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Downside Risk and Flight to Quality in the Currency Market

by

Victoria Dobrynskaya

(London School of Economics)

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Victoria Dobrynskaya[▲*]

Abstract

Some currencies systematically crash together with the stock market, while others serve as a 'safe haven'. This paper studies which country macroeconomic fundamentals are consistently related to the riskiness of its currency. I look at various macroeconomic variables and find that high real interest rates in a country are associated with high downside risk of its currency, while inflation rate, nominal interest rate and other variables are not that relevant. But to be a 'safe haven' currency, both low real interest rate and low inflation rate are required. I suggest that there is a 'flight to quality' in the currency market when the stock market goes down.

JEL classification: G11, G15, F31

Keywords: currency risk, downside beta, crash risk, carry trades

▲ London School of Economics, Houghton St. London WC2A 2AE, and Center for Advanced Studies of Higher School of Economics, 11, Pokrovsky Boulevard, Moscow. E-mail: v.v.dobrynskaya@lse.ac.uk, tel: +44(0)7765595504.
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Introduction

If currencies serve as investment assets, for a diversifying investor the correlation of exchange rates with the stock market (or the market beta) is important. A growing volume of empirical evidence suggests that currency returns are not random. Some currencies tend to co-move with the stock market, especially on the downside, while others seem to be immune to stock market changes and, hence, can serve as a hedging instrument. In this paper I study whether there is a systematic relationship between a country's macroeconomic fundamentals and the stock market risk of its currency. I try to answer the question: which currencies tend to crash when the stock market goes down and which currencies serve as a 'safe haven'?

The relationship between stock market returns and exchange rate movements has been explored in Campbell et al. (2010) and Ronaldo and Söderlind (2009) for the currencies of several developed countries. Campbell et al. (2010) find a consistent positive correlation of the Australian dollar and the Canadian dollar with the global equity markets and a negative correlation of the euro and the Swiss franc (the Japanese yen, the British pound and the US dollar fall in the middle of the two extremes). A high-frequency analysis in Ronaldo and Söderlind (2009) uncovers a similar pattern: the Swiss franc and the Japanese yen (and to a lesser extent the euro) appreciate when the US stock market goes down, while the opposite is observed for the British pound. The 'safe haven' properties of the Swiss franc and the Japanese yen are confirmed in periods of political, natural or financial disasters.

Rather than looking at few particular currencies, I take a sample of 50 developed and emerging countries and look at their various macroeconomic variables to identify which country macroeconomic variables (if any) are consistently associated with the market risk of its currency. I perform the analysis for single currencies as well as for portfolios of currencies sorted by some particular characteristic. I find that the level of the real interest rate in an economy explains the cross-section of currencies' market risk much better that any other macroeconomic variable studied. Currencies of countries with high real interest rates have high stock market betas, downside betas

and coskewness with the stock market while low real interest rate currencies have low and insignificant stock market risk. Local nominal interest rates and inflation also have high explanatory power, but it vanishes once the real rates are taken into account. Other macroeconomic variables seem to be unrelated to currencies' market risk.

These findings suggest that there is 'flight to quality' in the currency market: when the stock market goes down or its volatility increases, investors withdraw funds from currencies with high default risk, as signaled by high local real interest rates, and transfer them to relatively safe currencies with low real interest rates or other assets. This leads to high stock market betas and negative coskewness of the former currencies and insignificant (sometimes even negative) betas of the latter currencies.

My findings shed some light on why a carry trade is a very risky investment strategy. A carry trade – borrowing in low nominal interest rate currencies and investing in high nominal interest rate currencies – generates high excess returns which are negatively skewed (Brunnermeier et al., 2008), have high stock market beta (Lustig and Verdelhan, 2010) and an even higher downside market beta (Dobrynskaya, 2010). Since nominal interest rates can be high due to high real interest rates, high inflation rates or both, I decompose nominal interest rates into inflation and real interest rates and show that currencies with the same level of real interest rates but different inflation rates have the same stock market risk, while, controlling for inflation, currencies with higher real interest rates have much higher market risk. Therefore, the high downside market risk of carry trades turns out to be a consequence of high real interest rates in investment countries and low real interest rates in the funding countries, rather than the nominal interest rates. If the carry trade portfolio were sorted by the real interest rates rather than the nominal ones, its downside risk would be even higher.

The paper is organized as follows. In section 1 I describe the data. In section 2 I show that there are indeed significant differences in the stock market risk of various currencies. Section 3 lays out the main results for currency portfolios sorted by various macroeconomic fundamentals. Section 4 is devoted to a cross-section regression analysis of individual currencies. Section 5 concludes.

1. Data

The data covers the period from January 1990 until April 2009 at a monthly frequency. The sample of countries consists of 50 developed and emerging economies with floating or managed floating exchange rate regimes and significant volume of currency turnover, according to BIS (2007). The full list of countries and the respective periods of available data are provided in the appendix.

For each country, I collect the three-month Treasury bill rate (or the return of a comparable instrument), the CPI inflation rate and the exchange rate against the US dollar. An increase in the exchange rate means an appreciation of the respective currency against the US dollar. The source of the data is the Global Financial Database.

To study the stock market risk of currencies, I also collect data on the US stock market returns. MSCI US index serves as a proxy for the US stock market index.

2. Downside risk of currencies

In this section I show that stock market risk is indeed an important type of currency risk and how market risk varies across currencies. I use three measures of market risk: market beta, downside market beta and coskewness with the stock market. Downside beta shows how a currency's exchange rate changes when the global stock market goes down and it is estimated in the following regression:

$$\Delta er_{jt} = \alpha_j + \beta_j r_{mt} + \delta_j dummy_t * r_{mt}$$

where Δer_{jt} is the exchange rate return of asset j, r_{mt} is the stock market return, $dummy_t = \begin{cases} 0, r_{mt} < 0 \\ 1, r_{mt} > 0 \end{cases}$ and β_j is the estimate of downside beta. A positive value of β_j means that the currency usually depreciates when the stock market return is negative, and a higher value of β_j reflects a higher downside risk of a currency.

Coskewness with the stock market shows how a currency's exchange rate changes in periods of high stock market volatility and, hence, is not conditional on the downside. But since high volatility is usually observed when the stock market goes down, and not up, coskewness can also measure the downside risk. I estimate coskewness in the following regression:

$$\Delta er_{jt} = \alpha_j + \gamma_j r_{mt}^2$$

where γ_j is the estimate of coskewness. A negative value of γ_j means that the currency usually depreciates when the volatility of the market return is high.

The range of downside betas of individual currencies is wider than the range of standard betas. During 1990-2009, the lowest downside beta of -0.1 is observed for Japanese yen, while the highest downside beta of 0.42 is observed for Turkish lira. During 1999-2009 the downside risk has increased for all currencies, but the same currencies are on the edges of the range with downside betas of -0.04 and 0.71, respectively. Other countries with the highest downside risk of their currencies are Brazil, Australia, Iceland and New Zealand. The full list of currencies and their downside betas is presented in Appendix 2.

Since individual currency downside betas can be measured with errors, to get a more reliable picture of the downside risk in the currency market I sort all currencies by their individual downside betas, form five equally-weighted portfolios and estimate the risk measures for these portfolios. Then measurement errors should be cancelled out if the portfolios are diversified enough. Table 1 presents the characteristics of the five portfolios (portfolio with a higher rank contains currencies with higher downside betas).

[Table 1 somewhere here]

The range of downside betas is wider than the range of standard betas in the both samples, and this is not due to the sorting procedure. If I sort all currencies by their standard betas into

portfolios and estimate downside betas for these portfolios, I also obtain a wider range of downside betas. Therefore, downside risk is more pronounced in the currency market. Currencies in the top portfolios systematically depreciate when the stock market performs poorly, while currencies in the bottom portfolio generally do not react to the stock market dynamics and can serve as a hedging instrument.

The last decade is marked by a greater downside risk of currencies with high betas. For example, downside betas and coskewness of the fifths portfolio are almost twice as high as they were in 90s. This is a sign of a greater interdependence of the currency and the stock markets.

3. Macroeconomic fundamentals and downside risk

In this section I study which country macroeconomic fundamentals are systematically related to the high downside risk of its currency. Specifically, I look at nominal interest rates, inflation and real interest rates[1]. To minimise the measurement errors of betas, I estimate betas of portfolios of currencies sorted by each macroeconomic variable, rather than individual currencies. Every month, all currencies are sorted by a variable and split into five portfolios so that portfolio one contains 20 percent of currencies with the lowest value of the variable in the respective month and portfolio five contains 20 percent of currencies with the highest value of the variable. If a variable is indeed systematically related to the market risk of currencies, sorting by this variable would produce the highest range of betas and coskewness because, for instance, portfolio five would always pick the currencies with the highest value of the variable in the respective period and, hence, the highest market risk. Since macroeconomic variables and the currency risk vary with time, periodic rebalancing should result in the most striking differences between the risks of portfolios. We should also find a monotonic relationship between the risk measures and portfolio rank if the sort variable is a relevant one.

[1] I have also looked at the GDP growth and the degree of openness, measured by the volume of exports to GDP. These variables proved to have no relation to the market risk of currencies. The results are available upon request.

Table 2 shows various risk measures of currency portfolios sorted by nominal interest rate, inflation rate and real interest rate. The average value of the sort variable for each portfolio is presented in the first line of each panel. The last line of each panel shows the average number of currencies in each portfolio.

The second line shows the average monthly appr-/depreciation of each currency portfolio. The general tendency is that currencies with higher nominal interest rates, inflation and real interest rates tend to depreciate against the US dollar, on average, while currencies with low values of these variables tend to appreciate. Particular monotonicity is observed for inflation rate sorting, which is not surprising because a high inflation rate almost automatically leads to a depreciation of the currency in this country. But there is no such monotonicity in panel C where portfolios one and five have the lowest levels of exchange rate returns. In other words, currencies with the highest and the lowest (negative) real interest rates tend to depreciate more than currencies with moderate real interest rates.

Turning to the riskiness of these portfolios, I look at three measures of stock market risk of currencies: market beta, downside beta and coskewness. While beta has been the most common measure of market risk of various financial instruments since the invention of the CAPM, downside beta and coskewness are more relevant because they show relative performance of an asset in adverse states of the world when the marginal utility of financial wealth is particularly high and asset returns are particularly important to investors. Downside beta is restricted to periods of negative returns of the stock market, while coskewness is conditional on high stock market volatility. Several studies show that downside beta and coskewness have high explanatory power of returns in the stock market (Ang et al., 2006, and Harvey and Siddique, 2000) and currency market (Dobrynskaya, 2010).

[Table 2 somewhere here]

In all three panels the market risk of portfolios is increasing with the portfolio rank, and hence all three sort variables are to some degree related to the riskiness of currencies. The ranges of downside betas are always wider than the ranges of betas, suggesting that currencies of countries with high nominal and real interest rates and inflation tend to depreciate more on the downside while currencies of countries with low values of these variables tend to depreciate less on the downside and hence are rather immune to adverse stock market conditions. The same conclusion can be drawn for coskewness. Coskewness of the first portfolios is close to zero and statistically insignificant which means that such currencies do not crash in periods of high stock market volatility. Coskewness of the top portfolios is, on the contrary, very low and statistically significant. Therefore, adding such currencies to a diversified market portfolio would worsen the skewness of the resulting portfolio.

Comparing across the sort variables, we do not see significant differences. The ranges of betas, downside betas and coskewness are very similar in the three panels. For instance, the riskiest portfolios in each panel (portfolios ranked 5) have betas of 0.24, 0.19 and 0.31 and downside betas of 0.3, 0.25 and 0.31. Sorting by inflation rate produces the lowest range of market risk of the extreme portfolios, which suggests that inflation is the least relevant variable for explaining the market risk. Sorting by real interest rates, on the contrary, produces the highest range of betas. Portfolio five in panel C has the highest beta and downside beta (0.31) than any other portfolio in Table 2, and hence it contains the most risky currencies. Therefore, real interest rates seem to have the greatest explanatory power for the differences in the market risk of currencies. A portfolio of currencies with the highest nominal interest rates also has very high downside beta (0.3), which is in line with the findings in Dobrynskaya (2010). Table 2 suggests that this is probably due to the high real interest rates in these countries, rather than the nominal ones[2].

To test the robustness of these results over time, I repeat the same exercise for the first decade of the 21 century separately. Table 3 presents the statistics of the portfolios in this recent subsample. Inflation rates

[2] A nominal interest rate is approximately a sum of a real interest rate and an inflation rate.

and, hence, nominal interest rates of the high-ranked portfolios have decreased significantly. But the market risk has increased. For any sort variable and any portfolio, the betas and coskewness are almost twice as high as they were previously.

For inflation rate sorting, portfolio five has much lower average inflation rate but a higher downside risk. This signals the irrelevance of inflation rate for the market risk. Moreover, sorting by inflation leads to lower downside risk of the top portfolios than sorting by the nominal and real interest rates.

The highest market risk is again observed for the portfolio of currencies with the highest real interest rates. The portfolio downside beta of 0.52 is the same as the downside beta of portfolio five in Table 1. Hence, currencies with the highest real interest rates are the ones with the highest downside risk. But we cannot say the opposite about currencies with the lowest real interest rates. The downside beta of portfolio one in panel C of Table 3 (0.2) is much higher than the downside beta of portfolio 1 in Table 1 (0.03). It is also higher than the downside betas of the first portfolios in panels A and B. Therefore, low (negative) real interest rates do not ensure low market risk of currencies. Having low real interest rates is not a sufficient condition for a currency to be a 'safe heaven'.

[Table 3 somewhere here]

Since all three sort variables are closely related, in order to separate the effects of real interest rates and inflation, I use the following double sorting procedure. First, all currencies are sorted by inflation rate into three portfolios. Then, currencies of each portfolio are sorted by real interest rates and split again into two portfolios. As previously, the portfolios are rebalanced every month. The descriptive statistics of the six portfolios is presented in Table 4.

[Table 4 somewhere here]

If real interest rates and inflation rates were orthogonal to each other, portfolio pairs one and two, three and four, five and six would have similar average inflation rates but different average real

interest rates. This is indeed true for portfolios one to four. But the average inflation rate of portfolio five is much higher than that of portfolio six. It means that countries with very low (negative) real interest rates tend to be the ones with the highest inflation rates. The average nominal interest rates of portfolios five and six are similar, and hence we can see the effect of the real interest rate on the market risk clearly.

Betas and especially downside betas of portfolios one, three and five are much lower than those of portfolios two, four and six, respectively. For instance, beta and downside beta of portfolio six (0.29 and 0.36 respectively) are three times as high as those of portfolio five (0.09 and 0.12 respectively). In all three portfolio pairs, portfolios with higher real interest rates have much higher market risk. The same conclusion can be drawn from looking at coskewness of portfolio pairs.

To determine whether inflation rate is related to the market risk of currencies, we should look across portfolio pairs. Higher inflation rate is somewhat related to higher market risk, but this relationship is not that strong. The average inflation rate of portfolio five (34.69 percent p.a.) is approximately nine times as high as the average inflation rate of portfolio three (3.96 percent p.a.), but the market risk of these portfolios, measured in whatever way, is the same. The market risk of portfolio six is three times as high as that of portfolio five, but its inflation rate is lower. Portfolio four also has much lower inflation rate than portfolio five but it has higher betas and lower coskewness. Hence, we hardly see any monotonic effect of inflation on the market risk of currencies.

Moreover, the market risk of portfolio six is higher than that of any portfolio in Table 2. Also, the downside risk of portfolio six is higher than the downside risk of portfolio five in Table 1, which, by definition, contains currencies with the highest downside betas. But portfolios in Table 1 are not rebalanced, while portfolios in Table 4 are. If a currency's market risk is changing over time with the changing macroeconomic conditions, regular rebalancing would always pick currencies with the highest contemporary risk and, hence, the average downside beta would be higher. This is what we observe in Table 4. By separating the effects of inflation and real interest rate, we have

managed to identify the currencies with the highest level of downside risk. These are the currencies with the highest real interest rates.

The study of the last decade even reinforces this finding. In each portfolio pair, the average inflation rate of the portfolios is approximately the same, but the market risk increases significantly with higher real interest rates.

But low real interest rates do not ensure 'safe heaven' properties. Portfolio with the lowest average real interest rate in the both periods is portfolio five. This portfolio has high average inflation rate and rather high downside risk. The lowest downside risk, though, is observed for portfolio one, which has both low real interest rate and low inflation rate. Consequently, this portfolio also has the lowest nominal interest rate. But it is not the low nominal interest rate per se which ensures low downside risk, because portfolio one in panels A of Tables 2 and 3 had higher downside risk. Low nominal interest rate can be a consequence of high inflation rate and a negative real interest rate in the economy, but such currencies have rather high market risk. Therefore, to be a 'safe heaven' currency, both low inflation rate and low real interest rate are required.

Since countries with high real interest rates are considered to have high default risk and these currencies also have the highest downside risk, we can conclude that there is 'flight to quality' in the currency market. When the general market conditions worsen, investors sell currencies of countries with high real interest rates because of their high default risk (which increases further in such states) and accumulate currencies of countries with low real interest rates and low inflation rates. This results in high downside risk of the former currencies and zero (insignificant) downside risk of the latter currencies.

4. Cross-section analysis

This section is devoted to a cross-section analysis of downside risk of individual currencies, rather than portfolios of currencies. The sample period is restricted to 1999-2009 due to the absence of data for some emerging countries in the earlier years. I regress downside market betas on various

macroeconomic variables to determine which one possesses the greatest explanatory power for the cross-section of the downside risk.

Table 5 presents the regression coefficients, their t-statistics and R^2 of alternative specifications. Although higher nominal interest rate, inflation and real interest rate are all associated with higher downside betas, the real interest rate has the greatest explanatory power, as evidenced by R^2. Its explanatory power is twice as high as that of inflation rate. Inflation and real interest rate together explain 45 percent of the variance of the downside beta. The nominal interest rate alone is not that powerful, and hence disentangling the nominal interest rate into inflation and real interest rate is important.

[Table 5 somewhere here]

Controlling for the degree of openness in specifications (5) and (6), proxied by export-to-GDP ratio[3], further improves the fit of the regression. Export-oriented countries tend to have lower market risk of their currencies, ceteris paribus.

5. Conclusion

Several studies have shown that some particular currencies serve as a 'safe haven' (Campbell et al., 2010, Ronaldo and Söderlind, 2009). In this paper I show that these currencies have two common features – low inflation and low real interest rates. Currencies which tend to crash with the stock market are, on the contrary, those with the highest real interest rates. This suggests that there is a 'flight to quality' in the currency market in periods of adverse stock market movements. Other macroeconomic variables do not seem to play a significant role in explaining the market risk of currencies.

[3] Export-to-GDP ratio does not have high explanatory power alone, therefore, these results are not reported here.

These findings have important implications for portfolio choice when currencies are considered as investment assets. Although betas of currencies are generally lower than betas of stocks, currencies of countries with high real interest rates (but not necessarily with high nominal interest rates) are not attractive from the point of view of portfolio diversification. In order to reduce the overall market risk of a portfolio, investing into currencies of countries with both low real interest rates and low inflation rates is desirable, because such currencies tend to be stable or even appreciate when the stock market goes down and, hence, they can serve as a hedging instrument.

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Appendix 1. Data

Sample of countries (period of available data in the parentheses): Australia (01.90-04.09), Austria (01.90-12.90), Belgium (01.90-12.98), Brazil (01.95-04.09), Bulgaria (01.92-01.08), Canada (01.90-04.09), Chile (07.97-04.09), China (01.02-04.09), Cyprus (01.90-12.07), Czech Republic (08.93-04.09), Denmark (01.90-07.07), Euro Zone (02.99-04.09), France (01.90-12.98), Germany (01.90-12.98), Greece (01.90-12.00), Hong Kong (06.91-04.09), Hungary (01.90-04.09), Iceland (01.90-04.09), India (01.93-04.09), Indonesia (02.00-12.03), Ireland (01.90-12.98), Italy (01.90-12-98), Japan (01.90-04.09), Latvia (05.94-03.08), Lithuania (08.96-04.09), Malaysia (01.90-04.09), Malta (01.90-12.07), Mexico (01.90-04.09), Netherlands (01.90-12.98), New Zealand (01.90-04.09), Norway (01.90-04.09), Philippines (01.90-02.09), Poland (05.91-04.09), Portugal (01.90-12.98), Romania (03.94-09.05), Russia (07.94-04.09), Singapore (01.90-04.09), Slovakia (02.93-12.07), Slovenia (05.98-12.06), South Africa (01.90-04.09), Spain (01.90-12.98), Sweden (01.90-04.09), Switzerland (01.92-04.09), Taiwan (01.90-03.09), Thailand (01.97-04.09), Turkey (01.90-04.09), UK (01.90-04.09).

Exchange rate data have been corrected for denominations in the following cases: Mexico (01.93), Poland (01.95), Russia (01.98), Turkey (01.05), Romania (07.05).

Appendix 2. Downside betas of individual currencies

1990-2009				1999-2009			
Japan	-0,10	Thailand	0,11	Japan	-0,04	Greece	0,35
Slovenia	-0,10	Romania	0,13	Malta	-0,02	South Korea	0,35
Ireland	-0,07	India	0,14	Hong Kong	-0,01	Canada	0,36
Cyprus	-0,06	Denmark	0,15	China	0,00	Mexico	0,38
Malta	-0,06	Estonia	0,16	Cyprus	0,03	Poland	0,39
France	-0,06	Lithuania	0,20	Switzerland	0,08	Sweden	0,40
Italy	-0,05	Russia	0,22	Argentina	0,09	Indonesia	0,40
Germany	-0,05	Norway	0,22	Slovenia	0,09	Hungary	0,42
Belgium	-0,05	Slovakia	0,24	Taiwan	0,10	South Africa	0,45
Finland	-0,05	Hungary	0,24	Philippines	0,10	Chile	0,46
Spain	-0,05	Czech Rep	0,25	Singapore	0,13	New Zealand	0,47
Portugal	-0,04	Sweden	0,25	Thailand	0,14	Iceland	0,47
Netherlands	-0,04	Euro Zone	0,26	UK	0,14	Australia	0,52
Austria	-0,03	Canada	0,28	Russia	0,18	Brazil	0,69
Bulgaria	-0,02	Mexico	0,29	India	0,18	Turkey	0,71
Switzerland	-0,01	South Korea	0,29	Czech Rep	0,23		
Hong Kong	0,00	Iceland	0,30	Estonia	0,25		
China	0,02	Latvia	0,30	Lithuania	0,25		
Indonesia	0,04	South Africa	0,33	Bulgaria	0,25		
Philippines	0,07	New Zealand	0,34	Denmark	0,25		
UK	0,08	Brazil	0,34	Euro Zone	0,26		
Taiwan	0,08	Chile	0,35	Latvia	0,26		
Greece	0,08	Poland	0,37	Slovakia	0,26		
Argentina	0,09	Australia	0,39	Norway	0,32		
Singapore	0,09	Turkey	0,42	Romania	0,34		

Table 1. Risk characteristics of currency portfolios sorted by downside beta

	Pfl 1	2	3	4	Pfl 5
	1990-2009				
Average ER return (percent p.m.)	0,03	-0,29	-0,51	-0,58	-1,00
Beta	**0,01**	**0,06**	**0,11**	**0,15**	**0,28**
t-stat	[0,36]	[1,97]	[3,68]	[4,08]	[8,04]
Downside beta	**-0,10**	**0,04**	**0,12**	**0,23**	**0,34**
t-stat	[-1,66]	[0,78]	[2,33]	[3,60]	[5,83]
Coskewness	**1,28**	**-0,32**	**-0,67**	**-1,68**	**-1,91**
t-stat	[2,98]	[-0,85]	[-1,88]	[-3,78]	[-4,26]
Average number of currencies	6,49	7,80	9,50	9,25	9,94
	1999-2009				
Average ER return (percent p.m.)	0,01	-0,02	0,21	-0,11	-0,20
Beta	**0,04**	**0,14**	**0,20**	**0,34**	**0,43**
t-stat	[1,42]	[6,04]	[4,04]	[10,39]	[10,60]
Downside beta	**0,03**	**0,15**	**0,27**	**0,38**	**0,52**
t-stat	[0,64]	[3,85]	[3,36]	[6,98]	[7,84]
Coskewness	**-0,09**	**-0,94**	**-1,92**	**-2,19**	**-3,10**
t-stat	[-0,28]	[-3,34]	[-3,64]	[-4,88]	[-5,66]
Average number of currencies	7,52	8,00	7,96	7,19	8,00

t-statistics are in brackets.

Table 2. Risk characteristics of currency portfolios sorted by nominal and real interest rates and inflation 1990-2009

	Pfl 1	2	3	4	Pfl 5
Panel A: Nominal interest rate sorting					
Nom. int. rate (percent p.a.)	2,63	4,80	6,48	9,84	32,75
Average ER return (percent p.m.)	0,03	0,14	0,01	-0,23	-1,10
Beta	**0,09**	**0,13**	**0,18**	**0,21**	**0,24**
t-stat	[3,72]	[4,49]	[5,61]	[6,59]	[6,43]
Downside beta	**0,05**	**0,14**	**0,18**	**0,23**	**0,30**
t-stat	[1,27]	[2,87]	[3,35]	[4,16]	[4,75]
Coskewness	**-0,05**	**-0,86**	**-1,06**	**-1,42**	**-1,85**
t-stat	[-0,18]	[-2,52]	[-2,72]	[-3,51]	[-3,92]
Av. No of currencies	7,39	7,25	7,21	6,64	6,44
Panel B: Inflation rate sorting					
Inflation rate (percent p.a.)	0,87	2,53	4,40	8,57	186,86
Average ER return (percent p.m.)	0,05	0,00	-0,07	-0,26	-1,81
Beta	**0,11**	**0,16**	**0,18**	**0,18**	**0,19**
t-stat	[4,02]	[4,99]	[6,60]	[7,01]	[3,65]
Downside beta	**0,06**	**0,16**	**0,18**	**0,23**	**0,25**
t-stat	[1,32]	[3,01]	[3,95]	[5,29]	[2,89]
Coskewness	**-0,18**	**-0,99**	**-1,07**	**-1,45**	**-1,33**
t-stat	[-0,54]	[-2,58]	[-3,13]	[-4,56]	[-2,16]
Av. No of currencies	8,22	8,29	8,72	8,25	7,85
Panel C: Real interest rate sorting					
Real int. rate (percent p.a.)	-3,75	1,04	2,65	4,36	9,60
Average ER return (percent p.m.)	-0,23	-0,01	-0,07	-0,18	-0,93
Beta	**0,10**	**0,11**	**0,16**	**0,20**	**0,31**
t-stat	[3,85]	[3,88]	[5,90]	[6,60]	[6,98]
Downside beta	**0,09**	**0,08**	**0,15**	**0,31**	**0,31**
t-stat	[1,95]	[1,75]	[3,25]	[6,06]	[4,16]
Coskewness	**-0,43**	**-0,34**	**-0,85**	**-2,18**	**-1,79**
t-stat	[-1,32]	[-0,99]	[-2,46]	[-5,85]	[-3,18]
Av. No of currencies	7,44	7,40	7,21	6,47	5,03

t-statistics are in brackets.

Table 3. Risk characteristics of currency portfolios sorted by nominal and real interest rates and inflation 1999-2009

	Pfl 1	2	3	4	Pfl 5
Panel A: Nominal interest rate sorting					
Nom. int. rate (percent p.a.)	1,72	3,50	4,97	7,65	19,68
Average ER return (percent p.m.)	0,03	0,26	0,10	-0,18	-0,38
Beta	**0,12**	**0,18**	**0,24**	**0,27**	**0,39**
t-stat	[4,45]	[5,01]	[6,46]	[6,81]	[9,16]
Downside beta	**0,11**	**0,20**	**0,28**	**0,33**	**0,51**
t-stat	[2,50]	[3,36]	[4,57]	[5,14]	[7,40]
Coskewness	**-0,49**	**-1,33**	**-1,72**	**-2,21**	**-2,96**
t-stat	[-1,52]	[-3,23]	[-3,97]	[-4,82]	[-5,51]
Av. No of currencies	7,65	7,43	7,27	6,05	6,00
Panel B: Inflation rate sorting					
Inflation rate (percent p.a.)	0,30	2,08	3,36	5,56	16,06
Average ER return (percent p.m.)	0,08	0,07	0,11	-0,17	-0,21
Beta	**0,14**	**0,23**	**0,26**	**0,25**	**0,30**
t-stat	[4,31]	[5,82]	[7,57]	[7,25]	[8,05]
Downside beta	**0,11**	**0,26**	**0,30**	**0,29**	**0,42**
t-stat	[2,20]	[4,06]	[5,26]	[5,23]	[6,98]
Coskewness	**-0,65**	**-1,67**	**-1,81**	**-1,93**	**-2,42**
t-stat	[-1,79]	[-3,68]	[-4,25]	[-4,78]	[-5,42]
Av. No of currencies	7,25	7,87	8,00	7,85	7,06
Panel C: Real interest rate sorting					
Real int. rate (percent p.a.)	-2,10	0,69	1,92	3,60	8,49
Average ER return (percent p.m.)	0,12	0,19	0,03	-0,20	-0,44
Beta	**0,17**	**0,17**	**0,21**	**0,27**	**0,45**
t-stat	[5,45]	[4,72]	[6,32]	[6,62]	[9,30]
Downside beta	**0,20**	**0,17**	**0,22**	**0,43**	**0,52**
t-stat	[4,05]	[2,99]	[3,84]	[6,54]	[6,54]
Coskewness	**-1,15**	**-0,93**	**-1,40**	**-2,94**	**-2,97**
t-stat	[-3,21]	[-2,30]	[-3,45]	[-6,54]	[-4,74]
Av. No of currencies	7,73	7,70	7,30	6,05	4,48

t-statistics are in brackets.

Table 4. Double sorting by inflation and real interest rates

	Pfl 1	2	3	4	5	Pfl 6
	Low infl Low r	Low infl High r	Med infl Low r	Med infl High r	High infl Low r	High infl High r
	1990-2009					
Inflation rate (percent p.a.)	1,46	1,27	3,96	3,99	34,69	18,74
Real int. rate (percent p.a.)	1,40	4,46	0,93	4,85	-4,30	6,42
Nom. int. rate (percent p.a.)	2,89	5,79	4,93	9,03	28,89	26,36
Average ER return (percent p.m.)	0,13	0,00	0,08	-0,24	-0,43	-0,95
Beta	**0,09**	**0,14**	**0,12**	**0,24**	**0,09**	**0,29**
t-stat	[3,23]	[4,40]	[4,29]	[6,92]	[3,16]	[7,98]
Downside beta	**0,03**	**0,12**	**0,12**	**0,26**	**0,12**	**0,36**
t-stat	[0,64]	[2,26]	[2,58]	[4,44]	[2,34]	[5,78]
Coskewness	**0,19**	**-0,76**	**-0,72**	**-1,69**	**-0,76**	**-2,15**
t-stat	[0,54]	[-1,92]	[-2,10]	[-3,88]	[-2,13]	[-4,53]
Av. No of currencies	5,68	5,57	5,66	5,59	5,57	5,37
	1999-2009					
Inflation rate (percent p.a.)	1,16	0,77	3,28	3,32	10,84	11,59
Real int. rate (percent p.a.)	0,68	3,59	0,25	3,73	-2,26	5,70
Nom. int. rate (percent p.a.)	1,85	4,39	3,54	7,17	8,34	17,95
Average ER return (percent p.m.)	0,18	0,04	0,18	-0,15	0,00	-0,33
Beta	**0,11**	**0,18**	**0,18**	**0,33**	**0,17**	**0,42**
t-stat	[3,17]	[5,08]	[5,30]	[7,83]	[4,81]	[10,18]
Downside beta	**0,08**	**0,19**	**0,21**	**0,40**	**0,23**	**0,54**
t-stat	[1,37]	[3,19]	[3,73]	[5,86]	[4,16]	[8,07]
Coskewness	**-0,25**	**-1,24**	**-1,28**	**-2,62**	**-1,42**	**-3,24**
t-stat	[-0,63]	[-3,04]	[-3,22]	[-5,22]	[-3,68]	[-6,03]
Av. No of currencies	5,74	5,48	5,65	5,48	5,61	5,11

t-statistics are in brackets.

Table 5. Cross-section regressions for individual currencies

	Dependent variable: Downside market beta, Sample period: 1999-2009					
	1	2	3	4	5	6
Nominal interest rate	1,27					1,06
	[3,77]					[3,24]
Inflation rate		1,21		1,00	0,76	
		[2,48]		[2,45]	[1,95]	
Real interest rate			3,84	3,54	3,27	
			[3,95]	[3,90]	[3,85]	
Export-to-GDP ratio					-0,21	-0,22
					[-2,47]	[-2,39]
Intercept	0,19	0,22	0,21	0,16	0,27	0,31
	[4,95]	[5,29]	[6,18]	[4,20]	[4,66]	[5,01]
R2	0,31	0,17	0,34	0,45	0,54	0,42
Adjusted R2	0,29	0,14	0,31	0,41	0,49	0,39

t-statistics are in brackets.