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Foreign Currency Returns and Systematic Risks

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Abstract

We apply an empirical approximation of the intertemporal capital asset pricing model (ICAPM) to show that cross-sectional dispersion in currency returns can be rationalized by differences in currency excess returns' sensitivities to the market return's cash-flow news component. This finding echoes recent explanations of the value and growth stock market anomaly. The distinction between cash-flow news and discount-rate news is key to jointly explain average stock and currency returns. Our analysis reveals the presence of a common source of systematic risk in stock and foreign currency returns that is reflected in the market return's cash-flow news component.

I. Introduction

Sensitivities of asset returns to the return on the market portfolio should explain their cross-sectional dispersion. This is one basic insight from the standard unconditional capital asset pricing model (CAPM) (Sharpe (1964), Lintner (1965)). The intertemporal version of the CAPM (Merton (1973)) additionally reveals that sensitivity to the market return's cash-flow news should be awarded with a higher compensation than sensitivity to the market return's discount-rate news. This theoretical result offers valuable guidance for evaluations of empirical

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asset pricing anomalies. For instance, Campbell and Vuolteenaho (2004) show that the value and growth stock market anomaly (significant differences in average returns on high vs. low book-to-market ratio stock portfolios) can be rationalized by differences in the sensitivity to the market's cash-flow news. Value stocks have greater sensitivities to the riskier cash-flow shocks than growth stocks, but their total market betas (i.e., the sum of cash-flow and discount-rate sensitivities) are of similar size.

This paper uses the vector autoregressive framework of Campbell (1991) and Campbell and Vuolteenaho (2004) to examine if the logic of the intertemporal capital asset pricing model (ICAPM) applies to asset classes other than equities. More specifically, we apply the Campbell and Vuolteenaho "bad" cash-flow and "good" discount-rate beta decomposition to excess returns, that is, ex post deviations from the uncovered interest rate parity (UIP) condition, on foreign currency portfolios and jointly on foreign currency and stock portfolio returns. Campbell (1993) shows that the ICAPM can be interpreted in terms of preferences and parameters of consumption-based asset pricing models. Our work thus complements Lustig and Verdelhan (2006), (2007), who assess the ability of consumption-based models to rationalize deviations from UIP. We contribute to a growing literature, both theoretical (e.g., Bansal and Shaliastovich (2013), Verdelhan (2010), and Farhi and Gabaix (2011)) and empirical (e.g., Lustig and Verdelhan (2007), Ranaldo and Söderlind (2010), Lustig, Roussanov, and Verdelhan (2011), and Menkhoff, Sarno, Schmeling, and Schrimpf (2012)), that exploits basic insights from asset pricing theory to show that violations of the UIP reflect risk premia. More importantly, we study the common sources of systematic risk across asset classes in a general, theoretically grounded asset pricing framework. Burnside (2012) argues that models that correctly identify the underlying risk factors should have joint explanatory power for currency and stock returns unless foreign exchange and equity markets are segmented. Asness, Moskowitz, and Pedersen (2013) show that value and momentum strategies for different asset classes, ranging from stock portfolios to commodity and currency markets, are closely related to each other. In this vein, Verdelhan (2012) finds that countries' systematic stock market risk is positively related to systematic bond and currency risk.

We find that over the sample period from Dec. 1983 to Dec. 2010, sensitivities to the market return's cash-flow news are significantly related to average excess returns on foreign currency portfolios and can jointly rationalize the cross section of both stock and foreign exchange returns. An ICAPM reinterpretation of Backus, Foresi, and Telmer (2001) and Lustig and Verdelhan (2006) suggests that high-interest-rate currencies depreciate when the home stock market receives bad cash-flow news associated with capital losses, whereas low-interest-rate currencies appreciate under the same conditions: High-interest-rate currencies are risky, while low-interest-rate currencies provide a hedge. Our results are robust to a variety of robustness checks. However, this success comes at a cost of implausibly high values of risk aversion implied by our risk price estimates. The variation in average returns is actually too large to be justified by cash-flow betas. Replacing aggregate consumption data with financial market information cannot solve the issue of extremely high risk aversion required by asset pricing models to fit foreign currency returns.

What hides behind these results? Our empirical model implicitly assumes that a persistent component of the stochastic discount factor is highly correlated across countries. Colacito and Croce (2011) show theoretically that a model based on persistent long-run consumption growth risk that disentangles risk aversion from elasticity of intertemporal substitution can explain exchange rate dynamics and national equity premiums at the same time. Likewise, our paper provides strong empirical support for common determination of national (from the perspective of a U.S. investor) stock and foreign currency returns by explicitly distinguishing between persistent (cash-flow related) and less persistent (discount-rate related) risks. This distinction is key for our findings. We show that this insight could not have been derived from the standard CAPM. The decomposition of the market return into its cash-flow and discount-rate news-driven components is crucial to uncover the link between stock returns, currency returns, and a common source of systematic risk.

At the same time, the ICAPM cannot tell a perfect risk story. Responsible for this shortcoming is the fact that our empirical model does not explicitly take into account a desire to smooth consumption intertemporally, in contrast to Colacito and Croce (2011). Only risk aversion affects risk premia in our setup, as the coefficient of intertemporal substitution is assumed to be around one (Campbell (1993)). A combination of persistent components of the stochastic discount factor with explicit modeling of the elasticity of intertemporal substitution seems to be the key to reasonable values of risk aversion in the Colacito and Croce framework. Our findings are nonetheless in line with evidence from consumption-based asset pricing models such as Lustig and Verdelhan (2007), who employ the setup of Yogo (2006) to examine the explanatory power of different versions of consumption-based CAPMs for average foreign currency portfolio returns. The model that performs best allows a distinction between risk aversion, intertemporal substitution, and intratemporal substitution between nondurable and durable consumption. However, this specification also relies on implausibly high values of the risk aversion parameter.

Both multifactor return-based models and models that allow for time variation in exposure to systematic risk can deliver a better description of asset returns. In particular, multifactor models outperform the ICAPM in explaining average stock (Campbell and Vuolteenaho (2004)) and currency returns (Lustig et al. (2011)). Moreover, Christiansen, Ranaldo, and Söderlind (2011) show that the market exposure of carry trades (returns on investment strategies going long in high-interest-rate and short in low-interest-rate currencies) is time varying and regime dependent. The regime dependency appears to be related to funding liquidity risk and volatility on foreign exchange markets. These important insights are not easily combined in a unified framework, though. In fact, multifactor models that work well for stock returns (e.g., the Fama and French (1993) model) typically perform poorly when confronted with currency portfolios (Lustig and Verdelhan (2007)). The ICAPM is appealing in this context, as it is firmly grounded in economic theory that applies to both asset classes. However, as emphasized above, the cost of this approach is that it is not the best way to rationalize average stock or foreign currency returns per se. Rather, the model highlights a common source of systematic risks in stock and foreign exchange markets that is reflected in the stock market's cash-flow news component.

The remainder of the paper is organized as follows: Section II briefly sketches the decomposition of stock returns into cash-flow and discount-rate shocks and introduces the ICAPM our empirical analysis is based on. Section III describes the data. Section IV presents our empirical results, and Section V concludes. Additional robustness checks of our empirical analysis are provided in the Online Appendix (available at https://sites.google.com/site/tnitschka/home/publications).

II. Cash-Flow News, Discount-Rate News, and Foreign Currency Returns

A. Stock Market Return Decomposition

Changes in asset prices must be associated with changes in expected future cash flows or discount rates (Campbell and Shiller (1988a)). Elaborating on this insight, Campbell (1991) extends the log-linear present-value approach to show that the unexpected stock return at any time can be decomposed into news about future cash flows (i.e., dividends or consumption) and news about future discount rates (i.e., expected returns):

$$r^M_{t+1} - \mathrm{E}_t r^M_{t+1} = (\mathrm{E}_{t+1} - \mathrm{E}_t)\left\{\sum_{s=0}^{\infty} \rho^s \Delta d^M_{t+1+s} - \sum_{s=1}^{\infty} \rho^s r^M_{t+1+s}\right\}, \tag{1}$$

where r^M is the market log return, d^M denotes log dividends, and E is the expectation operator. Furthermore, Δ denotes a 1-period backward difference, and ρ is a parameter strictly less than unity. The cash-flow news

$$N^M_{\mathrm{CF},t+1} \equiv (\mathrm{E}_{t+1} - \mathrm{E}_t)\sum_{s=0}^{\infty} \rho^s \Delta d^M_{t+1+s} \tag{2}$$

corresponds to revision in expectations about future dividend growth, and the discount-rate news

$$N^M_{\mathrm{DR},t+1} \equiv (\mathrm{E}_{t+1} - \mathrm{E}_t)\sum_{s=1}^{\infty} \rho^s r^M_{t+1+s} \tag{3}$$

corresponds to revision in expectations about future discount rates. While an increase in expected cash flows must be associated with a capital gain, a rise in discount rates leads to a capital loss. As argued by Campbell and Vuolteenaho (2004), returns caused by cash-flow news are never reversed, since the shock is permanent. In contrast, returns generated by discount-rate news retain their mean-reverting feature due to the transitory nature of a shock.

We assume that the data are generated by a first-order[1] vector autoregressive (VAR(1)) model,

$$\mathbf{z}_{t+1} = \mathbf{a} + \boldsymbol{\Gamma}\mathbf{z}_t + \mathbf{u}_{t+1}, \tag{4}$$

[1]As discussed by Campbell and Shiller (1988a), the assumption that the VAR is first-order is not restrictive, since this formulation also allows for higher-order VAR models by stacking lagged values into the state vector.

where $\mathbf{z}_{t+1}$ is an m-by-1 state vector with r^M_{t+1} as its first element, $\mathbf{a}$ and $\boldsymbol{\Gamma}$ are m-by-1 vector and m-by-m companion matrix of constant parameters, and $\mathbf{u}_{t+1}$ is an independent and identically distributed (iid) m-by-1 vector of shocks.

It follows immediately that the discount-rate news can be written as

$$N^M_{\mathrm{DR},t+1} = \mathbf{e1}'\lambda\mathbf{u}_{t+1}, \tag{5}$$

where $\lambda \equiv \rho\boldsymbol{\Gamma}\left(\mathbf{I} - \rho\boldsymbol{\Gamma}\right)^{-1}$ and $\mathbf{e1}$ denotes an m-by-1 vector whose first element is unity and the remaining elements are all 0.

The cash-flow news can be further backed out as a residual,

$$N^M_{\mathrm{CF},t+1} = \left(\mathbf{e1}' + \mathbf{e1}'\lambda\right)\mathbf{u}_{t+1}. \tag{6}$$

This decomposition might be useful in several ways. First, it allows us to study the relative importance of permanent and transitory news components of the stock market index. Second, it allows us to understand how currency portfolio returns react to stock market news arrival.

B. Asset Pricing Implications of ICAPM

In order to relate foreign currency returns to stock market news in a meaningful way, we impose basic insights from the ICAPM of Campbell (1993). A log-linear approximation of the intertemporal budget constraint

$$W_{t+1} = R^M_{t+1}(W_t - C_t) \tag{7}$$

around the mean ratio of consumption to aggregate wealth (including human capital) implies an asset pricing model that makes no reference to consumption. The log-linear approximation of equation (7) implies that surprises in consumption today are associated with revisions of expectations about wealth today, news about future returns on wealth, and/or revisions in expected future consumption growth:

$$c_{t+1} - \mathrm{E}_t(c_{t+1}) = (\mathrm{E}_{t+1} - \mathrm{E}_t)\sum_{j=0}^{\infty}\rho^j r^M_{t+j+1} - (\mathrm{E}_{t+1} - \mathrm{E}_t)\sum_{j=1}^{\infty}\rho^j \Delta c_{t+j+1}, \tag{8}$$

where c denotes log consumption and r^M the log return on wealth approximated by the optimal market portfolio.

Employing a functional form proposed by Epstein and Zin (1989), (1991) and Weil (1989),

$$U_t = \left\{(1-\delta)C_t^{(1-\gamma)/\theta} + \delta\left(\mathrm{E}_t\left[U_{t+1}^{1-\gamma}\right]\right)^{1/\theta}\right\}^{\theta/(1-\gamma)}, \tag{9}$$

where δ represents the investor's subjective discount factor, γ is the coefficient of relative risk aversion, and $\theta = (1-\gamma)/[1-(1/\phi)]$. Campbell (1993) derives an approximate solution of the utility maximization problem by substituting out consumption from a standard intertemporal asset pricing model. Under log-normality and homoskedasticity, the approximation is accurate if the elasticity of intertemporal substitution, ϕ, is close to 1, $\delta = \rho$, and the consumption-wealth ratio is constant. In this case, the risk premium on any asset i obeys

$$\text{(10)} \qquad \mathrm{E}_t(r^i_{t+1}) - r^f_{t+1} + \frac{\sigma^2_{i,t}}{2} = \gamma \mathrm{cov}_t\left(r^i_{t+1}, r^M_{t+1} - \mathrm{E}_t\left(r^M_{t+1}\right)\right) + (1-\gamma)\mathrm{cov}_t\left(r^i_{t+1}, -N^M_{\mathrm{DR},t+1}\right),$$

where r^f is the risk-free rate, σ^2_i denotes the variance, and N^M_{DR} is the same as above. Obviously, $\gamma = 1$ implies the static CAPM framework.

Exploiting the fact that $r^M_{t+1} - \mathrm{E}_t r^M_{t+1} = N^M_{\mathrm{CF},t+1} - N^M_{\mathrm{DR},t+1}$, Campbell and Vuolteenaho (2004) rewrite equation (10) to relate asset returns to cash-flow and discount-rate news:

$$\text{(11)} \qquad \mathrm{E}_t(r^i_{t+1}) - r^f_{t+1} + \frac{\sigma^2_{i,t}}{2} = \gamma\sigma^2_{M,t}\beta^i_{\mathrm{MCF},t} + \sigma^2_{M,t}\beta^i_{\mathrm{MDR},t},$$

where

$$\text{(12)} \qquad \beta^i_{\mathrm{MCF}} \equiv \frac{\mathrm{cov}\left(r^i_{t+1}, N^M_{\mathrm{CF},t+1}\right)}{\mathrm{var}\left(r^M_{t+1} - \mathrm{E}_t r^M_{t+1}\right)},$$

and

$$\text{(13)} \qquad \beta^i_{\mathrm{MDR}} \equiv \frac{\mathrm{cov}\left(r^i_{t+1}, -N^M_{\mathrm{DR},t+1}\right)}{\mathrm{var}\left(r^M_{t+1} - \mathrm{E}_t r^M_{t+1}\right)}.$$

Both betas add up to the traditional CAPM market beta,

$$\text{(14)} \qquad \beta^i_M = \beta^i_{\mathrm{MCF}} + \beta^i_{\mathrm{MDR}}.$$

Please note that this definition of sensitivities is different from regression coefficients that would normalize the covariance of the currency returns with the variance of the respective news components. Furthermore, the discount-rate beta is defined as sensitivity to "better-than-expected" news. Equation (11) states that sensitivity to cash-flow news should be rewarded with a risk price that is γ times greater than the risk price of discount-rate news. This theoretical insight offers valuable guidance for evaluations of empirical asset pricing anomalies.

It is an empirical question which of the two news components explains the cross-sectional differences in currency risk premia. Interestingly, Colacito and Croce (2011) show that news about long-run (i.e., persistent) consumption growth is an important determinant of exchange rate dynamics. Against this backdrop, we conjecture that the exposure to cash-flow rather than discount-rate shocks is reflected in the cross section of foreign currency returns.

C. The Underlying Mechanism

Empirical evidence suggests that the UIP condition fails to hold, with the exception of high-inflation countries (Hansen and Hodrick (1980), Fama (1984), and Bansal and Dahlquist (2000)). We interpret (ex post) deviations from UIP as currency excess returns, that is, $\mathrm{cr}_{t+1}^k = i_t^k - i_t - \Delta s_{t+1}^k$, where i_t^k denotes country k interest rate, i_t the home country equivalent, here the United States, and Δs_{t+1}^k the change in the log spot exchange rate of country k relative to the home currency measured in units of foreign currency per U.S. dollar. An increase in s^k means a dollar appreciation. Alternatively, one could define $\mathrm{cr}_{t+1}^k = f_t^k - s_{t+1}^k$, exploiting the fact that the covered interest rate parity, $f_t^k - s_t^k = i_t^k - i_t$, holds at daily or lower frequencies (Akram, Rime, and Sarno (2008)). To study the asset pricing implications of this relation, Lustig et al. (2011) build currency portfolios based on the currencies' forward discounts. They obtain a stable pattern: High-interest-rate currencies offer higher returns than low-interest-rate currencies. We apply an empirical approximation of the ICAPM to show that cross-sectional dispersion in these currency returns can be rationalized by their sensitivities to the market cash-flow news component.

This section exploits the fundamental insights from Backus et al. (2001) to uncover the underlying mechanism driving this result. Basic finance theory suggests that high-interest-rate currencies depreciate when the U.S. stock market receives bad cash-flow news associated with capital losses, whereas low-interest-rate currencies depreciate under the same conditions: Holding high-interest-rate currencies is risky for a U.S. investor, while investing in low-interest-rate currencies provides a hedge.

Following Backus et al. (2001), we consider a basic asset pricing equation for a U.S. investor:

$$(15) \qquad 1 = \mathrm{E}_t(M_{t+1}R_{t+1}),$$

where M_{t+1} is the dollar-denominated stochastic discount factor (SDF) and R_{t+1} the gross return on the dollar asset. An analogous equation holds, for instance, for pound-denominated assets:

$$(16) \qquad 1 = \mathrm{E}_t\left(M_{t+1}^k R_{t+1}^k\right),$$

where M_{t+1}^k denotes the pound SDF and R_{t+1}^k the gross return on the pound-denominated asset. Alternatively, we can convert the return on the pound asset into dollars and value it with the dollar discount factor. The dollar returns on the pound asset then obey $R_{t+1} = (S_{t+1}^k/S_t^k)R_{t+1}^k$, and

$$(17) \qquad 1 = \mathrm{E}_t\left(M_{t+1}\left(\frac{S_{t+1}^k}{S_t^k}\right)R_{t+1}^k\right),$$

where S^k is the pound-dollar exchange rate, and an increase in S^k corresponds to dollar appreciation as above.[2] From equations (16) and (17), it follows that both the pound- and the dollar-denominated discount factors could be used to explain exchange rate changes. This insight has strong asset pricing implications for foreign currency risk premia.

[2]Please note for comparison that Backus et al. (2001) and Lustig and Verdelhan (2006), (2007) use the direct quotation for exchange rates. In this paper, we work with portfolios constructed by Lustig et al. (2011) and follow their choice of the indirect quotation here and later in the text.

Under log-normality, the Euler equation can be restated in terms of the real currency risk premium (Lustig and Verdelhan (2007)). Abstracting from nominal risk by assuming that foreign inflation is orthogonal to the U.S. investor's SDF, the log currency risk premium can be stated as

$$\text{(18)} \qquad \mathrm{cr}_{t+1}^{k} \quad = \quad -\mathrm{cov}_t\left(m_{t+1}, -\Delta s_{t+1}^{k}\right),$$

where lowercase letters denote logs. Equation (18) highlights that interest rates play no role for the determination of conditional risk premia; only the covariance between the SDF and exchange rate changes matters. Lustig and Verdelhan (2006), (2007) examine the implications of this relation for a consumption-based SDF. They argue that high-interest-rate currencies tend to depreciate when domestic consumption growth is low, and this explains their high average returns compared to low-interest-rate currencies.

To reinterpret these findings in an ICAPM environment,[3] we combine an SDF that is linear in the total market portfolio $m_{t+1} \simeq \kappa - b_M r_{t+1}^{M}$ with $r_{t+1}^{M} = \mathrm{E}_t r_{t+1}^{M} + N_{\mathrm{CF},t+1}^{M} - N_{\mathrm{DR},t+1}^{M}$. Treating the expectation term as a constant leads to an expression for the conditional log currency risk premium,

$$\text{(19)} \qquad \mathrm{cr}_{t+1}^{k} \quad \simeq \quad b_M \mathrm{cov}_t\left(N_{\mathrm{CF},t+1}^{M}, -\Delta s_{t+1}^{k}\right) + b_M \mathrm{cov}_t\left(-N_{\mathrm{DR},t+1}^{M}, -\Delta s_{t+1}^{k}\right),$$

where $N_{\mathrm{CF},t+1}^{M}$ and $N_{\mathrm{DR},t+1}^{M}$ are as previously defined. Equation (19) reveals the key mechanism underlying the empirical failure of the UIP: High-interest-rate currencies depreciate when i) the U.S. stock market receives bad cash-flow news associated with capital losses or ii) the U.S. stock market receives unfavorable discount-rate news associated with increases in discount rates, or both. So, U.S. investors require a premium for holding risky high-interest-rate currencies. Conversely, low-interest-rate currencies appreciate when $N_{\mathrm{CF},t+1}^{M}$ is low (negative) and/or $N_{\mathrm{DR},t+1}^{M}$ is high (positive). These currencies thus provide a hedge for U.S. investors.

Under complete markets, log exchange rate changes can be further expressed as

$$\text{(20)} \qquad -\Delta s_{t+1}^{k} \quad = \quad m_{t+1}^{k} - m_{t+1}.$$

Assuming for simplicity $m_{t+1}^{k} \simeq \kappa - b_M r_{t+1}^{M,k}$, where $r_{t+1}^{M,k} = \mathrm{E}_t r_{t+1}^{M,k} + N_{\mathrm{CF},t+1}^{M,k} - N_{\mathrm{DR},t+1}^{M,k}$ and $\mathrm{E}_t r_{t+1}^{M,k} = \mathrm{E}_t r_{t+1}^{M}$, equation (20) can be conveniently reformulated as

$$\text{(21)} \qquad -\Delta s_{t+1}^{k} \quad = \quad b_M\left[\left(N_{\mathrm{CF},t+1}^{M} - N_{\mathrm{CF},t+1}^{M,k}\right) - \left(N_{\mathrm{DR},t+1}^{M} - N_{\mathrm{DR},t+1}^{M,k}\right)\right].$$

This expression implies that the relative cash-flow and discount-rate news components determine fluctuations in exchange rates. In particular, the foreign currency appreciates if unexpected capital losses abroad are more severe than those at home, ceteris paribus.

[3]For a more general representation of the SDF, please consult Lustig and Verdelhan (2007).

Lustig and Verdelhan (2006) show that the conditional log currency risk premium is equal to

$$\text{cr}_{t+1}^{k} \simeq \text{std}_t m_{t+1}\left[\text{std}_t m_{t+1} - \text{corr}_t\left(m_{t+1}, m_{t+1}^{k}\right)\text{std}_t m_{t+1}^{k}\right]. \tag{22}$$

In general, the right pattern in average currency returns obtains if the foreign SDF is more volatile and/or the correlation of home and foreign SDFs is high for low-interest-rate currencies, and the opposite for high-interest-rate currencies. To illustrate the intuition in the ICAPM environment, we abstract from variation in discount-rate news. If a foreign SDF is more volatile than the domestic SDF and they are strongly correlated, a bad cash-flow shock in the United States translates into an even worse cash-flow shock in the United Kingdom, and it comes to a pound appreciation according to equation (21). In this case, foreign currency offers a hedge against bad cash-flow news at home, and we expect low interest rates abroad according to equation (22). The reverse is true for high-interest-rate currencies.

Our empirical assessment maintains two further auxiliary assumptions. First, working with currency portfolios limits the role of locally priced risk (Verdelhan (2012)), as idiosyncratic risks are averaged out when portfolios are constructed. Second, Lustig et al. (2011) show that sensitivity to global risk explains the cross-sectional dispersion of currency portfolio returns. We consider the U.S. market return as a representative for the global market return: Taking the point of view of a U.S. investor is equivalent to taking the point of view of, for example, a U.K. investor. This assumption is in line with Fama and French (1998), who show that country market returns are basically linear functions of the world market return. In addition, Nitschka (2010) finds strong empirical support for this assumption. He shows that the cross-sectional dispersion in European value and growth stocks can be explained by differences in the exposure to national markets' cash-flow news. This finding indicates a strong correlation in common risk sources embodied in international cash-flow news.

III. Data

This section describes the state variables used in the estimation of the VAR and presents details on the Lustig et al. (2011) currency portfolios.

A. VAR State Variables

Bianchi (2011) points out that the Campbell-Shiller (1988a) decomposition and the "bad beta, good beta" analysis of Campbell and Vuolteenaho (2004) depend strongly on the use of the small stock value spread and the extraction of news series over a sample period that includes the stock market crash that preceded the Great Depression. The value spread inherits important information from the crisis in the early 1930s, such that the original VAR of Campbell and Vuolteenaho can also be described as a two-state Markov-switching process. One regime is closely related to the Great Depression, the other is not. The former regime receives a large weight when agents form their expectations according to the ICAPM. In addition, Chen and Zhao (2009) show that not only the sample period but also the choice of state variables have a large impact on the findings of Campbell and Vuolteenaho.

Against this backdrop, we define a baseline setup that follows Campbell and Vuolteenaho (2004) as closely as possible in specifying the VAR model. We construct the news series from two samples: one including the Great Depression, and one corresponding to the available currency return data. We study extensively the sensitivity of our conclusions to a variety of combinations of different state variables in the VAR following the criticism of Chen and Zhao (2009). Details of this and other robustness checks are presented in the Online Appendix.

The state variables for the baseline specification are defined as follows: First, the excess market return r^M is measured as the log excess return on the Center for Research in Security Prices (CRSP) value-weight index. Second, the term yield spread (TY) is measured as the difference between the 10-year constant maturity taxable bond yield in annualized percentage points and the yield on short-term taxable notes prior to Dec. 2001, and as the difference between the market yield on U.S. Treasury securities at 10-year constant maturity,[4] quoted on an investment basis from the Federal Reserve[5] and the annualized 3-month U.S. Treasury bill rate since 2002. Third, the market's smoothed price-earnings ratio (PE) is constructed as the log ratio of the Standard & Poor's (S&P) 500 price index[6] to a 10-year moving average of S&P 500 earnings. Finally, the fourth variable, the small-stock value spread (VS), is computed from the Kenneth R. French data library[7] as the difference between the log book-to-market ratios of small value and small growth stocks.

As a robustness check, we follow Chen and Zhao (2009) and consider a number of alternative state variables: 1-year price-earnings ratio, defined as the log ratio of the S&P 500 price index to a 1-year moving average of S&P 500 earnings; dividend yield, defined as the dividend-price ratio of the S&P 500; the book-to-market spread, defined as the log difference between book-to-market equity on value over growth portfolios; inflation, defined as the monthly rate of change in the consumer price index; and the stock variance, defined as the cross-sectional variance of the 25 book-to-market ratio and size-sorted Fama–French (1993) stock portfolios.

B. Currency Portfolio Returns

We use a monthly data set consisting of six foreign currency portfolio returns from a perspective of a U.S. investor constructed by Lustig et al. (2011).[8] The sample contains 37 countries, including both developed and emerging markets for which forward contracts are traded. At the end of month $t+1$, all currencies

[4]To check how closely our measure of yield spread is related to that of Campbell and Vuolteenaho (2004), we have calculated it also for the period prior to 2002. The correlation between both spread measures for the period 1928–2001 turned out to be highly significant.

[5]See http://www.federalreserve.gov/releases/h15/data.htm

[6]Online data are available at http://www.econ.yale.edu/~shiller/data.htm

[7]See http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

[8]Monthly foreign currency excess return data are available on Adrien Verdelhan's Web site at http://web.mit.edu/adrienv/www/Data.html

in the sample are allocated into six bins on the basis of their forward discounts observed at the end of period t, net of transaction costs. The portfolios are rebalanced at the end of every month, so that the first portfolio always contains currencies with the smallest forward discounts and the sixth portfolio always contains the largest forward-discount currencies. The currency excess return, cr_{t+1}^{i} for portfolio i, is computed as the average of the currency excess returns in portfolio i. The currency portfolio returns take into account transaction costs (i.e., bid and ask spreads). Lustig et al. (2011) provide further details on portfolio-building methodology. Table 1 presents annualized average returns (in percentages) as well as Sharpe ratios on the six forward-discount-rate-sorted currency portfolios over the time span[9] from Dec. 1983 to Dec. 2010. Portfolio F1 contains currencies with the lowest forward discounts. Portfolio F6 contains currencies with the highest forward discounts.

TABLE 1

Descriptive Statistics of Forward-Discount-Sorted Foreign Currency Portfolios

Table 1 gives the average returns, standard deviations, and Sharpe (1966) ratios of 6 forward-discount-sorted currency portfolio returns from Lustig et al. (2011) for the Dec. 1983–Dec. 2010 period. All moments are expressed in percent per annum. F1 is the portfolio consisting of the lowest-forward-discount currencies. Portfolio F6 consists of the highest-forward-discount currencies.

	Portfolios					
	F1	F2	F3	F4	F5	F6
Mean	−0.35	−0.61	0.18	2.59	2.71	4.60
Standard deviation	8.19	7.45	7.67	7.66	8.58	9.68
Sharpe ratio	−0.04	−0.08	0.02	0.34	0.32	0.47

The pattern in average currency excess returns and Sharpe ratios strongly resembles the results obtained by Lustig and Verdelhan (2007), who study risk premia across currency portfolios sorted on past interest rates. Average returns increase from low to high forward discounts and vary from −0.61% up to 4.60% per annum (p.a.).

IV. Empirical Results

This section first shows the estimates from a VAR model used to calculate the market return's cash-flow and discount-rate news components for different sample periods employing the state variables examined by Campbell and Vuolteenaho (2004). We then present the currency portfolios' sensitivities to these news components. Finally, we discuss the cross-sectional pricing results and a number of robustness checks.

A. VAR Dynamics

Panel A of Table 2 reports the benchmark characteristics of the VAR(1) model described previously for the sample period from Dec. 1928 to Dec. 2010.

[9]Please note that the respective sample period for the VAR(1) model needs to start in Nov. 1983 due to the lag structure.

TABLE 2

Benchmark VAR Characteristics

Table 2 gives the OLS parameter estimates for a VAR(1) model including a constant, the market return (r^M), price-earnings ratio (PE), small-stock value spread (VS), and term yield spread (TY). OLS t-statistics are in parentheses. Each row corresponds to a different dependent variable. The first five columns report coefficients on the explanatory variables listed in the column header; the last column shows the adjusted R^2 statistics. Panel A presents the results for the sample period Dec. 1928–Dec. 2010. The correlation between the implied cash-flow and discount-rate news is −0.02. Panel B presents the corresponding results for the sample period Nov. 1983–Dec. 2010. The correlation between the implied cash-flow and discount-rate news is 0.44.

	Constant	r_t^M	TY_t	PE_t	VS_t	R^2 (%)
Panel A. VAR Sample Period: Dec. 1928–Dec. 2010						
r_{t+1}^M	0.07	0.11	0.01	−0.02	−0.01	2.35
	(3.40)	(3.40)	(1.85)	(−3.11)	(−2.27)	
TY_{t+1}	0.01	0.04	0.89	−0.02	0.08	83.47
	(0.13)	(0.24)	(63.14)	(−0.91)	(2.89)	
PE_{t+1}	0.02	0.52	0.00	0.99	−0.00	99.07
	(1.88)	(24.51)	(0.97)	(299.26)	(−0.90)	
VS_{t+1}	0.02	−0.02	−0.00	−0.00	0.99	98.26
	(1.16)	(−0.61)	(−0.01)	(−0.33)	(206.10)	
Panel B. VAR Sample Period: Nov. 1983–Dec. 2010						
r_{t+1}^M	0.07	0.11	−0.00	−0.01	−0.02	1.08
	(1.96)	(2.01)	(−0.48)	(−0.97)	(−1.16)	
TY_{t+1}	0.04	−0.38	0.91	−0.08	0.20	84.86
	(0.23)	(−1.23)	(39.19)	(−1.63)	(1.90)	
PE_{t+1}	0.05	0.46	−0.00	0.99	−0.00	99.07
	(2.39)	(12.61)	(−1.21)	(164.03)	(−0.31)	
VS_{t+1}	0.09	−0.05	−0.01	0.01	0.93	86.95
	(2.41)	(−0.77)	(−1.37)	(0.58)	(43.61)	

Panel B gives the corresponding estimates for a shorter sample period running from Nov. 1983 to Dec. 2010. The VAR is estimated using ordinary least squares (OLS) and employing $\rho = 0.95^{1/12}$ for monthly data. The results do not alter qualitatively for other plausible linearization parameter values. Each row of Table 2 corresponds to a different dependent variable listed in the header of the row. OLS t-statistics are reported in parentheses below the coefficient estimates. The first five columns give coefficients on the explanatory variables listed in the column header; the last column gives the adjusted R^2 statistics.

The top row of Panel A of Table 2 gives the stock market return forecasting equation when lags of returns, price-earnings ratio, value spread, and term yield spread are applied as regressors. All four state variables exhibit some forecasting potential. In line with previous findings, the momentum property is strongly pronounced for monthly returns. The past small-stock value spread negatively forecasts the stock market with a t-statistic of -2.27. Intuitively, the coefficient on the term yield spread is positive and marginally significant. Finally, similar to Campbell and Shiller (1988b), Campbell and Vuolteenaho (2004), and Campbell, Giglio, and Polk (2013), a higher price-earnings ratio is associated with lower returns. The R^2 statistic for the return equation is 2.35% over the full sample.

The next rows summarize the forecasting power of the VAR system for the remaining state variables. Overall, R^2 statistics are relatively high, and the autoregressive coefficients of the price-earnings ratio, value spread, and term yield spread are all very close to unity. The shocks to cash flows are almost unrelated to shocks to expected returns with a correlation coefficient of -0.02.

Panel B of Table 2 shows that the forecasting power of the state variables for the stock market returns is declining with the number of observations. The autocorrelation of the market return captures most of the forecasting power of the VAR for this sample period, while the value spread, term yield spread, and price-earnings ratio exhibit no predictive power for the market return at conventional significance levels over this particular sample period. These estimates justify the criticism of Chen and Zhao (2009).

B. Cash-Flow and Discount-Rate Betas of Foreign Currencies

The first six columns of Table 3 display the cash-flow, discount-rate, and total market betas of six currency portfolio returns. The cash-flow and discount-rate betas add up to the total market return beta per definition. Sensitivities of currencies to underlying sources of permanent and transitory risks are determined as adjusted slope coefficients of portfolio returns on the respective market news components. Panel A delivers the betas for the news components based on the full sample VAR from Dec. 1928 to Dec. 2010. Panel B provides the corresponding betas based on a VAR estimated over Nov. 1983 to Dec. 2010, such that the respective news length corresponds to the available currency portfolio data sample. Newey–West (1987) corrected t-statistics are presented in parentheses below beta estimates.

The loadings of low-forward-discount-rate currencies on the market cash-flow news are negative, albeit not statistically distinguishable from 0. In contrast, high-forward-discount-rate currencies show a significant exposure to the

TABLE 3

Betas of Currency Portfolios

Table 3 gives the estimated cash-flow, discount-rate, and total market betas for 6 forward-discount-sorted currency portfolio returns over the period Dec. 1983–Dec. 2010. Panel A presents the betas based on a VAR system estimated over Dec. 1928–Dec. 2010 and reported in Panel A of Table 2. Panel B gives the corresponding betas based on a VAR system estimated over Nov. 1983–Dec. 2010 and reported in Panel B of Table 2. Heteroskedasticity- and autocorrelation-consistent t-statistics (Newey–West (1987)) are in parentheses below beta estimates. Column F6 − F1 reports the spread in the estimated betas between the portfolio with the highest forward discount rates and the portfolio with the lowest forward discount rates and the associated bootstrap t-statistic in parentheses. The last two columns present the bootstrap p-values from the monotonic relation (MR) test applied to estimated betas, based either on the minimum set of portfolio comparisons or on all possible comparisons (Patton and Timmermann (2010)).

	Portfolios								
	F1	F2	F3	F4	F5	F6	F6 − F1	MR^{min}	MR^{all}
Panel A. VAR Sample Period: Dec. 1928–Dec. 2010									
β^i_{MCF}	−0.01	−0.01	−0.01	0.00	0.02	0.03	0.05	0.00	0.00
	(−0.75)	(−0.73)	(−0.40)	(0.35)	(1.54)	(2.10)	(3.32)		
β^i_{MDR}	0.02	0.05	0.05	0.04	0.09	0.14	0.12	0.01	0.01
	(0.56)	(1.38)	(1.45)	(1.41)	(2.99)	(3.04)	(3.69)		
β^i_{M}	0.01	0.04	0.04	0.05	0.11	0.17	0.17	0.00	0.00
	(0.17)	(1.09)	(1.20)	(1.45)	(3.30)	(3.89)	(5.41)		
Panel B. VAR Sample Period: Nov. 1983–Dec. 2010									
β^i_{MCF}	−0.00	0.02	0.02	0.03	0.07	0.10	0.10	0.00	0.00
	(−0.02)	(0.85)	(0.91)	(1.62)	(3.26)	(4.32)	(6.02)		
β^i_{MDR}	0.01	0.02	0.02	0.02	0.05	0.07	0.06	0.02	0.02
	(0.61)	(1.28)	(1.24)	(1.24)	(2.95)	(2.80)	(3.28)		
β^i_{M}	0.01	0.04	0.04	0.05	0.12	0.18	0.16	0.00	0.00
	(0.32)	(1.16)	(1.22)	(1.57)	(3.54)	(4.02)	(5.30)		

permanent risk component in stock market fluctuations. Similarly, the discount-rate betas are low (high) for low (high) forward-discount-rate currencies. These features in risk exposure of foreign exchange markets to underlying risk forces are consequently mirrored in total market betas.

Spreads in the estimated betas between the portfolio with the highest forward discount rates and the portfolio with the lowest forward discount rates are throughout positive, as supported by a bootstrap *t*-test reported in parentheses in Column F6 − F1 of Table 3. Yet, comparing the top and bottom sorted currency portfolios is not sufficient to learn about monotonicity in the overall relation between currency returns and fundamental risk sources. In particular, a Student *t*-test does not relate simultaneously the cross-sectional pattern in returns to the pattern in risk characteristics of portfolios.

To address this issue, we apply a recently proposed nonparametric monotonic relation (MR) test of Patton and Timmermann (2010) to estimated betas. The last two columns of Table 3 present the bootstrap *p*-values from the MR test, based either on the minimum set of portfolio comparisons (5 in the case of 6 portfolios) or on all possible comparisons (15 in the case of 6 portfolios). The MR test specifies a flat or weakly declining pattern in betas under the null hypothesis, while under the alternative it maintains a monotonically increasing relation. Simulated returns are generated as bootstrap samples from the monthly portfolios returns. Following Patton and Timmermann, we use 1,000 bootstrap replications for a Student *t* and the MR tests. We choose the average block length to be 10 months (Politis and Romano (1994), Patton and Timmermann (2010)). The *p*-values in the last two columns of Table 3 support a uniformly increasing pattern in the cash-flow, discount-rate, and hence total market betas from low to high forward-discount-sorted currency portfolios. The null of identical or weakly decreasing betas is strongly rejected in favor of a monotonically increasing relation with *p*-values between 0.00 and 0.02. Thus, a systematic relation between an asset's expected return and its risk exposure, as suggested by the theoretical ICAPM, could be attributed to both news components. Please notice also that despite the fact that total market betas are low, the dispersion in cash-flow betas is of a similar order of magnitude as in the case of value and growth stocks (Campbell and Vuolteenaho (2004)).

A comparison between the betas in Panels A and B of Table 3 reveals two further insights. First, total market return betas do not vary substantially across the sample periods. They are of similar size and relatively low. Second, the relative importance of cash-flow and discount-rate news is time varying. Over the full VAR sample period presented in Panel A of Table 3, the market betas of currency portfolio returns are clearly dominated by the discount-rate components. In contrast, over the subsample period presented in Panel B of Table 3, the discount-rate news drives the betas of low-forward-discount-rate currencies, while the cash-flow news drives the betas of high-forward-discount-rate currencies.

The monotonic pattern in betas, as well as their economic magnitude, appears robust to minor changes in the VAR specification, different VAR sample periods, and alternative measures of cash-flow news. These results are not provided here but are available from the authors.

C. Cross-Sectional Pricing Results

This section presents our cross-sectional findings. The first subsection discusses the explanatory power of the two-beta CAPM for currency portfolio returns. The second subsection employs the 25 size and book-to-market sorted Fama–French (1993) stock portfolio returns as test assets. The third subsection contains the results on the cross-sectional fit of the two-beta CAPM for currency and stock portfolios jointly. The fourth subsection briefly summarizes the main results of robustness analysis. Further details on robustness checks (variation in the VAR state variables, direct estimation of the cash-flow news, and time variation in betas) are presented in the Online Appendix.

1. Foreign Currency Portfolios

We use the cash-flow and discount-rate betas presented in Table 3 to assess the explanatory power of the standard CAPM and the two-beta CAPM version when confronted with returns on foreign currencies. In doing so, we run cross-sectional regressions of the Lustig et al. (2011) average currency portfolio excess returns on the total market betas,

$$\text{(23)} \qquad \mathrm{E}\left(\mathrm{cr}^i\right) \quad = \quad \beta_M^i \lambda_M,$$

and the estimated cash-flow and discount-rate betas,

$$\text{(24)} \qquad \mathrm{E}\left(\mathrm{cr}^i\right) \quad = \quad \beta_{\mathrm{MCF}}^i \lambda_{\mathrm{MCF}} + \beta_{\mathrm{MDR}}^i \lambda_{\mathrm{MDR}},$$

where cr^i denotes excess return on currency portfolio i as defined in previous sections. We do not consider constant terms in the cross-sectional regressions as we deal with excess returns. Our asset pricing exercises over the Dec. 1983 to Dec. 2010 period are summarized in Table 4. Panel A of Table 4 provides the results for the news series obtained based on a full sample VAR covering the time period from Dec. 1928 to Dec. 2010. Panel B of Table 4 gives the corresponding

TABLE 4

Asset Pricing Tests with Currency Portfolios

Table 4 reports the Fama–MacBeth (1973) estimates of the risk prices using 6 forward-discount-sorted currency portfolios as test assets. Shanken (1992) corrected *t*-statistics are in parentheses. Estimates are for the Dec. 1983–Dec. 2010 period for forward-discount-sorted portfolios. The underlying news series for the risk premia in Panel A are based on a VAR system estimated over Dec. 1928–Dec. 2010 and reported in Panel A of Table 2. The underlying news series for the risk premia in Panel B are based on a VAR system estimated over Nov. 1983–Dec. 2010 and reported in Panel B of Table 2. Mean squared pricing error (MSE) and mean absolute pricing error (MAE) are in percentage points per annum.

λ_M	λ_{MCF}	λ_{MDR}	R^2 (%)	MSE	MAE
Panel A. VAR Sample Period: Dec. 1928–Dec. 2010					
25.55			75.39	0.90	0.77
(3.75)					
	74.49	15.70	81.15	0.55	0.52
	(1.70)	(1.48)			
Panel B. VAR Sample Period: Nov. 1983–Dec. 2010					
24.46			75.13	0.91	0.81
(3.73)					
	91.70	−65.91	87.01	0.38	0.44
	(2.26)	(−1.21)			

results for the news series obtained based on the currency returns sample period from Nov. 1983 to Dec. 2010.

The main results are easily summarized. At first glance, the standard CAPM does a surprisingly good job in fitting the foreign currency data. It explains about 75% of the cross-sectional dispersion in portfolio returns. However, its risk price is about five times higher than its sample mean. The two-beta version of the CAPM is a slightly better description of the average currency returns than the standard CAPM judged by the measures of fit. There is a significant improvement in terms of pricing errors, which are cut by almost 50%. Even though both cash-flow and discount-rate betas increase from low to high-forward-discount portfolios, it is the cash-flow beta that is associated with a risk premium on foreign exchange markets. This is true for both sample periods presented in Table 4. The good fit, however, comes at a cost of a high price of cash-flow risk of almost 75% p.a. for the full sample period and about 92% for the restricted sample period. Yet, estimates of this order of magnitude do not seem to deviate substantially from previous findings reported in the literature. For instance, Campbell and Vuolteenaho (2004) obtain a cash-flow premium of between 58% p.a. and 69% p.a. when pricing equity returns over the sample from July 1963 to Dec. 2001. The ICAPM predicts that the price of cash-flow risk should be $\gamma\sigma_M^2$ and the price of discount-rate risk should reflect σ_M^2, where σ_M^2 is the variance of the unexpected return on the market portfolio and γ denotes the coefficient of relative risk aversion. These risk price estimates imply a relative risk aversion coefficient of above 100, which is close to estimates obtained in consumption-based models (Lustig and Verdelhan (2007)) but by far too high compared with plausible values suggested by theory.

Is the two-beta CAPM then a good model to price currency returns? We show that the ICAPM reveals important shortcomings when faced with excess returns on foreign currencies. Multifactor models along the lines of Lustig et al. (2011) might be better suited for that purpose. However, the ICAPM can distinguish between persistent and less persistent risks, and this attractive feature is useful to jointly explain stock and currency returns as suggested by the theoretical work of Colacito and Croce (2011).

2. The 25 Fama–French Portfolios

Prior to assessing the performance of the two-beta CAPM for both foreign currency and stock portfolio returns simultaneously, we present the pricing results for 25 book-to-market and size-sorted stock portfolio excess returns. Table 5 summarizes our findings.

Three points stand out. First, the single-beta CAPM provides a poor description of average stock portfolio returns. The R^2 statistic is negative, and the pricing errors are very large. Second, we confirm the main finding of Campbell and Vuolteenaho (2004) when we use information over 1928 to 2010 to derive the news components. Panel A of Table 5 indicates that average excess returns on book-to-market and size-sorted portfolios mirror differences in their sensitivities to the market return's cash-flow news. Differences in sensitivities to the discount-rate news component play a negligible role. Third, the restriction of the time period used to back out the news components leaves the explanatory power

TABLE 5

Asset Pricing Tests with Stock Portfolios

Table 5 reports the Fama–MacBeth (1973) estimates of the risk prices using the 25 book-to-market and size-sorted Fama–French (1993) stock portfolios. Shanken (1992) corrected *t*-statistics are in parentheses. Estimates are for the Dec. 1983–Dec. 2010 period. The underlying news series for the risk premia in Panel A are based on a VAR system estimated over Dec. 1928–Dec. 2010 reported in Panel A of Table 2. The underlying news series for the risk premia in Panel B are based on a VAR system estimated over Nov. 1983–Dec. 2010 reported in Panel B of Table 2. Mean squared pricing error (MSE) and mean absolute pricing error (MAE) are in percentage points per annum.

λ_M	λ_{MCF}	λ_{MDR}	R^2 (%)	MSE	MAE
Panel A. VAR Sample Period: Dec. 1928–Dec. 2010					
8.21			−71.16	12.20	2.42
(8.10)					
	44.29	2.49	26.13	5.05	1.79
	(4.94)	(1.59)			
Panel B. VAR Sample Period: Nov. 1983–Dec. 2010					
8.05			−69.34	12.07	2.40
(8.15)					
	36.82	−24.62	20.94	5.40	1.84
	(4.80)	(−2.83)			

of sensitivities to cash-flow news largely unaffected. However, the discount-rate news seems to be also priced, albeit with a negative sign, as indicated by the estimates in Panel B. Chen and Zhao (2009) similarly report a negative and strongly significant estimate of the discount-rate news for a VAR based on excess equity market return, term yield spread, and value spread. The variation of the sample period or underlying state vector has the potential to alter considerably the conclusions drawn by Campbell and Vuolteenaho.

3. Foreign Currency and Stock Portfolios

Table 6 presents risk price estimates when both foreign currency portfolio returns and stock portfolio returns are considered jointly as test assets.

Our conclusions remain unchanged. Cash-flow sensitivities are related to the cross section of both foreign currency and stock portfolio returns. A general asset pricing model, such as the empirical implementation of the ICAPM considered in this paper, is a powerful tool to explain cross-sectional differences in returns across asset classes. In particular, the ICAPM substantially outperforms the static CAPM in explaining average stock and currency returns jointly. The R^2 statistic of the ICAPM is more than 60%, compared with roughly 25% for the standard CAPM. The pricing errors of the two-beta CAPM are about 50% lower than those of the standard CAPM. The distinction between cash-flow and discount-rate components is key to achieve this result. Our estimates suggest that there is a common source of systematic risk across stock and currency markets that is reflected in the market's cash flows. In this vein, Colacito and Croce (2011) propose a theoretical model that distinguishes between persistent long-run and temporary short-run components in consumption growth and explicitly takes into account the elasticity of intertemporal substitution to jointly explain the equity and foreign exchange markets.

Interestingly, the sample period seems to affect the relative importance of the cash-flow and discount-rate risks for pricing asset returns in Table 6. This finding

TABLE 6

Asset Pricing Tests with Stock and Currency Portfolios

Table 6 reports the Fama–MacBeth (1973) estimates of the risk prices using the 25 book-to-market and size-sorted Fama–French (1993) stock portfolios as well as the 6 forward-discount-sorted currency portfolio returns jointly as test assets. Shanken (1992) corrected *t*-statistics are in parentheses. Estimates are for the Dec. 1983–Dec. 2010 period. The underlying news series for the risk premia in Panel A are based on a VAR system estimated over Dec. 1928–Dec. 2010 reported in Panel A of Table 2. The underlying news series for the risk premia in Panel B are based on a VAR system estimated over Nov. 1983–Dec. 2010 reported in Panel B of Table 2. Mean squared pricing error (MSE) and mean absolute pricing error (MAE) are in percentage points per annum.

λ_M	λ_{MCF}	λ_{MDR}	R^2 (%)	MSE	MAE
Panel A. VAR Sample Period: Dec. 1928–Dec. 2010					
8.24			25.24	10.46	2.23
(8.82)					
	44.59	2.48	66.24	4.57	1.68
	(5.29)	(1.68)			
Panel B. VAR Sample Period: Nov. 1983–Dec. 2010					
8.08			26.06	10.35	2.21
(8.88)					
	37.29	−25.09	64.68	4.78	1.70
	(5.23)	(−3.10)			

reflects one of the criticisms raised by Chen and Zhao (2009). In addition, Christiansen et al. (2011) show that the stock market exposure of carry trade returns (going long in high-forward-discount and short in low-forward-discount currencies) is time varying and regime dependent. We address these points in a series of robustness checks that we briefly summarize in the next subsection.

4. Summary of Robustness Checks

Chen and Zhao (2009) show that the Campbell and Vuolteenaho (2004) framework depends heavily on the choice of state variables. To address this concern, we consider seven alternative combinations of various state variables. Moreover, we use two separate VAR systems to model both news series directly. In fact, the risk price of the directly modeled cash-flow news decreases substantially compared with the estimates provided in the previous subsections. Finally, we perform in- and out-of-sample Fama–MacBeth (1973) regressions with time-varying betas estimated using overlapping rolling windows.[10] Our main results remain unaffected. Please consult the Online Appendix for details.

V. Conclusions

Asset pricing models that identify the true underlying risk factors should price assets of different classes. We show that an empirical proxy of the ICAPM has joint explanatory power for both foreign currency and stock portfolios. The decomposition of the market return into its cash-flow and discount-rate news-driven components is key in this respect. Our paper highlights a common source of systematic risk in stock and currency returns that is reflected in the market return's cash-flow news.

[10]We thank Adrien Verdelhan for suggesting this course of analysis.

We contribute to two strands of literature. First, we show that an empirical approximation of the ICAPM rationalizes average excess returns on foreign currencies. This finding provides further support for the view that ex post deviations from the UIP condition reflect compensation for risk. Second, we show that systematic risk (proxied by cash-flow news on a stock market return) is related to risk premia on foreign currency and national stock markets. This finding extends a growing literature that highlights significant links between different asset classes.

References

Akram, F. Q.; D. Rime; and L. Sarno. "Arbitrage in the Foreign Exchange Market: Turning on the Microscope." *Journal of International Economics*, 76 (2008), 237–253.

Asness, C. S.; T. J. Moskowitz; and L. H. Pedersen. "Value and Momentum Everywhere." *Journal of Finance*, 68 (2013), 929–985.

Backus, D. K.; S. Foresi; and C. I. Telmer. "Affine Term Structure Models and the Forward Premium Anomaly." *Journal of Finance*, 56 (2001), 279–304.

Bansal, R., and M. Dahlquist. "The Forward Premium Puzzle: Different Tales from Developed and Emerging Markets." *Journal of International Economics*, 51 (2000), 115–144.

Bansal, R., and I. Shaliastovich. "A Long-Run Risks Explanation of Predictability Puzzles in Bond and Currency Markets." *Review of Financial Studies*, 26 (2013), 1–33.

Bianchi, F. "Rare Events, Agents' Expectations, and the Cross-Section of Asset Returns." Working Paper, Duke University (2011).

Burnside, C. "Carry Trades and Risk." In *Handbook of Exchange Rates*, J. James, I. W. Marsh, and L. Sarno, eds. Hoboken, NJ: John Wiley & Sons (2012).

Campbell, J. Y. "A Variance Decomposition for Stock Returns." *Economic Journal*, 101 (1991), 157–179.

Campbell, J. Y. "Intertemporal Asset Pricing Without Consumption Data." *American Economic Review*, 83 (1993), 487–512.

Campbell, J. Y.; S. Giglio; and C. Polk. "Hard Times." *Review of Asset Pricing Studies*, 3 (2013), 95–132.

Campbell, J. Y., and R. J. Shiller. "The Dividend-Price Ratio and Expectations of Future Dividends and Discount Factors." *Review of Financial Studies*, 1 (1988a), 195–228.

Campbell, J. Y., and R. J. Shiller. "Stock Prices, Earnings, and Expected Dividends." *Journal of Finance*, 43 (1988b), 661–676.

Campbell, J. Y., and T. Vuolteenaho. "Bad Beta, Good Beta." *American Economic Review*, 94 (2004), 1249–1275.

Chen, L., and X. Zhao. "Return Decomposition." *Review of Financial Studies*, 22 (2009), 5213–5249.

Christiansen, C.; A. Ranaldo; and P. Söderlind. "The Time-Varying Systematic Risk of Carry Trade Strategies." *Journal of Financial and Quantitative Analysis*, 46 (2011), 1107–1125.

Colacito, R., and M. M. Croce. "Risks for the Long Run and the Real Exchange Rate." *Journal of Political Economy*, 119 (2011), 153–181.

Epstein, L. G., and S. E. Zin. "Substitution, Risk Aversion, and the Temporal Behavior of Consumption and Asset Returns: A Theoretical Framework." *Econometrica*, 57 (1989), 937–969.

Epstein, L. G., and S. E. Zin. "Substitution, Risk Aversion, and the Temporal Behavior of Consumption and Asset Returns: An Empirical Analysis." *Journal of Political Economy*, 99 (1991), 263–286.

Fama, E. F. "Forward and Spot Exchange Rates." *Journal of Monetary Economics*, 14 (1984), 319–338.

Fama, E. F., and K. R. French. "Common Risk Factors in the Returns on Stocks and Bonds." *Journal of Financial Economics*, 33 (1993), 3–56.

Fama, E. F., and K. R. French. "Value versus Growth: The International Evidence." *Journal of Finance*, 53 (1998), 1975–1999.

Fama, E. F., and J. D. MacBeth. "Risk, Return, and Equilibrium: Empirical Tests." *Journal of Political Economy*, 81 (1973), 607–636.

Farhi, E., and X. Gabaix. "Rare Disasters and Exchange Rates." Working Paper, Harvard University, National Bureau of Economic Research, and New York University (2011).

Hansen, L. P., and R. J. Hodrick. "Forward Exchange Rates as Optimal Predictors of Future Spot Rates: An Econometric Analysis." *Journal of Political Economy,* 88 (1980), 829–853.

Lintner, J. "The Valuation of Risk Assets and the Selection of Risky Investments in Stock Portfolios and Capital Budgets." *Review of Economics and Statistics*, 47 (1965), 13–37.

Lustig, H.; N. Roussanov; and A. Verdelhan. "Common Risk Factors in Currency Markets." *Review of Financial Studies*, 24 (2011), 3731–3777.

Lustig, H., and A. Verdelhan. "Investing in Foreign Currency Is Like Betting on Your Intertemporal Marginal Rate of Substitution." *Journal of the European Economic Association*, 4 (2006), 644–655.

Lustig, H., and A. Verdelhan. "The Cross Section of Foreign Currency Risk Premia and Consumption Growth Risk." *American Economic Review*, 97 (2007), 89–117.

Menkhoff, L.; L. Sarno; M. Schmeling; and A. Schrimpf. "Carry Trades and Global Foreign Exchange Volatility." *Journal of Finance*, 67 (2012), 681–718.

Merton R. C. "An Intertemporal Capital Asset Pricing Model." *Econometrica*, 41 (1973), 867–887.

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

Nitschka, T. "Cashflow News, the Value Premium and an Asset Pricing View on European Stock Market Integration." *Journal of International Money and Finance*, 29 (2010), 1406–1423.

Patton, A. J., and A. Timmermann. "Monotonicity in Asset Returns: New Tests with Applications to the Term Structure, the CAPM, and Portfolio Sorts." *Journal of Financial Economics*, 98 (2010), 605–625.

Politis, D. N., and J. P. Romano. "The Stationary Bootstrap." *Journal of American Statistical Association*, 89 (1994), 1303–1313.

Ranaldo, A., and P. Söderlind. "Safe Haven Currencies." *Review of Finance*, 14 (2010), 385–407.

Shanken, J. "On the Estimation of Beta-Pricing Models." *Review of Financial Studies*, 5 (1992), 1–55.

Sharpe, W. F. "Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk." *Journal of Finance*, 19 (1964), 425–442.

Sharpe, W. F. "Mutual Fund Performance." *Journal of Business*, 39 (1966), 119–138.

Verdelhan, A. "A Habit-Based Explanation of the Exchange Rate Risk Premium." *Journal of Finance*, 65 (2010), 123–146.

Verdelhan, A. "The Share of Systematic Risk in Bilateral Exchange Rates." Working Paper, Massachusetts Institute of Technology and National Bureau of Economic Research (2012).

Weil, P. "The Equity Premium Puzzle and the Risk-Free Rate Puzzle." *Journal of Monetary Economics*, 24 (1989), 401–421.

Yogo, M. "A Consumption-Based Explanation of Expected Stock Returns." *Journal of Finance*, 61 (2006), 539–580.