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Bill B. Francis

Rensselaer Polytechnic Institute, francb@rpi.edu

Kimberly Gleason

Florida Atlantic University, kgleason@fau.edu

Delroy M. Hunter

University of South Florida, dhunter@coba.usf.edu

Charles A. Malgwi

Bentley College, Cmalgwi@bentley.edu

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Information Risk in the International Currency Markets: Evidence from the Violation of UIRP*

Bill B. Francis
Lally School of Management & Technology
Rensselaer Polytechnic Institute
110 8th Street, Troy, NY 12180-8196
(518) 276-3908 (Phone)
(518) 276-8661 (Fax)
francb@rpi.edu (e-mail)

Kimberly Gleason
Department of Finance
Florida Atlantic University
(561) 236 1295 (Phone)
Kgleason@fau.edu (e-mail)

Delroy M. Hunter
College of Business Administration
University of South Florida
Tampa, FL 33620
(813) 974-6319 (Phone)
(813) 974-3084 (Fax)
dhunter@coba.usf.edu (e-mail)

Charles A. Malgwi
Department of Accountancy
Bentley College
Waltham, MA 02452
(781) 891-2774 (Phone)
(781) 891-2896 (Fax)
Cmalgwi@bentley.edu (e-mail)

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Abstract

Drawing on the theoretical and empirical evidence that private information risk is priced in the expected returns of equities, we hypothesize that information risk premium is an important component of the risk premium that leads to the violation of uncovered interest rate parity (UIRP). Using an asset pricing model in which the risk factors are a world currency factor, a world equity factor, and a world private information factor, we find that UIRP is violated for 28 single currencies plus the euro and that violation is due to the existence of a significant time-varying risk premium. The component of the risk premium attributable to private information is economically large, statistically significant, and frequently dominates the component due to the world equity and currency factors, respectively. As far as we are aware, this is the first evidence that information risk is priced in assets other than equities and in the international financial markets. Together, the factors explain the average currency excess returns (alpha is equal zero) suggesting that, contrary to recent studies, UIRP is violated because investors require a risk premium on their currency deposits. We show that proxies for the country's information environment explain the cross-sectional variation of exposures to private information risk.

Keywords: uncovered interest rate parity, private information, information risk premium, order flow, currency returns

JEL classification: G12, F31

1. Introduction

The interaction between investors with private information and those without is critical to the efficient functioning of financial markets.¹ To induce private information search, those with private information should earn a return for their efforts (Grossman and Stiglitz (1980)). Uninformed investors are cognizant of the fact that they are at a disadvantage and will lose out to informed investors. However, because uninformed investors have portfolio choices to make and cannot rationally expect to maximize their utility if they refrain from trading, they choose to trade in assets or markets where the risk of being taken advantage of is lowest and require a premium for the information risk they bear (O'Hara (2003)).

One of the rational portfolio choices that investors make is to invest in international financial markets in order to obtain the maximum benefits of international diversification. In this paper, we examine (i) if U.S. investors demand a risk premium for exposure to information risk in the international financial markets as they do in domestic financial markets, (ii) if the required compensation is reflective of the information environment within which the foreign investment takes place, and (iii) whether or not U.S. investors revise their expectations of the magnitude of the compensation for information risk following a major change in the information environment.

O'Hara (2003), in her presidential address to the American Finance Association, argues that information risk should be accounted for in asset pricing tests. She points out that failure to account for information risk would be “unimportant if asset pricing models work well in the sense of explaining the observed behavior of asset prices...” This, she argues, is not the case given the proliferation of anomalies in the asset pricing literature. Evidence in support of the importance of information risk for asset pricing is reported by Easley et al. (2003), Easley and O'Hara (2004), Francis et al. (2006), and others.

The role of information risk in asset pricing models has been investigated only for equity securities in a domestic market context. However, it is likely that information risk plays a more important role in international investments because nonresident investors may be at an informational disadvantage

¹ Interpreted broadly, private information is regarded as information that one group of investors (e.g., local investors in foreign markets) have that another group (e.g., U.S. residents) does not have.

in comparison to domestic investors given, for instance, the absence of full information disclosure, differences in legal and accounting systems, and other potential barriers to becoming as informed as domestic investors. As a result, the returns nonresident investors earn from international investments would include an information risk premium, the magnitude and sign of which would be a function of the information environment of the particular market.

This argument is consistent with the observation that a firm's information environment affects its cost of capital (see Healy and Palepu (2001) for a survey). In fact, the information risk faced by U.S. investors has been offered as an explanation for the observed home bias (Cooper and Kaplanis (1994)), whereby investors require higher expected returns to invest in foreign markets than to invest in their local markets.² It is also the case that the continuing debate about whether or not foreign (U.S.) investors are more or less informed than local investors about the local financial markets makes the issue of information risk in the international financial markets the more intriguing and worthy of investigation.

In examining the role of information risk in international financial markets, we use uncovered interest rate parity (UIRP), one of the most fundamental relationships in international finance, as our platform. UIRP states that when the domestic nominal interest rate is less than the foreign interest rate the domestic currency is expected to appreciate by an amount approximately equal to the interest rate differential. An important implication of this is that the return on an uncovered foreign currency deposit should be equal to the return on an equivalent domestic deposit.

Empirical tests of UIRP find that, in general, it does not hold (see survey in Engel (1996)). A leading explanation for this failure is the existence of a time-varying risk premium as compensation for the speculative position in the foreign currency.³ However, Engel and others point out that the risk premium approach to explaining the violation of UIRP has met with only marginal success. These

² The idea of a home bias has been extended to the domestic market, where investors in a certain locality put a greater value (demand lower expected returns) on local companies than on companies in other distant locations (see, e.g., Coval and Moskowitz (2002)). This is perhaps a reflection of the information risk that investors face when they analyze firms that are not in close proximity to where they are located.

³ Other explanations include, inefficient currency forward markets, the "peso" problem causing bias in the forward rate, speculative bubbles, and rational learning about potential changes in currency regimes (see, e.g., Engel (1996)).

disappointing results would appear to cast doubt on the existence of a risk premium and suggest that the violation may be due to other factors. For example, Bansal and Dahlquist (2000) conclude that currency excess returns are not compensation for systematic risks. They find that country-specific attributes, such as country credit ratings, interest rate differentials with the U.S. (when the foreign interest rate is lower), and per capita GNP play a more important role in explaining the cross-section of currency excess returns.

In this paper, we conjecture that the reason for the failure of previous studies to establish the existence of a risk premium as the cause of the violation of UIRP is the failure to account for the role of information risk. There is considerable evidence that there is private information in the international currency, interbank, and fixed-income markets where the interaction between traders determines whether or not UIRP holds. For example, Peiers (1997) finds that large private banks act on private information around the time of central bank intervention in the currency market. Likewise, Ito et al. (1998) find evidence of private information in the Japanese currency market. More broadly, Evans and Lyons (2002a, b) show that private information plays a major role in determining exchange rate changes. In the international interbank market, Bernard and Bisignano (2000) find that banks require a premium to supply credit because of information asymmetry between borrowers and lenders. Portes et al. (2001) show that information risk is an important determinant of U.S. trades in foreign corporate and treasury bonds.

In examining the role of information risk in the international financial markets we take the perspective of a U.S. investor, such as a global or international fixed-income fund manager. Asymmetric information about likely shifts in foreign monetary policy and central bank intervention in the currency market, for example, could have severe consequences for the U.S. dollar return on the manager's foreign assets. This would particularly affect a fund manager who frequently disposes of foreign assets prior to their maturity, where the dollar return on the trades is a function of existing interest and exchange rates.

We specify a three-factor asset pricing model (the factors are equity, currency and private information) and estimate both risk exposures and risk prices to determine if information risk is priced in currency excess returns. This model is an extension of the International CAPM of Adler and Dumas (1983) in which market-wide equity and currency factors generate assets' expected returns. In the UIRP

(and international finance) literature, our model is novel in the sense that the third risk factor is a measure of market-wide private information.

Arriving at a measure of private information is difficult because the extent to which it exists is not directly observable. We utilize the notion that innovations in currency order flow convey private information related to the rebalancing of currency, fixed income, and equity portfolio positions. The choice of this variable as a measure of private information arises from recent developments, particularly in the exchange rate literature, where several theoretical and empirical papers conclude that innovations in currency order flow is a proxy for private information (see, for example, Evans and Lyons (2002a, b), Francis et al. (2006), among others). And equally important, unexpected currency order flow has significant explanatory power, both contemporaneously and in a predictive sense, for exchange rate changes (Evans and Lyons (2002a, b) and Francis et al. (2006)), currency excess returns (Froot and Ramadorai (2005)), and equity returns (Froot and Ramadorai (2004) and Francis et al. (2006)).

To demonstrate the adequacy of our information risk proxy, we examine if cross-sectional differences in information risk premiums are explained by country-specific variables that characterize the information environment of the currency. If country-specific attributes employed by Bansal and Dahlquist (2000) reflect the country's information environment, then it is not surprising that these attributes explain the currency excess returns in an asset pricing model that omits an information risk factor. That is, the information risk of a country may be related to its credit rating because a high level of information asymmetry conceals the true level of national indebtedness or the country's foreign exchange reserves (Bernard and Bisignano (2000)). Likewise, it could be related to interest rate differentials with the U.S. because countries with severe information risk may use credit rationing, rather than interest rates, to clear loan demands, therefore allowing them to keep interest rates artificially low (Kletzer (1984)).

We focus on currency, rather than equity, excess returns because, while international equity returns are also likely to contain an information risk premium, it is the violation of UIRP that remains an anomaly and is in more urgent need of a rational explanation.

Determining why UIRP fails and the role of a risk premium are important for several other reasons. McCallum (1994) points out that UIRP is a key behavioral relationship in virtually all the important exchange rate determination models. Violation of UIRP also indicates that capital markets are not integrated (Frankel (1992)). Evidence on the extent to which markets are integrated is mixed. This evidence is based primarily on the equity markets, hence an analysis of UIRP for a broad range of countries at different stages of capital market development can provide an alternative perspective on the issue of world capital market integration. Thus, from both a research and policy perspective understanding why UIRP fails to hold is important.

More generally, studying currency excess returns provides an interesting complement to the many papers that focus on the diversification benefits of investing in equities. U.S. investors have substantial equity investments in the emerging markets arising from the view that these investments provide the benefits of diversification. Given recent reforms, the level of equity diversification might have diminished as the level of integration of these markets with the U.S. market increases. Thus, investments in foreign currency deposits may be an alternative source of international diversification benefits. Malliaropulos (1997) finds that currency excess returns are less volatile than foreign equity returns and that the addition of currency deposits to an international equity portfolio provides additional diversification benefits. Similarly, Bansal and Dahlquist (2000) find that adding emerging market currency returns to those from developed markets results in higher Sharpe ratios.

There are several advantages to our study relative to previous papers that examine whether the violation of UIRP is due to the existence of a time-varying risk premium. First, we provide additional evidence of the recently established theoretical and empirical finding that information risk is priced (Easley et al. (2003), Easley and O'Hara (2004)). What is more, as far as we are aware, this is the first examination of whether or not information risk is priced in assets other than equities and in the international financial markets. If information risk is indeed systematic, then it should be able to explain cross-sectional differences in the average returns of several asset classes.

Second, we use the introduction of the euro to provide new insights into two important issues—whether euro deposits display deviation from UIRP and the effect its introduction had on the level of information risk in the financial markets. One of the arguments proffered for the introduction of the euro is that a strong, single currency would reduce the currency risk premium in international financial markets. Hence, our test can be regarded as providing evidence on this proposition. The changes in the eurozone financial markets have attracted significant numbers of new, sophisticated investors—foreign banks, bond dealers, and other financial firms—and competition has increased tremendously (Francis and Hunter (2004)). It is likely that this has led to a reduction in the gain from private information because, as Grossman and Stiglitz (1980) point out, as the proportion of informed traders increase the marginal gain to being informed declines. In addition, arbitrageurs have less incentive to search for private information in a unified euro market relative to a fragmented 12-currency market. Hence, if information risk is truly a systematic factor in currency excess returns we should observe lower information risk premiums in the post-euro sub-period. Finally, as detailed in the Methodology section below, relative to previous studies a multi-factor model such as ours is more appropriate for testing for the presence of risk premiums in currency excess returns (see, e.g., Engel (1996)).

We find that UIRP is violated because U.S. investors require a significant time-varying risk premium for investing in the international currency markets. More specifically, (i) currency excess returns from 28 countries and for the euro have significant betas relative to each of our three risk factors; (ii) the three risk factors are jointly and individually priced in currency excess returns; (iii) private information risk premium is economically large and statistically significant, (iv) the magnitude of the information risk premium declines dramatically after the introduction of the euro; and (v) the total estimated risk premium from our model is not statistically significantly different from the realized currency excess returns for any of the currencies (i.e., model alpha is zero). The latter indicates that our model explains why UIRP does not hold—investors require a risk premium. Finally, we show that country characteristics related to the information environment (e.g., regulatory quality, political stability,

government effectiveness, and others) have significant explanatory power for the cross-sectional differences in information risk premium.

The remainder of the paper has six sections. Section 2 discusses the theoretical rationale of a role for market-wide information risk in the international financial markets and specifically as a risk premium in currency excess returns. Section 3 describes the methodology. In section 4 we present summary statistics of the data and preliminary evidence on the extent to which UIRP holds. Section 5 presents the risk exposures and risk premiums, while section 6 discusses how legal and political institutions of a country can affect the information environment and presents results on the cross-sectional differences in sensitivity to information risk. Section 7 summarizes and suggests further research.

2. Information Risk and Currency Returns

Our focus on the role of information risk in asset pricing in general and the foreign currency deposit market in particular is motivated by the recent literature that shows that a different aspect of the trading and price discovery process—private information—affects asset returns (see, e.g., Easley (2003), Easley and O’Hara (2004), Easley et al. (2003), Evans and Lyons (2002a, 2002b, 2004), Albuquerque et al. (2004), Francis et al. (2006), Peiers (1997), Ito et al. (1998), and others).

Easley (2003) and Easley and O’Hara (2004) develop a model in which stocks have differing levels of public and private information and in equilibrium uninformed traders require compensation to hold stocks with greater private information. This compensation reflects the fact that private information increases the risk to uninformed investors of holding the stock because informed investors are better able to shift their portfolio weights to incorporate new information. As a result, uninformed traders always hold too much of stocks with bad news, and too little of stocks with good news. In their model, holding more stocks cannot remove this risk because the uninformed are always on the wrong side. Moreover, for the uninformed, not holding stocks at all is sub-optimal because a higher level of utility is still achieved when holding risky assets even if they are trading with informed investors. Further, as pointed out by the authors, the standard separation theorem that typically characterizes asset pricing models does not hold

here because informed and uninformed investors perceive different risks and returns, and thus hold different portfolios. Thus, the existence of private information induces a new form of systematic risk, and in equilibrium investors require compensation for this risk. In empirical tests, using the individual firm's probability of informed trading (PIN), Easley et al. (2003) provide strong evidence that information-based trading has a large and significant positive effect on asset returns.

Although their work deals exclusively with equities, the underlying intuition is applicable to the currency market. This is particularly the case given that several papers show both theoretically and empirically the existence of private information in the foreign exchange markets.

In their seminal paper, Evans and Lyons (2002a) present an exchange rate model that explicitly incorporates a determinant from the field of microstructure—currency order flow. Their empirical results show that when order flow is included in the usual list of macroeconomic variables in determining exchange rate changes the model produces an R^2 of about 60%. Further analyses show that nearly all of this variation in daily exchange rates is due to order flow. Although not explicitly tested, they argue that this impact is due to unanticipated currency order flow acting as a vehicle for private information flow. In a follow-up paper, Evans and Lyons (2002b) explicitly test the hypothesis that macroeconomic news is a determinant of currency order flow and, consequently, that order flow's remarkable explanatory power for exchange rate variation is primarily due to its acting as a vehicle for macroeconomic (i.e., public) information flow. They find that about two-thirds of the impact of macro news on exchange rates is transmitted via order flow. Additionally, upon the arrival of news, the importance of order flow in the determination of exchange rate increases. They report that together, the two information channels of macro news (the direct channel and the channel via order flow) account for approximately 30% of the variation in exchange rates. However, more important to our paper, they also find that only a third of the impact of order flow on exchange rate changes is due to macro news, while the remaining two-thirds is not macro news related. They conclude that unanticipated order flow is a proxy for market-wide private information and there exists an important role for private information in the foreign exchange market.

Along similar lines, Francis et al. (2006) hypothesize that there are dynamic relationships between the volatilities of the U.S. stock market, the stock market of a foreign country, and the exchange rate between the dollar and the currency of the foreign country. They further hypothesize that these relationships are due to the flow of market-wide private information related to portfolio rebalancing of U.S. investors between domestic and foreign equity markets via the currency market. Using unanticipated currency order flows as a measure of market-wide private information, they find evidence of private information in both equity markets and the currency market and that the previously strong intermarket volatility relationships all but disappear when they account for private information.

Likewise, Albuquerque et al. (2004) use unanticipated international equity flows of U.S. investors as a measure of market-wide private information. They examine how information flow in equity markets impacts currency returns in an economy characterized by both informed and uninformed investors, and where informed investors act upon both market-wide and firm-specific private information. In empirical tests of their model they find that there exists market-wide private information in equity markets, and that this information reliably forecasts currency returns.

These papers are not the first to document the existence of private information in the currency markets. Peiers (1997) finds that in periods characterized by Bundesbank intervention, the Deutschebank acts as a price leader in the mark/dollar market, indicating the existence of private information. Ito et al. (1998), using as their experiment the time period when the restrictions on trading in the Japanese foreign exchange market was lifted, find strong evidence of the existence of private information in the foreign exchange market.

While, to our knowledge, no previous study has examined whether there is an information risk premium in the expected returns of securities in the international capital markets, several previous studies have acknowledged the role of information risk in the international interbank market and in influencing the flow of international investments. For instance, Bernard and Bisignano (2000, and references therein) recognize that information risk, arising from information asymmetry between borrowers and lenders, play an important role in the international interbank market. They argue that, faced with information risk,

banks require a premium to supply interbank credit and this they obtain as an “implicit deposit insurance without actually having to pay for it.” That is, “the lack of information on potential international interbank borrowers is in many cases arguably “compensated for” by an assumed but nonetheless uncertain implicit public guarantee of repayment.”

They further point out that the subsidy is most important in markets where information risk is at its greatest—the developing economies. This severe information risk in developing markets is reflected in shorter debt maturity, predominance of bank rather than bond financing, and even credit rationing in lieu of the use of interest rates to clear the loan market (see, e.g., Kletzer (1984)). Related to our paper, we propose that an additional effect of high levels of information risk is that foreign investors in the currency deposit market (which is not unrelated to the international interbank market) will require an information risk premium because high levels of information risk conceals the true level of national indebtedness. Hence, additional borrowing from foreigners could lead to a reduction in the probability of repayment because the foreign currency exposure of local banks could overwhelm the country’s foreign exchange reserves. In fact, the information environment could be so opaque that even the country’s foreign exchange reserves are not known with certainty, adding to the likelihood that foreigners will demand a risk premium.

Finally, Portes and Rey (2004) find that information risk is one of the major determinants of the level of bilateral gross cross-border equity flows between 14 countries. Portes et al. (2001) also find that information risk is an important determinant of U.S. bilateral trades in foreign assets and that information plays a greater role for stocks and corporate bonds, where the assets are considered to have higher information content, but is not as important for low information-content treasury bonds.

It is noteworthy that, from the perspective of the U.S. investor, the private information risk premium in currency excess returns can be of either sign. There is a growing debate as to whether U.S. investors are at an informational disadvantage relative to local investors about foreign financial markets. The existing empirical evidence is mixed. Seasholes (2000), Grinblatt and Keloharju (2000), Froot and Ramadorai (2005), and Albuquerque et al. (2004) present evidence consistent with U.S. investors being

more informed than locals, while Choe et al. (2001), Hau (2001), and Dvorák (2005) find the opposite. We argue that if U.S. investors are more informed than local residents about local financial markets, then U.S. investors may be prepared to pay a premium (accept a negative premium) on their investments in these markets because they provide the benefits of international diversification. On the other hand, if U.S. investors are informationally disadvantaged they will require a positive information risk premium.

In summary, there is overwhelming evidence that there is market-wide private information in the foreign exchange market indicating the existing of both informed and uninformed investors. The question that has not been addressed in the literature, but which needs to be answered to further our understanding of the role of private information in the trading and price discovery process, is whether information risk is a priced factor in currency excess returns and, therefore, leads to the violation of UIRP.

3. Methodology

Previous studies that use asset pricing models to examine if the violation of UIRP is due to the existence of a time-varying risk premium (see, e.g., McCurdy and Morgan (1991), Malliaropulos (1997), Bansal and Dahlquist (2000)) have met with limited success. A possible explanation for this lack of success is that these studies use a model with a single world equity factor to explain currency excess returns (Engel (1996)).

Our approach provides two distinct methodological advantages over previous papers. New to the interest rate parity literature is our conjecture that U.S. investors who hold local currency deposits/assets in foreign countries face information risk and, as a result, expect compensation for this risk. To see if there is support for this conjecture we include a proxy for information risk in our estimation. This risk factor is then combined with two other factors in a three-factor model to test for the presence of time-varying risk premiums in currency excess returns. Korajczyk and Viallet (1992), among others, argue that the same pervasive factors that explain excess returns on equities should explain the variation in the risk premiums in forward exchange markets. Ikeda (1991) shows that a linear factor model specified in local currency terms, does not hold internationally unless the same factor-pricing model governs both

equities and exchange rates. Consistent with this line of research, asset-pricing models employed by De Santis and Gerard (1998), among others, successfully use equity benchmarks to price excess returns on foreign currency deposits. Consequently, we include an equity factor. Our final factor is a currency risk factor and it is represented by percentage changes in a trade-weighted currency index and is motivated by the idea that the dollar return a U.S. investor demands on a deposit in a foreign country is influenced not only by expected appreciation of the individual foreign currency but also by the expected movements of other similar currencies.⁴

The second methodological advantage of our paper is that we jointly estimate the risk premiums for a large set of currencies. The benefit of this is that it provides for a much more efficient estimation of the risk premiums compared to previous studies such as those by McCurdy and Morgan (1991).

The asset pricing model that we estimate is a version of the Arbitrage Pricing Theory of Ross (1976) and our estimation technique is similar to that used by Jorion (1991), Bailey and Chung (1995), Antoniou, Garret, and Priestley (1998), among others. The model specifies the realized currency excess returns as a function of K systematic risk factors and associated prices of risk. The prices of risk are the expected compensation for bearing a unit of exposure to systematic risk. Specifically:

$$\mathbf{r}_t = E_{t-1}(\mathbf{r}_t) + \mathbf{B}\mathbf{f}_t + \mathbf{e}_t, \quad (1)$$

where \mathbf{r}_t is an N vector of observed excess returns at time t , $E_{t-1}(\mathbf{r}_t)$ is an N vector of expected excess returns conditional on investors' information set at time $t-1$, \mathbf{f}_t is a K vector of zero-mean factors, \mathbf{B} is an $N \times K$ matrix of factor sensitivities (i.e., betas), with element b_{ik} a measure of the sensitivity of asset i to factor k , and \mathbf{e}_t is an N vector of asset-specific returns at time t .⁵

The APT represents the expected returns as:

⁴ This would be consistent with the "meteor showers" hypothesis of Engle et al. (1990) that there are spillovers between currencies.

⁵ The non-market factors are zero-mean, serially uncorrelated residuals obtained from projecting the "raw" factors on a set of lagged instruments (described in the Data section below). To increase the efficiency with which the factors are estimated, the above is done simultaneously with the estimation of the system of equations described below. Unreported chi-squared tests indicate that the factors are, individually and jointly, predictable with p -values of the null hypothesis of no predictability rejected at less than the 1% level. Additionally, the results indicate that the instruments produced serially uncorrelated factors.

$$E_{t-1}(\mathbf{r}_t) = \mathbf{B}\boldsymbol{\lambda}_{t-1}, \quad (2)$$

where $\boldsymbol{\lambda}$ is a K vector of prices of risk. The price of risk is constrained to be the same for each asset in vector \mathbf{r} . Substituting (2) into (1), we obtain

$$\mathbf{r}_t = \mathbf{B}\boldsymbol{\lambda}_{t-1} + \mathbf{B}\mathbf{f}_t + \mathbf{e}_t. \quad (3)$$

As pointed out earlier, the violation of UIRP is, among other reasons, attributed to a time-varying risk premium. To capture the time-varying risk premium (which is the product of beta and the risk price, $\mathbf{B}\boldsymbol{\lambda}_{t-1}$) the above model estimates time variation of the risk prices associated with each factor. However, it does not allow for time variation in the betas.⁶ We do not believe that this poses a problem for our inferences because it is now well established that most of the variation in expected returns is due to the variation of the price of risk and not of beta (see, e.g., Ferson and Harvey (1991)).⁷ Additionally, evidence in McCurdy and Morgan (1992), De Santis and Gerard (1998), and others, clearly establishes that it is the variation in the price of risk and not the variation of beta that drives the significance of currency risk premium. Nonetheless, in recognition of the possibility that betas change over time, we also estimate the model over two sub-periods.

We assume that the risk prices are a linear function of a set of instruments (see, e.g., De Santis and Gerard (1998)):

$$\boldsymbol{\lambda}_{t-1} = (\mathbf{Z}'_{t-1}\boldsymbol{\delta}), \quad (4)$$

where \mathbf{Z} is an L vector of instruments (which need not be the same for each risk price) and a constant, and $\boldsymbol{\delta}$ is an L vector of coefficients to be estimated. If this coefficient vector is significantly different from zero it indicates that the risk prices are statistically significant. Further, because the vector of instruments

⁶ To allow time variation in betas would reduce tractability significantly. For instance, to estimate time-varying betas relative to the three factors for N countries' currency returns using a constant and three instruments would require estimating $(N*4*3)$ coefficients. In contrast, allowing time variation of the three risk prices requires estimating $(3*4)$ 12 coefficients.

⁷ Fama and French (1997) also note that in estimating industry expected returns precision in the estimation of the expected factor premium is more important than in the estimation of beta.

include a column of ones, we can test directly the hypothesis that the risk prices are time varying by testing the null hypothesis that the coefficients of $\boldsymbol{\delta}$ other than the constants are jointly equal to zero.

More explicitly, for the N currency excess returns we jointly estimate the following system of equations:

$$\begin{aligned}
r_{1t} &= b_{11}(\mathbf{Z}'_{t-1}\boldsymbol{\delta}_1 + f_{1t}) + b_{12}(\mathbf{Z}'_{t-1}\boldsymbol{\delta}_2 + f_{2t}) + b_{13}(\mathbf{Z}'_{t-1}\boldsymbol{\delta}_3 + f_{3t}) + e_{1t} \\
r_{2t} &= b_{21}(\mathbf{Z}'_{t-1}\boldsymbol{\delta}_1 + f_{1t}) + b_{22}(\mathbf{Z}'_{t-1}\boldsymbol{\delta}_2 + f_{2t}) + b_{23}(\mathbf{Z}'_{t-1}\boldsymbol{\delta}_3 + f_{3t}) + e_{2t} \\
&\cdot \\
&\cdot \\
&\cdot \\
r_{Nt} &= b_{N1}(\mathbf{Z}'_{t-1}\boldsymbol{\delta}_1 + f_{1t}) + b_{N2}(\mathbf{Z}'_{t-1}\boldsymbol{\delta}_2 + f_{2t}) + b_{N3}(\mathbf{Z}'_{t-1}\boldsymbol{\delta}_3 + f_{3t}) + e_{Nt}.
\end{aligned} \tag{5}$$

The model represents the realized currency excess returns r_{it} of the N currencies as being comprised of three parts. The first component is the (sum of the) product of the exposure b_{ik} to the systematic risk factor k and the time-varying price of risk for factor k , $\mathbf{Z}'_{t-1}\boldsymbol{\delta}_k$. This component furnishes us with the ex ante expected risk premium associated with each of the k risk factors and is the part of the estimated model that is of interest in the analyses below. The second component is the unexpected currency excess return arising from the (sum of the) product of the exposure b_{ik} and the unanticipated factor realization f_{kt} . The third component is currency-specific excess return and is unrelated to systematic risks.

We estimate a factor exposure b_{ik} for each currency excess return relative to each of the K factors. In contrast, the coefficients associated with the L instruments in \mathbf{Z} , $\boldsymbol{\delta}_k = \boldsymbol{\delta}_{k1}, \dots, \boldsymbol{\delta}_{kL}$, are restricted to be equal for all the N currency excess returns. The fitted prices of risk are computed as $\mathbf{Z}'_{t-1}\hat{\boldsymbol{\delta}}_k$ and the ex ante expected currency excess returns as $\sum_k \hat{\beta}_{ik} \mathbf{Z}'_{t-1} \hat{\boldsymbol{\delta}}_k$. The market risk price can be regarded as a wealth-weighted average relative risk aversion of investors and should, therefore, be positive. Following

De Santis and Gerard (1998), and others, we use $\exp(\mathbf{Z}'_{t-1} \hat{\boldsymbol{\delta}}_M)$ to impose a non-negativity restriction on this risk price.

Both b_{ik} and δ_k in (5) are to be estimated; thus this model is the multi-factor version of the Fama-MacBeth two-step approach that estimates the risk exposures b_{ik} in the first step and then uses them in a second step to estimate the associated risk prices δ_k . However, in this paper, we do in a single step what Fama-MacBeth accomplishes in two. That is, we simultaneously estimate the betas (\mathbf{B}) and the risk prices ($\boldsymbol{\delta}$). To accomplish this, the estimation requires a nonlinear process. Following Jorion (1991), Bailey and Chung (1995), and others, we estimate the model as a system of equations using an iterated nonlinear seemingly unrelated regression estimation (INSURE) technique. Estimating the above N equations as a system allows us to impose the cross-equation restriction that the time-varying risk price for each factor k is the same across the N currency excess returns.

An advantage to estimating the system of equations using the INSURE is that it allows us to exploit any cross correlations in the model residuals of each currency excess returns. The residuals of the currency excess returns may be correlated because the currency excess returns share some common characteristics. Connor and Korajczyk (1993) note that the asset pricing model should account for such cross correlations without treating the common characteristic as a factor. Another advantage of the INSURE is that because it jointly estimates the risk exposures and risk prices it does not suffer from some of the econometric problems associated with the Fama-MacBeth two-pass methodology. These include the errors-in-variables problem, which biases the standard errors of the risk prices and could, therefore, lead to spurious conclusions about their statistical significance. Whereas the Fama-MacBeth approach uses portfolios to attenuate this bias, the INSURE technique is suitable to be applied to individual assets as well as portfolios of assets.

A potential disadvantage of both the Fama-MacBeth and INSURE techniques is that the system requires a large number of assets with significant cross-sectional variation in the betas if the risk prices are to be estimated with reasonable precision. In our estimations below, the number of currency excess

returns in a system ranges from 16 to 23. In order to ensure enough degrees of freedom, given that we estimate three risk prices with 12 (3×4) coefficients, we add the equity returns of the countries whose currency returns are included in the system, hence doubling the number of assets. This is consistent with, Ferson and Harvey (1991) who include short- and long-term debt securities in their system to estimate the risk premiums in stock returns. Furthermore, since it is well established that currency and equity risk factors are priced in both equity and currency excess returns (see, e.g., De Santis and Gerard (1998)) and that private information risk, as represented by unanticipated currency order flow, has explanatory power for both currency and equity returns (see, e.g., Francis et al. (2006), and others), the inclusion of equity returns in the system does not pose any problem. We do not report the results for the equity portfolios, but they are available on request.

4. Data

4.1 Description of data

This study uses weekly Wednesday-to-Wednesday data over the sample period January 11, 1995 to August 11, 2004, for a total of 492 observations. The tests are also conducted over two sub-periods. The first pre-dates the euro, January 1995 to December 1998 (206 observations). The second is from May 1999 to August 2004 (292 observations), with the starting date selected to include as many newly liberalized emerging markets as possible. In the full period, the currency excess returns are for the following 16 countries: Argentina, Australia, Canada, Czech Republic, Denmark, Hong Kong, Japan, Mexico, New Zealand, Norway, Poland, Singapore, Slovakia, Sweden, Switzerland, and the United Kingdom. In the pre-euro sub-period, the above were augmented with seven countries that later adopted the euro: Belgium, France, Germany, Italy, Netherlands, Portugal, and Spain. In the second sub-period, the sample of 16 countries was augmented with five emerging markets: Indonesia, Malaysia, Philippines, Thailand, and South Africa. The euro currency excess returns were also added in this period.

In our analyses, we take the position of a U.S. (domestic) investor. Nonetheless, we use world risk factors in our estimation to reflect the fact that the currencies that we study are from economies that

are regarded as being internationally integrated (industrialized countries) or those that took steps to become integrated into the world capital markets (the emerging markets). Specifically, for our equity factor, we use the Datastream world market equity price index in U.S. dollars. Returns on this index are estimated as 100 times the log first differences of the index. Excess returns are then computed by subtracting the corresponding 7-day Eurodollar deposit return (USADEP). Panel A of Table 1 indicates that the mean excess return is a statistically insignificant 0.0258% per week.

[Table 1 about here]

The currency factor is represented by 100 times the log first difference of the U.S. Treasury broad trade-weighted currency index (inverted to U.S. dollar/foreign currency). The index contains the currencies of the top 35 trading partners of the U.S., 19 of which are the larger developing economies. Hence, from the U.S. perspective of a deposit in a single country, this can be regarded as a world currency factor. Panel A reports a mean depreciation of the average currency of this index of 0.0418% per week (about 2.2% annualized), which is significantly different from zero at the 0.10 level. Except for the market portfolio that represents returns of a traded asset and are not autocorrelated, we use unanticipated factor realizations in the APT model. To obtain these we exploit the autocorrelation in the changes in the currency index. Additionally, given evidence in Evans and Lyons (2002a), Francis et al. (2006), and others, that currency order flow predicts exchange rate changes, we project the exchange rate changes on its first two lags and three lags of the order flow variable and use the residuals as the unanticipated factor realizations. Unreported chi-squared tests indicate that the factor is predictable with p -values of the null hypothesis of no predictability less than 0.01. Autocorrelation analyses of the residuals indicate that the instruments produced serially uncorrelated (unpredictable) factors.

Most previous studies that utilize currency order flow (e.g., Evans and Lyons (2002a), Froot and Ramadorai (2005)) rely on proprietary data. Unfortunately, these are not available to us. Thus, we use a publicly available proxy for currency order flow. The order flow proxy data are reported in the U.S. Treasury Bulletin and represent the foreign currency position of the major foreign exchange market participants (banks with \$50 billion in outstanding foreign exchange contracts at the end of any quarter in

the previous year) at the close of business each Wednesday. The reported balances are the unsettled purchases and sales of spot, forward, and futures contracts. While the reported balances do not include all transactions that occurred over the last week and are, therefore, not truly a flow variable, they are a close proxy as they represent the bulk of the transactions during the week. This is because of the two-day settlement policy for spot transactions and the fact that most non-spot transactions entered into since the last report would be outstanding at the time of the new report.

The use of a proxy for currency order flow biases our tests against finding support for the hypothesis that innovations in currency order flow are a vector for private information that gives rise to information risk. Furthermore, this bias is greater because we use aggregate flows including the proprietary data related to international equity transactions that have been used by other authors and no doubt flows related to exports and imports and other transactions not related to foreign currency deposits. For example, Tien (2003) finds that aggregate order flow obscures the information content of specific components, such as the flows related to hedging demand.⁸ Thus, if we do find support for our hypothesis this indicates that our results are rather strong.

On the other hand, the use of this data set provides several advantages relative to other publicly available data. Bohn and Tesar (1996), Brennan and Cao (1997), Albuquerque et al. (2004), and others use monthly international equity flows of U.S. investors obtained from the Treasury International Capital (TIC) database of the U.S. Treasury. One disadvantage pointed out by Albuquerque et al. (2004) is that the use of this data may overstate the role of private information because intra-month transactions motivated by the arrival of new public information may be counted as trades due to private information. Given the greater frequency of the weekly data used in our tests this bias is significantly reduced. A second advantage of our data is that because they are aggregate currency flows they are relevant to studying the impact of private information on other asset types than equities. A third advantage of our

⁸ Furthermore, we cannot disaggregate the data to reflect the fact that not all participants in the currency markets are concerned about the existence of private information. For instance, a farmer in the international wheat trade with the need to hedge future foreign currency inflows is less concerned with being at an informational disadvantage about future foreign interest rate and currency values than a U.S. global bond trader who may have discretionary liquidity needs that require liquidating foreign fixed-income securities prior to their maturity.

data is that because they include derivative transactions they are more likely to reflect private information than equity flows alone. That is, given an update of, say, a U.S. mutual fund manager's information set the fund manager may decide to act on this information not by a transaction in equities but rather in equity or currency derivatives. The same applies to a currency deposit in the sense that new information about future interest or currency rates that could affect the currency returns need not trigger a change in the size of the currency deposit, as the investor could seek to exploit the new information by taking a position in currency or interest rate derivatives.

Panel A reports three measures of currency order flow. The first, CURFLO, includes the net purchases of the Canadian dollar, the pound, the Swiss franc, and the yen and is available for the full sample period. The second, CURFLOG, adds the deutsche mark to the above currencies and is available over the pre-euro period. The third, CURFLOE, includes the above four flows plus the euro currency flows and is available over the post-euro sub-period. We compute net flows as the sum of the purchases of all currencies less the sum of all sales. These purchases/sales are denominated in U.S. dollars by the U.S. Treasury. Summary statistics of net purchases ($\times 0.0001$) are reported in Panel A. They indicate that, on average, market participants sell more foreign currencies than they purchase. The flows exhibit significant autocorrelation, which is a nice feature of the data because persistence in the risk factor complements the well-documented time variation in equity and other financial asset returns. Furthermore, we exploit the autocorrelation to estimate the unanticipated order flow. Specifically, as a part of the nonlinear system, we project order flow on a constant plus three of its own lags and two lags of the exchange rate changes. Unreported chi-squared tests reject the null hypothesis that this factor is not predictable. Additionally, when we regress order flow and exchange rate changes on the respective sets of instruments using OLS, an analysis (unreported) of the residuals indicates that they have the requisite unpredictable property of shocks. The use of an augmented autoregressive model to capture the predicted and, hence, the unexpected order flow is consistent with work in the asset pricing literature.

A possible drawback of this measure of private information is that it may not be orthogonal to public information, especially given that Evans and Lyons (2002b) show that currency order flow

incorporates macro news. We do not believe this is the case for two reasons. First, Albuquerque et al. (2004) show that lagged order flows dominate the variation of current order flows in the presence of local or international information instruments. Second, given that we use weekly information and most macro announcements are made on a monthly basis it is unlikely that our measure of private information contains public information. An additional benefit of weekly data relative to, say, daily data is that they enable us to obtain only the private information contained in order flow. Because of the presence of informed and uninformed agents in the international financial markets, the price impact of unanticipated order flow will be permanent if it represents private information, while having only a temporary effect if it represents liquidity-based trading. Hence, over the span of a week the effects of liquidity-based trading should dissipate, leaving only the private information effect.

We also require a set of instruments to obtain time variation in the risk prices. We select instruments that are well known in the asset pricing literature. For the market risk price, we use the lagged default premium (DEFAULT), measured as the difference in yields between Baa- and AAA-rated bonds, the lagged average weekly interest rate of the U.S. plus the countries whose currency returns are included in the model (AVGINT), and a dummy variable defined as 1 after the introduction of the euro and 0 otherwise (EURODUM). For the currency risk price, the instruments are the lagged changes in the currency index, the lagged order flow variable used in the model, and the euro dummy variable. To predict the currency order flow risk price we use the first two lags of the order flow variable and the euro dummy variable.

4.2 Preliminary analyses of currency excess returns

To compute currency excess returns, we require comparable deposit interest rate and exchange rate data from each country. These data are obtained from Datastream. The appropriate interest rate data are not available for several countries; hence, our sample is limited to the countries noted above. The exchange rates are expressed as dollars per unit of foreign currency. The interest rates are mainly mid rates of 7-day eurocurrency deposits, similar to those used by McCurdy and Morgan (1991) and others.

In the case of Hong Kong, the eurocurrency rate is not available and so we use a 7-day deposit mid rate. For Argentina and Mexico we use interbank mid rates. The use of the Japanese interest rates required some judgment. For most of the period the euroyen 7-day mid rate was used. However, Datastream reported negative rates starting on August 14, 2002. A check with alternative data sources (e.g., Economagic LIBOR data available on the Internet) reported positive rates. Hence, at this point we replaced the euroyen rates with 1-week interbank rates also from Datastream. These rates or those from Economagic could not be used over the full period because they were not available before December 1997. We do not believe that this introduces any problems given that the correlation between the two rates is 0.913 and the average difference in rates is 0.009% between December 1997 and August 2002.

Additionally, in the case of Argentina, around the major depreciation of December 2001, interest rates were increased to as high as 400% per year from December 05, 2001 to January 16, 2002. Consequently, for this time period we use the average of the rates for the five weeks prior to December 05, 2001 and the five weeks after January 16, 2002. For Slovakia we replaced an outlier on June 04, 1997 and January 12, 2000 with the average of the rates in the week before and the week after.

Currency excess returns are computed as follows. At the beginning of the week a U.S. dollar is converted to local currency at the spot exchange rate against the U.S. dollar (s_{t-1}) and deposited at the deposit rate (computed for a 7-day investment) of the country of reference (i^*). At the end of the week, the local currency proceeds are converted to U.S. dollars at the end-of-week spot exchange rate (s_t). The return on this currency deposit (CURRET) is then compared to the one-week return on the Eurodollar deposit (i^S) to compute the currency excess return (XCURRET). All returns are in U.S. dollar terms and are weekly percentages: $CURRET = ((s_t/s_{t-1}) \times (1+i^*)) - 1$ and $XCURRET = 100 * (CURRET - i^S)$.

Panel B of Table 1 reports summary statistics of the weekly currency excess returns for each country over the period that the data are available. The first column indicates that the mean annualized currency excess returns range from about -5.72 basis points for Denmark to 7.43% for Mexico. There are 23 mean excess returns that are greater in magnitude than 1% per year, and 10 are greater than 4% per year. These mean excess returns are broadly similar to those from previous studies, such as McCurdy and

Morgan (1991). The excess returns display some general patterns. For instance, for the industrialized countries they are generally smaller than those of the currencies of the developing countries. However, for Japan, the U.K., New Zealand, Singapore, Belgium, France, Germany, and the Netherlands the annualized mean excess returns are all larger than 2.50% in magnitude. The currencies of the transition economies of the Czech Republic, Poland, and Slovakia have the highest average excess returns of any group, about 5.90% per year. Also, roughly half of the mean returns are negative, indicating that the U.S. investor would, on average, earn a higher rate of return from the eurodollar deposit than from the foreign country's eurocurrency deposit.

With the introduction of the euro, intended as a strong alternative to the U.S. dollar, it is interesting to examine whether or not there are deviations from UIRP with regards to deposits in this currency. Recent empirical evidence and several theoretical arguments suggest that there may not be a violation of UIRP because the currency union is designed to reduce uncertainty and, hence, the risk premium.⁹ Bris, Koskinen, and Nilsson (2003) find that the “euro is good after all” in that since its introduction, firms in the eurozone have experienced improved performance due to a reduction of the cost of equity (and an increase in expected cash flows). Similarly, Francis and Hunter (2004) find that there has been a significant reduction in the currency risk premium and overall cost of equity for the world's major banking industries after the introduction of the euro. The results indicate that the euro provides a positive mean excess currency return of about 1.33% per year.

As is common in the literature (see, e.g., McCallum (1994)) we also regress the changes in the exchange rate index (reported in column 3) on the interest rate differentials (reported in column 4) to determine if UIRP holds. Unreported results indicate that the slope coefficients are considerably different from 1, and 19 of the 29 currencies have large negative slope coefficients. Taken together, these results indicate that UIRP does not hold and this may be the result of the existence of a risk premium.¹⁰

⁹ As we point out in the introduction, UIRP may be violated due to other reasons than a risk premium.

¹⁰ Preliminary evidence that UIRP is violated can be obtained from the fact that the mean appreciation of the dollar (column 3) is not equal to the mean interest rate differential (column 4) for many currencies.

5. Empirical Results

In this section, we present our main empirical results. In the first sub-section (5.1), we provide evidence that currency excess returns are exposed to private information and other systematic risks. In sub-sections 5.2 and 5.3 we examine the time-varying risk premiums in currency excess returns for various currencies in the sample. In sub-section 5.4, we present evidence of the impact of the introduction of the euro on the magnitude of the information risk premium in the estimated currency excess returns. Finally, in sub-section 5.5, we discuss some of the diagnostic checks employed in our estimation to ensure the validity of our results.

5.1. Exposure of currency excess returns to private information and other risks

Table 2 presents evidence that U.S. investors in foreign currency deposits are exposed to systematic risks and, most important for this paper, to market-wide private information risk.

[Table 2 about here]

Panel A reports estimates of the world equity, currency, and private information betas (with their associated p -values) for each of the 16 currency excess returns for which data are available for the full sample period. The results indicate that the currency excess returns of most of the 16 currencies are significantly exposed to all three risks. The market betas are positive and statistically significant at conventional levels for Australia, Canada, New Zealand, Argentina, and Mexico. In contrast, the currency excess returns of Hong Kong, Denmark, Switzerland, the U.K., and the Czech Republic are negatively associated with changes in the world equity factor. These negative betas suggest that currency deposits in these countries would provide investors who invest in the world equity markets with the benefits of international diversification. Finally, market risk seems to have no significant effect on the excess returns for the currencies of Japan, Norway, Singapore, Sweden, Poland, and Slovakia.

The results indicate that currency excess returns of Australia, Canada, Hong Kong, Japan, New Zealand, Singapore, Slovakia, Argentina, and Mexico have statistically significant positive currency

betas, while those for the Czech Republic and Poland are negative. For the remaining countries—Denmark, Hong Kong, Sweden, Switzerland, and the U.K.—the betas are not different from zero.

Indicative of the proposition that private information plays a significant role in the international financial markets and contributes to the violation of UIRP, we find that currency excess returns for 13 of the 16 currencies are statistically significantly exposed to private information risk. Specifically, the private information beta is negative and statistically significant at conventional levels for Australia, Canada, Denmark, Hong Kong, Japan, New Zealand, Singapore, Switzerland, the U.K., and Argentina. Assuming that the price of information risk is on average positive the finding that developed economies, which have a better information environment, have negative information betas is not surprising. The result for Argentina is likely due to the fact that over most of the sample period it had a transparent monetary policy arising from the currency board arrangement. Additionally, the International Finance Corporation (IFC) regarded Argentina as one of the freest emerging markets, being 100% investable with high quality information in its financial markets. On the other hand, the information beta is significantly positive for the Czech Republic, Poland, and Mexico. This implies that, on average, U.S. investors faced greater information risk in these markets. This result is not surprising given the institutional weaknesses in terms of transparency (e.g., scant disclosure requirements, weak creditor protection, and low minority shareholder protection) typically found in the transition economies and emerging markets. Finally, the information betas of the currency excess returns of Norway, Sweden, and Slovakia are not significant.

Complementing the significance of the individual betas are chi-squared statistics shown in Panel B. They indicate that the null hypothesis that the equity market betas are jointly zero can be rejected at less than the 0.01 level. Similarly, the null hypothesis that the currency betas are jointly zero can be rejected. Most important, we reject the null hypothesis that the market-wide private information betas are jointly zero.

In sum, we find that excess returns generated from uncovered interest arbitrage are significantly exposed to private information risk. These results are consistent with those of Evans and Lyons (2002a) and Francis et al. (2006) who find that private information, as represented by unanticipated currency order

flows, impact currency changes. We leave further interpretation of our results until we consider the risk prices and risk premiums.

5.2. Is private information risk priced in currency excess returns?

Thus far, our results indicate that currency excess returns are significantly exposed to the world equity, currency, and private information risks. However, it is yet to be determined if investors require a statistically significant and economically meaningful compensation for the exposure to each unit of risk. That is, are these risks priced in currency excess returns? In Table 3, we present evidence that the three risk prices are economically and statistically significant.

[Table 3 about here]

Panel A reports descriptive summary statistics of each risk price. The mean market price of risk is 0.017 and is significant at the 0.01 level. The minimum and maximum values indicate that, as per the imposed restriction, the market risk price is always non-negative. The price of currency risk has a mean of -0.067 that is significant at the 0.01 level. It is both positive and negative over the sample period, consistent with theory and empirical evidence that currency risk price can be of either sign (see, e.g., Adler and Dumas (1983), De Santis and Gerard (1998)). The mean price of private information risk is 0.029, with a similar level of significance as the others. Because there is no theory requiring us to restrict the sign of this risk price it also changed sign over the sample period. It is noteworthy that the mean information risk price is economically larger than that of the market factor. Judging from the relative magnitudes of the market and information betas in Table 2 it appears that the information risk premium is larger than the market risk premium in currency excess returns.

Panel B provides information regarding the statistical significance of and time variation in each factor's risk price. For all three factors we reject the null hypothesis that the price of risk is zero at conventional levels. Further, with the exception of the market factor, we can also reject the null hypothesis that they are constant. The last two rows of the panel indicate that the three risk prices are jointly significant and jointly time varying. These results indicate that information asymmetry in the

world currency markets is a source of systematic risk, that U.S. investors require significant compensation to bear this risk, and that the compensation for this risk varies over time.

Our results present new evidence that market-wide private information risk is a priced factor in the excess returns of a large sample of currencies. As far as we are aware it is the first time that private information is shown to be a significant risk factor in the returns of assets other than equities. We also present new evidence that world currency risk is priced in currency excess returns. These are important results in light of the fact that the existing evidence of a risk premium in currency excess returns is based on equity market risk.

5.3. The role of private information risk in the violation of UIRP

[Table 4 about here]

So far, we have presented evidence that currency excess returns are significantly exposed to the three market-wide risks and that these risks are priced in the expected currency excess returns. In Table 4, we provide estimates of individual risk premiums attributable to exposure to each of the factors, thereby enabling us to determine if currency excess returns are due to the existence of a risk premium and to ascertain the importance, or lack thereof, of information risk premium in the total risk premium.

As shown in column 1, the mean equity risk premiums are statistically significant for all currencies. For the developing countries, equity risk premiums range from -0.150% per year for the Argentine peso and 0.135% per year for the Mexican peso to 0.0016% for the Hong Kong dollar. For the developed markets, the equity risk premium in the currency excess returns range from 0.085% for the New Zealand dollar to 0.021% for the Japanese yen. By themselves, these average risk premiums are economically small suggesting that equity risk premiums do not explain much of the excess returns obtained from foreign currency deposits. The importance of this, along with the small market betas, is that it lends support to the argument by Engel (1996) that a single equity factor model will not properly account for the realized currency excess returns, and its use might have led to the conclusion by Bansal and Dahlquist (2000) that the currency excess returns are not the result of a risk premium.

Column 2 reports the currency risk premiums. In almost all cases, the mean currency risk premium is large relative to the equity risk premium. The largest magnitudes for currency risk premiums are found for the transition economies: 1.955% per year for the Czech Republic and 1.648% per year for Poland. Among the other non-industrialized countries, Argentina and Mexico both have large currency risk premiums (over 1% in magnitude). However, it is not the case that large currency risk premiums are unique to the currencies of non-industrialized economies. For example, the magnitude of the currency risk premiums in the excess returns of the currencies of Australia (1.362% per year), Japan (1.586%), and New Zealand (1.487%) are also large.

Our results regarding the market-wide private information risk premium provide conclusive evidence that private information risk contributes significantly to deviations from UIRP. Column 3 of Table 4 indicates that private information risk premium is both statistically and economically significant, with risk premium ranging from 1.640% per year for Mexico and 1.404% per year for Poland to -1.592% per year for Japan and -1.076% per year for New Zealand.

In the financial markets of the typical developing and transition economies, which are characterized by relatively low levels of disclosure and transparency, it is not unexpected to observe large positive private information risk premiums because U.S. investors consider themselves to be at an informational disadvantage in these markets. On the contrary, for most of the industrialized countries with large, sophisticated financial markets characterized by relatively high levels of disclosure, we expect to find a low positive to negative information risk premium.

A closer inspection of our results bears this out. Of the 11 industrialized economies, only the currency excess returns of Norway have a positive mean private information risk premium (0.057% per year), which turns out to be the smallest information risk premium in terms of magnitude. This result suggests that, in general, U.S. investors are the informed investors in the currency deposit market of the industrialized economies. The most likely reason why U.S. investors may be more informed in these markets is that these economies, and specifically that component of the economy that is most relevant to interest rate and exchange rate determination, are significantly affected by the monetary and fiscal

policies of the U.S. federal government and U.S. investors know more about these policies than local investors in foreign markets. This conjecture is plausible given evidence that shocks to U.S. output spill over to the output of foreign countries (see, e.g., Kwart (1999)) and U.S. monetary policy shocks affect the current account and growth of foreign countries (see, e.g., Kim (2001)). If U.S. investors who invest in foreign currency deposits are better informed about or are more adept at interpreting these U.S. output or monetary shocks than local investors in foreign markets, then U.S. investors may be more informed about likely developments in the foreign currency markets than local investors. U.S. investors may be willing to give up their information advantage (accept a negative information risk premium), given the international diversification benefits offered by these deposits.

In sharp contrast, for the developing countries, only Argentine currency has a negative mean information risk premium, quite likely for the reasons previously discussed. Among the other four non-industrialized countries, the information risk premium ranges from a high of 1.638% for Mexico to a low of 0.128% for Slovakia, consistent with the notion that U.S. investors are at an informational disadvantage in these markets.

The estimated currency excess returns, representing the sum of the three risk premiums U.S. investors demand as compensation for exposure to systematic risk in the international currency deposit markets, are reported in column 4. Except for the Swedish kroner, all mean estimated currency excess returns are statistically significant at mostly the 0.01 level. The magnitudes of the estimated currency excess returns are highest for the Japanese yen (3.15% per year), the Polish zloty (3.10%), the Mexican peso (3.00%), the Czech Republic koruna (2.77%), and the New Zealand dollar (2.48%). The evidence in Table 4 indicates that there is broad-based violation of UIRP across currencies of different characteristics and that the violation results from the existence of time-varying risk premiums.

Comparing the individual risk premiums to the estimated currency excess returns, we find that currency and information risks are the main causes of the violation of UIRP. For the currencies with positive mean currency excess returns and risk premiums—Czech Republic, Mexico, Norway, Poland, Slovakia, and Sweden—currency and information risk premiums, respectively, account for a large portion

of the currency excess returns. As an example, for the Czech Republic, currency risk premium represents over 70% of total estimated currency excess returns, and for Poland, 53%.

More important to this paper, the private information risk premium comprises 55% of estimated currency excess returns for the Mexican currency and overwhelms the other risk premiums in the case of the Norwegian currency, resulting in the private information risk premium being larger than the mean estimated currency excess return. Of the other three currencies with a positive information risk premium, it accounts for between 27% and 45% of the total estimated currency excess returns. Similarly, for the currencies with negative information risk premium the magnitudes of the risk premiums are large relative to the magnitudes of the currency excess return.

Our results have several important implications. First, we have established that UIRP does not hold for the sample of currencies examined, and that this is due to the existence of time-varying risk premiums. Second, private information risk premium plays a significant role in the violation of UIRP and it is much more important in currency excess returns than equity risk premium and is about the same magnitude as the currency risk premium. These findings are consistent with recent evidence that market-wide private information, as proxied by currency order flow, explains changes in exchange rates (e.g., Evans and Lyons (2002a, b), Francis et al. (2006), and others) and equity returns (Froot and Ramadorai (2005), Francis et al. (2006)). Third, omitting currency and private information risks from the model leads to misspecification and no doubt plays a significant role in earlier conclusions that the violation of UIRP is not due to the existence of a risk premium (see, e.g., Bansal and Dahlquist (2000)).

5.4. Effect of the introduction of the euro on information risk

As previously discussed, the marginal gains from trading as an informed investor is expected to decline with the introduction of a single currency where 12 existed before. If this were the case, while we may still find that UIRP is violated after the introduction of the euro, we should find that the information risk premium now plays a substantially less significant role because the information environment in the largest currency deposit markets has improved. It is likely that the currency and equity risk premiums

were also affected by the introduction of the euro. An important argument in favor of introducing a common European currency was the reduction in exchange rate risk, which would benefit European firms and foreign corporations with significant trade or investments in Europe. On the other hand, because the formation of the European monetary union was also accompanied by significant regulatory changes designed to increase competition and open up the capital markets of the countries belonging to the eurozone to the rest of the world it is possible that the market risk premium has increased. This would be consistent with an increase in their international integration with the rest of the world. Therefore, we can use the introduction of the euro as a sort of reality check of our model and main hypothesis.

[Table 5 about here]

In Table 5, we report the results when we separate the sample into pre-and post-euro introduction. In the pre-euro sub-period the sample of currencies includes the 16 previously estimated over the full sample plus seven from the eurozone countries (Belgium, France, Germany, Italy, the Netherlands, Portugal, and Spain), while in the post-euro sub-period five developing countries' currencies (Indonesia, Malaysia, the Philippines, Thailand, and South Africa) plus the euro are added to the original 16.

The results are striking. For those currencies that are common to the pre- and post-euro samples the introduction of the euro has significantly affected the risk premiums, with dramatic reductions in the magnitude of the information and currency risk premiums and a less dramatic increase in just over a third of the market risk premiums. These results support our previously discussed propositions.¹¹

Focusing on the information risk premium, three of the five currencies from the non-industrialized countries in the sample have experienced a change from a large positive information risk premium to a negative information risk premium, while the other two have experienced upward of an 85% reduction (without a change in sign). Given these large changes in the information premium of the developing countries' currencies, it may be argued that this has less to do with the improvement of their information environment around the introduction of the euro than with the financial liberalization that

¹¹ Note that although the two sub-period models contain 16 common currencies the samples are different. However, the results are broadly similar if the two sub-period models contained only the 16 currencies used in the full sample.

these markets started in the late 1980s. This argument is not without merit because liberalization improves the information environment of these markets. However, while we cannot disentangle these alternatives we believe that the changes are related to the introduction of the euro, not only because these changes are consistent with the expectations discussed above, but also because by the beginning of 1999 the non-industrialized countries in the sample had already undertaken major liberalization and had become reasonably highly integrated into the world financial markets so that liberalization is unlikely to be the cause of the changes in the information risk premium. Furthermore, this dramatic change is not confined to the emerging and transition economies, as currencies such as the Danish kroner, the Japanese yen, the New Zealand dollar, and others, have experienced similar large changes. In fact, 13 of the 16 currencies experienced a decline in their information risk premium.

It is also interesting to note that the information risk premium of the currencies that later adopted the euro all exhibit positive mean information risk premiums in the pre-euro sub-period. This is somewhat expected given that Hau (2001) find that foreign (U.S.) investors are informationally disadvantaged in the German financial markets. Juxtaposed to this, however, we find that the euro has a large negative information risk premium, suggesting that the average currency that adopted the euro would have displayed negative information risk premium after adopting the euro. In light of the recent findings by Dvorak (2005) that foreign investors in Indonesia are informationally disadvantaged, we are not surprised that the information risk premium for the rupiah is positive and economically large.

Finally, judging from the magnitudes of the estimated mean currency excess returns in the two sub-periods, UIRP is violated in both periods due to the existence of market, currency, and information risk premiums. However, for 12 of the 16 currencies in the pre- and post-euro sub-periods the magnitude of the currency excess returns declined significantly after the introduction of the euro.

5.5. Model Diagnostics

No hypothesis test using an asset pricing model escapes several potential problems that could compromise the inferences drawn from the results. One such potential problem is the joint-hypothesis

problem that the asset pricing model holds when we test the hypothesis of interest. In this paper, we have put in place several checks to reduce the probability that the results are an artifact of a misspecified model. For instance, our use of the INSURE approach overcomes the errors-in-variables problem faced with the Fama-MacBeth two-step approach. Additionally, simultaneously estimating the unanticipated components of the risk factors, the betas, risk prices, and the expected currency excess returns significantly increases the efficiency of our estimation of the standard errors of the coefficients. Further, because we include the excess equity market returns of each country in the system of equations (resulting in the smallest system having 32 returns) and include countries at different levels of economic, financial, and legal development there is significant variation in the factor betas, which sharply increases the precision with which the risk prices and, hence, risk premiums are estimated.

Nonetheless, one of the primary diagnostic tests of any asset pricing model is the size of the model's alpha (intercept). That is, how well does the model do in explaining the cross-sectional variation in the average returns of the securities in the system? In a well-specified model these alphas should not be statistically significantly different from zero. For the sake of tractability we estimated the model without an intercept, thereby reducing the number of coefficients by a minimum of 32 in the different systems. Fama and French (1997), in their estimation of industry cost of equity, find that both the CAPM and the three-factor model perform better when estimated without an intercept in that they produced forecast errors with less dispersion. Therefore, we rely on a slightly different approach—the pricing errors. The pricing error of a model is the realized currency excess returns minus the estimated currency excess returns (see, e.g., Harvey (1991)). Given that the residuals from the models are mean zero, omitting the intercept pushes the “alpha” into the residuals. Thus, the mean pricing error is the alpha.

The mean pricing errors for the full-sample model are reported in column 6 of Table 4. We also report the realized mean currency excess returns from Table 1 to allow for easy comparison. The estimated currency excess returns in column 4 are economically large relative to the realized currency excess returns in column 5. This indicates that, overall, the model does a good job explaining the realized currency excess returns. More important, the mean pricing error (alpha) is statistically insignificant for

all currencies. (Similar statistically insignificant pricing errors for the other models are not reported but are available on request.)¹² The statistically insignificant pricing errors indicate that the model is well specified. That is, there appears to be no misspecification to compromise the inferences drawn from the above results.

6. Explaining the Cross-Sectional Variation in Sensitivity to Information Risk

We argue above that innovations in currency order flow represent market-wide private information and that U.S. investors may require a (positive or negative) risk premium for being exposed to the risk attendant with this private information. This risk arises from the asymmetry in information between U.S. investors and resident investors of the foreign market in which the currency deposit is made. That is, although it is not a foregone conclusion, U.S. investors are likely to know less about the economic, institutional, political, and other forces influencing the currency deposit market than local residents and, thus, require an information risk premium. In this section, we hypothesize that the cross-sectional variation in the sensitivity of the currency excess returns to information risk (the information risk beta) and, hence, the magnitude and sign of the information risk premium is a function of the information environment of the particular country (or more specifically, of the particular currency).

The information environment, in turn, will be determined, *inter alia*, by the contracting and regulatory environments and the services of information intermediaries. Healy and Palepu (2001) note that several economic and institutional features, such as the ability to write and enforce optimal contracts, economic costs of full disclosure, regulatory imperfections, and incentive problems for intermediaries that provide information, will determine if asymmetric information will be eliminated.

We propose that the variables that affect the information environment can be classified under two broad sub-headings—legal institutions and political stability.

¹² Some pricing errors are economically large possibly because there is a withholding tax on interest earned by foreign investors from bond and money market instruments. For example, the IFC/S&P Global Stock Market Fact Book reports that countries such as the Czech Republic, Mexico, Poland, and Slovakia imposed such taxes (of up to 40% in Poland in 1998) during our sample period. Asset pricing models typically cannot account for this effect.

Legal institutions. Legal institutions may affect the information environment and consequently the information risk that investors bear. First, insider trading rules and their enforcement affect adverse selection risk in trading securities. In the case of currency deposits, foreigners would bear greater adverse selection risk if weak legal systems allowed domestic investors prior access to information pertinent to the determination of exchange rates and interest rates. Conversely, if, as previously discussed, U.S. investors were more informed about exchange rate and interest rate changes in foreign countries, then they would be less sensitive to adverse selection risk, which would be reflected in lower exposure to world information risk.

Second, corruption inflates the costs of contracting and monitoring, thus increasing asymmetric information. Further, Mauro (1995) finds that corruption reduces investment and economic growth. Given that the latter are determinants of exchange rate changes, it is likely that corruption will induce a risk premium in currency deposits because the return on the deposit is a function of future spot rate.

Finally, if a country has generally poor disclosure laws and government agencies (and corporations) selectively reveal value-relevant information, this leads to greater information risk for outsiders (Healy and Palepu (2001)). Accounting systems and disclosure rules flourish in a climate of openness, and so can be regarded as a proxy for government openness and fair disclosure.

Political risk. Political risk also affects the information environment and, hence, the information risk premium in securities' returns. For instance, foreigners investing in countries with less stable governments and underdeveloped political institutions face higher information risk. This is because, in countries with central banks influenced and/or controlled by the political directorate it is difficult for foreigners to adequately assess the likely direction of monetary policy because such policies may be influenced more by the shifting political fortunes of the governing party and the imminence of elections rather than by sound economic policies. Hence, "outsiders" who are not in the know about the local political situation will face significant information risk as a result of the weak political system.

Additionally, several previous researchers note that the returns on foreign currency deposits are sensitive to political risk (see, e.g., Aliber (1973) and Dooley and Isard (1980)). The fear of this risk is

likely to increase for currencies from countries with less open governments and less transparent sovereign debt markets. No doubt, this is why the International Monetary Fund (IMF) has urged countries dependent on private international capital flows to proactively establish and maintain a strong communication link between the country's authorities and its debtholders, which the IMF argues would “contribute to the stability of international financial flows and help prevent crises.” It is unlikely that political risk is the underlying factor of our information risk proxy. This is because the information factor is derived from currency order flow, which has been shown theoretically and empirically to be related to private information (Evans and Lyons (2002a,b), Francis et al. (2006), and others). Furthermore, the size and sign of the estimated information risk premiums (compared to the measure of political stability reported below) make it highly unlikely that they could be political risk premiums for many of these countries.

Six variables are used to proxy for the foreign countries’ legal institutions and their political stability. These are Voice and Accountability, Political Stability, Government Effectiveness, Regulatory Quality, Rule of Law, and Control of Corruption. These data, which are obtained from the World Bank, have recently become commonplace in the finance literature. While by no means this represents an exhaustive list, we believe that there is enough variability in these variables to adequately capture the cross-sectional variation in the information risk premium.

[Table 6 about here]

Information betas and country characteristics are shown in Panel A of Table 6, with the correlations between these variables shown in Panel B. The country characteristics are available for 1996, 1998, 2000, and 2002. The first two are averaged for the pre-euro mean value, the last two for the post-euro mean value, and the four for the entire sample. The quality of each measure increases with the mean; for example, Switzerland (1.64) is more politically stable than Argentina (0.18). As expected, on average, a lower quality information environment characterizes the countries belonging to the emerging markets and the transition economies. Interestingly, we find that of the 28 countries 14 have a negative beta. This indicates that U.S investors rather than being at an informational disadvantage are at an

informational advantage for these countries. The correlations shown in panel B indicate that these variables are all highly correlated with each other, which we take into consideration in our regressions.

[Table 7 about here]

Table 7 reports cross-sectional regressions of the estimated information betas on the proxies for the information environment. Given that the variables are generally highly correlated we enter the variables individually in the regressions and report these results in columns 1 to 6 of Panels A, B, and C. Column 7 reports results for a multivariate model. The results indicate that, in general, the proxies for the information environment do a good job explaining the cross-sectional variation in the information risk betas and, hence, the information risk premiums. Put differently, these results state that our proxy for world information risk is adequate in that it is highly related to country characteristics that define the currency's information environment. This is shown by the relatively large adjusted R^2 s of the majority of the 18 regressions of the information betas on the individual proxies for the information environment. For example, of the 18 regressions, 14 have adjusted R^2 s greater than 10%, and 7 of the 14 are greater than 20% with a maximum of 58.65%. This is remarkable given that there is only one explanatory variable in each equation. A closer inspection of the results are consistent with our a priori expectations in that for each equation the coefficient on each explanatory variable is negative, and is statistically significant in 10 of the 18 equations. This finding supports our earlier conjecture that the higher the quality of the information environment, the less is the amount of private information and, therefore, the less is the information risk premium. The results from the individual variables are complemented by the multivariate regressions in column 7, where the χ^2 statistics indicate that the variables are collectively significant at less than the 0.01 level and produce adjusted R^2 s of 16 to 60%. Finally, these results are consistent with the results in Table 5, where we observed that the compensation demanded for exposure to information risk declined with the introduction of the euro. That is, the number of regressions in which the slope coefficient is significant declines from five to three after the introduction of the euro. Further, in every regression the coefficient estimate has declined in absolute terms and, except for the equation with voice and accountability as the independent variable, the adjusted R^2 s have also declined.

7. Conclusions and Future Research

Several recent papers consider the implications of the interaction between informed and uninformed investors for asset pricing. O'Hara (2003) notes that given the proliferation of anomalies in the asset pricing literature there is an important role for information risk in asset pricing tests. However, so far, information asymmetry as a source of risk in asset pricing models is considered only in the domestic market and for equity securities. In this paper, we argue that information asymmetry plays a greater role in the international financial markets where presumably uninformed nonresident investors would be at the greatest informational disadvantage. We argue further that investors in the international financial markets demand a risk premium for exposure to information risk and that the magnitude of the risk premium is a function of the information environment of the particular market.

We test these propositions using the currency excess returns for 28 single currencies and the euro. Empirical tests of UIRP have found that, in general, UIRP does not hold. A leading explanation of this finding is the existence of a time-varying risk premium as compensation for the speculative position in the foreign currency. In general, models that have used a time-varying risk premium approach to address this issue have at best met with limited success, casting doubt on the existence of a risk premium. In this paper we hypothesize that one reason for the above results is that previous models have not properly accounted for the possible risks that investors in the currency deposit markets are exposed to. In particular, they have not allowed for a role for market-wide private information.

We specify a three-factor asset pricing model in which we include a proxy for market-wide information risk and a world currency risk, along with the world equity risk that has been used in previous work. We find that UIRP is violated in the sample of currencies for the 28 countries and the euro and that this is because U.S. investors require a significant time-varying risk premium for investing in the international currency deposit markets. Specifically, we find that: (i) currency excess returns have significant betas relative to each of the three risk factors; (ii) the three risk factors are jointly and individually priced in currency excess returns; (iii) private information risk premium is economically

large and statistically significant, and (iv) the total estimated risk premium from our model is not statistically significantly different from the realized currency excess returns for any of the currencies (i.e., model alpha is zero). The importance of the latter finding is that it enables us to state why UIRP does not hold—investors require a risk premium.

Consistent with our priors, we also find that subsequent to the introduction of the euro there is a decline in compensation required for information risk. This is important in that it shows that one of the benefits of the introduction of the euro is a decline in market-wide private information in global capital markets. Finally, we show that country characteristics that influence the information environment (e.g., regulatory quality, political stability, government effectiveness) significantly explain cross-sectional differences in exposure to information risk.

As a candidate for future research, examining the role of market-wide information risk in the world equity market returns is a viable exercise. In particular, it would be interesting to see if information risk is priced in a wide cross-section of equity markets and if differences in investor protection, legal systems, and other country characteristics that have been shown recently to be important in the determination of a number of corporate behaviors, are also important for explaining the differences in information risk across countries.

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Table 1**Summary Statistics of Currency Excess Returns**

In Panel A, CURFLO is weekly currency order flow ($\times 10^4$) represented as the sum of the net purchase of the Canadian dollar, British pound, Swiss franc, and Japanese yen. CURFLOG adds the German mark order flow to the above currencies in the pre-euro period and CURFLOE adds the order flow of the euro to the flows in CURFLO in the post-euro period. All order flows are denominated in U.S. dollars and include spot, forward, and futures contracts. XVWRET is the return on the MSCI world market portfolio in excess of the Eurodollar return. FXRRET is the log first difference of the Treasury BROAD trade-weighted index (inverted to U.S. dollars/foreign currency). DEFAULT is the difference in yields of Baa- and AAA-rated corporate bonds, AVGINTP is the average weekly deposit rate (%) of the countries in the full period, and USADEP is the average weekly Eurodollar return. Panel B reports weekly percentage returns in U.S. dollars, annualized by multiplying by 52, from currency deposits in the respective countries in excess of the one-week return on the Eurodollar deposit. Mean interest rate differential is represented as $\{[(1+i^S)/(1+i^F)] - 1\}$. There are 492 full-sample weekly observations over the period 01.11.95-08.11.04, 206 weekly observations in the pre-euro period 01.11.95-12.30.98 and 272 after the euro, 04.14.99-12.30.04. ***, **, and * represent significance at the 1%, 5%, and 10% levels.

Panel A Risk Factors and Instruments

	Mean	Std Dev	Min	Max	Autocorr (ρ_1)	Obs
CURFLO	-3.0855***	1.6867	-8.3312	2.2024	0.8879***	492
CURFLOG	-1.8817***	1.8990	-5.5449	4.4470	0.9330***	206
CURFLOE	-6.3842***	3.2948	-13.807	2.0162	0.9140***	272
XVWRET	0.0258	2.0603	-7.8390	8.1584	-0.0500	492
FXRRET	-0.0418*	0.5046	-1.9617	2.0162	0.2675***	492
DEFAULT	0.8240***	0.2368	0.5000	1.4600	0.9854***	492
AVGINTP	0.1225***	0.0377	0.0486	0.2161	0.9837***	492
USADEP	0.0008***	0.0004	0.0002	0.0013	0.9975***	492

Panel B Annualized currency excess returns and their components

Currency	Currency excess returns		Mean exchange rate change	Mean interest rate differential	Obs	Dates
	Mean	Std Dev				
Australia	1.0764	10.468	-0.6344	-1.1700***	492	01.11.95-08.11.04
Canada	0.7696	5.814	0.6448	0.0416***	492	"
Denmark	-0.0572	9.860	-0.1716	0.3692***	492	"
Hong Kong	-0.1976*	0.357	-0.0884	0.1092***	492	"
Japan	-4.3472	11.684	-1.1804	3.8376	492	"
New Zealand	2.9484	10.683	0.2548	-2.1268***	492	"
Norway	1.2168	10.062	-0.2392	-0.9516***	492	"
Singapore	-3.536*	5.687	-1.7472	1.9448	492	"
Sweden	0.5408	10.099	-0.1352	-0.1716***	492	"
Switzerland	-1.7784	10.739	0.1924	2.5428**	492	"
United Kingdom	2.9588	7.448	1.5496	-1.1284***	492	"
Czech Rep	4.8048	11.805	0.6864	-3.4216	492	"
Poland	7.1864**	10.119	-4.2016	-10.8470***	492	"
Slovakia	5.6992	11.208	-0.702	-5.7616*	492	"
Argentina	-3.2916	19.931	-11.804	-6.1256*	492	"
Mexico	7.4308*	11.831	-8.0288	-14.7004*	492	"
Belgium	-3.8376	9.502	-2.5272	1.7576**	206	01.11.95-12.30.98
France	-2.5532	9.152	-1.7316	1.2376***	206	"
Germany	-4.0352	9.550	-2.6156	1.8720**	206	"
Italy	1.4924	7.599	-0.8736	-2.0800**	206	"
Netherlands	-4.316	9.473	-2.7196	2.0436**	206	"
Portugal	-0.9048	8.852	-2.3088	-1.014***	206	"
Spain	-0.6708	8.544	-2.0124	-0.9776***	206	"
Indonesia	2.8132	42.500	-15.241	-11.7520***	272	04.14.99-08.11.04
Malaysia	-4.8776	11.996	-4.238	-0.2600***	272	"
Philippines	-1.5704	7.996	-8.7256	-5.2000***	272	"
Thailand	-4.108	14.075	-5.3716	-1.3416**	272	"
South Africa	4.7164	15.635	-5.9748	-8.1484*	272	"
Euro	1.326	10.442	0.9152	0.1456***	272	"

Table 2 Factor Loadings (Betas) of Currency Excess Returns

Panel A reports the estimated betas (p -values) of the currency excess returns relative to the three risk factors. Weekly returns are in U.S. dollar (%) from currency deposits in the respective countries in excess of the one-week return on the Eurodollar deposit. The information risk factor is represented by the unanticipated component of CURFLO—currency order flow ($\times 10^{-4}$), which is the sum of the net purchase of the Canadian dollar, pound, Swiss franc, and yen. All order flows are denominated in U.S. dollars and include spot, forward, and futures contracts. The world market factor (XVWRET) is the return on the MSCI world market portfolio in excess of the Eurodollar return. The currency factor (FXRRET) is the log first difference ($\times 100$) of the Treasury BROAD trade-weighted index (inverted to U.S. dollars/foreign currency). In Panel B the degrees of freedom is 16 for all hypothesis tests. There are 488 full-sample weekly observations over the period 01.11.95-08.11.04, after taking 4 lags in the estimation.

Panel A Betas of Currency excess returns

Currency	Market risk	Currency risk	Information risk
	0.1084	0.3934	-0.5020
Australia	(0.002)	(0.000)	(0.000)
	0.0755	0.2107	-0.0920
Canada	(0.000)	(0.000)	(0.086)
	-0.1004	-0.0396	-0.2605
Denmark	(0.000)	(0.642)	(0.000)
	-0.0018	0.0016	-0.0507
Hong Kong	(0.099)	(0.781)	(0.000)
	0.0242	0.4572	-1.0561
Japan	(0.500)	(0.000)	(0.000)
	0.0967	0.4294	-0.7141
New Zealand	(0.005)	(0.000)	(0.000)
	-0.0290	0.0003	0.0370
Norway	(0.383)	(0.997)	(0.632)
	0.0014	0.2584	-0.5440
Singapore	(0.934)	(0.000)	(0.000)
	0.0332	-0.0284	-0.0589
Sweden	(0.289)	(0.739)	(0.430)
	-0.1689	0.0943	-0.5210
Switzerland	(0.000)	(0.325)	(0.000)
	-0.0469	0.0638	-0.3124
United Kingdom	(0.022)	(0.363)	(0.000)
	-0.0941	-0.5640	0.5985
Czech Rep	(0.009)	(0.000)	(0.000)
	0.0574	-0.4758	0.9328
Poland	(0.107)	(0.000)	(0.000)
	-0.0454	-0.1090	0.0816
Slovakia	(0.163)	(0.295)	(0.465)
	0.1701	0.2975	-0.8405
Argentina	(0.026)	(0.023)	(0.000)
	0.1527	-0.3538	1.0895
Mexico	(0.000)	(0.000)	(0.000)

Panel B Hypotheses Tests

H ₀ : Market betas are jointly zero [χ^2 (p -value)]	119.061 (0.000)
H ₀ : Currency betas are jointly zero [χ^2 (p -value)]	118.221 (0.000)
H ₀ : information betas are jointly zero [χ^2 (p -value)]	835.370 (0.000)

Table 3 **Estimates of Factor Prices of Risk**

Panel A reports summary statistics of the estimated time-varying prices of risk. The private information risk is represented by the unanticipated component of currency order flow (CURFLO $\times 10^{-4}$)—the sum of the net purchase of the Canadian dollar, pound, Swiss franc, and yen. All order flows are denominated in U.S. dollars and include spot, forward, and futures contracts. The market factor (XVWRET) is the return on the MSCI world market portfolio in excess of the Eurodollar return. The currency factor (FXRRET) is the percentage change in the Treasury BROAD trade-weighted index (inverted to U.S. dollar/foreign currency). Panel B reports various hypotheses tests about the risk prices. There are 488 full-sample *weekly* observations over the period 01.11.95-08.11.04, after using 4 lags in the estimation. ***, **, and * represent significance at the 1%, 5%, and 10% levels.

Panel A Summary Statistics of Risk Prices

	Mean	Std Dev	Min	Max
Market	0.0170***	0.0734	0.0000	0.7551
Currency	-0.0666***	0.4685	-1.5753	1.0825
Information	0.0289***	0.1915	-0.4631	0.5341

Panel B Hypotheses Tests

H ₀ : Market price of risk is zero [χ^2 (<i>p</i> -value)]	9.692 (0.046)
H ₀ : Market price of risk is constant [χ^2 (<i>p</i> -value)]	3.936 (0.269)
H ₀ : Currency price of risk is zero [χ^2 (<i>p</i> -value)]	45.075 (0.000)
H ₀ : Currency price of risk is constant [χ^2 (<i>p</i> -value)]	44.397 (0.000)
H ₀ : Information price of risk is zero [χ^2 (<i>p</i> -value)]	31.563 (0.000)
H ₀ : Information price of risk is constant [χ^2 (<i>p</i> -value)]	29.482 (0.000)
H ₀ : All prices of risks are zero [χ^2 (<i>p</i> -value)]	85.854 (0.000)
H ₀ : All prices of risks are constant [χ^2 (<i>p</i> -value)]	63.077 (0.000)

Table 4 Full-Sample Estimates of Currency Excess Returns and Factor Risk Premiums

The table reports the estimated currency excess returns and the component risk premiums attributed to the three risk factors. All returns and risk premiums are in percent, in U.S. dollar terms, and are annualized by multiplying the weekly returns and premiums by 52. Weekly currency excess returns are the returns on currency deposits in the respective countries in excess of the one-week return on the Eurodollar deposit. The information risk factor is represented by the unanticipated component of CURFLO, currency order flow ($\times 10^4$), which is the sum of the net purchase of the Canadian dollar, pound, Swiss franc, and yen. All order flows are denominated in U.S. dollars and include spot, forward, and futures contracts. The market factor (XVWRET) is the return on the MSCI world market portfolio in excess of the Eurodollar return. The currency factor (FXRRET) is the log first difference of the Treasury BROAD trade-weighted index (inverted to U.S. dollar/foreign currency). The pricing error is defined as: realized currency excess returns (col. 5) minus estimated currency excess returns (col. 4). The realized excess return is the same as that in Table 1, repeated here for convenience. There are 488 full-sample weekly observations over the period 01.11.95-08.11.04, after using 4 lags in estimation. ***, **, and * represent significance at the 1%, 5%, and 10% levels.

Currency	Market risk premium	Currency risk premium	Information risk premium	Estimated currency excess returns	Realized currency excess returns	Pricing error
Australia	0.0936***	-1.3624***	-0.7540***	-2.0228***	1.0764	3.0992
Canada	0.0676***	-0.7280***	-0.1404***	-0.8008***	0.7696	1.5704
Denmark-	-0.0884***	0.1352***	-0.3900***	0.3432***	-0.0572	0.2860
Hong Kong	0.0016***	-0.0052***	-0.0780***	-0.0832***	-0.1976*	-0.1144
Japan	0.0208***	-1.5860***	-1.5912***	-3.1512***	-4.3472	-1.1908
New Zealand	0.0520***	-1.4872***	-1.0764***	-2.4752***	2.9484	5.4288
Norway	-0.0260***	0.0012***	0.0572***	0.0312*	1.2168	1.1856
Singapore	0.0012***	-0.8944***	-0.8164***	-1.7108***	-3.536*	-1.8200
Sweden	0.0312***	0.0988***	-0.0884***	0.0416	0.5408	0.5044
Switzerland	-0.1508***	-0.3276***	-0.7852***	-1.2584***	-1.7784	-0.5200
United Kingdom	-0.0416***	-0.2236***	-0.4680***	-0.7332***	2.9588	3.6920
Czech Rep	-0.0832***	1.9552***	0.8996***	2.7716***	4.8048	2.0332
Poland	0.0520***	1.6484***	1.4040***	3.1044***	7.1864**	4.0820
Slovakia	-0.0416***	0.3796***	0.1248***	0.4628***	5.6992	5.2364
Argentina	0.1508***	-1.0296***	-1.2636***	-2.1476***	-3.2916	-1.1440
Mexico	0.1352***	1.2272***	1.6380***	3.0004***	7.4308*	4.4304

Table 5 Sub-Period Estimates of Currency Excess Returns and Factor Risk Premiums

The table reports the estimated currency excess returns and the component risk premiums attributed to the three risk factors. The information risk factor is represented by the unanticipated component of CURFLOG, currency order flow ($\times 10^{-4}$), which is the sum of the net purchase of the Canadian dollar, pound, Swiss franc, yen, and German mark in the pre-euro period (01.11.95 – 12.30.98, 202 weekly observations after using 4 lags in the estimation) and the unanticipated component of CURFLOE, the sum of the net purchase of the Canadian dollar, pound, Swiss franc, yen, and the euro in the post-euro period (04.14.99-12.30.04, 268 weekly observations after using 4 lags in the estimation). All order flows are denominated in U.S. dollars and include spot, forward, and futures contracts. The market factor (XVWRET) is the return on the MSCI world market portfolio in excess of the Eurodollar return. The currency factor (FXRRET) is 100 times the log first difference of the Treasury BROAD trade-weighted index (inverted to U.S. dollar/foreign currency). All returns and risk premiums are in %, in U.S. dollar terms, and are annualized by multiplying the weekly currency returns and premiums by 52. Weekly currency excess returns are the returns on currency deposits in the respective countries in excess of the one-week return on the Eurodollar deposit. ***, **, and * represent significance at the 1%, 5%, and 10% levels.

	Pre-euro sub-period				Post-euro sub-period			
	Equity premium	Currency premium	Information premium	Est. excess returns	Equity premium	Currency premium	Information premium	Est. excess returns
Austr	-0.0049***	-3.6307***	-0.7880***	-4.4235***	0.2267***	-2.9887***	-0.7114***	-3.4734***
Can	0.0487***	-2.7996***	-1.1223***	-3.8732***	0.1182***	-0.1747***	-0.7655***	-0.8220***
Den	-0.2073***	-2.0350***	2.4453***	0.2030	-0.1242***	-1.2756***	-1.4661***	-2.8659***
H. K.	-0.0053***	0.1525***	0.0782***	0.2253***	-0.0010***	-0.0693***	-0.0837***	-0.1540***
Jpn	-0.0357***	-8.0723***	1.6887***	-6.4193***	0.0301***	-0.0696***	-0.1087***	-0.1482***
N. Z.	0.0007***	-3.9138***	1.1948***	-2.7183***	0.1992***	-3.0933***	-1.5918***	-4.4859***
Nor	-0.0790***	-1.3599***	-0.9574***	-2.3963***	-0.0181***	-0.2561***	-1.6302***	-1.9043***
Sing	-0.0663***	-3.0290***	-1.8715***	-4.9668***	0.0350***	-1.2626***	0.2585***	-0.9691***
Swd	-0.0916***	-3.2530***	2.6738***	-0.6709*	0.1112***	1.0135***	-2.9978***	-1.8731***
Swz	-0.3182***	-3.8660***	3.4595***	-0.7247	-0.1957***	-1.5521***	-1.2297***	-2.9774***
U. K.	-0.0887***	0.0505***	3.6484***	3.6101***	-0.0621***	-3.2503***	0.4315***	-2.8809***
Czh	-0.1920***	3.4718***	4.1982***	7.4780***	-0.1253***	-2.1282***	0.6442***	-1.6093***
Pol	-0.0485***	-3.3929***	10.3438***	6.9024***	0.0909***	1.6377***	-0.1808***	1.5478***
Slo	-0.0698***	-5.3624***	9.2843***	3.8521***	-0.0683***	-0.8030***	-1.1196***	-1.9908***
Arg	0.0004***	-0.0700***	1.5340***	1.4644***	0.3871***	-1.0633***	-0.1629***	-0.8391***
Mex	0.2375***	-6.8023***	12.0889***	5.5240***	0.1093***	3.7507***	0.0389***	3.8989***
Bel	-0.2119***	-2.2397***	1.2584***	-1.1932***	-----	-----	-----	-----
Fra	-0.2187***	-1.1570***	1.6209***	0.2451	-----	-----	-----	-----
Ger	-0.2111***	-1.7299***	0.5138***	-1.4272***	-----	-----	-----	-----
Ita	-0.1479***	-1.0887***	4.0387***	2.8020***	-----	-----	-----	-----
Net	-0.2005***	-1.7999***	0.1796***	-1.8208***	-----	-----	-----	-----
Por	-0.2034***	-1.8304***	3.5323***	1.4985***	-----	-----	-----	-----
Spn	-0.1954***	-2.1380***	3.8292***	1.4958***	-----	-----	-----	-----
Indo	-----	-----	-----	-----	0.2042***	-3.4782***	4.8001***	1.5261***
Mal	-----	-----	-----	-----	0.0024***	-0.0111***	-0.5573***	-0.5660***
Phil	-----	-----	-----	-----	0.0493***	-0.3273***	-0.4295***	-0.7076***
Thai	-----	-----	-----	-----	0.0971***	-2.8565***	0.9398***	-1.8196***
S. A.	-----	-----	-----	-----	0.1826***	1.2755***	-4.5943***	-3.1362***
Euro	-----	-----	-----	-----	-0.1206***	-1.3640***	-1.6254***	-3.1099***

Table 6 Proxies for Information Environment

Panel A reports the mean of Voice and Accountability (VocAccn), Political Stability (PolStab), Govt Effectiveness (GovtEff), Regulatory Quality (RegQual), Rule of Law (RuleLaw), and Control of Corruption (ContCor), respectively, for our sample of currencies. The first 16 rows report the mean of the above variables for each country over the full sample, while the next seven rows report the variables for the pre-euro period and the last five for the post-euro period. In the latter two cases, to conserve space, we do not report the means for the first 16 countries. The variables are available for 1996, 1998, 2000, and 2002. The first two are averaged for the pre-euro average, the last two for the post-euro average, and the four for the entire sample. The quality of each measure increases with the mean; i.e., Switzerland (1.64) is more politically stable than Argentina (0.18). Information betas are repeated here for convenience. Panel B reports correlations between the variables.

Panel A Mean of Proxies for Information Environment

Full sample period Currency returns	Information Beta	Country Characteristics					
		VocAccn	PolStab	GovtEff	RegQual	RuleLaw	ContCor
Australia	-0.5020	1.56	1.20	1.77	1.39	1.91	1.97
Canada	-0.0920	1.36	1.11	1.89	1.32	1.89	2.21
Denmark	-0.2605	1.60	1.31	1.91	1.47	1.96	2.32
Hong Kong	-0.0507	0.04	0.86	1.45	1.66	1.58	1.51
Japan	-1.0561	1.01	1.15	1.10	0.76	1.62	1.26
New Zealand	-0.7141	1.51	1.34	1.82	1.59	2.01	2.31
Norway	0.0370	1.59	1.44	1.81	1.25	2.04	2.08
Singapore	-0.5440	0.21	1.37	2.34	1.94	2.03	2.34
Sweden	-0.0589	1.58	1.42	1.79	1.36	1.94	2.33
Switzerland	-0.5210	1.61	1.64	2.23	1.37	2.17	2.23
U. Kingdom	-0.3124	1.39	0.98	2.06	1.63	1.91	2.06
Czech Rep	0.5985	1.01	0.94	0.68	0.89	0.64	0.41
Poland	0.9328	1.05	0.73	0.58	0.61	0.57	0.43
Slovakia	0.0816	0.66	0.75	0.24	0.40	0.24	0.21
Argentina	-0.8405	0.37	0.18	0.14	0.28	-0.01	-0.36
Mexico	1.0895	0.01	-0.17	0.15	0.60	-0.27	-0.34
Pre-euro Sub-period							
Belgium	0.0749	1.37	0.89	1.30	1.08	1.43	1.14
France	0.0965	1.26	0.90	1.52	0.97	1.50	1.52
Germany	0.0306	1.42	1.30	1.66	1.24	1.85	1.92
Italy	0.2405	1.13	0.93	0.86	0.75	0.96	0.71
Netherlands	0.0107	1.56	1.48	2.20	1.51	1.93	2.24
Portugal	0.2103	1.32	1.31	1.18	1.21	1.29	1.35
Spain	0.2280	1.18	0.66	1.66	1.06	1.26	1.15
Post-euro Sub-period							
Indonesia	0.3693	-0.50	-1.61	-0.53	-0.55	-0.85	-1.12
Malaysia	-0.0429	-0.27	0.42	0.80	0.46	0.56	0.28
Philippines	-0.0331	0.28	-0.40	0.02	0.22	-0.50	-0.51
Thailand	0.0723	0.22	0.41	0.24	0.51	0.36	-0.25
South Africa	-0.3535	0.89	-0.10	0.45	0.37	0.24	0.43

Panel B Correlation between Variables

	VocAccn	PolStab	GovtEff	RegQual	RuleLaw
PolStab	0.700				
GovtEff	0.545	0.845			
RegQual	0.295	0.685	0.921		
RuleLaw	0.627	0.906	0.966	0.860	
ContCor	0.624	0.884	0.976	0.887	0.983

Table 7 Explanatory Power of Proxies for Information Environment

The table reports cross-sectional OLS tests of the significance of Voice and Accountability (VocAccn), Political Stability (PolStab), Govt Effectiveness (GovtEff), Regulatory Quality (RegQual), Rule of Law (RuleLaw), and Control of Corruption (ContCor) for the cross-sectional variation in the exposure to world information risk. The last column reports chi-squared statistic (p -value) of the test that the coefficients on all variables are jointly zero. Coefficients in bold are significant at least at the 10% level. The currency order flow used to estimate the information risk beta are the unanticipated component of CURFLOG - the sum of the net purchase of the Canadian dollar, British pound, German mark, Swiss franc, and Japanese yen in the pre-euro sub-period 01.11.95 - 12.30.98, the unanticipated component of CURFLOE - the sum of the net purchase of the Canadian dollar, British pound, Euro, Swiss franc, and Japanese yen in the post-euro sub-period, 04.14.99-12.30.04, and the unanticipated component of CURFLO - the sum of the net purchase of the Canadian dollar, pound, Swiss franc, and yen over the full sample. All order flows are denominated in U.S. dollars and include spot, forward, and futures contracts.

Panel A Full sample period

	VocAccn	PolStab	GovtEff	RegQual	RuleLaw	ContCor	All Variables
Constant	0.1118	0.4533	0.3469	0.3038	0.3872	0.2542	$\chi^2(6)$
(t -stat)	(0.316)	(0.981)	(0.858)	(0.588)	(1.015)	(0.705)	
Variable	-0.2415	-0.5821	-0.3538	-0.3818	-0.3783	-0.2732	34.600
(t -stat)	(-0.970)	(-1.582)	(-1.654)	(-1.114)	(-1.836)	(-1.538)	(0.000)
Adj R^2	-1.068	15.45	14.86	3.592	22.63	15.54	16.08
d.f.	14	14	14	14	14	14	9

Panel B Pre-euro sub-period

	VocAccn	PolStab	GovtEff	RegQual	RuleLaw	ContCor	All Variables
Constant	0.3484	0.4793	0.4846	0.5779	0.4941	0.4150	$\chi^2(6)$
(t -stat)	(2.191)	(5.106)	(4.894)	(4.921)	(5.382)	(4.448)	
Variable	-0.1674	-0.3150	-0.2275	-0.3730	-0.2318	-0.1749	68.113
(t -stat)	(-1.444)	(-4.091)	(-3.863)	(-4.227)	(-4.313)	(-3.415)	(0.000)
Adj R^2	12.87	38.24	49.54	44.85	58.65	47.92	58.87
d.f.	21	21	21	21	21	21	16

Panel C Post-euro sub-period

	VocAccn	PolStab	GovtEff	RegQual	RuleLaw	ContCor	All Variables
Constant	0.0518	0.0220	0.0237	0.0273	0.0167	0.0144	$\chi^2(6)$
(t -stat)	(1.049)	(0.395)	(0.378)	(0.372)	(0.771)	(0.307)	
Variable	-0.1084	-0.0815	-0.0575	-0.0681	-0.0536	-0.0513	46.587
(t -stat)	(-2.622)	(-1.681)	(-1.427)	(-1.199)	(-1.522)	(-1.916)	(0.000)
Adj R^2	28.54	19.77	9.44	7.94	11.14	16.23	45.51
d.f.	19	19	19	19	19	19	14