Currency excess returns and global downside market risk

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Abstract

Sensitivity to downside risk in global stock markets, i.e. exposure to the global stock market when it is falling, is priced in average currency excess returns. Upside risk, exposure to a rising global stock market, is not. Differences in the sensitivity to global downside risk explain more than 40% of the cross-sectional dispersion in 20 monthly currency excess returns from the U.S. investor's perspective during the sample period from January 1999 to March 2012. Moreover, we show that exposure to a recently proposed "carry trade" risk factor for currency excess returns reflects global downside risk.

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1 Introduction

The difference between current forward and spot exchange rates, i.e. the forward discount, should be a predictor of future exchange rate movements. However, a wealth of studies starting with Tryon (1979), Hansen and Hodrick (1980) and Fama (1984) find that exchange rate changes do not follow the predictions of forward discounts or, equivalently, interest rate differentials. Regressing realized spot exchange rate changes on the previous period's forward discounts or interest rate differentials typically produces negative point estimates.[1] This means that currencies with a forward discount tend to appreciate on average while the forward discount predicts a depreciation. This ex post deviation from the uncovered interest rate parity condition (UIP) or "forward premium puzzle" can potentially be explained by the presence of a risk premium that investors demand for foreign currency denominated investments.

Explanations of the forward premium puzzle that are based on the risk premium view on UIP deviations suggest that investors take into account crash risk or rare events (e.g. Brunnermeier et al., 2009; Farhi et al., 2009; Farhi and Garbaix, 2011), peso problems (e.g. Burnside et al., 2011), or differences in the sensitivity of currencies to systematic risk factors (e.g. Ang and Chen, 2010; Christiansen et al., 2011; Lustig and Verdelhan, 2006, 2007; Lustig et al., 2011; Menkhoff et al., 2011; Verdelhan, 2010, 2011). Especially this latter strand of the literature attracts a lot of attention because it adopts well established frameworks and methods from time series and cross-sectional analysis of stock and bond returns to the exchange rate context. However, this strand of research faces some criticism based on two main grounds. First, typically the formation of currency portfolios is needed to show empirically that there is a relation between systematic risk factors and deviations from UIP (e.g. Ang and Chen, 2010; Galsband and Nitschka, 2011; Lustig et al, 2011; Lustig and Verdelhan, 2011). Second,

[1] Bansal and Dahlquist (2000) show that this observation does not pertain to high inflation countries. Meredith and Chinn (2005) use long-term government bond yields as proxies for risk-free rates to evaluate the explanatory power of long-term yield differentials for exchange rate changes, i.e. uncovered interest rate parity (UIP) at long horizons. They find that UIP holds at time horizons of 5 years or beyond. Lothian and Wu (2005) show that UIP holds in a long sample period until the 1980s. Huisman et al. (1998) use a panel setup to show that UIP is violated but with significant, non-negative regression coefficients.

general pricing models, e.g. the Sharpe (1964) and Lintner (1965) capital asset pricing model (CAPM), have not been particularly successful in pricing currency excess returns (Burnside et al., 2011; Burnside, 2011). The most successful empirical pricing models for currency excess returns employ rather specific risk factors for average currency excess returns such as the "carry trade factor", i.e. the return difference between high and low forward discount sorted currency portfolios, introduced by Lustig et al. (2011) or a measure of global volatility on foreign exchange markets (Menkhoff et al., 2011).

This paper addresses these concerns by proposing a simple extension of the standard empirical version of the CAPM. Our preferred empirical model has two key features. First, it takes explicitly into account country-specific and global market risk from a national investor's point of view. Second, our model distinguishes between global upside and downside risk. We define global upside risk as sensitivity to the global component of the market return when it is positive. Global downside risk is the sensitivity to the global component of the market return when it is negative. For the sample period from January 1999 to March 2012, this empirical model explains more than 40% of the cross-sectional dispersion in 20 monthly, individual currency excess returns from a U.S. investor's perspective. The distinction between country-specific and global risk combined with the distinction between global upside and global downside risk is crucial for explaining the individual average currency excess returns under study. We find that the sensitivity to the global downside risk component of the market return is significantly priced in average currency excess returns. In addition, it is economically important. In line with estimates from downside risk models confronted with firm-level stock returns, a two standard deviation increase in the exposure to global downside risk would lead to an 8% p.a. increase in currency excess returns.

What motivates these extensions of the CAPM? The first extension, i.e. the explicit distinction between country-specific and global components in the market return, is motivated by earlier risk-based explanations for deviations from UIP. These risk-based explanations clearly highlight that differences in the sensitivity to global risk factors are crucial to explain average currency excess returns (Lustig and Verdelhan, 2011; Lustig et al., 2011; Menkhoff et al., 2011). Hence, we explicitly take global and country-specific components of the market return into account. The second feature of our preferred model is based on evidence by Ang et al. (2006), Botshekan et al. (2012) and Galsband (2012) who show that downside risk is significantly priced in average stock returns while upside risk is not. The basic rationale for the success of these downside risk models is investors' loss aversion (e.g. Kahnemann and Tversky, 1979; Gul, 1991) which is a general concept applicable to all asset returns. In such a setting, an asset that covaries strongly with a falling market return but less strongly with a rising market return is particularly unattractive. This sounds like a description of the relation between the typical carry trade, going long in high forward discount currencies and short in low forward discount currencies, and the return on the U.S. stock market during the 2007/2008 mortgage crisis. Lustig and Verdelhan (2011) depict this relation in their Figure 4, here reproduced as Figure 1.[2] The correlation between the carry trade return and the U.S. stock market was about 0.7 during that mortgage crisis period. This high correlation stands in marked contrast to substantially lower correlations in times of stock market upswings. We suggest that this strong correlation could reflect currency returns' sensitivity to global downside risk in general and does not necessarily be confined to particular crises periods or specific currency characteristics (Ranaldo and Söderlind, 2010).

[about here Figure 1]

How are our main results related to the specific risk factors for currency excess returns identified in earlier studies? We address this question by focusing on the "carry trade factor" identified by Lustig et al. (2011).[3] Our assessment suggests that currency excess returns' sensitivities to the carry trade factor are closely related to their sensitivities to global

[2] We thank Adrien Verdelhan for providing us with the original graphic file.

[3] Menkhoff et al. (2011) argue that their global foreign exchange rate market volatility factor is closely related to the Lustig et al. (2011) carry trade factor. Hence, we focus on the Lustig et al. (2011) factors which are publicly available on Adrien Verdelhan's website.

downside risk. Once we regard a currency return's exposure to global downside risk relative to its exposure to the carry trade factor, the explanatory power of global downside risk for currency excess returns vanishes. Conversely, the Lustig et al. (2011) model loses its explanatory power for the currency excess returns under study once we control for global downside risk. There seems to be collinearity in cross-sectional regressions which feature both exposure to global downside risk and exposure to the carry trade factor. These findings suggest that the risk in exposure to the carry trade factor in the Lustig et al. (2011) model reflects global, downside market risk.

The remainder of the paper is organized as follows. We present the definition of currency excess returns in section 2. Section 3 explains our extension of the static, empirical version of the CAPM. Section 4 presents the data. Section 5 provides our econometric framework and the main results. Section 6 relates our main results to the Lustig et al. (2011) model. Finally, Section 7 concludes. An appendix addresses the question if our empirical model allows us to price both excess returns on stock portfolios and foreign currency excess returns.

2 Definition of currency excess returns

We define currency excess returns as ex post deviations from the uncovered interest rate parity condition, i.e.

$$\phi_{t+1}^{i} = i_{t}^{i} - i_{t} - \Delta s_{t+1}^{i} \tag{1}$$

in which ϕ_{t+1}^{i} represents the currency excess return, i_{t}^{i} is the country *i* short-term interest rate, i_{t} its home country, here U.S., counterpart and Δs_{t+1}^{i} the change in the log spot exchange rate of country *i* relative to the home currency. An increase in *s* corresponds to an appreciation of the home or depreciation of the foreign currency.

Since we regard monthly excess returns, a frequency at which covered interest rate parity usually holds (Akram et al., 2008), interest rate differentials are roughly equal to forward discounts. Hence,

$$i_t^i - i_t \approx f_t^i - s_t^i \qquad (2)$$

with f_t^i the log forward exchange rate, such that the currency excess return can be written as difference between the forward discount and the spot rate change

$$\phi_{t+1}^i = (f_t^i - s_t^i) - \Delta s_{t+1}^i \qquad (3)$$

which is equivalent to buying a foreign currency in the forward market and selling it one period late, here one month, in the spot market, i.e.

$$\phi_{t+1}^i = f_t^i - s_{t+1}^i . \qquad (4)$$

because $\phi_{t+1}^i = f_t^i - s_t^i - (s_{t+1}^i - s_t^i)$.

In the subsequence, we do not take transaction costs into account as we do not know a priori if an investor would buy or sell a specific currency.

3 Methodology

This section briefly explains how we incorporate the distinction between country-specific and global risk in the empirical version of the CAPM. We then introduce the upside and downside risk concept by Ang et al. (2006) to our framework.

3.1 Incorporating country-specific and global risk in a national CAPM

The currency risk factor literature emphasizes that differences in the sensitivity to a global risk factor explain average currency excess returns (Lustig et al., 2011; Lustig and Verdelhan, 2011; Menkhoff et al., 2011). Hence, the distinction between country-specific and global risk seems to be important in the context of pricing currency excess returns. We argue that such a distinction can be easily incorporated into a simple empirical version of the Sharpe (1964) and Lintner (1965) CAPM.

To show this, suppose we aim to explain the dispersion in excess returns on *i* currencies in the standard CAPM setting and take a U.S. investor's perspective. In this case, differences in the sensitivities to the U.S. market return should explain average currency excess returns. These sensitivities obey

$$\beta^{i,M} = \frac{\text{cov}(\phi_t^i, r_t^{M,US})}{\text{var}(r_t^{M,US})}. \tag{5}$$

with $r_t^{M,US}$ the return on the U.S. stock market in excess of the risk-free rate.

We introduce the distinction between country-specific and global components of the U.S. market excess return by adding to and subtracting from the U.S. market return the excess return on a "rest-of-the-world" market portfolio such that

$$r_t^{M,US} = r_t^{M,US} - r_t^{M,RoWexUS} + r_t^{M,RoWexUS} \tag{6}$$

in which $r_t^{M,RoWexUS}$ denotes the excess return on the "rest-of-the-world" market portfolio excluding the U.S. In Equation (6), we interpret $(r_t^{M,US} - r_t^{M,RoWexUS})$ as country-specific component of the market return, henceforth abbreviated as $r_t^{M,USspecific}$. This component captures that part of the U.S. market return that is unrelated to the "rest-of-the-world". Accordingly, we interpret the second term, $r_t^{M,RoWexUS}$, as global component of the U.S. market return and henceforth abbreviate it with $r_t^{M,global}$.

We are now in the position to distinguish between sensitivities to country-specific and global components in the U.S. market return. The exposure to the country-specific component is

$$\beta^{i,specific} = \frac{\text{cov}(\phi_t^i, r_t^{M,USspecific})}{\text{var}(r_t^{M,USspecific})}. \tag{7}$$

while the exposure to the global component is defined as

$$\beta^{i,global} = \frac{\text{cov}(\phi_t^i, r_t^{M,global})}{\text{var}(r_t^{M,global})}. \tag{8}$$

3.2 Upside and downside global market risk

Lustig and Verdelhan (2011) show that typical carry trade returns and U.S. stock market returns are highly correlated in crisis periods. We argue that this strong positive correlation could be the reflection of a more general notion that investors are loss averse. Investors seem to place more emphasis on the disutility of large losses than on the positive utility of equally high gains (Kahnemann and Tversky, 1979). The general concept of loss aversion already played a role in the early portfolio theory literature (Markowitz, 1959) and influenced asset pricing theory (Bawa and Lindenberg, 1977; Harlow and Rao, 1989; Hogan and Warren, 1974; Jahankhani, 1976). However, Ang et al. (2006) were the first to show that downside risk is actually priced in average stock returns. Stock returns which covary strongly with the market return when it is below its unconditional mean (or negative) have to compensate this downside risk by offering relatively high average returns.

We apply this reasoning to individual currency excess returns by distinguishing between upside and downside risk in the global component of the U.S. market return. Sensitivity to global upside risk is captured by

$$\beta_{up}^{i,global} = \frac{\operatorname{cov}(\phi_t^i, r_t^{M,global} \mid r_t^{M,global} \geq 0)}{\operatorname{var}(r_t^{M,global} \mid r_t^{M,global} \geq 0)} \tag{9}$$

and sensitivity to global downside risk by

$$\beta_{down}^{i,global} = \frac{\operatorname{cov}(\phi_t^i, r_t^{M,global} \mid r_t^{M,global} < 0)}{\operatorname{var}(r_t^{M,global} \mid r_t^{M,global} < 0)}. \tag{10}$$

4 Data

We examine a sample of monthly U.S. dollar exchange rates from 20 countries. According to the Morgan Stanley Capital International (MSCI) classification of stock markets our country sample comprises 10 developed and 10 emerging markets. Table 1 presents an overview of these countries. We do not include those countries in our sample which essentially peg or officially tie their currencies to other single currencies. Therefore, for instance, we did not include the Danish krone in our sample as it is closely tied to the euro. The krone is only allowed to fluctuate within a narrow band around the euro (+/- 2.5%) even though the European Exchange Rate Mechanism II (ERM II) would allow fluctuations of +/- 15%. By contrast, we include Singapore in our sample as it manages its currency against an undisclosed basket of other currencies. The sample period runs from January 1999 to March 2012. Countries that agreed to adopt the euro as their currency were obliged to introduce similar exchange rate related policies thus leading to strong covariation of these currencies even before the formal introduction of the euro. By limiting the sample period to start with the formal introduction of the euro in January 1999 we address this "pre-euro" bias. Eastern European countries like Czech Republic, Poland or Hungary are not yet members of ERM II.

In addition to the list of countries, table 1 provides the average currency excess returns for all of the countries under study. The data sources for the spot and foreign exchange rates to construct the currency excess returns are WM/Reuters and Barclays available via Datastream. End of month values are constructed from daily rates.

[about here Table 1]

To disentangle U.S. specific from global components in the U.S. stock market return as in Equation (6), we use the MSCI price, standard index for the U.S. and the MSCI price, standard world index excluding the U.S. Both indices are denominated in U.S. dollars, are measured at the end of month and are freely available on http://www.msci.com/. These indices have the advantage that they are broad based and aim to capture at least 80% of the stock market capitalisation. The MSCI World ex U.S. index aggregates stock market information from 23 developed countries.

We use the 1-month T-bill rate from the Fama and French Research Factors file as the risk-free rate to calculate excess returns on the stock market indices from the U.S. investor's point of view. This data is published on Kenneth French's website.[4]

5 Econometric framework, baseline results and robustness checks

In this section, we present our basic econometric framework, the baseline results as well as a variety of robustness checks

5.1 Econometric framework and baseline results

Our assessment of the ability of empirical variants of CAPM-based models to explain the cross-sectional dispersion in individual currency excess returns exploits the standard beta representation of the basic asset pricing equation. We estimate the beta representation via a Fama-MacBeth regression (Fama-MacBeth, 1973) , i.e. a cross-sectional regression of the excess returns on their sensitivities to risk factors at each point in time.

As baseline specifications, we confront four model variants with the 20 individual excess returns under study. The first variant is the standard CAPM assuming that sensitivity to the U.S. market return determines average currency excess returns.

The cross-sectional regression then takes the following form

$$\phi_t^i = \lambda^M \hat{\beta}^{i,M} + v_t^i, \forall t \tag{11}$$

The results are presented in panel A of table 2. The table provides the cross-sectional R^2 and gives the risk price estimates, λ, as well as the mean squared pricing errors (mspe) and mean absolute pricing errors (mape) in percentage points per annum.

The results highlighted in panel A of Table 2 show that the standard CAPM from the U.S. perspective, Equation (11), seems to capture some of the cross-sectional dispersion in the 20 monthly currency excess returns under study. The risk price estimate is positive and

[4] http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/

significant. However, the standard CAPM explains only 16% of the cross-sectional variation in currency excess returns. In addition, the pricing errors are quite large and the risk price estimate above 50% p.a. is far bigger than the sample mean of the U.S. market excess return of -1.55% p.a. over the sample period. The mean return is approximately the theoretically correct price of market risk since one could regress the market return on itself, delivering a sensitivity of unity, such that the price of risk must be the mean market excess return. In sum, the standard CAPM does not seem to be particularly helpful to explain average currency excess returns.

Does the distinction between country-specific and global components in the market return help in this respect? We assess this question with the following cross-sectional regressions of currency excess returns on their exposure to the U.S.-specific and the global component of the market return

$$\phi_t^i = \lambda^{specific} \hat{\beta}^{i,specific} + \lambda^{global} \hat{\beta}^{i,global} + v_t^i, \forall t. \tag{12}$$

Panel B of Table 2 displays the corresponding estimates. In line with the currency risk factor literature (Lustig and Verdelhan, 2011; Lustig et al., 2011; Menkhoff et al., 2011), global risk seems to be more important than country-specific risk in explaining currency excess returns. The sensitivity to the global component of the U.S. market return is significantly priced in individual currency excess returns. The country-specific component is not. This CAPM variant also produces lower pricing errors than the standard one. The cross-sectional fit, however, drops below 10% and the risk price of sensitivity to the global market return component still appears to be far too high. The distinction between country-specific and global components of the market return is hence not sufficient to explain average currency excess returns.

Based on the evidence of a strong relation between currency excess returns and the market return highlighted by Lustig and Verdelhan (2011), we argue that we have to additionally take into account upside and downside risks in the market return's global component, i.e.

$$\phi_t^i = \lambda^{specific}\hat{\beta}^{i,specific} + \lambda_{up}^{global}\hat{\beta}_{up}^{i,global} + +\lambda_{down}^{global}\hat{\beta}_{down}^{i,global} v_t^i, \forall t. \quad (13)$$

in which the upside and downside risk sensitivities follow the definitions in Equation (9) and (10).

The results presented in Panel C of Table 2 confirm this hypothesis. It is global downside market risk that is significantly priced in average currency excess returns. The pricing errors drop substantially compared with the estimates in Panel A and B of Table 2. Furthermore, this empirical model explains more than 40% of the cross-sectional dispersion in the 20 currency excess returns under study.

[about here: Table 2]

Figure 2 shows why global downside risk is significantly priced. This figure visualizes the relation between average currency excess returns on the horizontal axis of each panel and the sensitivity to the U.S. specific component of the market return (upper panel), the sensitivity to the global upside risk component (middle panel) and to the global downside risk component of the market return (lower panel). Apparently, high average currency excess returns go hand in hand with a high sensitivity to global downside risk. To a lesser extent this is also the case for global upside risk. But there is no coherent pattern in the sensitivity to the U.S. specific component in the market return and average currency excess returns. The figure also reveals one extreme outlier with an average currency excess return of 17% p.a. and relatively low sensitivity to all risk factors. This outlier is South Africa. The main results remain qualitatively unaltered when we leave South Africa out of the currency sample. In fact, the results improve in terms of better fit and lower pricing errors. These results are not reported but are available upon request.

[about here: Figure 2]

To give a visual impression of the fit of this CAPM variant, Figure 3 plots the average realized currency excess returns against the average returns predicted by the model. If the fit were perfect, all points would lie on the 45 degree line. There are a couple of individual currency excess returns that are not well described by the model. South Africa is the most extreme outlier in terms of pricing errors in line with the link between global downside risk sensitivities and average returns presented in Figure 2. However, the majority of average currency excess returns predicted by the model are close to their realized counterparts.

[about here: Figure 3]

Is the risk price estimate of global downside risk, roughly 30% p.a., economically important? Is it too high? To answer these questions we exploit the assessment of the economic importance of downside risk for individual stock returns in Ang et al. (2006). The authors find that a two standard deviation increase in the sensitivity to downside market risk leads to an increase of the excess return on stocks by about 10% p.a. Our risk price estimates lead to a similar order of magnitude for currency excess returns. To see this, notice that the mean global downside risk sensitivity is about 0.16 with a cross-sectional standard deviation of 0.14. A two standard deviation increase in the exposure to global downside risk hence leads to an increase in the currency excess return of 2 x 0.14 x 29.7% p.a. = 8.3% p.a. In sum, global downside market risk is priced in average currency excess returns and its economic significance is roughly in line with earlier estimates of the economic importance of downside market risk for national, firm-level stock returns.

Panel D of Table 2 assesses if we need to take into account the U.S. specific component at all by running a regression of the currency excess returns on their global upside and downside risk sensitivities, i.e.

$$\phi_t^i = \lambda_{up}^{global} \hat{\beta}_{up}^{i,global} + +\lambda_{down}^{global} \hat{\beta}_{down}^{i,global} v_t^i, \forall t. \tag{14}$$

The results show that our main conclusions remain unaltered, i.e. global downside market risk is significantly priced in currency excess returns. However, we also see that pricing errors slightly increase and the measure of fit marginally decreases. Global downside risk seems to matter most for the determination of currency excess returns but country-specific risk seems to play at least a minor role. This finding is also consistent with Backus et al. (2001) who show that both country-specific and global risk could provide a solution to the forward premium puzzle.

5.2 Robustness Checks

This section presents a couple of robustness checks. We follow Ang et al. (2006) and evaluate a different definition of global upside and downside risk sensitivities, assess if the average sensitivity to global risk in the upside and downside states drives the results and check if downside risk is really different from upside risk. In addition, we exploit that our sample of currencies consists of 10 developed and 10 emerging economies according to the MSCI classification of stock markets. We assess if our results pertain to both classes of countries.

5.2.1 Is it really downside risk that is priced?

We start the robustness checks by repeating the regression given in Equation (13) and presented in Panel C of Table 2 but defining the upside and downside risk sensitivities relative to the unconditional mean of the global market return component, μ^{global}, over the full sample period such that

$$\gamma_{up,}^{i,global} = \frac{\operatorname{cov}(\phi_t^i, r_t^{M,global} \mid r_t^{M,global} \geq \mu^{global})}{\operatorname{var}(r_t^{M,global} \mid r_t^{M,global} \geq \mu^{global})} \tag{15}$$

and

$$\gamma_{down}^{i,global} = \frac{\operatorname{cov}(\phi_t^i, r_t^{M,global} \mid r_t^{M,global} < \mu^{global})}{\operatorname{var}(r_t^{M,global} \mid r_t^{M,global} < \mu^{global})} \tag{16}$$

in line with the baseline specification in Ang et al. (2006). Panel A of Table 3 gives the results of this assessment from the following cross-sectional regression

$$\phi_t^i = \lambda^{specific} \hat{\beta}^{i,specific} + \lambda_{up}^{global} \hat{\gamma}_{up}^{i,global} + + \lambda_{down}^{global} \hat{\gamma}_{down}^{i,global} v_t^i, \forall t. \tag{17}$$

This assessment shows that our main results do not depend on the particular definition of global upside and downside risk sensitivities. The global downside risk is still priced significantly with a risk premium of 28% p.a. This risk price is close to the one displayed in Panel C of Table 2 under the definition of upside and downside market states by distinguishing between positive or negative realizations of the global market return component.

Next we assess if it is really the downside risk sensitivity that drives our results. We do so by evaluating the explanatory power of upside and downside global risk sensitivities, $\beta_{up}^{i,global}, \beta_{down}^{i,global}$, relative to their regular global risk exposure ($\beta^{i,global}$) for average currency excess returns. We thus control if the incremental upside or downside risk in global markets is rewarded with a risk premium or if our results are mechanically driven by high regular unconditional global risk sensitivities. The estimate equation then takes the following form

$$\phi_t^i = \lambda^{specific} \hat{\beta}^{i,specific} + \lambda_{up}^{global} (\hat{\beta}_{up}^{i,global} - \hat{\beta}^{i,global}) + \lambda_{down}^{global} (\hat{\beta}_{down}^{i,global} - \hat{\beta}^{i,global}) + v_t^i, \forall t. \quad (18)$$

Panel B of Table 3 reveals that the incremental global downside risk is priced in the currency excess returns under study. The risk price of the relative global downside risk sensitivity is positive and significant. Our main results hence really capture the impact of global downside risk on currency excess returns.

Finally, we gauge the relative importance of global downside and upside risk by estimating the following regression

$$\phi_t^i = \lambda^{specific} \hat{\beta}^{i,specific} + \lambda_{down-up}^{global} (\hat{\beta}_{down}^{i,global} - \hat{\beta}_{up}^{i,global}) + v_t^i, \forall t. \quad (19)$$

If downside risk is more important than upside risk we should expect a positive risk price when we regress currency excess returns on the difference between these returns' sensitivity to downside and upside risk. The results displayed in Panel C of Table 3 indeed leave this impression. Global downside risk is more important than global upside risk for currency excess returns. The relative sensitivity is significantly and positively priced.

[about here: Table 3]

5.2.2 Do our results pertain only to a particular group of currencies?

Our sample comprises 20 currency pairs vis-à-vis the U.S. dollar. Table 1 has already given an overview divided into developed and emerging economies according to the MSCI classification of stock markets. This subsection assesses if our main results pertain to both groups of economies by running a regression of either the 10 currency excess returns vis-à-vis developed or vis-à-vis emerging economies on our preferred model from Equation (13). The results are summarized in Table 4. Panel A displays the results for the developed economies. Panel B of Table 4 presents the results for the emerging economies.

This assessment provides some interesting insights. First, the impression that differences in the sensitivity to global downside market risk is priced in average currency excess returns applies to both sets of economies. The statistical significance is lower for the developed economies. In this country sample the risk price of global downside risk is only significant at the 90% confidence level. For the emerging economies the statistical significance is stronger. Second, the fit of our preferred CAPM variant is better for the developed economies' currency excess returns. It explains more than 50% of the cross-sectional variation for the developed economies. The fit drops to 30% for the emerging economies which is largely due to the fact that the most mispriced currency excess return in the sample, the return vis-à-vis the South African rand, receives more weight in this smaller sample. That is why the pricing errors for the emerging economies are by far higher than the corresponding pricing errors for the developed economies. Again, the main culprit for the pricing errors is the South African rand. As emphasized earlier, our results would be stronger for the emerging economies if we had left South Africa out of the sample.

Taken together, these findings underscore that global downside market risk is priced in average currency excess returns of developed and emerging markets. Single countries can affect the degree of statistical significance but do not alter the general conclusions.

[about here: Table 4]

6 Global downside market risk and its relation to specific currency risk factors

This section links our main results, based on a variety of a general asset pricing model, to recently proposed, specific currency risk factors. We focus on the two-factor model proposed by Lustig et al. (2011). Their model is not only informative about the cross-sectional dispersion in excess returns on currency portfolios but also about average individual currency excess returns. Another example of a rather specific pricing model for currency excess returns by Menkhoff et al. (2011) shows that sensitivity to volatility in global foreign exchange markets explains average currency excess returns. Menkhoff et al. (2011) also show that this risk factor is closely linked to the carry trade factor in Lustig et al. (2011). Hence, we focus on the Lustig et al. (2011) model.

There are two factors in the Lustig et al. (2011) model. Both factors are constructed from excess returns on forward discount sorted currency portfolios. The first factor, R^{FX}, is a level and country-specific factor as it is virtually indistinguishable from the average excess return across currency portfolios. This country-specific factor is decisive for an explanation of the time variation in currency excess returns. The second factor is a slope and global factor in currency excess returns. It is closely related to the return difference between high and low forward discount rate sorted currency portfolios such that it seems justified to call it a carry trade factor, HML^{FX}. This factor is decisive for an explanation of cross-sectional variation in currency excess returns.

In a first step, we assess if the Lustig et al. (2011) model explains the 20 individual currency excess returns under consideration in this study. The sample period for this assessment runs from January 1999 to November 2011 restricted by the availability of data on the Lustig et al. (2011) currency portfolios. This data is freely available on Adrien Verdelhan's website.[5] We construct the two factors from excess returns on those currency portfolios that do not take

[5] http://web.mit.edu/adrienv/www/

transaction costs into account to be consistent with our definition of currency excess return. The cross-sectional regression then follows

$$\phi_t^i = \lambda^{RFX} \hat{\beta}_{RFX}^i + \lambda^{HML} \hat{\beta}_{HML}^i + v_t^i, \forall t. \tag{20}$$

Panel A of Table 5 shows that the Lustig et al. (2011) two-factor model explains the 20 average currency excess returns under study. It captures about 34% of the cross-sectional dispersion in our currency excess returns. Differences in the sensitivity to HML^{FX} are significantly priced. The risk price of 23% p.a. is considerably higher than the sample mean of HML^{FX} of about 9%. However, Lustig et al. (2011) show that the performance of their model for individual currency excess returns can be substantially improved by allowing time-varying sensitivities. Given our relatively short sample period we refrain from doing so as our objective in this section is a comparison between the static global upside and downside risk model introduced in this paper and a (static) version of the Lustig et al. (2011) model.

Is the Lustig et al. (2011) model still successful when we control for global upside and downside risk? Panel B of Table 5 provides the answer to this question. It provides the results from a regression in which we control for global upside and downside market risk in the Lustig et al. (2011) model and estimate

$$\phi_t^i = \lambda^{RFX} \hat{\beta}_{RFX}^i + \lambda^{HML} \hat{\beta}_{HML}^i + \lambda_{up}^{global} \hat{\beta}_{up}^{i,global} + \lambda_{down}^{global} \hat{\beta}_{down}^{i,global} + v_t^i, \forall t. \tag{21}$$

Incorporating the sensitivities to global upside and downside risk drives out the explanatory power of HML^{FX} for currency excess returns. However, global downside risk is also not priced. Moreover, the explanatory power of the empirical model presented in Equation (21) does not really improve compared with the results in Panel A of the table. We interpret this outcome as evidence that global downside risk does not capture additional information about average currency excess returns. The significance of both sensitivities to HML^{FX} and to global downside risk disappear given the presence of the other. This finding suggests that there is some degree of collinearity between the exposures to HML^{FX} and the exposures to global downside risk.

We gauge the plausibility of this latter point in Panel C of Table 5. Here we take the global upside and downside risk model as a starting point and ask if there is an incremental impact of these risks relative to currency excess returns' exposure to HML^{FX}. The cross-sectional regression specification then obeys

$$\phi_t^i = \lambda^{specific}\hat{\beta}^{i,specific} + \lambda_{up-HML}^{global}(\hat{\beta}_{up}^{i,global} - \hat{\beta}_{HML}^{i}) + \lambda_{down-HML}^{global}(\hat{\beta}_{down}^{i,global} - \hat{\beta}_{HML}^{i}) + v_t^i, \forall t. \quad (22)$$

The estimates show that there is no incremental impact of global downside risk given the sensitivity to HML^{FX}. Again this finding highlights that HML^{FX} could be interpreted as a reflection of global downside market risk. Panel C of Table 5 also shows that the incremental impact of upside risk seems to be priced with a negative risk price. However, this finding is the outcome of the explanatory power of HML^{FX} for the cross-section of currency excess returns and the lack of it when global upside risk is considered. The negative risk price reflects compensation for sensitivities to the negative of HML^{FX}.

[about here: Table 5]

7 Conclusions

This paper has shown that a simple extension of a general, empirical asset pricing model explains the cross-sectional dispersion in individual currency excess returns. Our simple model takes into account important insights from the literature on currency risk factors, namely the distinction between country-specific and global risk factors, and connects it to empirical studies that exploit investors' loss aversion. Our results corroborate that differences in the sensitivity to global risk factors explain average currency excess returns. In addition, our main findings show that it is the sensitivity to global downside risk that is priced in average currency excess returns. This finding also sheds light on the economic sources of risk that underlie recently proposed specific currency risk factors. Our paper suggests that these risk factors are reflections of global downside market risk.

Beyond the contribution of this paper to the debate on risk-based explanations of deviations from UIP, the simple empirical model that we propose in this paper is potentially useful for assessments of risk-return relations in other contexts. Does cross-sectional variation in firm-level stock returns reflect country-specific or global upside and downside risk? Is global downside risk priced across different asset classes? Asness et al. (2011) show that momentum and value strategies in various asset markets are strongly correlated. Do these strategies reflect the same underlying risks? Questions such as these are beyond the scope of this paper but could be meaningfully addressed within the framework suggested in this paper.

Appendix: Global downside risk and national stock portfolio returns

Galsband and Nitschka (2011) show that a two-beta CAPM variety of Campbell and Vuolteenho (2004) which distinguishes between the U.S. market return's cash-flow and discount-rate news components can price not only excess returns on portfolios of foreign currencies but at the same time also excess returns on national stock portfolios. Against this backdrop, it is natural to ask if the same reasoning applies to the global upside and downside risk variant of the CAPM employed in this paper. Basic asset pricing theory teaches us that one discount factor should be applied to any asset.

However, there are a variety of reasons why such an assessment might deliver negative results in this case. First, Ang et al. (2006) notice in their firm-level evidence that their (national) upside and downside risk model does not drive out the statistical significance of stock characteristics such as book-to-market ratio or momentum. Hence, it would be rather surprising if an upside and downside risk model explained average returns on e.g. book-to-market ratio sorted stock portfolios. In addition, Lustig and Verderlhan (2011) show that the strong correlation of U.S. stock market returns and carry trade returns in times of crisis does not pertain to well-known investment strategies for stocks. Excess returns on momentum, size and value strategies appeared to be unrelated to the stock market downturn in 2007/2008 (Lustig and Verdelhan, 2011).

Therefore, the risk price estimates and pricing errors in Table A1 from a regression of 25 size and book-to-market ratio sorted stock portfolios (available on Kenneth French's website) on our CAPM variant distinguishing between country-specific and global upside and downside risk should not come as a surprise. In the sample period from January 1999 to December 2011, our preferred CAPM variety for pricing of currency excess returns does not explain the cross-sectional variation in average stock excess returns. If anything then it is the sensitivity to the country-specific component of the CAPM that is priced in excess returns on the size and book-to-market sorted stock portfolios.

Table A1: 25 stock portfolios (size and book-to-market sorted)

and global downside market risk

	$\lambda^{specific}$	λ_{up}^{global}	λ_{down}^{global}	R^2	*mspe*	*mape*
	-15.63 (−1.63)	-1.41 (−0.24)	5.50 (0.72)	0.40	8.30	2.06

Notes: This table presents risk price estimates (in % p.a.), the measure of cross-sectional fit, R^2, mean squared pricing errors and mean absolute pricing errors (both in % p.a.) when excess returns on 25 size and book-to-market sorted stock portfolios are used as test assets in in a test of a CAPM variety that distinguishes between global and U.S.-specific components in the market return and between upside and downside global risk. The sample period runs from January 1999 to December 2011. The asterisk signals significant estimates at 95% confidence level according to Fama-MacBeth standard errors. The estimate equation obeys

$$r_t^{e,k} = \lambda^{specific} \hat{\beta}^{k,specific} + \lambda_{up}^{global} \beta_{up}^{k,global} + \lambda_{down}^{global} \hat{\beta}_{down}^{k,global} + v_t^k, \forall t$$

with $r_t^{e,k}$ the excess return on stock portfolio *k*.

References

Ang, Andrew and Joseph Chen (2010), "Yield Curve Predictors of Foreign Exchange Returns", unpublished working paper.

Ang, Andrew, Joseph Chen and Yuhang Xing (2006), "Downside Risk", *Review of Financial Studies* 19, 1191-1239.

Akram, Q. Farook, Dagfinn Rime and Lucio Sarno (2008), "Arbitrage in the Foreign Exchange Market: Turning on the Microscope", *Journal of International Economics* 76, 237-253.

Asness, Clifford S., Tobias J. Moskowitz and Lasse H. Pedersen (2011), "Value and Momentum 'Everywhere'", unpublished working paper.

Backus, David K., Silverio Foresi and Chris I. Telmer (2001), "Affine Term Structure Models and the Forward Premium Anomaly", *Journal of Finance* 56, 279-304.

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

Bawa, Vijaj S. and Eric B. Lindenberg (1977), "Capital Market Equilibrium in a Mean-Lower Patial Moment Framework", *Journal of Financial Economics* 5, 189-200.

Botshekan, Mahmoud, Roman Kraeussl and Andre Lucas (2012), "Cash Flow and Discount Rate Risk in Up and Down Markets: What is Actually Priced?", forthcoming *Journal of Financial and Quantitative Analysis*.

Brunnermeier, Markus K., Stefan Nagel and Lasse H. Pedersen (2009), "Carry trades and currency crashes", *NBER Macroeconomic Annual 2008*, Vol 23, 313-347.

Burnside, Craig (2011), "The Cross Section of Foreign Currency Risk Premia and Consumption Growth Risk: Comment", *American Economic Review* 101, 3456-3476.

Burnside, Craig, Martin Eichenbaum, Isaac Kleshchelski and Sergio Rebelo (2011), "Do Peso Problems Explain the Returns to the Carry Trade", *Review of Financial Studies* 24, 853-891.

Campbell, John Y. and Tuomo Vuolteenaho (2004), "Bad Beta, Good Beta", *American Economic Review* 94, 1249-1275.

Christiansen, Charlotte, Angelo Ranaldo and Paul Söderlind (2011), "The Time-Varying Systematic Risk of Carry Trade Strategies", *Journal of Financial and Quantitative Analysis* 46, 1107-1125.

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

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

Farhi, Emanuel, Samuel Fraiberger, Xavier Garbaix, Romain Ranciere and Adrien Verdelhan (2009), "Crash Risk in Currency Markets", unpublished working paper.

Farhi, Emanuel and Xavier Garbaix (2011), "Rare Disasters and Exchange Rates", unpublished working paper NBER, NYU Stern and Harvard University.

Galsband, Victoria (2012), "Downside Risk of International Stock Returns", forthcoming *Journal of Banking and Finance*.

Galsband, Victoria and Thomas Nitschka (2011), "Foreign currency returns and systematic risks", working paper Deutsche Bundesbank and Swiss National Bank.

Gul, Faruk (1991), "A Theory of Disappointment Aversion", *Econometrica* 59, 667-686.

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

Harlow, W.V. and Ramesh K.S. Rao (1989), "Asset Pricing in a Generalized Mean-Lower Partial Moment Framework: Theory and Evidence", *Journal of Financial and Quantitative Analysis* 24, 285-311.

Hogan, William W. and James M. Warren (1974), "Toward the development of an equilibrium capital-market model based on semivariance", *Journal of Financial and Quantitative Analysis* 9, 1-11.

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

Jahankhani, Ali (1976), "E-V and E-S Capital Asset Pricing Models: Some Empirical Tests", *Journal of Financial and Quantitative Analysis* 11, 513-528.

Kahneman, Daniel and Amos Tversky (1979), "Prospect Theory: An Analysis of Decision Under Risk", *Econometrica* 47, 263-291.

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

Lothian, James R. and Liuren Wu (2005), "Uncovered Interest-Rate Parity over the Past Two Centuries", unpublished working paper Fordham University.

Lustig, Hanno, Nikolai Roussanov and Adrien Verdelhan (2011), "Common Risk Factors in Currency Markets", *Review of Financial Studies* 24, 3731-3777.

Lustig, Hanno and Adrien Verdelhan (2006), "Investing In Foreign Currency Is Like Betting On Your Intertemporal Marginal Rate Of Substitution", *Journal of the European Economic Association* 4, 644-655.

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

Lustig, Hanno and Adrien Verdelhan (2011), "The Cross Section of Foreign Currency Risk Premia and Consumption Growth Risk: Reply", *American Economic Review* 101, 3477-3500.

Markowitz, Harry (1959), "Portfolio Selection", Yale University Press, New Haven, CT.

Menkhoff, Lukas, Lucio Sarno, Maik Schmeling and Andreas Schrimpf (2011), "Carry Trades and Global Foreign Exchange Volatility", forthcoming *Journal of Finance*.

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

Ranaldo, Angelo and Paul Söderlind (2010), "Safe Haven Currencies", *Review of Finance* 14, 385-407.

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

Tryon, Ralph (1979), "Testing For Rational Expectations In Foreign Exchange Markets", International Finance Discussion Papers No. 139, Board of Governor's of the Federal Reserve System.

Verdelhan, Adrien (2010), "A Habit-Based Explanation of the Exchange Rate Risk Premium", *Journal of Finance* 55, 123-147.

Verdelhan, Adrien (2011), "The Share of Systematic Risk in Bilateral Exchange Rates", unpublished working paper MIT Sloan and NBER.

Tables

Table 1: Overview of countries in sample and average currency excess return

(sample period: January 1999 to March 2012)

Developed	ϕ_t^i (in % p.a.)	Emerging	ϕ_t^i (in % p.a.)
Australia	6.41	Czech Republic	4.11
Canada	3.43	Hungary	6.00
Euro Area	0.91	India	2.09
Japan	-0.01	Indonesia	3.68
New Zealand	6.08	Kuwait	3.69
Norway	3.47	Mexico	4.73
Singapore	1.15	Philippines	3.37
Sweden	0.99	Poland	5.93
Switzerland	1.75	South Africa	17.00
United Kingdom	-0.88	Thailand	2.84

Notes: This table gives an overview of the countries under study. The classification into "developed" and "emerging" countries follows the classification of stock markets by Morgan Stanley Capital International (MSCI). In addition, the table presents the respective average foreign currency excess return (in % p.a.) from the U.S. investor's point of view.

Table 2: Baseline cross-sectional regression results

			Panel A			
	λ^{M}			R^2	*mspe*	*mape*
(I)	51.74^{*} (2.26)			0.16	18.97	3.28
			Panel B			
	$\lambda^{specific}$	λ^{global}		R^2	*mspe*	*mape*
(II)	-3.59 (−0.32)	40.82^{*} (2.04)		0.09	13.75	2.28
			Panel C			
	$\lambda^{specific}$	λ^{global}_{up}	λ^{global}_{down}	R^2	*mspe*	*mape*
(III)	9.93 (0.94)	1.34 (0.18)	29.74^{*} (2.90)	0.42	8.07	1.90
			Panel D			
		λ^{global}_{up}	λ^{global}_{down}	R^2	*mspe*	*mape*
(IV)		-0.30 (−0.04)	21.34^{*} (1.97)	0.34	8.96	2.07

Notes: This table presents risk price estimates (in % p.a.), the measures of cross-sectional fit, R^2, mean squared pricing errors and mean absolute pricing errors (both in % p.a.) when using 20 individual currency excess returns as test assets of four variants of the CAPM in the sample period from January 1999 to March 2012. The rows (I) to (IV) indicate the different CAPM varieties. The asterisk signals significant estimates at 95% confidence level according to Fama-MacBeth standard errors.

The first variant is the standard CAPM assuming that sensitivity to the U.S. market return determines average currency excess returns. The second variant distinguishes between global and U.S.-specific components in the market return while the third variety additionally distinguishes between upside and downside global risk. Finally, we assess if this upside and downside global risk distinction alone would be sufficient to explain the cross-sectional dispersion in currency excess returns.

The cross-sectional regressions obey

$$\phi_t^i = \lambda^M \hat{\beta}^{i,M} + v_t^i, \forall t \tag{I}$$

$$\phi_t^i = \lambda^{specific} \hat{\beta}^{i,specific} + \lambda^{global} \hat{\beta}^{i,global} + v_t^i, \forall t. \tag{II}$$

$$\phi_t^i = \lambda^{specific} \hat{\beta}^{i,specific} + \lambda_{up}^{global} \hat{\beta}_{up}^{i,global} + + \lambda_{down}^{global} \hat{\beta}_{down}^{i,global} v_t^i, \forall t. \tag{III}$$

$$\phi_t^i = \lambda_{up}^{global} \hat{\beta}_{up}^{i,global} + + \lambda_{down}^{global} \hat{\beta}_{down}^{i,global} v_t^i, \forall t. \tag{IV}$$

Table 3: Cross-sectional regression results

Is global downside risk really priced?

Panel A: Upside and downside measured by unconditional mean market return						
	$\lambda^{specific}$	λ_{up}^{global}	λ_{down}^{global}	R^2	*mspe*	*mape*
(I)	8.63 (0.80)	-5.89 (−0.70)	28.12 * (2.75)	0.37	8.79	2.04
Panel B: Incremental impact of global upside and downside risk						
	$\lambda^{specific}$	λ_{up}^{global}	λ_{down}^{global}	R^2	*mspe*	*mape*
(II)	6.70 (0.70)	2.51 (0.30)	42.40 * (3.10)	0.44	7.63	2.20
Panel C: Relative downside and upside risk						
	$\lambda^{specific}$	$\lambda_{down-up}^{global}$		R^2	*mspe*	*mape*
(III)	0.58 (0.06)	20.21* (2.71)		0.23	10.67	2.37

Notes: This table presents risk price estimates (in % p.a.), the measures of cross-sectional fit, R^2, mean squared pricing errors and mean absolute pricing errors (both in % p.a.) when using 20 individual currency excess returns as test assets of different variants of the CAPM distinguishing between different definitions of sensitivity to global downside market risk. The sample period runs from January 1999 to March 2012. The asterisk signals significant estimates at 95% confidence level according to Fama-MacBeth standard errors.

The first variant defines upside and downside global market risk states relative to the unconditional mean of the global market return component. The second variant assesses the incremental impact of global upside and downside on average currency excess returns while the third variety evaluates the relative importance of global downside and upside risk.

The cross-sectional regressions obey

$$\phi_t^i = \lambda^{specific}\hat{\beta}^{i,specific} + \lambda_{up}^{global}\hat{\gamma}_{up}^{i,global} + +\lambda_{down}^{global}\hat{\gamma}_{down}^{i,global} v_t^i, \forall t. \qquad \text{(I)}$$

$$\phi_t^i = \lambda^{specific}\hat{\beta}^{i,specific} + \lambda_{up}^{global}(\hat{\beta}_{up}^{i,global} - \hat{\beta}^{i,global}) + \lambda_{down}^{global}(\hat{\beta}_{down}^{i,global} - \hat{\beta}^{i,global}) + v_t^i, \forall t. \quad \text{(II)}$$

$$\phi_t^i = \lambda^{specific}\hat{\beta}^{i,specific} + \lambda_{down-up}^{global}(\hat{\beta}_{down}^{i,global} - \hat{\beta}_{up}^{i,global}) + v_t^i, \forall t. \quad \text{(III)}$$

Table 4: Cross-sectional regression results

(Distinction between developed and emerging economies)

Panel A: Developed economies					
$\lambda^{specific}$	λ_{up}^{global}	λ_{down}^{global}	R^2	*mspe*	*mape*
5.90 (0.55)	6.50 (0.78)	21.31 (1.75)	0.54	3.10	1.33
Panel B: Emerging economies					
$\lambda^{specific}$	λ_{up}^{global}	λ_{down}^{global}	R^2	*mspe*	*mape*
9.19 (0.64)	−10.48 (−0.49)	30.89* (2.50)	0.29	11.89	2.33

Notes: This table presents risk price estimates (in % p.a.), the measures of cross-sectional fit, R^2, mean squared pricing errors and mean absolute pricing errors (both in % p.a.) when using 10 individual currency excess returns vis-à-vis developed economies (Panel A) and 10 individual currency excess returns vis-à-vis emerging economies as test assets in a test of a CAPM variety that distinguishes between global and U.S.-specific components in the market return and between upside and downside global risk. The sample period runs from January 1999 to March 2012. The asterisk signals significant estimates at 95% confidence level according to Fama-MacBeth standard errors. The cross-sectional regression obeys

$$\phi_t^i = \lambda^{specific} \hat{\beta}^{i,specific} + \lambda_{up}^{global} \hat{\gamma}_{up}^{i,global} + + \lambda_{down}^{global} \hat{\gamma}_{down}^{i,global} v_t^i, \forall t.$$

Table 5: Model comparison

(Global downside risk vs specific currency risk factors)

Panel A: Rerun of Lustig et al. (2011) two factor model

λ^{RFX}	λ^{HML}			R^2	*mspe*	*mape*
-5.92 (-1.05)	22.92 * (2.22)			0.34	8.78	2.00

Panel B: Lustig et al. (2011) model

controlling for sensitivity to global upside and downside risk

λ^{RFX}	λ^{HML}	λ_{up}^{global}	λ_{down}^{global}	R^2	*mspe*	*mape*
-12.61 (-1.67)	9.80 (1.27)	0.83 (0.11)	18.73 (1.23)	0.41	7.66	1.95

Panel C: Global upside and downside risk CAPM

controlling for sensitivity to carry trade risk factor

	$\lambda^{specific}$	$\lambda_{up-HML}^{global}$	$\lambda_{down-HML}^{global}$	R^2	*mspe*	*mape*
	-0.61 (-0.06)	-18.18* (-2.55)	5.88 (0.71)	0.23	10.33	2.24

Notes: This table presents the analysis conducted to link a CAPM variant distinguishing between country-specific and global upside and downside market risk with the Lustig et al. (2011) currency pricing model. Panel A provides estimates of the performance of the Lustig et al. (2011) model when confronted with 20 individual currency excess returns as test assets. Panel B presents the performance of this model when controlling for sensitivity to global upside and downside market risk. Finally, Panel C displays results from a CAPM variant that controls for global upside and downside risk sensitivities of the currency excess returns under study relative to the sensitivity to the Lustig et al. (2011) carry trade factor. This table presents risk price estimates (in % p.a.), the measures of cross-sectional fit, R^2, mean squared pricing errors and mean absolute pricing errors (both in % p.a.). The asterisk signals significant estimates at 95% confidence level according to Fama-MacBeth standard errors. The cross-sectional regressions obey

Panel A: $\phi_t^i = \lambda^{RFX} \hat{\beta}_{RFX}^i + \lambda^{HML} \hat{\beta}_{HML}^i + v_t^i, \forall t.$

Panel B: $\phi_t^i = \lambda^{RFX} \hat{\beta}_{RFX}^i + \lambda^{HML} \hat{\beta}_{HML}^i + \lambda_{up}^{global} \hat{\beta}_{up}^{i,global} + \lambda_{down}^{global} \hat{\beta}_{down}^{i,global} + v_t^i, \forall t.$

Panel C: $\phi_t^i = \lambda^{specific} \hat{\beta}^{i,specific} + \lambda_{up-HML}^{global} (\hat{\beta}_{up}^{i,global} - \hat{\beta}_{HML}^i) + \lambda_{down-HML}^{global} (\hat{\beta}_{down}^{i,global} - \hat{\beta}_{HML}^i) + v_t^i, \forall t.$

Figures

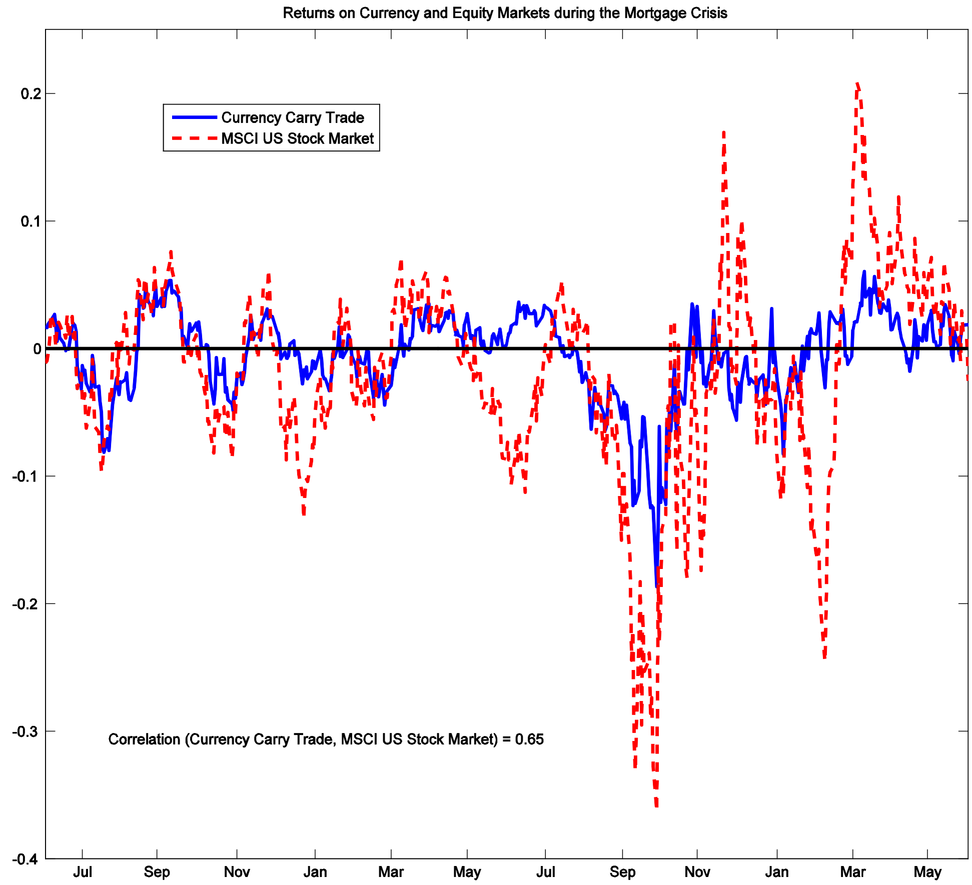

Figure 1: Correlation between typical currency carry trade (long position in high forward discount currencies and short position in low forward discount currencies) and U.S. stock market return during June 2007 to May 2009.

Source: Lustig and Verdelhan (2011)

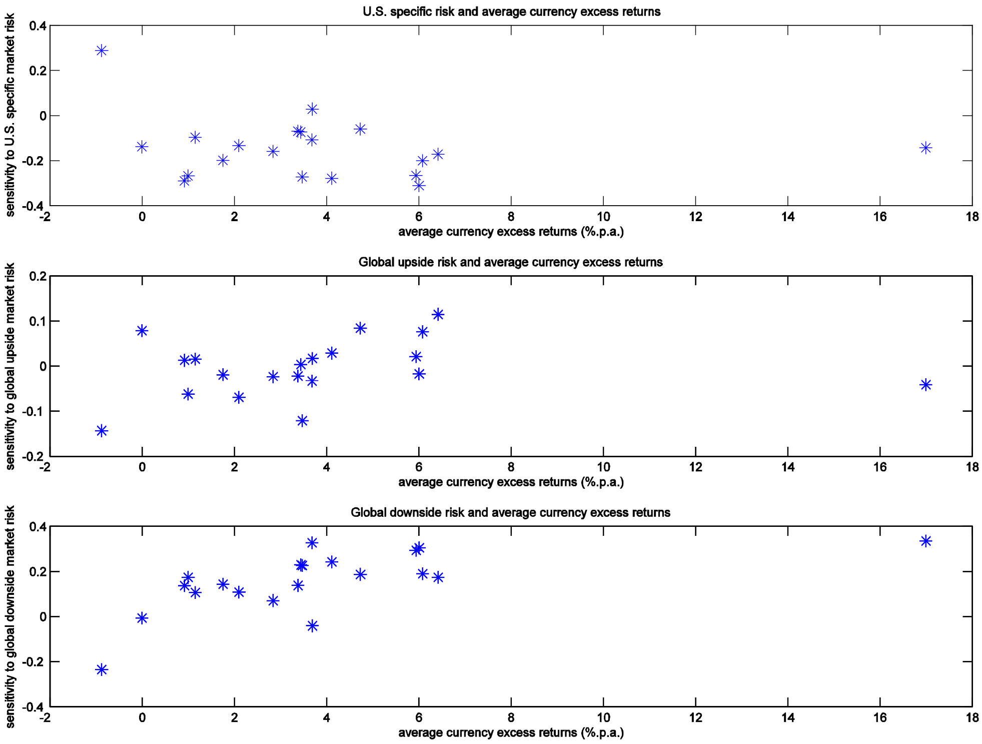

Figure 2: Average currency excess returns (in % p.a.) relative to their sensitivities to the U.S. specific component of the U.S. market return (upper panel), the global upside risk of the U.S. market return (middle panel) and its corresponding global downside risk component (lower panel).

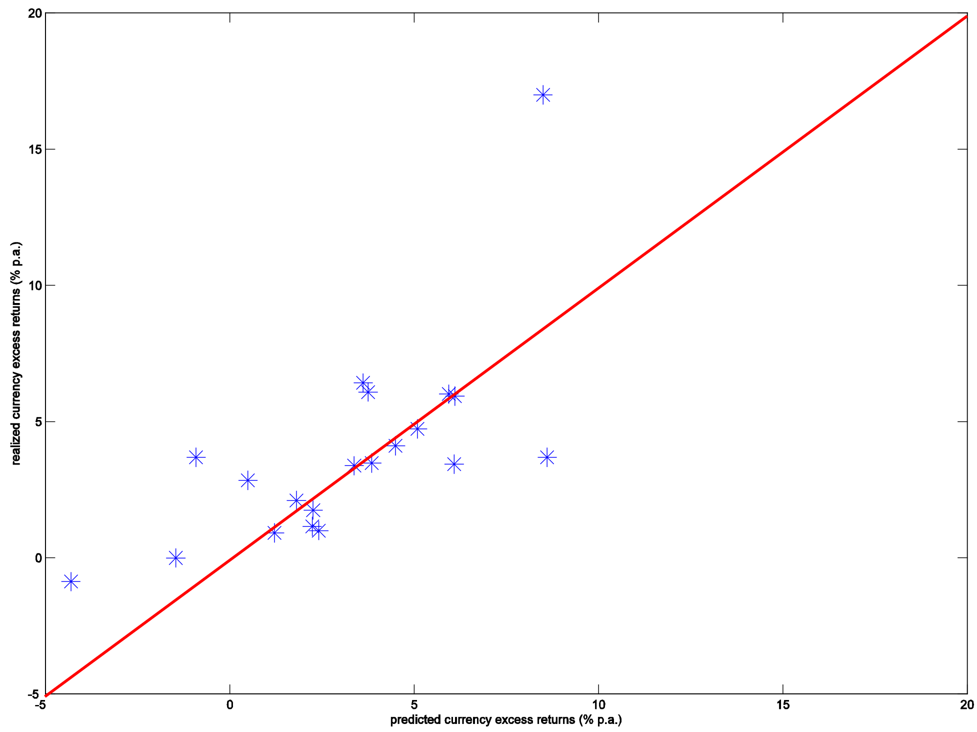

Figure 3: Fit of the CAPM for average currency excess returns when distinguishing between U.S.-specific, global upside and global downside risk. This figure compares the actually realized average currency excess returns (in % p.a.) on the vertical axis with the ones predicted by this CAPM variety on the horizontal axis. If the fit were perfect, all points would lie on the 45 degree line.