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Currency excess returns and global downside market risk

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A B S T R A C T

We assess cross-sectional differences in 23 bilateral currency excess returns in an empirical model that distinguishes between US-specific and global risks, conditional on US bull (upside) or bear (downside) markets. Using the US dollar as numeraire currency, our results suggest that global downside risk is compensated in conditional and unconditional, bilateral currency excess returns. This finding is mostly driven by the emerging markets' currencies in our sample. We also find that the link between the global downside risk and risks associated with a typical carry trade strategy is much weaker for emerging markets' currencies than for developed markets' currencies.

1. Introduction

The difference between current forward and spot exchange rates, i.e. the forward discount, should be a reliable predictor of future exchange rate movements according to the uncovered interest rate parity condition (UIP). However, a wealth of studies initiated by Tryon (1979), Hansen and Hodrick (1980) and Fama (1984) find that exchange rate changes do not follow forward discounts or,

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equivalently, interest rate differentials at short time horizons.[2] This ex post deviation from the UIP, also known as the "forward premium puzzle", can be potentially rationalized by means of a time-varying risk premium that investors demand on foreign currency denominated investments.[3]

Risk premia on foreign currencies that lead to violations of the UIP might reflect crash risk or rare events (e.g. Brunnermeier et al., 2009; Dupuy, 2013; Farhi et al., 2013; Farhi and Garbaix, 2011) or differences in the sensitivity of currencies to systematic risk factors (e.g. Ang and Chen, 2010; Christiansen et al., 2011; Galsband and Nitschka, 2013; Lustig and Verdelhan, 2006, 2007; Lustig et al., 2011; Menkhoff et al., 2012; Rafferty, 2011; Verdelhan, 2010, 2012). However, this latter strand of the literature faces the criticism that general proxies of systematic risk, such as the market return, are virtually uncorrelated with returns on currency investment strategies (Barroso and Santa-Clara, 2013; Burnside et al., 2007, 2011; Burnside, 2011).

Two recent papers challenge this view. Dobrynskaya (2014) and Lettau et al. (2014) argue that the weak link between standard risk factors and currency excess returns can be overcome by considering a CAPM version that distinguishes between exposure to the market risk in times of negative/low market returns (downside risk) and in times of positive/high market returns (upside risk). The basic rationale for the success of these models is investors' loss aversion (Kahneman and Tversky, 1979; Gul, 1991). In such a setting, investors care differently about an asset's comovement with falling markets as opposed to an asset's comovement with rising markets (Ang et al., 2006; Botshekan et al., 2012; Galsband, 2012). Indeed, Dobrynskaya (2014) shows that global downside risk is priced in excess returns on portfolios of foreign currencies and stocks. She sorts the currency portfolios on past periods' interest rate differentials and relates them to a world stock market return in upside and downside risk states. Lettau et al. (2014) take the perspective of a US investor and extend the set of test assets to portfolios of other asset classes such as commodities and bonds. Moreover, they examine more generally the relation of downside risk models to risk factors extracted from principal component analysis.

However, the formation of currency portfolios severely limits the number of test assets to five or six (see e.g. Lustig et al., 2011). Hence, inference from cross-sectional asset pricing tests based on such a low number of test assets might be impaired by relatively few degrees of freedom. In addition, most currency investment strategies, such as the carry trade, typically involve currency pairs (see. e.g. Brunnermeier et al., 2009).

Against this backdrop our study focuses on bilateral currency excess returns calculated from a perspective of a US investor, i.e. we work with US dollar exchange rates and use the US dollar as our numeraire currency. We evaluate the performance of a downside risk model variety specifically adjusted to assess the importance of currency-specific and global risks for bilateral currency excess returns. In addition, the model distinguishes between US specific and global components of the US market return. This approach is motivated by Verdelhan (2012) who shows that both currency-specific risk as well as global risks are compensated in average currency excess returns. In contrast to the model variants proposed by Dobrynskaya (2014) and Lettau et al. (2014) our preferred specification directly addresses this issue. While it is natural to think of a global risk explanation of returns on currency portfolios due to diversification of currency-specific risks in the portfolio formation, it is not clear a priori that a global risk explanation applies to bilateral currency returns too (Backus et al., 2001). Our empirical framework allows us to answer this question and at the same time link this assessment to standard risk factors as opposed to the risk factors constructed from currency portfolio data proposed by Verdelhan (2012).

Moreover, we analyse conditional and unconditional bilateral currency excess returns. Conditional currency returns are the returns from long or short positions in the foreign currency based on the sign of the interest rate differential vis-à-vis the US in the previous period. The advantage of this return

[2] 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 at long horizons. They find that the UIP holds at time horizons of 5 years or beyond. Lothian and Wu (2005) show that the UIP holds in a long sample period until the 1980s. Huisman et al. (1998) use a panel setup to show that the UIP is violated but with significant, non-negative regression coefficients.

[3] Backus et al. (2010) provide a theoretical model in which monetary policy, central banks in big closed and small open economies following different Taylor Rules, could generate violations of the UIP. Burnside et al. (2011) argue that peso problems account for violations from the UIP.

computation method is that it takes transaction costs into account. The latter are particularly important in assessments of currency investment strategies (Burnside et al., 2007). Conditioning the bilateral currency returns on interest rate differentials additionally amounts to incorporating information from the respective currencies' bond markets. This point reflects insights by Ang and Chen (2010) who show that any variable that predicts the domestic bond yield curve, such as the short-term interest rate, potentially signals future exchange rate changes as well. To judge the importance of the bond market information for the performance of the downside risk model, we run cross-sectional pricing tests for unconditional bilateral currency returns as well.

Our main results are easily summarized. We find that global downside risk is priced in bilateral, conditional and unconditional currency excess returns. We find no evidence in favour of country-specific downside risk as explanation of bilateral currency excess returns. Furthermore, our twist to the downside risk models of Dobrynskaya (2014) and Lettau et al. (2014) outperforms their model variants when confronted with bilateral currency excess returns as test assets.

In addition, we form currency portfolios sorted on global downside risk betas to highlight that the global downside risk explanation of bilateral currency excess returns is mainly driven by the emerging market currencies in our sample. This empirical evidence pertains not only to the US dollar as the numeraire currency but holds true also from the perspective of other countries' investors. Moreover, we show that the payoffs from a conventional carry trade and an investment strategy which is long in currencies with high downside risk exposure and short in currencies with low downside risk exposure are linked. Interestingly, this finding is more pronounced for currencies from developed market countries than for currencies from emerging market countries.

The remainder of the paper is organized as follows. We present the definition of currency excess returns in Section 2. We show our extension of the empirical version of the CAPM in Section 3 and describe the data in Section 4. Section 5 provides our econometric framework, main results, and a summary of robustness checks. Finally, Section 6 concludes. An Online appendix provides details of additional results.

2. Definition of currency excess returns

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

$$\phi^j_{t+1} = i^j_t - i_t - \Delta e^j_{t+1}, \tag{1}$$

in which ϕ^j_{t+1} represents the currency excess return, i^j_t is the country j short-term interest rate, i_t its home country, here US, counterpart, and Δe^j_{t+1} the change in the log spot exchange rate of country j relative to the home currency. An increase in e corresponds to an appreciation of the home or depreciation of the foreign currency.

We regard excess returns at the monthly frequency for which covered interest rate parity usually holds (Akram et al., 2008). Thus interest rate differentials are roughly equal to forward discounts

$$i^j_t - i_t \approx f^j_t - e^j_t, \tag{2}$$

where f^j_t is the log forward exchange rate and the log currency excess return can be written as a difference between the log forward discount and the log spot rate change

$$\phi^j_{t+1} = \left(f^j_t - e^j_t\right) - \Delta e^j_{t+1}. \tag{3}$$

This representation is equivalent to buying a foreign currency in the forward market and selling it one period, here one month, later in the spot market:

$$\phi^j_{t+1} = f^j_t - e^j_{t+1}. \tag{4}$$

This is an unconditional currency excess return. In order to take transaction costs into account we examine conditional, bilateral foreign currency excess returns. The conditioning variable for the excess return in $t+1$ corresponds to the sign of the difference between forward and spot rates observed at time t. If this difference is positive, then we assume a long position in the foreign currency j next period, i.e.

$$\phi_{t+1}^{j,l} = f_t^{j,b} - e_{t+1}^{j,a}. \tag{5}$$

If the difference is negative, then we assume a short position in the foreign currency j next period, i.e.

$$\phi_{t+1}^{j,s} = -f_t^{j,a} + e_{t+1}^{j,b}, \tag{6}$$

where a and b abbreviate "ask" and "bid" prices and l and s abbreviate "long" and "short" positions, respectively. In each month and for each currency pair, we take either a short or a long position depending on the sign of the forward discount in the previous month. As a result, there is a lot of variation with respect to long and short positions in each bilateral exchange rate over our sample period.

Conditional currency excess returns capture similar features of exchange rate data as portfolios of currencies that are sorted on forward discounts. One disadvantage of the use of bilateral currency returns are related to the loss of the sample period length when emerging market currencies are included in the sample. The advantage is a higher number of test assets and thus more degrees of freedom in cross-sectional asset pricing tests (Burnside, 2011).

3. Methodology

3.1. Incorporating country-specific and global risk in the market return

A simple distinction between country-specific and global risk factors in the framework of the standard CAPM allows to easily account for the previous literature on the importance of global risks for foreign exchange markets (Lustig et al., 2011; Lustig and Verdelhan, 2011; Menkhoff et al., 2012).

From a US investor's perspective, a standard CAPM setting implies that differences in the sensitivities to the US market return should explain average currency excess returns. The unconditional sensitivities of the bilateral currency excess return vis-à-vis country j obey

$$\beta^{j,M} = \frac{\text{cov}\left(\phi_t^j, r_t^{M,\text{US}}\right)}{\text{var}\left(r_t^{M,\text{US}}\right)}, \quad t = 1, \ldots, T. \tag{7}$$

where $r_t^{M,\text{US}}$ is the return on the US stock market in excess of the risk-free rate.

In order to assess the importance of currency-specific and global risks as determinants of bilateral currency returns we distinguish between US-specific and global components of the market return. We obtain these components by regressing the US market return, $r_t^{M,\text{US}}$, on a constant, a, and the return on the world market index, $r_t^{M,\text{World}}$:

$$r_t^{M,\text{US}} = a + b * r_t^{M,\text{World}} + \varepsilon_t \tag{8}$$

The global market return component is that part of the US market return that is perfectly correlated with the world market return, $r_t^{M,\text{global}} = b * r_t^{M,\text{World}}$. We label the residual from this regression, i.e. that component of the US market return that is uncorrelated to the world market return, as the US-specific market return component, $r_t^{M,\text{specific}} = a + \varepsilon_t$.

3.2. Upside and downside risks

The baseline definition of upside and downside states is based on the US market return. If the market return is negative, we are then in a downside state. If the market return is bigger than or equal to zero, we are then in an upside state. Dobrynskaya (2014) makes the same baseline assumption in her assessment of currency portfolio and stock portfolio returns while Lettau et al. (2014) argue that the threshold should be defined as a multiple of the market return standard deviation around its mean. We evaluate the definition of upside and downside risk states according to positive or negative thresholds for the market return and provide results for the Lettau et al. (2014) definition of the downside risk state in the Online Appendix.

Taken together, our baseline empirical model can distinguish between four variants of currency excess returns' sensitivity to the market return: Upside risk as well as downside risk in the US-specific and the global component of the market return. More formally, these sensitivities are

$$\beta_{\text{up}}^{j,\text{specific}} = \frac{\text{cov}\left(\phi_t^j, r_t^{M,\text{specific}} \middle| r_t^{M,\text{US}} \geq 0\right)}{\text{var}\left(r_t^{M,\text{specific}} \middle| r_t^{M,\text{US}} \geq 0\right)}, \quad t = 1, \dots, T, \tag{9}$$

$$\beta_{\text{down}}^{j,\text{specific}} = \frac{\text{cov}\left(\phi_t^j, r_t^{M,\text{specific}} \middle| r_t^{M,\text{US}} < 0\right)}{\text{var}\left(r_t^{M,\text{specific}} \middle| r_t^{M,\text{US}} < 0\right)}, \quad t = 1, \dots, T, \tag{10}$$

$$\beta_{\text{up}}^{j,\text{global}} = \frac{\text{cov}\left(\phi_t^j, r_t^{M,\text{global}} \middle| r_t^{M,\text{US}} \geq 0\right)}{\text{var}\left(r_t^{M,\text{global}} \middle| r_t^{M,\text{US}} \geq 0\right)}, \quad t = 1, \dots, T. \tag{11}$$

and

$$\beta_{\text{down}}^{j,\text{global}} = \frac{\text{cov}\left(\phi_t^j, r_t^{M,\text{global}} \middle| r_t^{M,\text{US}} < 0\right)}{\text{var}\left(r_t^{M,\text{global}} \middle| r_t^{M,\text{US}} < 0\right)}, \quad t = 1, \dots, T. \tag{12}$$

This decomposition of the market return allows us to directly assess the importance of country-specific and global risks in currency returns and at the same time enables us to link this assessment to standard risk factors. It is thus particularly useful when assessing bilateral currency returns as opposed to returns on currency portfolios because country-specific risks should be diversified away in the portfolio formation.

4. Data and descriptive statistics of conditional, bilateral currency excess returns

4.1. Data

In our benchmark specification, we examine a sample of monthly US dollar exchange rates from 23 economies for which spot and one-month forward exchange rates are available during the entire sample period from January 1999 to March 2013. We follow Lustig et al. (2011) in the choice of currencies.[4]

According to the Morgan Stanley Capital International (MSCI) classification of stock markets our sample comprises 12 developed and 11 emerging markets. The data sources for the spot and forward foreign exchange rates (bid and ask) are WM/Reuters and Barclays available via Datastream. End of

[4] We exclude Indonesia and Malaysia because of violations of the covered interest rate parity condition during substantial parts of our sample period. In addition, we did not take the Korean won into our sample as the respective forward data only starts in 2002.

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

Developed	ϕ^j(in % p.a.)	Emerging	ϕ^j(in % p.a.)
Australia	6.92 (3.42)	Czech Republic	0.71 (3.49)
Canada	−1.01 (2.38)	Hungary	3.52 (4.03)
Denmark	−0.41 (2.81)	India	1.78 (1.88)
Euro Area	3.09 (2.80)	Kuwait	0.86 (1.13)
Hong Kong	0.13 (0.13)	Mexico	4.33 (2.68)
Japan	0.04 (2.60)	Philippines	−0.28 (1.81)
New Zealand	6.24 (3.60)	Poland	0.48 (3.87)
Norway	1.49 (3.01)	Saudi Arabia	0.07 (0.12)
Singapore	−0.50 (1.51)	South Africa	7.71 (5.29)
Sweden	3.85 (3.12)	Taiwan	−1.44 (1.31)
Switzerland	−4.01 (2.95)	Thailand	−0.16 (1.93)
United Kingdom	−1.39 (2.34)		

Notes: This table presents the average, bilateral conditional foreign currency excess return (in % p.a.) from the US investor's point of view. Standard errors are provided below the mean in parentheses. The sample period runs from January 1999 to March 2013.

month values are constructed from daily rates. Since most US dollar exchange rates on Datastream are only available since January 1997, and not for all of the currencies under study, we chose January 1999 as a natural starting point of our sample due to the introduction of the euro at that date. In addition, we opted to use forward rates to construct currency excess returns, instead of (money market) interest rate differentials, because this approach takes transaction costs (bid/ask spreads) into account. Transaction costs could be interpreted as a measure of market liquidity of the respective currency pair.[5]

To disentangle US specific from global market components in the US stock market return, we use the MSCI standard gross index for the US and the MSCI World all country (AC) gross index. The MSCI World AC index comprises both developed and emerging markets. Both indices are denominated in US dollars and measured at the end of the month. These data are freely available on http://www.msci.com/. MSCI indices have the advantage that they are broad and calculated using the same methodology. Gross indices assume that dividend payments are reinvested.

We use daily data on the MSCI country stock indices (price indices denominated in local currency) to calculate a measure of global equity market volatility. We follow Lustig et al. (2011) and calculate this measure in two steps. First, we compute the standard deviation of daily returns in a month for each of the country indexes. Then we take the cross-sectional mean of these monthly volatility series to obtain the measure of global equity market volatility. We use these volatility series as a control variable in our robustness checks since falling stock markets are typically associated with rising volatility. So, a priori, it is not immediately clear if the exposure to the market return in downside states differs from the exposure to global financial market volatility. Finally, 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 perspective. This data is published on Kenneth French's website.[6]

4.2. *Descriptive statistics of conditional, bilateral currency excess returns*

Table 1 gives an overview of the 23 markets and presents the mean conditional excess return on each currency pair under study along with its standard error. All of the moments are in percent p.a.

There is a large dispersion in the mean, conditional excess returns across currency pairs. For example, from a US investor's perspective, the conditional excess return, i.e. going long and short according to the sign of the previous period's forward discount, on an investment in the Australian dollar delivers a return of about 7% p.a. By contrast, the conditional excess return on a Swiss franc

[5] Transaction costs seem to be particularly important for returns on emerging markets' currencies for which we find pronounced differences between excess returns after taking transaction costs into account and before adjusting for bid/ask spreads.
[6] http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/.

investment lies around −4% p.a. The standard errors of the conditional currency excess returns are rather large. A majority of the mean bilateral, conditional currency excess returns is not significantly different from zero at conventional significance levels. Due to their substantial noisiness, bilateral currency excess returns are a challenge for asset pricing and macroeconomic models alike. However, there are significant cross-sectional differences between these bilateral currency excess returns. These differences are the focus of our study. Dobrynskaya (2014) and Lettau et al. (2014) analyse interest rate differential or forward discount sorted currency portfolio returns and find the distinction between upside and downside states of the market return is useful in understanding their average excess returns. We examine whether this finding holds for excess returns on currency pairs.

5. Econometric framework, baseline results and robustness checks

5.1. Econometric framework and baseline results

Our assessment of the ability of CAPM-based models to explain the cross-sectional dispersion in bilateral currency excess returns exploits the standard beta representation of the basic asset pricing equation. We estimate the beta specifications via the Fama-MacBeth methodology (Fama and MacBeth, 1973) in a series of cross-sectional regressions of the excess returns on their sensitivities to the underlying risk factors at each point in time.

In a first step we define two dummy variables that indicate if the US market return is positive or negative, i.e. if we are in the upside or downside risk state. The two dummies (up, down) are defined as

$$\mathrm{up}_t = \begin{cases} 1 & if\ r_t^{M,\mathrm{US}} > 0 \\ 0 & if\ r_t^{M,\mathrm{US}} < 0 \end{cases}, \quad t = 1, \ldots, T \tag{13}$$

and

$$\mathrm{down}_t = \begin{cases} 1 & if\ r_t^{M,\mathrm{US}} < 0 \\ 0 & if\ r_t^{M,\mathrm{US}} > 0 \end{cases}, \quad t = 1, \ldots, T \tag{14}$$

Conceptually this approach is similar to the one used by Dobrynskaya (2014) and Lettau et al. (2014) but not identical because we directly estimated both the upside and downside risk sensitivities with these two dummies. We discuss the similarities and the (minor) differences compared with Dobrynskaya (2014) and Lettau et al. (2014) in a separate Online Appendix.

To obtain the upside and downside risk betas introduced in Equations (9)–(12) we run the following time series regression of currency excess return j on a constant, the country-specific part of the market return interacted with the two dummy variables that indicate upside or downside risks and the global component of the market return interacted with the two dummies. The regression equation follows

$$\begin{aligned} \phi_t^j = \alpha^j &+ \beta_{\mathrm{up}}^{j,\mathrm{specific}}\left(r_t^{M,\mathrm{specific}} * \mathrm{up}_t\right) + \beta_{\mathrm{down}}^{j,\mathrm{specific}}\left(r_t^{M,\mathrm{specific}} * \mathrm{down}_t\right) + \beta_{\mathrm{up}}^{j,\mathrm{global}}\left(r_t^{M,\mathrm{global}} * \mathrm{up}_t\right) \\ &+ \beta_{\mathrm{down}}^{j,\mathrm{global}}\left(r_t^{M,\mathrm{global}} * \mathrm{down}_t\right) + \varepsilon_t^j \end{aligned} \tag{15}$$

We then use the estimates of the different sensitivities to the market return components in the second stage of the Fama-MacBeth procedure to assess the cross-sectional differences in the bilateral currency excess returns under study. The following subsections present these results.

5.1.1. Cross-sectional pricing results: conditional, bilateral currency excess returns

We evaluate three model variants with the 23 bilateral, conditional currency excess returns under study. The first variant is the standard CAPM which implies that sensitivity to the US market return is the only determinant of average currency excess returns. The expected return on currency pair j is then a function of the sensitivity to the market return, $\widehat{\beta}^{j,M}$, and the price of risk, λ_t^M.

The results of the cross-sectional regression of the following form

$$\phi_t^j = \lambda_t^{M,\mathrm{US}} \widehat{\beta}^{j,M,\mathrm{US}} + \nu_t^j, \ \forall t \tag{16}$$

are summarized in Panel A of Table 2. The table provides a cross-sectional R^2, the average risk price estimate, λ, the mean squared pricing errors (*mspe*) and the mean absolute pricing errors (*mape*) in percentage points per annum.

Panel A of Table 2 shows that the standard CAPM from the US perspective summarized in Equation (16), seems to capture some of the dispersion in the 23 monthly currency excess returns under study. The risk price estimate is positive and significant. However, the standard CAPM explains only 19% of the cross-sectional variation in currency excess returns at the country level during the period between January 1999 and March 2013. In addition, the pricing errors are quite large.

In the CAPM framework, the market return represents all systematic risks. Hence, only the exposure to the market return should be compensated in other assets' returns. Since the CAPM should price any asset return, it should price the return on the market portfolio as well. In a regression of the market return on itself, the slope coefficient is unity and thus the price of market risk should be equal to the average return on the market portfolio. Against this backdrop, the estimated risk price of 40% p.a. seems to be too high. It exceeds the mean of the US market excess return of 0.27% p.a. over the sample period by far and is also substantially higher than the long-run mean US market excess return of about 5% p.a. In

Table 2
Baseline cross-sectional regression results: conditional currency returns.

Panel A: standard CAPM							
	λ^M				R^2	*mspe*	*mape*
(I)	40.29				0.19	6.75	1.97
	(1.85)						
Panel B: upside and downside risk in US market return							
	$\lambda_{\mathrm{up}}^{M,\mathrm{US}}$	$\lambda_{\mathrm{down}}^{M,\mathrm{US}}$			R^2	*mspe*	*mape*
(II)	18.19	20.86			0.19	6.80	1.99
	(1.53)	(1.78)					
Panel C: upside and downside risk in country-specific and global component of market return							
	$\lambda_{\mathrm{up}}^{\mathrm{specific}}$	$\lambda_{\mathrm{down}}^{\mathrm{specific}}$	$\lambda_{\mathrm{up}}^{\mathrm{global}}$	$\lambda_{\mathrm{down}}^{\mathrm{global}}$	R^2	*mspe*	*mape*
(III)	5.69	−3.07	0.77	18.63	0.60	3.23	1.46
	(1.15)	(−1.04)	(0.06)	(1.69)			

Notes: This table presents average 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 23 bilateral currency excess returns as test assets in three CAPM variants over the sample period from January 1999 to March 2013. Fama-MacBeth (1973) corrected t-statistics appear below the point estimates in parentheses.
The first model variant is the standard CAPM assuming that sensitivity to the US market return determines average currency excess returns (Panel A). The second variant distinguishes between sensitivities to the market return when it is positive (upside) and negative (downside). These results are presented in Panel B. The third empirical model additionally distinguishes between country-specific and global components in the market return and combines this distinction with upside and downside states (Panel C).
The respective Fama-MacBeth (1973) regressions are

$$\phi_t^j = \lambda_t^M \widehat{\beta}^{j,M} + \nu_t^j, \ \forall t \tag{I}$$

$$\phi_t^j = \lambda_{t,\mathrm{up}}^{M,\mathrm{US}} \widehat{\beta}_{\mathrm{up}}^{j,M,\mathrm{US}} + \lambda_{t,\mathrm{down}}^{M,\mathrm{US}} \widehat{\beta}_{\mathrm{down}}^{j,M,\mathrm{US}} + \nu_t^j, \ \forall t \tag{II}$$

$$\phi_t^j = \lambda_{\mathrm{up},t}^{\mathrm{specific}} \widehat{\beta}_{\mathrm{up}}^{j,\mathrm{specific}} + \lambda_{\mathrm{down},t}^{\mathrm{specific}} \widehat{\beta}_{\mathrm{down}}^{j,\mathrm{specific}} + \lambda_{\mathrm{up},t}^{\mathrm{global}} \widehat{\beta}_{\mathrm{up}}^{j,\mathrm{global}} + \lambda_{\mathrm{down},t}^{\mathrm{global}} \widehat{\beta}_{\mathrm{down}}^{j,\mathrm{global}} + \nu_t^j, \ \forall t. \tag{III}$$

view of these facts, the standard CAPM does not appear particularly helpful in understanding average currency excess returns in line with the points made by Burnside (2011) and Burnside et al. (2011).

However, Dobrynskaya (2014) and Lettau et al. (2014) show that a conditional CAPM version which distinguishes between the exposure to the market return conditional on high (positive) or low (negative) realizations of the market return, can explain a large part of cross-sectional differences in currency portfolio returns. This is the second CAPM variety that we examine.

We assess if the mere distinction between upside and downside risks in the US market return helps to explain the cross-sectional dispersion in the conditional, bilateral currency excess returns that are the focus of this study. The cross-sectional regression then takes the following form:

$$\phi_t^j = \lambda_{t,\text{up}}^{M,\text{US}} \widehat{\beta}_{\text{up}}^{j,M,\text{US}} + \lambda_{t,\text{down}}^{M,\text{US}} \widehat{\beta}_{\text{down}}^{j,M,\text{US}} + \nu_t^j, \forall t \tag{17}$$

The upside and downside betas are obtained from a time series regression similar to the one introduced in Equation (15) but without decomposing the US market return into its country-specific and global components. Panel B of Table 2 gives the cross-sectional regression results. The regression estimates show that it is not clear if it is the upside or downside risk that is compensated in the average bilateral conditional currency excess returns. The risk prices are both positive and very similar around 18% and 20% p.a. In addition, the upside/downside risk distinction in the US market return does not improve the cross-sectional fit of the CAPM. The R^2 statistic is again only 19% and the mean squared as well as the mean absolute pricing errors are about the same as in the case of the standard CAPM. In sum, the application of the downside risk model that is successful in explaining average currency portfolio returns is not helpful in explaining bilateral currency excess returns.

Against this backdrop, we additionally introduce the distinction between country-specific and global components to the upside and downside risk model and run the following cross-sectional regression

$$\phi_t^j = \lambda_{\text{up},t}^{\text{specific}} \widehat{\beta}_{\text{up}}^{j,\text{specific}} + \lambda_{\text{down},t}^{\text{specific}} \widehat{\beta}_{\text{down}}^{j,\text{specific}} + \lambda_{\text{up},t}^{\text{global}} \widehat{\beta}_{\text{up}}^{j,\text{global}} + \lambda_{\text{down},t}^{\text{global}} \widehat{\beta}_{\text{down}}^{j,\text{global}} + \nu_t^j, \forall t, \tag{18}$$

where the upside and downside sensitivities follow the definitions in Equations (9)–(12). The pricing results are reported in Panel C of Table 2. These results show that the distinction between country-specific and global risks on top of the upside and downside risk distinction matters. The pricing errors drop substantially compared with the estimates in Panels A and B of Table 2. Furthermore, this empirical model explains roughly 60% of the cross-sectional dispersion in the bilateral currency excess returns. In addition, the risk price estimates highlight that global downside risk is compensated in average bilateral conditional currency returns but none of the other potential risks related to the market return in upside and downside states of the world. Our empirical model thus allows us to pinpoint the underlying risks of bilateral currency excess returns and relate these risks to a standard risk factor such as the market return.

5.1.2. Cross-sectional pricing results: unconditional, bilateral currency excess returns

How much does the success of our preferred downside model specification rest on the use of conditional currency excess returns? This is an important question as Ang and Chen (2010) emphasize that the short-rate and any other explanatory variable of the term structure of interest rates has the potential to signal future exchange rate returns. By employing bilateral currency returns conditional on the sign of the forward discount we basically incorporate information from both currencies' bond markets and hence bond market risks. This is due to the covered interest rate parity condition, which states that the forward discount is approximately equal to differences in short-term interest rates, and the fact the variation in short-term rates affect the whole term structure and hence risk factors, e.g. term yield spreads, derived from bond market data.

To evaluate the importance of the conditioning information from the forward discounts we confront the empirical models from the previous subsection with unconditional, bilateral currency excess returns as introduced in Equation (4). This empirical exercise does not take transaction costs into account and the bilateral currency returns, in particular those of the emerging markets' currencies, are on average higher than the conditional returns presented in Table 1. We provide descriptive statistics of these returns in a separate Online Appendix.

Table 3 presents the details of the cross-sectional pricing results for unconditional bilateral currency excess returns. In general, the results are very similar to the ones for conditional currency returns. If anything, the standard CAPM and particularly the downside risk model specification along the lines of Dobrynskaya (2014) and Lettau et al. (2014) perform better when confronted with the unconditional currency returns than when confronted with conditional returns. Our preferred specification works about equally well for both conditional and unconditional bilateral currency excess returns. Hence, the impact of bond market information – reflected in the forward discounts/interest rate differentials as conditioning variable – is not decisive in order to explain the performance of our preferred downside risk model for bilateral currency returns. A potential explanation for this finding is provided by Hasseltoft (2012) who argues that stock and bond markets are driven by the same macroeconomic risks. Hence, risk factors extracted from either stock market or bond market data should capture similar underlying risks.

5.2. Summary of robustness checks

This section highlights several robustness checks of the baseline results presented in Table 2. These results have either been reported in an earlier, working paper version of this paper or in a separate Online Appendix or are available upon request.

As emphasized by Ang et al. (2006), it is important to control the sensitivities to the market return in the upside and downside states for the unconditional market return exposure as upside and downside

Table 3
Cross-sectional regression results: unconditional currency returns.

Panel A: standard CAPM							
	λ^M				R^2	*mspe*	*mape*
(I)	34.77 (3.11)				0.29	8.27	2.35
Panel B: upside and downside risk in US market return							
	$\lambda_{up}^{M,US}$	$\lambda_{down}^{M,US}$			R^2	*mspe*	*mape*
(II)	−1.90 (−0.14)	28.80 (2.43)			0.52	5.61	1.68
Panel C: upside and downside risk in country-specific and global component of market return							
	$\lambda_{up}^{specific}$	$\lambda_{down}^{specific}$	λ_{up}^{global}	λ_{down}^{global}	R^2	*mspe*	*mape*
(III)	2.99 (0.78)	−2.64 (−0.67)	4.82 (0.61)	19.38 (2.78)	0.70	3.48	1.37

Notes: This table presents average 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 23 bilateral currency excess returns as test assets in three CAPM variants over the sample period from January 1999 to March 2013. Fama-MacBeth (1973) corrected t-statistics appear below the point estimates in parentheses.

The first model variant is the standard CAPM assuming that sensitivity to the US market return determines average currency excess returns (Panel A). The second variant distinguishes between sensitivities to the market return when it is positive (upside) and negative (downside). These results are presented in Panel B. The third empirical model additionally distinguishes between country-specific and global components in the market return and combines this distinction with upside and downside states (Panel C).

The respective Fama-MacBeth (1973) regressions are

$$\phi_t^j = \lambda_t^M \widehat{\beta}^{j,M} + \nu_t^j, \forall t \tag{I}$$

$$\phi_t^j = \lambda_{t,\text{up}}^{M,\text{US}} \widehat{\beta}_{\text{up}}^{j,M,\text{US}} + \lambda_{t,\text{down}}^{M,\text{US}} \widehat{\beta}_{\text{down}}^{j,M,\text{US}} + \nu_t^j, \forall t \tag{II}$$

$$\phi_t^j = \lambda_{\text{up},t}^{\text{specific}} \widehat{\beta}_{\text{up}}^{j,\text{specific}} + \lambda_{\text{down},t}^{\text{specific}} \widehat{\beta}_{\text{down}}^{j,\text{specific}} + \lambda_{\text{up},t}^{\text{global}} \widehat{\beta}_{\text{up}}^{j,\text{global}} + \lambda_{\text{down},t}^{\text{global}} \widehat{\beta}_{\text{down}}^{j,\text{global}} + \nu_t^j, \forall t. \tag{III}$$

states could simply coincide with periods of low and high unconditional sensitivities to the market return. Therefore, we augment our baseline specification to account for the marginal contribution of downside risk on top of the unconditional market return exposure. In sum, despite slightly lower measures of fit, our baseline results are unchanged both in economic and statistical terms.

A related, natural concern is that our risk measures could be a reflection of the exposure of foreign currencies to global equity market volatility. Volatility tends to be high when the market return is falling and vice versa. In line with this argument, Dobrynskaya (2014) finds that global downside risk and high market return volatility are closely intertwined. We find the same relation here even when we distinguish between US-specific and global equity market volatility.

Furthermore, we examined several subsample periods to check if our results are driven by specific episodes, e.g. the recent crisis period in 2007–2009 or the early part of our sample period which starts immediately after the Asian currency crisis. We find that the qualitative results are not driven by any particular market downturns.

In addition, one could allow for time-variation in the sensitivities to upside and downside risk components of the market return. For instance, Lustig et al. (2011) stress that it is important to allow for time variation in the sensitivity to their carry trade factor in order to rationalize the cross-section of bilateral currency excess returns in their model. Under a downside risk specification with negative market return, it turns out that time variation in the downside risk exposure does not improve the cross-sectional fit of the model.

In addition, we follow the definition of a downside risk state by Lettau et al. (2014) and define the upside and downside risk dummies from Equations (13) and (14) in the following way:

$$\mathrm{up}_t = \begin{cases} 1 \;\; if \;\; r_t^{M,\mathrm{US}} > \bar{r}_t^{M,\mathrm{US}} - \mathrm{std}\left(r_t^{M,\mathrm{US}}\right) \\ 0 \;\; if \;\; r_t^{M,\mathrm{US}} < \bar{r}_t^{M,\mathrm{US}} - \mathrm{std}\left(r_t^{M,\mathrm{US}}\right) \end{cases}, \quad t = 1, \ldots, T \tag{19}$$

and

$$\mathrm{down}_t = \begin{cases} 1 \;\; if \;\; r_t^{M,\mathrm{US}} < \bar{r}_t^{M,\mathrm{US}} - \mathrm{std}\left(r_t^{M,\mathrm{US}}\right) \\ 0 \;\; if \;\; r_t^{M,\mathrm{US}} > \bar{r}_t^{M,\mathrm{US}} - \mathrm{std}\left(r_t^{M,\mathrm{US}}\right) \end{cases}, \quad t = 1, \ldots, T \tag{20}$$

where $\bar{r}_t^{M,\mathrm{US}}$ denotes the mean US market return and $\mathrm{std}(r_t^{M,\mathrm{US}})$ the standard deviation of the market return over the sample period. In case of the Lettau et al. (2014) definition of downside risk, only 26 dates in our baseline sample qualify as downside risk states. The performance of this downside risk model specification is very similar to the estimates provided in Tables 2 and 3. The detailed results are provided in the Online Appendix.

We also assessed the sensitivity of our results to the choice of stock market indexes. All of our empirical findings remain unaltered if we use the CRSP value-weighted stock market index for the US instead of the respective MSCI index. Moreover, we experimented with the MSCI World price index, i.e. excluding dividend payments, and the MSCI World index only including developed markets. The particular choice of the World index has no influence on our qualitative results.

5.3. Currency portfolios: global downside risk vs carry trade risk

5.3.1. Currency portfolios based on global downside risk exposure

As a double-check of our cross-sectional pricing exercises we examine if portfolios formed according to global downside risk exposure exhibit the positive relation between sensitivity to global downside risk and average currency returns that our cross-sectional pricing tests suggest. Cochrane (2011) highlights that the formation of asset return portfolios according to specific characteristics (e.g. size or the ratio of book equity to market equity in the case of stock returns) is equivalent to non-parametric cross-sectional regressions. While splitting currencies in developed and emerging countries samples results in a significant reduction in degrees of freedom, the portfolio formation approach is better suited to assess the relative importance of developed and emerging market currencies compared to cross-sectional regressions.

In addition, portfolio formation also helps to address a further important issue. As has been highlighted in earlier studies, it should be the covariation of exchange rate changes, $-\Delta e_t^i$, with risk factors that determines the risk premium on foreign currency investments (see e.g. Lustig and Verdelhan, 2007 and Burnside et al., 2011). We thus sort currencies into high or low global downside risk portfolios according to the sensitivity of the respective log exchange rate changes to global downside risk. Then we form currency portfolios based on a hypothetical investment strategy which goes long in the high global downside risk portfolio currencies and short in the low global downside risk portfolio currencies. In principle, this kind of strategy could be exploited by investors. We highlight in the robustness check section that the cross-sectional fit of the downside risk model is not improved by allowing for time-variation in the sensitivity to the different market return components. Hence, the average downside risk exposure should suffice as a signal of excess returns on currency pairs. Moreover, since the upside/downside risk definition used in this paper rests on negative or positive market returns, an investor equipped with information about the average downside risk sensitivities and an indicator of future stock market returns could exploit this information for an investment strategy. For example, Nitschka (2013) shows that momentum in stock market returns – the observation that positive (negative) stock market returns tend to predict positive (negative) stock market returns in the near future– can be exploited to form currency portfolios that display significant spreads in average currency returns.

To form currency portfolios based on exposure to global downside risk, we regress $-\Delta e_t^j$ for each currency j on the contemporaneously measured four different market return components as in Equation (15) to obtain the exchange rates' analogues of the sensitivities in Equations (9)–(12). We work with the same sample period running from January 1999 to March 2013. Table 4 reports these sensitivities along with the corresponding Newey–West corrected standard errors (Newey and West, 1987).

Based on these full sample betas we form two portfolios based on the exposure to global downside risk. One portfolio consists of the five currencies with the highest downside risk beta over the whole sample period and another portfolio consists of the five currencies with the lowest downside risk beta over the sample period. We compute returns on a zero-cost portfolio resulting from an investment strategy with a long position in the high global downside risk portfolio and a short position in the low global downside risk currency portfolio. The excess returns in the portfolios are equally weighted averages of the country-level excess returns as is common in the literature on currency portfolios sorted on interest rate differentials. In addition, to sharpen the risk-return estimates we deliberately focus on the two extreme portfolios. The most significant spread in currency portfolio returns is found between the extreme portfolios (Lustig and Verdelhan, 2007; Lustig et al., 2011).

Panel A of Table 5 presents the mean excess returns on the two portfolios separately, their return differential and the associated standard errors of these portfolio returns in parentheses below the mean returns. All moments are expressed in % p.a. The high downside risk portfolio consists of returns relative to the currencies of Australia, Hungary, Poland, New Zealand and South Africa. The low global downside risk portfolio consists of returns on currencies of Denmark, Japan, Kuwait, Saudi Arabia and Switzerland. A long position in the high global downside risk portfolio delivers an annualized excess return of close to 4.8% p.a. while shorting the low global downside risk beta currencies gives a return of −1.9% p.a. such that going long in high and short in low global downside risk currencies promises a return of about 6.6% p.a. The standard errors indicate that the mean returns are statistically different from zero. This sorting exercise confirms our baseline results for currency pairs which suggest that global downside risk is priced in currency excess returns. We show in the Online Appendix that this result also holds for unconditional currency excess returns and when alternative numeraire currencies other than the US dollar are used for this purpose.

Panel B of Table 5 gives the corresponding statistics when we focus on the twelve currencies from developed markets. In this case we use three extreme currencies to form the high and low global downside risk portfolios.[7] Evidently, both the low and the high global downside risk portfolio returns are not distinguishable from zero. As a result, the strategy to go long in the high global downside risk portfolio and short in the low global downside risk portfolio delivers a return that is statistically not

[7] The high global downside risk portfolio then contains the returns on currencies of Australia, New Zealand and Sweden. The low global downside risk portfolio comprises currencies of Denmark, Japan and Switzerland.

Table 4
Estimates of sensitivities to market return components (the negative of unconditional, log exchange rate changes).

	$\widehat{\beta}_{up}^{j,specific}$	$\widehat{\beta}_{down}^{j,specific}$	$\widehat{\beta}_{up}^{j,global}$	$\widehat{\beta}_{down}^{j,global}$
Australia	−0.98 (0.20)	−0.93 (0.21)	0.64 (0.07)	0.57 (0.10)
Canada	−0.52 (0.15)	−0.33 (0.17)	0.40 (0.07)	0.38 (0.06)
Czech Republic	−1.14 (0.23)	−1.35 (0.29)	0.50 (0.11)	0.26 (0.12)
Denmark	−0.97 (0.18)	−1.16 (0.24)	0.37 (0.09)	0.24 (0.10)
Euro Area	−0.91 (0.19)	−1.17 (0.24)	0.38 (0.09)	0.24 (0.10)
Hong Kong	−0.01 (0.01)	−0.01 (0.01)	0.01 (0.01)	−0.00 (0.01)
Hungary	−1.24 (0.21)	−1.16 (0.35)	0.51 (0.13)	0.51 (0.16)
India	−0.48 (0.11)	−0.50 (0.21)	0.24 (0.06)	0.24 (0.05)
Japan	−0.01 (0.28)	−0.55 (0.28)	0.11 (0.10)	−0.12 (0.12)
Kuwait	−0.07 (0.03)	−0.14 (0.07)	0.03 (0.02)	0.05 (0.03)
Mexico	−0.00 (0.17)	−0.23 (0.23)	0.34 (0.08)	0.46 (0.11)
New Zealand	−0.84 (0.22)	−0.90 (0.29)	0.53 (0.08)	0.53 (0.11)
Norway	−0.76 (0.18)	−1.26 (0.25)	0.44 (0.09)	0.31 (0.12)
Philippines	−0.20 (0.14)	−0.43 (0.22)	0.18 (0.06)	0.14 (0.04)
Poland	−0.98 (0.23)	−1.14 (0.32)	0.70 (0.11)	0.50 (0.14)
Saudi Arabia	0.00 (0.00)	−0.02 (0.01)	0.00 (0.00)	−0.00 (0.00)
Singapore	−0.38 (0.12)	−0.40 (0.14)	0.22 (0.05)	0.18 (0.05)
South Africa	−1.11 (0.25)	−1.03 (0.30)	0.53 (0.13)	0.56 (0.12)
Sweden	−0.56 (0.21)	−1.08 (0.24)	0.55 (0.08)	0.40 (0.10)
Switzerland	−0.96 (0.22)	−1.35 (0.30)	0.29 (0.08)	0.12 (0.11)
Taiwan	−0.22 (0.09)	−0.32 (0.09)	0.20 (0.04)	0.13 (0.04)
Thailand	−0.35 (0.18)	−0.40 (0.24)	0.23 (0.07)	0.17 (0.05)
United Kingdom	−0.81 (0.19)	−0.78 (0.18)	0.30 (0.05)	0.15 (0.10)

Notes: This table provides estimates of the sensitivities of the negative of unconditional, log exchange rate changes to US-specific and global components of the US market return in upside and downside states. A downside state is defined as periods with the market return being negative. If the market return is above this level, it is considered to be an upside risk state. Newey–West (1987) corrected standard errors appear below the estimates in parentheses. The sample period runs from January 1999 to March 2013.

significantly different from zero. Since the portfolio formation is based on the exposure of exchange rate returns on the four market return components, this finding suggests that the developed markets' excess returns are driven by the interest rate differentials rather than the exposure of exchange rates to standard risk factors. This observation is in line with the criticism of recent risk factor based explanations of currency returns by Burnside (2011) and Burnside et al. (2011) and evidence by Hassan and Mano (2013). While we do not think that this evidence invalidates the explanatory power of the downside risk model as such, it highlights that the downside risk explanation of currency excess returns is not an unambiguous success but deserves further scrutiny.

The picture is fundamentally different when we focus on the extreme downside risk currencies from the emerging markets sample.[8] Panel C of Table 5 shows that the return differential between the portfolios of high and low global downside risk sorted currency portfolios is larger and statistically

[8] In this case, the high global downside risk currency portfolio comprises currencies of Hungary, Poland and South Africa. The low global downside risk portfolio covers currencies of Kuwait, Saudi Arabia and Taiwan.

Table 5
Currency portfolios sorted by global downside risk beta of unconditional exchange rate changes.

	High beta	Low beta	High minus Low
Panel A: full country sample			
Mean excess return (% p.a.)	4.75 (3.35)	−1.89 (1.45)	6.64 (4.43)
Panel B: developed markets sample			
Mean excess return (% p.a.)	3.10 (3.13)	−1.37 (2.25)	4.47 (4.97)
Panel C: emerging markets sample			
Mean excess return (% p.a.)	4.77 (3.68)	−2.15 (0.61)	6.93 (4.00)

Notes: This table presents mean excess returns and standard errors of currency portfolios sorted according to the exposure of unconditional, log exchange rate changes to the global downside risk component of the US market return as presented in Table 4. The sample period runs from January 1999 to March 2013. We report excess returns on long positions in the high beta portfolios and short positions in the low beta portfolios. Standard errors of the mean returns are in parentheses. In the full sample of countries (Panel A), the high global downside risk beta portfolio comprises currencies of Australia, Hungary, Poland, New Zealand and South Africa. The low downside risk portfolio consists of currencies of Denmark, Japan, Kuwait, Saudi Arabia and Switzerland. In the developed (Panel B) and emerging markets sample (Panel C), we use only three currencies to form the high and low global downside risk portfolios. In the case of the developed markets sample, the high beta portfolio contains currencies of Australia, New Zealand and Sweden. The low global downside risk portfolio comprises currencies of Denmark, Japan and Switzerland. In the case of the emerging markets sample, the high beta portfolio comprises currencies of Hungary, Poland and South Africa. The low beta portfolio contains currencies of Kuwait, Saudi Arabia and Taiwan.

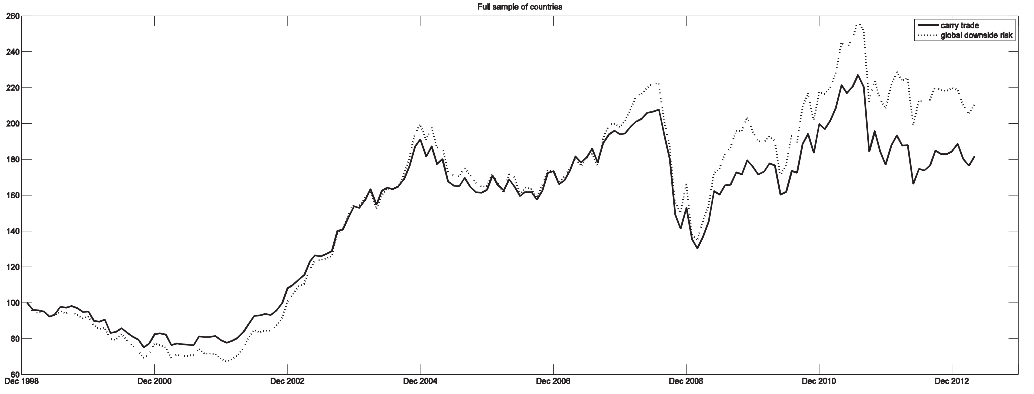
significant. Exposure of exchange rate returns to the global downside risk appears to be a good explanation of average excess returns on these currencies. In this country sample the relation between exchange rate changes and risk factors is in line with asset pricing theory.

In sum, the portfolio formation exercise confirms that the exposure to global downside risk is compensated in average currency excess returns. In addition, it suggests that the global downside risk explanation of average currency excess returns is primarily driven by the emerging markets in our sample.

5.3.2. Global downside risk vs carry trade risk

The payoff from a typical carry trade strategy appears to be fundamentally different from the payoff of a stock market investment (e.g. Burnside et al., 2007; Burnside et al., 2011). Yet, less is known about the relation between payoffs from the carry trade relative to a global downside risk based strategy. To investigate this question we compare the payoffs from the global downside risk sorted currency portfolios from the previous subsection with currency portfolios sorted according to interest rate differentials from the same 23 currencies under study. We distinguish between a high and a low interest rate differential portfolio and rebalance these portfolios every month based on the past month's forward discounts. Analogously to the global downside risk portfolios we allocate the currencies with the five highest interest rate differential markets into the high interest rate portfolio and the currencies with the five lowest interest rate differential markets into the low interest rate portfolio. Fig. 1 plots the cumulative payoff from a carry trade strategy which goes long in the high interest rate currencies and short in the low interest rate currencies against the cumulative payoff from a strategy based on portfolios formed according to currencies' global downside risk sensitivity from the previous subsection. The payoffs are normalized at the beginning of the period to 100, and the returns are cumulated under the assumption that the proceedings of the strategies are reinvested at each point in time. Notice that these payoffs take implicitly the transaction costs into account as the underlying investment strategies are long in the high interest rate or high global downside risk currencies and short in the low interest rate or low global downside risk currencies respectively.

Judged by Fig. 1, the payoffs of the two strategies are highly correlated. In fact, the asset pricing horse race tests between the downside risk model and other currency risk models in Dobrynskaya (2014) and Lettau et al. (2014) leave a similar impression. This evidence suggests that risks underlying a typical carry trade strategy on the one hand and a downside risk based investment strategy are closely related to each other. Fig. 1 is another way to highlight that carry trade strategies are linked to standard risk factors conditional on market upturns and downturns. Downside risk models hence appear an appropriate tool to relate carry trades return explanation to conventional risk factors in the standard asset pricing literature.

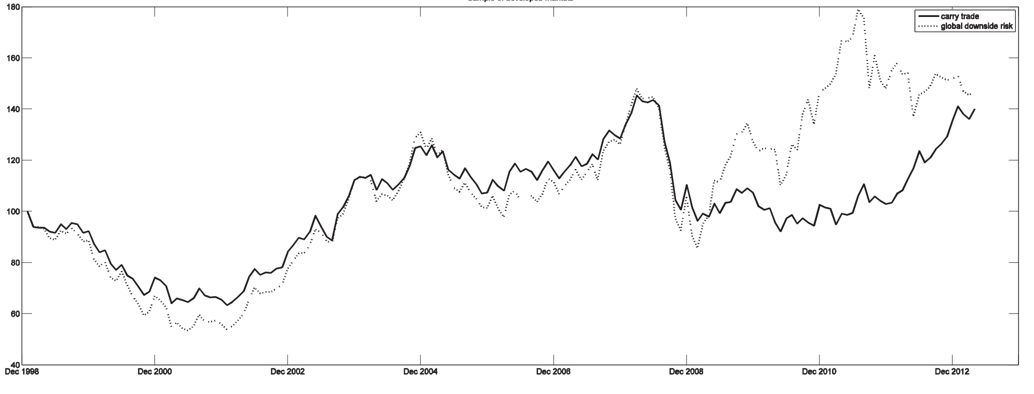


Notes: The figure plots the normalized cumulative payoffs from a typical carry trade strategy which goes long in high interest rate currencies and short in low interest rate currencies against an investment strategy which goes long in high downside risk currencies and short in low downside risk currencies over the sample period from January 1999 to March 2013. The underlying 23 currencies are listed in Table 1. The solid line represents the carry trade payoff while the dotted line gives the downside risk payoff.

Fig. 1. Payoff from investment strategies based on carry trade or global downside risk (full sample of developed and emerging markets).

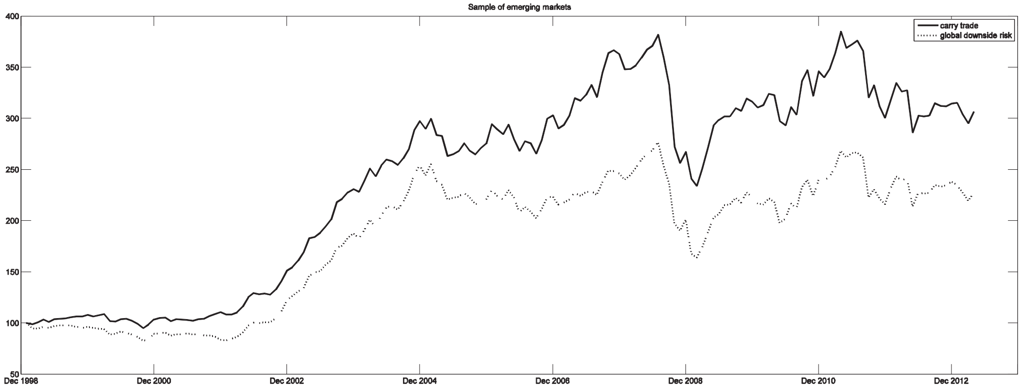
Does the distinction between developed and emerging markets matter in this respect? Fig. 2 gives the corresponding payoffs from carry trade against the global downside risk strategies when we focus on the subsample of developed markets only. Again, there is a close relation between the two payoffs until the collapse of Lehman brothers in late 2008. Consistent with Brunnermeier et al. (2009), the payoff from the carry trade deteriorates significantly during this period. This is not true for the payoff of the global downside risk strategy. Hence, the two payoffs diverge substantially from 2009 to 2012. Only in the last months of our sample did the payoffs reach similar levels again.

Fig. 3 demonstrates that the link between the typical carry trade and a global downside risk strategy is relatively loose for the emerging markets under study at least since 2005. For these currencies the



Notes: The figure plots the normalized cumulative payoffs from a carry trade strategy against a downside risk strategy for developed markets' currencies. The solid line represents the carry trade payoff while the dotted line gives the downside risk payoff.

Fig. 2. Payoff from investment strategies based on carry trade or global downside risk (developed markets only).



Notes: The figure plots the normalized cumulative payoffs from a carry trade strategy against a downside risk strategy for emerging markets' currencies. The solid line represents the carry trade payoff while the dotted line gives the downside risk payoff.

Fig. 3. Payoff from investment strategies based on carry trade or global downside risk (emerging markets only).

payoff from the carry trade strategy is about 50% higher than that of the global downside risk strategy over our sample period. This evidence is in line with Burnside et al. (2007) who show that the profitability of carry trade strategies can be greatly improved once emerging market currencies are taken into account.

6. Conclusions

We have proposed a downside risk model, i.e. a variety of the CAPM which distinguishes between country-specific and global market risk in times of bull (upside) and bear (downside) market returns, to specifically assess if differences in the sensitivity to the global or country-specific risk market return components explain average conditional and unconditional, bilateral currency excess returns. Our asset pricing results suggest that the global downside risk obtains a significant compensation in a cross-section of 23 excess returns on developed and emerging markets' currencies over the sample period from January 1999 to March 2013.

By forming currency portfolios based on bilateral exchange rates' sensitivity to the global downside risk component of the US market return, we show that emerging markets' currencies are mainly responsible for the success of the downside risk model under study. In addition, the assessment of the differences between investment strategies based on interest rate differentials and exposure to global downside risk also reveals important differences between developed and emerging markets' currencies. Our findings thus suggest that a closer examination of the risks associated with investments in emerging markets' currencies could be a fruitful avenue for future research.

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Determinants of Exchange Rates. The views expressed in this paper do not necessarily reflect the view of the Swiss National Bank. Any errors and omissions are our own.

Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.jimonfin.2014.06.006.

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