Return predictability on longer horizons: table XXII
- Business Cycle Properties of currency returns longer horizons: table XXIII
- Principal component analysis: table XXIV
- Asset pricing results for countries used in Burnside et al. (2006): table XXV
- Summary statistics on currency portfolios for foreign investors investing in developed and emerging countries: table XXVI
- Summary statistics on currency portfolios for foreign investors investing in developed and emerging countries (midpoint conversion): table XXVII
- Asset pricing results for foreign investors: table XXVIII
- Factor betas for foreign investors: table XXIX
- Summary statistics on currency and equity portfolios: table XXX

Appendix A. Additional Figures

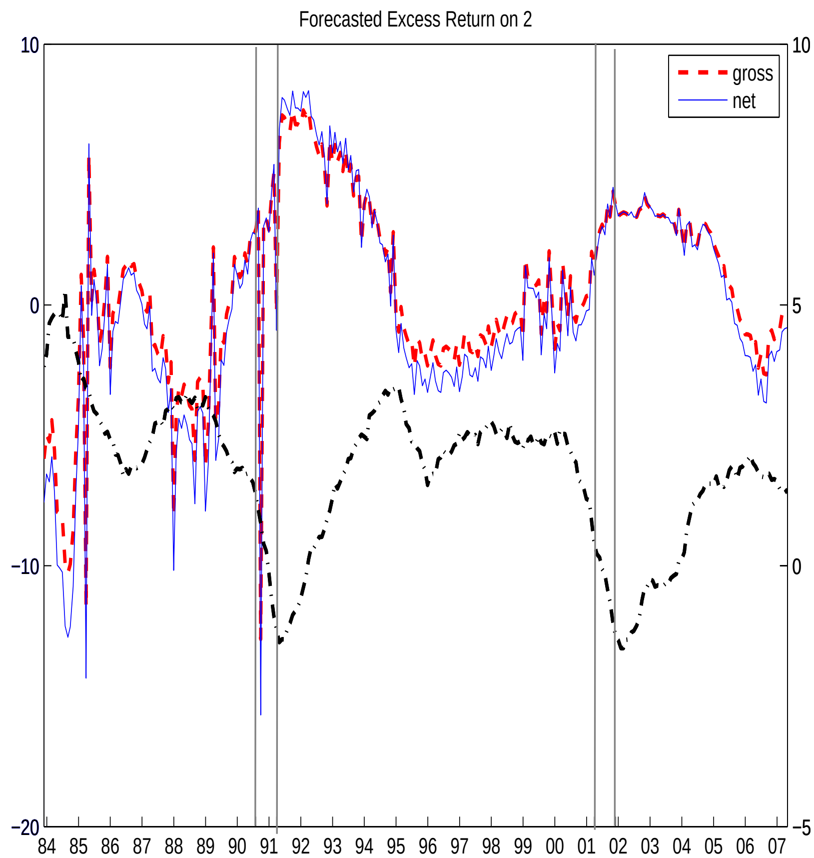

Figure 6. Forecasted Excess Return in Currency Markets and US Business Cycle.
This figure plots forecasted excess return on the second portfolio: $\widehat{E}_t rx^2_{t+1}$. The dashed line is the year-on-year log change in US Non-Farm Payrolls (Seasonally adjusted). Vertical lines identify NBER recession dates. In our sample, NBER recessions cover July 1990-March 1991 and March 2001-November 2001. All returns are annualized.

Appendix B. Additional Tables

Table XX
Summary Statistics - Longer Maturity Contracts

Portfolio	1	2	3	4	5	6
			1-month rx^j_{net}			
Mean	−2.18	0.15	1.11	2.44	1.99	3.13
SR	−0.26	0.02	0.15	0.32	0.25	0.34
			2-month rx^j_{net}			
Mean	−1.64	−0.12	0.78	2.92	2.73	3.68
SR	−0.20	−0.02	0.10	0.37	0.32	0.38
			3-month rx^j_{net}			
Mean	−1.31	−0.27	0.96	2.87	3.04	3.62
SR	−0.15	−0.04	0.12	0.35	0.34	0.36
			6-month rx^j_{net}			
Mean	−1.10	−0.25	0.74	2.99	3.13	3.41
SR	−0.11	−0.03	0.08	0.35	0.32	0.32
			1-year rx^j_{net}			
Mean	−0.33	−0.72	1.10	2.31	3.38	3.27
SR	−0.03	−0.08	0.12	0.27	0.34	0.29
			1-month $rx^j_{net} - rx^1_{net}$			
Mean		2.33	3.29	4.62	4.17	5.31
SR		0.43	0.59	0.69	0.65	0.59
			2-month $rx^j_{net} - rx^1_{net}$			
Mean		1.52	2.42	4.57	4.38	5.32
SR		0.28	0.41	0.68	0.64	0.55
			3-month $rx^j_{net} - rx^1_{net}$			
Mean		1.04	2.27	4.17	4.34	4.92
SR		0.19	0.38	0.59	0.62	0.49
			6-month $rx^j_{net} - rx^1_{net}$			
Mean		0.85	1.84	4.09	4.23	4.51
SR		0.15	0.25	0.60	0.62	0.44
			1-year $rx^j_{net} - rx^1_{net}$			
Mean		−0.39	1.43	2.64	3.71	3.60
SR		−0.06	0.22	0.36	0.50	0.33

Notes: This table reports summary statistics for currencies sorted into portfolios. We report the moments in dollars for average changes in log of the spot exchange rate Δs^j in portfolio j, the average log forward discount $f^j - s^j$, the average log excess return rx^j without bid-ask spreads, and the average log excess return rx^j with bid-ask spreads, and, the average returns on the long short strategy $rx^j - rx^1$. Log currency excess returns are computed as $rx^j_{t+1} = -\Delta s^j_{t+1} + f^j_t - s^j_t$. All moments are annualized and reported in percentage points. For excess returns, the table also reports Sharpe ratios, computed as ratios of annualized means to annualized standard deviations. The portfolios are constructed by sorting currencies into six groups at time t based on the one-month forward discount (i.e nominal interest rate differential) at the end of period $t-1$. Portfolio 1 contains currencies with the lowest interest rates. Portfolio 6 contains currencies with the highest interest rates. Data are monthly, from Barclays and Reuters (Datastream). The sample period is 11/1983 - 04/2007.

Table XXI
Return Predictability with Forward Rates

Portfolio	*Constant*	*Slope*	*p.(%)*	R^2	*Constant*	*Slope*	*p.(%)*	R^2
	Panel I: 1-month							
	$rx^{j,2}_{net,t+1} = \gamma_0 + \gamma_1(f^{j,1}_t - s_t) + \eta^j_t$							
1	1.68	1.00	0.17	3.78				
	[1.92]	[0.32]						
2	2.63	2.20	2.81	2.25				
	[1.58]	[1.00]						
3	1.13	1.60	13.64	1.08				
	[1.56]	[1.07]						
4	−0.90	3.18	0.02	4.96				
	[1.54]	[0.84]						
5	−6.06	2.98	0.15	4.76				
	[2.59]	[0.94]						
6	−2.25	0.62	0.27	1.95				
	[2.38]	[0.21]						
	Panel I: 2-month				**Panel II: 3-month**			
	$rx^{j,2}_{net,t+1} = \gamma_0 + \gamma_1(f^{j,2}_t - s_t) + \eta^j_t$				$rx^{j,3}_{net,t+1} = \gamma_0 + \gamma_1(f^{j,3}_t - s_t) + \eta^j_t$			
1	2.80	1.42	12.46	4.27	5.56	2.34	8.56	7.88
	[3.04]	[0.92]			[3.78]	[1.36]		0
2	2.14	1.99	6.19	2.94	2.40	2.35	2.35	6.29
	[1.67]	[1.07]			[1.60]	[1.04]		
3	0.78	2.55	1.76	4.97	0.98	2.90	1.50	8.51
	[1.63]	[1.07]			[1.71]	[1.19]		
4	−0.42	3.25	0.00	9.11	−0.39	3.25	0.00	12.20
	[1.53]	[0.74]			[1.35]	[0.74]		
5	−6.53	3.47	0.00	10.09	−5.37	3.18	0.02	10.77
	[2.60]	[0.77]			[2.74]	[0.87]		
6	−2.89	0.84	2.97	2.85	−3.59	0.97	3.39	3.93
	[2.94]	[0.38]			[3.37]	[0.46]		
	Panel I: 6-month				**Panel II: 12-month**			
	$rx^{j,2}_{net,t+1} = \gamma_0 + \gamma_1(f^{j,6}_t - s_t) + \eta^j_t$				$rx^{j,3}_{net,t+1} = \gamma_0 + \gamma_1(f^{j,12}_t - s_t) + \eta^j_t$			
1	10.03	4.13	0.00	26.39	8.54	3.31	0.00	26.69
	[2.23]	[0.74]			[1.60]	[0.73]		
2	2.56	2.63	0.18	13.11	1.48	2.07	0.31	13.05
	[1.50]	[0.84]			[1.11]	[0.70]		
3	0.81	2.90	0.39	13.66	1.43	2.70	0.16	21.45
	[1.70]	[1.01]			[1.41]	[0.85]		
4	−0.27	3.43	0.00	24.95	0.62	2.21	0.16	19.01
	[1.14]	[0.68]			[1.43]	[0.70]		
5	−5.89	3.57	0.02	20.63	−1.79	2.53	0.11	18.86
	[2.84]	[0.95]			[2.05]	[0.78]		
6	−4.28	1.13	1.71	6.79	−4.39	1.33	0.36	11.52
	[3.19]	[0.47]			[2.59]	[0.46]		

Notes: We report the R^2 in the time-series regression the log k-period currency excess return on the linear combination of log forward discounts for each portfolio j: $rx^{j,k}_{net,t+1} = \gamma_0 + \gamma_1(f^{j,k}_t - s^j_t) + \eta^j_t$ for each portfolio i. The standard errors in brackets are Newey-West standard errors computed with the optimal number of lags. The p-values is for the t-test on the slope coefficient. All the returns annualized and reported in percentage points. Data are monthly, from Barclays and Reuters (Datastream). The sample period is 11/1983 - 04/2007.

Table XXII
Return Predictability with Single Factor

Portfolio	*Constant*	*Slope*	*p.(%)*	R^2	*Constant*	*Slope*	*p.(%)*	R^2
	Panel I: 1-month							
	$rx^{j,2}_{net,t+1} = \gamma_0 + \gamma_1 \iota'(\mathbf{f}^1_t - \mathbf{s}_t) + \eta^j_t$							
1	−0.64	3.90	0.00	8.88		–		
	[0.16]	[0.66]						
2	−0.29	2.57	0.03	4.94				
	[0.16]	[0.70]						
3	−0.11	2.14	0.13	3.30				
	[0.16]	[0.67]						
4	0.06	2.38	0.03	3.94				
	[0.15]	[0.66]						
5	0.01	2.85	0.02	5.14				
	[0.14]	[0.75]						
6	0.16	3.33	0.01	5.13				
	[0.17]	[0.85]						
	Panel I: 2-month				**Panel II: 3-month**			
	$rx^{j,2}_{net,t+1} = \gamma_0 + \gamma_1 \iota'(\mathbf{f}^2_t - \mathbf{s}_t) + \eta^j_t$				$rx^{j,3}_{net,t+1} = \gamma_0 + \gamma_1 \iota'(\mathbf{f}^3_t - \mathbf{s}_t) + \eta^j_t$			
1	−1.19	4.33	0.00	14.83	−1.75	4.74	0.00	19.91
	[0.30]	[0.76]			[0.47]	[0.92]		
2	−0.62	2.87	0.11	7.37	−1.05	3.28	0.05	13.54
	[0.31]	[0.88]			[0.46]	[0.95]		
3	−0.43	2.90	0.08	7.54	−0.67	3.19	0.12	10.95
	[0.31]	[0.86]			[0.46]	[0.99]		
4	0.01	3.01	0.06	7.45	−0.11	3.33	0.03	10.98
	[0.31]	[0.88]			[0.41]	[0.92]		
5	−0.14	3.73	0.00	9.80	−0.17	3.69	0.00	11.60
	[0.28]	[0.77]			[0.42]	[0.87]		
6	0.12	3.74	0.05	7.70	0.02	3.93	0.10	10.58
	[0.33]	[1.07]			0.52	[1.19]		
	Panel I: 6-month				**Panel II: 12-month**			
	$rx^{j,2}_{net,t+1} = \gamma_0 + \gamma_1 \iota'(\mathbf{f}^6_t - \mathbf{s}_t) + \eta^j_t$				$rx^{j,3}_{net,t+1} = \gamma_0 + \gamma_1 \iota'(\mathbf{f}^{12}_t - \mathbf{s}_t) + \eta^j_t$			
1	−3.37	5.08	0.00	33.95	−3.85	4.29	0.00	36.49
	[0.80]	[0.74]			[1.89]	[0.84]		
2	−2.03	3.31	0.01	21.80	−2.90	2.32	0.06	17.40
	[0.84]	[0.84]			[1.63]	[0.68]		
3	−1.37	3.20	0.01	16.37	−1.26	3.00	0.01	25.50
	[0.81]	[0.84]			[1.60]	[0.79]		
4	−0.33	3.69	0.00	23.01	0.40	2.61	0.07	21.47
	[0.71]	[0.86]			[1.44]	[0.77]		
5	−0.58	4.27	0.00	23.57	1.32	2.96	0.10	19.94
	[0.86]	[0.86]			[1.71]	[0.90]		
6	−0.02	3.78	0.07	16.00	1.26	3.35	0.14	20.55
	[0.98]	[1.12]			[1.65]	[1.05]		

Notes: We report the R^2 in the time-series regression the log k-period currency excess return on the linear combination of log forward discounts for each portfolio j: $rx^{j,k}_{net,t+1} = \gamma_0 + \gamma_1 \iota'(\mathbf{f}^k_t - \mathbf{s}_t) + \eta^j_t$ for each portfolio i. The standard errors in brackets are Newey-West standard errors computed with the optimal number of lags. The p-values is for the t-test on the slope coefficient. All the returns annualized and reported in percentage points. Data are monthly, from Barclays and Reuters (Datastream). The sample period is 11/1983 - 04/2007.

Table XXIII
Business Cycle Properties of Expected Currency Returns

Portfolio	$\Delta \log Pay$	$\Delta \log Help$	*spread*	*slope*	*vol*
		Panel I: $Corr_t\left[\widehat{E}_t rx^2_{t+1}, x_t\right]$			
1	−0.23	−0.05	−0.09	0.20	−0.20
2	−0.77	−0.57	0.36	0.44	−0.16
3	−0.70	−0.57	0.33	0.45	−0.07
4	−0.57	−0.51	0.25	0.38	0.03
5	−0.46	−0.44	0.28	0.32	0.26
6	−0.11	−0.17	0.15	0.06	0.54
		Panel II: $Corr_t\left[\widehat{E}_t rx^3_{t+1}, x_t\right]$			
1	−0.44	−0.24	0.04	0.33	−0.20
2	−0.78	−0.59	0.37	0.44	−0.15
3	−0.70	−0.58	0.33	0.45	−0.06
4	−0.57	−0.52	0.25	0.37	0.04
5	−0.48	−0.46	0.29	0.33	0.26
6	−0.11	−0.19	0.15	0.03	0.55
		Panel III: $Corr_t\left[\widehat{E}_t rx^6_{t+1}, x_t\right]$			
1	−0.70	−0.50	0.23	0.45	−0.16
2	−0.79	−0.61	0.37	0.41	−0.09
3	−0.70	−0.60	0.34	0.43	−0.01
4	−0.59	−0.55	0.26	0.35	0.07
5	−0.49	−0.48	0.30	0.31	0.32
6	−0.12	−0.22	0.14	−0.04	0.55
		Panel IV: $Corr_t\left[\widehat{E}_t rx^{12}_{t+1}, x_t\right]$			
1	−0.75	−0.55	0.27	0.47	−0.17
2	−0.79	−0.60	0.36	0.41	−0.11
3	−0.69	−0.57	0.33	0.42	−0.03
4	−0.58	−0.53	0.24	0.33	0.04
5	−0.45	−0.35	0.14	0.38	0.15
6	−0.16	−0.19	0.07	−0.01	0.47

Notes: This table reports the contemporaneous correlation of forecasted excess returns $\widehat{E}_t rx^j_{t+k}$ with the percentage change in Total US Non-farm Payroll ($\Delta \log Pay_t$), of the Help-Wanted-Index ($\Delta \log Help_t$), the default spread ($spread_t$), the slope of the yield curve ($slope_t$) and the CBOE $S\&P$ 500 Volatility Index (vol_t). Data are monthly, from Barclays and Reuters (Datastream). The sample period is 11/1983 - 04/2007.

Table XXIV
Principal Components

Portfolio	1	2	3	4	5	6	
1	0.437	−0.402	0.187	−0.289	0.725	−0.052	0.701
2	0.392	−0.262	0.155	−0.023	−0.483	−0.721	0.122
3	0.385	−0.275	0.434	0.378	−0.303	0.594	0.061
4	0.378	−0.055	−0.707	0.575	0.150	−0.045	0.045
5	0.420	0.119	−0.407	−0.655	−0.321	0.334	0.037
6	0.433	0.822	0.297	0.111	0.155	−0.108	0.031

Notes: This table reports the principal component coefficients of the currency portfolios. The last column reports the principal component variances, i.e., the eigenvalues of the covariance matrix of X, divided by the sum of the variances. Data are monthly, from Barclays and Reuters (Datastream). The sample period is 11/1983 - 04/2007.

Table XXV
Asset Pricing - Portfolios of Countries in Burnside et al (2007)

Panel A: HML_{FX}			
λ_{HML}	β_1	β_2	β_3
6.57	-0.28	0.05	0.23
	[0.04]	[0.04]	[0.04]
Panel B: RX			
λ_{RX}	β_1	β_2	β_3
2.50	1.01	1.07	0.92
	[0.04]	[0.03]	[0.04]
Panel C: Pricing errors			
	R^2	$RMSE$	$p-val$
	93.09	0.37	0.44

Notes: This table reports asset pricing results. Test assets are 3 currency portfolios built with the small sample of currencies used in Burnside et alii (2007). The risk factors are HML_{FX}, estimated on a large sample of forward and spot rates, and RX the average excess return on the test assets. Market prices of risk are not estimated; sample means are used instead. The first two panels report the mean of the risk factors (in the first column) and the corresponding betas (in the next three columns). Standard errors are in brackets. The last panel reports R^2, the square-root of mean-squared errors $RMSE$ and the p-values of χ^2 tests in percentage points. The sample period is 11/1983 - 04/2007.

Table XXVI
Summary Statistics - Foreign Investors - Portfolios of Developed and Emerging Countries

Portfolio	1	2	3	4	5	6
Panel I: UK						
Excess Return: rx^j_{net} (with bid-ask)						
Mean	−4.94	−2.06	−1.34	0.79	−0.38	−0.60
Std	8.57	8.19	8.45	8.49	8.43	9.09
SR	−0.58	−0.25	−0.16	0.09	−0.04	−0.07
Long-Short: $rx^j_{net} - rx^1_{net}$						
Mean		2.88	3.60	5.73	4.56	4.34
Std		5.35	5.79	6.61	6.82	9.03
SR		0.54	0.62	0.87	0.67	0.48
Panel II: Japan						
Excess Return: rx^j_{net} (with bid-ask)						
Mean	−2.35	−2.08	−1.03	1.22	1.85	2.54
Std	9.20	10.30	9.98	10.75	9.95	11.54
SR	−0.26	−0.20	−0.10	0.11	0.19	0.22
Long-Short: $rx^j_{net} - rx^1_{net}$						
Mean		0.28	1.32	3.57	4.20	4.89
Std		5.47	5.59	6.07	6.55	8.79
SR		0.05	0.24	0.59	0.64	0.56
Panel III: Switzerland						
Excess Return: rx^j_{net} (with bid-ask)						
Mean	−3.78	−0.80	−1.04	0.21	1.03	1.79
Std	7.67	8.00	8.68	8.42	8.04	10.20
SR	−0.49	−0.10	−0.12	0.03	0.13	0.18
Long-Short: $rx^j_{net} - rx^1_{net}$						
Mean		2.98	2.74	3.99	4.81	5.57
Std		5.61	5.90	6.65	6.41	8.72
SR		0.53	0.46	0.60	0.75	0.64

Notes: This table reports summary statistics for currencies sorted into portfolios. We report averages and Sharpe ratios of log excess returns rx^j_{net} with bid-ask spreads and log excess returns on the long short strategy $rx^j_{net} - rx^1_{net}$ in *UK pounds*, in *Japanese yen*, and in *Swiss francs*. All moments are annualized and reported in percentage points. The portfolios are constructed by sorting currencies into six groups at time t based on the one-month forward discount (i.e nominal interest rate differential) at the end of period $t-1$. Portfolio 1 contains currencies with the lowest interest rates. Portfolio 6 contains currencies with the highest interest rates. Data are monthly, from Barclays and Reuters (Datastream). The sample period is 11/1983 - 04/2007.

Table XXVII
Summary Statistics - Foreign Investors - Portfolios of Developed and Emerging Countries - Midpoint Conversion

Portfolio	1	2	3	4	5	6
Panel I: UK						
			Excess Return: rx^j_{net}			
Mean	−5.71	−2.82	−2.01	0.26	−0.35	−0.02
SR	−0.67	−0.34	−0.24	0.03	−0.04	−0.00
			Long-Short: $rx^j_{net} - rx^1_{net}$			
Mean		2.90	3.70	5.97	5.36	5.69
SR		0.54	0.64	0.90	0.79	0.63
Panel II: Japan						
			Excess Return: rx^j_{net}			
Mean	−2.25	−1.57	−0.33	1.99	2.63	3.37
SR	−0.24	−0.15	−0.03	0.18	0.26	0.29
			Long-Short: $rx^j_{net} - rx^1_{net}$			
Mean		0.68	1.92	4.24	4.88	5.62
SR		0.12	0.35	0.70	0.75	0.64
Panel III: Switzerland						
			Excess Return: rx^j_{net}			
Mean	−3.77	−0.23	−0.39	1.08	2.09	2.92
SR	−0.49	−0.03	−0.05	0.13	0.26	0.29
			Long-Short: $rx^j_{net} - rx^1_{net}$			
Mean		3.54	3.38	4.85	5.86	6.69
SR		0.63	0.57	0.73	0.91	0.77

Notes: This table reports summary statistics for currencies sorted into portfolios. We report averages and Sharpe ratios of log excess returns rx^j_{net} with bid-ask spreads and log excess returns on the long short strategy $rx^j_{net} - rx^1_{net}$ in *UK pounds*, in *Japanese yen*, and in *Swiss francs*. All moments are annualized and reported in percentage points. The portfolios are constructed by sorting currencies into six groups at time t based on the one-month forward discount (i.e nominal interest rate differential) at the end of period $t-1$. Portfolio 1 contains currencies with the lowest interest rates. Portfolio 6 contains currencies with the highest interest rates. Data are monthly, from Barclays and Reuters (Datastream). The sample period is 11/1983 - 04/2007.

Table XXVIII
Asset Pricing - Foreign Investors

	λ_{HML}	λ_{RX}	b_{HML}	b_{RX}	R^2	$RMSE$	χ^2
			Panel I: UK				
GMM_1	5.33	−1.19	0.56	−0.13	47.23	1.40	
	[2.39]	[1.85]	[0.26]	[0.29]			4.08
GMM_2	5.31	−1.03	0.56	−0.10	46.55	1.41	
	[2.26]	[1.69]	[0.24]	[0.27]			4.10
FMB	5.33	−1.19	0.56	−0.13	47.23	1.40	
	[1.87]	[1.50]	[0.20]	[0.24]			1.19
	(1.87)	(1.50)	(0.20)	(0.24)			1.41
$Mean$	**6.18**	**-1.19**					
			Panel II: Japan				
GMM_1	6.54	1.38	0.74	0.02	70.24	1.13	
	[2.36]	[2.19]	[0.27]	[0.22]			10.16
GMM_2	6.36	1.91	0.71	0.07	63.58	1.25	
	[2.24]	[2.15]	[0.25]	[0.21]			10.52
FMB	6.54	1.38	0.74	0.02	70.24	1.13	
	[1.82]	[1.90]	[0.21]	[0.19]			7.94
	(1.82)	(1.90)	(0.21)	(0.19)			9.27
$Mean$	**6.35**	**1.37**					
			Panel III: Switzerland				
GMM_1	6.68	0.85	0.77	−0.04	73.79	1.06	
	[2.41]	[1.73]	[0.28]	[0.28]			11.73
GMM_2	7.92	1.16	0.91	−0.03	68.12	1.17	
	[2.22]	[1.64]	[0.26]	[0.26]			13.26
FMB	6.68	0.85	0.77	−0.04	73.79	1.06	
	[1.82]	[1.49]	[0.21]	[0.24]			7.57
	(1.82)	(1.49)	(0.21)	(0.24)			8.94
$Mean$	**7.36**	**0.86**					

Notes: This table reports results from GMM and Fama-McBeth asset pricing procedures. Market prices of risk λ, R^2, square-root of mean-squared errors $RMSE$ and p-values of χ^2 tests are reported in percentage points. b_1 represents the factor loading. The portfolios are constructed by sorting currencies into six groups at time t based on the interest rate differential at the end of period $t-1$. Portfolio 1 contains currencies with the lowest interest rate. Portfolio 6 contains currencies with the highest interest rate. Data are monthly, from Barclays and Reuters in Datastream. The sample period is 11/1983 - 04/2007. Excess returns used as test assets take into account bid-ask spreads. All excess returns are multiplied by 12. Standard errors are reported in brackets. Shanken-corrected standard errors are reported in parenthesis.

Table XXIX
Factor Betas - Foreign Investors

Portfolio	α_0^i	β_{HML}^i	β_{RX}^i	R^2	$\chi^2(\alpha)$	$p-value$
Panel I: UK						
					11.65	7.02
1	−1.625	−0.386	0.986	91.403		
	[0.549]	[0.021]	[0.029]			
2	−0.262	−0.151	0.997	81.946		
	[0.861]	[0.027]	[0.044]			
3	0.202	−0.084	1.023	79.430		
	[0.847]	[0.028]	[0.038]			
4	2.485	−0.085	0.984	72.816		
	[0.943]	[0.038]	[0.043]			
5	0.825	0.092	1.024	77.312		
	[0.841]	[0.037]	[0.038]			
6	−1.625	0.614	0.986	92.094		
	[0.549]	[0.021]	[0.029]			
Panel II: Japan						
					4.54	60.31
1	−0.665	−0.373	0.959	93.672		
	[0.494]	[0.020]	[0.019]			
2	−1.340	−0.169	1.049	86.262		
	[0.834]	[0.032]	[0.029]			
3	−0.423	−0.104	1.015	86.507		
	[0.726]	[0.031]	[0.027]			
4	1.705	−0.069	1.055	84.645		
	[0.923]	[0.042]	[0.050]			
5	1.388	0.087	0.962	83.967		
	[0.883]	[0.041]	[0.029]			
6	−0.665	0.627	0.959	95.890		
	[0.494]	[0.020]	[0.019]			
Panel III: Switzerland						
					10.19	11.68
1	−1.403	−0.376	0.990	88.912		
	[0.560]	[0.024]	[0.026]			
2	0.261	−0.128	0.992	76.706		
	[1.006]	[0.035]	[0.052]			
3	0.101	−0.126	1.087	79.271		
	[0.848]	[0.031]	[0.043]			
4	1.286	−0.075	1.003	72.303		
	[1.022]	[0.043]	[0.054]			
5	1.158	0.080	0.939	75.475		
	[0.902]	[0.043]	[0.054]			
6	−1.403	0.624	0.990	93.541		
	[0.560]	[0.024]	[0.026]			

Notes: This table reports results OLS estimates of the factor betas. The intercept α_0 β, and the R^2 are reported in percentage points. The standard errors in brackets are Newey-West standard errors computed with the optimal number of lags. The χ^2 test statistic $\alpha' V_\alpha^{-1} \alpha$ tests the null that all intercepts are jointly zero. This statistic is constructed from the Newey-West variance-covariance matrix (1 lag) for the system of equations (Cochrane (2001), p. 234). The portfolios are constructed by sorting currencies into six groups at time t based on the the currency excess return at the end of period $t-1$. Portfolio 1 contains currencies with the lowest previous excess return. Portfolio 5 contains currencies with the highest previous excess return. Data are monthly, from Barclays. The sample period is 11/1983 - 04/2007. Excess returns used as test assets take into account bid-ask spreads. All excess returns are multiplied by 12.

Table XXX
Summary Statistics on Equity Excess Returns - Portfolios of Developed and Emerging Countries

Portfolio	1	2	3	4	5	6
	Panel A: Equity Excess Returns in Foreign Currency					
Mean	12.99	11.19	9.63	7.61	10.03	1.12
Std	17.24	17.40	18.92	18.30	17.76	18.60
SR	0.75	0.64	0.51	0.42	0.56	0.06
	Panel B: Currency Excess Returns in US Dollars					
Mean	−1.78	0.10	1.31	3.62	2.57	4.36
Std	8.76	7.73	7.49	8.16	8.05	9.17
SR	−0.20	0.01	0.18	0.44	0.32	0.48
	Panel C: Equity Excess Returns in US Dollars					
Mean	9.86	10.51	10.67	11.34	13.46	7.98
Std	17.87	18.35	20.09	19.10	19.42	21.35
SR	0.55	0.57	0.53	0.59	0.69	0.37

Notes: This table reports mean, standard deviation and Sharpe ratio on equity and currency excess returns sorted into portfolios. The portfolios are constructed by sorting countries into six groups at time t based on the one-month forward discount (i.e nominal interest rate differential) at the end of period $t-1$. Portfolio 1 contains countries with the lowest interest rates. Portfolio 6 contains countries with the highest interest rates. For each portfolio, we compute the average equity and currency excess return. Exchange rate data are monthly, from Barclays and Reuters (Datastream). Equity data are monthly, from MSCI (Datastream). US Fama risk-free rates are monthly from CRSP (WRDS). The sample period is 11/1983 - 04/2007. All moments are annualized (averages are multiplied by 12 and standard deviations by $\sqrt{12}$). We compute equity excess returns in foreign currency as the change in the MSCI equity index in local currency minus the forward discount plus the US one-month Fama risk free rate. We compute equity excess returns in US dollars as the change in the MSCI equity index converted in US dollars minus the US one-month Fama risk free rate. Taking into account bid-ask spreads, currency excess returns are computed either as $R^{e,1}_{t+1} = F^{ask}_t / S^{bid}_{t+1} - 1$ or as $R^{e,2}_{t+1} = F^{bid}_t / S^{ask}_{t+1} - 1$, depending whether the investor goes long or short the foreign currency. We assume that the investor goes long the foreign currency when the forward discount is positive (and thus use $R^{e,2}$ in this case).