A Low-Risk Strategy based on Higher Moments in Currency Markets

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ABSTRACT: I identify a new strategy in currency forward markets that exploits the predictive power of functions of higher moments of currency returns. The strategy is long in currencies whose higher return moments are low relative to past levels and short in currencies whose higher return moments are high relative to past levels. The low-risk strategy based on higher moments is not spanned by traditional currency strategies. In a sample of roughly 25 years, it provides the highest mean excess payoff and Sharpe ratio as well as the smallest drawdown in comparison to them. The profitability of the strategy is not explained by standard risk factors and limits-to-arbitrage.

KEYWORDS: low-risk anomaly, higher moments, currencies, factor portfolios

JEL-CLASSIFICATION: F31, F37, G12, G15, G17

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1 Introduction

I investigate the pricing power of higher return moments for the cross-section of currencies which is motivated as follows. First, higher moments have predictive power for the cross-section of equities which suggests that such a link might exist in other asset classes alike.[1] Second, higher moment risk is the type of risk that investors are predominantly afraid of in currency markets such that it appears worthwhile to look for investment strategies which avoid exposure to higher-order moments.[2]

I discover a novel strategy in currency forward markets that is based on the predictive power of functions of higher return moments. The strategy takes long positions in currencies whose higher return moments are low relative to past levels and short positions in currencies whose higher return moments are high relative to past levels. The low-risk strategy captures information on the cross-section of currencies that is not provided by traditional currency strategies and delivers, in comparison to them, the highest mean excess payoff[3] and Sharpe ratio as well as the smallest drawdown. The performance of the strategy can neither be explained by the standard risk factors nor by limits-to-arbitrage.

Out of a basket of 20 of the most liquid developed and emerging market currencies against USD, I construct a monthly rebalanced low-risk strategy over a period of roughly 25 years. For each currency pair, I compute the 10-th non-central, non-standardized moment of the daily, discrete currency returns of the month that precedes the rebalancing date. In that way, I obtain a higher moment for each currency pair. From that moment, I, next, subtract the average of the 10-th non-central, non-standardized moment which is estimated with a rolling windows of 60 months, subsequently referred to as formation period. Based on

[1] Evidence on the cross-sectional link between stock returns and their higher moments is e.g. provided by Amaya et al. (2015), Chang, Christoffersen, and Jacobs (2013), and Conrad, Dittmar, and Ghysels (2013).

[2] Zunft (2015) analyzes moment risk premiums for moment orders two, three and four and finds that the economic and statistical significance of the premiums in currency markets increases in moment order.

[3] If not stated otherwise, I take the perspective of a US investor. Then, an excess payoff is the USD-denominated payoff which an investor receives when he sells USD against buying another currency in forward markets. The term excess payoff is standard in the literature (see e.g. Lustig and Verdelhan (2007) and Lustig, Roussanov, and Verdelhan (2011)) and refers to the characteristic that, in excess of changes in currency spot rates, excess payoffs comprise interest rate differentials.

the cross-sectional ranking of the resulting mean-adjusted moments of order 10, I form equally weighted quintile portfolios and track their excess payoffs over the next month. The average excess payoffs of the quintile portfolios tend to increase as we move from the quintile portfolio which contains the currency pairs with the high ex-ante mean-adjusted moments (bottom portfolio) to the quintile portfolio which contains the currency pairs with the low ex-ante mean-adjusted moments (top portfolio). I examine the robustness of this finding across moment orders and formation periods. In particular, I redo the sorting exercise and consider 13 even moment orders that range between 4 and 100. At the same time, I vary the formation period which now comprises 12 months, 24 months, 36 months, 48 months, 60 months, or an expanding window. In that way, I have 78 strategies (13 moment orders × 6 formation periods) under study. Without exception, the 78 long-short portfolios deliver positive excess payoffs on average that are highly significant in 71 cases and significant in 7 cases. Finally, I define a strategy where the moment order and the formation period adapt on the monthly rebalancing dates. Out of the 78 combinations of moment orders and formation periods considered so far, the one is employed that delivered the highest average excess payoff of the long-short portfolio over the three one-month holding periods that precede the respective rebalancing date. I refer to the mean-adjusted higher moment with adaptive moment order and adaptive formation period as moment risk. My interest throughout this work lies in portfolios that are formed on moment risk and I denote the excess payoffs of the corresponding long-short portfolio by RISK.

I explore the characteristics of portfolios formed on moment risk in detail and in the context of other currency strategies. Against this background, I form equally weighted quintile portfolios on forward discounts in order implement a carry trade strategy. I also create equally weighted portfolios based on momentum as well as on the exposure to the so-called global innovations factor in currency markets that follows Menkhoff et al. (2012a). I refer to the long-short portfolios associated with these strategies as CARR, MOME, and GVOL. In a nutshell, my results reveal that the portfolios formed on moment risk are not spanned by the other strategies and compare favourably to them.

My particular findings that evolve from the comparison of the low-risk strategy with well-known currency strategies are as follows. First, average RISK amounts to 11.07 USD p.a[4] and is highly significant. Mean MOME is 7.18 USD p.a. and mean CARR and GVOL amount to 10.48 USD p.a. and 4.01 USD p.a., respectively. Second, RISK not only delivers the highest mean excess payoff but also the lowest risk in terms of standard deviation. The Sharpe ratios are 1.38 p.a. for RISK, 0.84 p.a. for MOME, 1.08 p.a. for CARR, and 0.40 p.a. for GVOL, respectively. Third, RISK has smaller drawdowns and kurtosis than the other currency strategies. Fourth, certain patterns emerge with regard to the excess payoffs of the quintile portfolios formed on moment risk. Means, standard deviations and Sharpe ratios of excess payoffs are monotonically increasing as we move from the bottom to the top portfolio whereas kurtosis and maximum annual drawdowns tend to decrease. None of the traditional currency strategies provides these patterns in a body which indicates that RISK is structurally different from other strategies. Fifth, the excess payoffs of both the top and bottom portfolio formed on moment risk are statistically significant. This is not true for the equivalent portfolios formed on volatility betas. This finding substantiates the predictive power of moment risk for the cross-section of currencies and indicates that volatility betas have less power to discriminate between outperforming and underperforming currencies. Sixth, the predictability of moment risk is valid for holding periods up to twelve months. Seventh, RISK is positively driven by both spot rate changes and interest differentials. In contrast, the performances of CARR and GVOL are positively driven by interest rate differentials and spot rate changes have a negative impact. Next, positive MOME is almost exclusively generated by movements in currency rates whereas interest rate differentials do not matter much. Thus, the performance attribution of the low-risk strategy contrasts the performance attribution of the other strategies. Eighth, the turnover of RISK is considerably higher than of CARR and GVOL and substantially lower than of MOME. The results reveal that moment risk is subject to a certain time variation and, again, that RISK is structurally different from the other strategies.

[4] If not stated otherwise, transaction costs are excluded in portfolio statistics and the notional is 100 USD.

My findings that evolve from the combination of the low-risk strategy with well-known currency strategies are as follows. First, double-sorted portfolios indicate that the tendency of currencies with low moment risk to outperform currencies with high moment risk is still present when the basket is restricted to currency pairs with either low momentum, or high momentum, or low forward discounts, or high forward discounts, or low volatility betas, or high volatility betas. This finding provides profound evidence on the fact that moment risk contains different information than traditional metrics employed in currency sorts. Second, RISK has a correlation of 0.19 with MOME, 0.28 with CARR and 0.17 with GVOL. These numbers are smaller than the correlation between a market and a size factor that investors employ in the construction of equity portfolios.[5] Again, this is evidence of limited common movements of RISK with other currency strategies. Third, I compute efficient multi-factor currency portfolios in a mean-variance framework. The maximum available Sharpe ratio increases from 1.41 p.a. to 1.71 if RISK is included in the multi-factor portfolio which substantiates the merits of the low-risk strategy.

I suggest different mechanisms that might drive the result that currency pairs with low moment risk outperform currency pairs with high moment risk on average. First, significant RISK does not vanish when transaction costs are charged. Second, regression analyses reveal that the usual currency, equity, and macro factors as well as factors that mimic the performance of hedge funds cannot explain RISK. Third, I analyze the stability of RISK across time. The three-year rolling average of RISK is negative in 5 out of 238 cases, i.e. in 2.10% of the rolling windows. To put this result into context, the averages of MOME and CARR are negative in 19.33% and 8.40% of all rolling windows, respectively, and these strategies are implemented in real portfolios.[6] Fourth, momentum and carry

[5] As documented by a large number of studies including Chan, Chen, and Lakonishok (2002) and Frazzini, Kabiller, and Pedersen (2013), equity investors take substantial exposures to market, size, and value factors. According to a study conducted by Morningstar, there were 673 strategic-beta exchange-traded products with collective assets under management of approximately 396 billion USD worldwide as of June 30, 2014. The study is restricted to exchange-traded products and, thus, excludes specialized funds. It can be accessed via `http://www.morningstar.co.uk/static/UploadManager/Other/MorningstarManagerResearch-AGlobalGuidetostrategicBetaExchange-TradedProducts.pdf`.

[6] Currency investors take considerable exposure to carry trade and momentum-type strategies. Footnote 20 in Menkhoff et al. (2012b) provides references on that topic.

trade strategies require explicit engagements in riskier countries in order to obtain an average excess payoffs which is non-zero in statistical terms. This is not true for RISK. I conclude that time variation in excess payoffs and the requirement to engage in riskier countries are not able to wipe out a particular amount of arbitrage in RISK.

I provide robustness checks for my main result that currency pairs with low moment risk tend to outperform currency pairs with high moment risk. In particular, I show that the predictability of moment risk for the cross-section of excess payoffs holds when different sample periods are employed, when the basket of currency pairs changes, and when we change the viewpoint from a USD-investor to a GBP- or JPY-investor.

I discuss nearby alternative strategies. First, it is possible to set up a profitable low-risk strategy that is based on second moments only. However, second-moment based sorts are not as robust as sorts based on higher moments. Second, the excess payoffs of a low-risk strategy that is only based on mean-adjusted moments of orders up to eight is, statistically, not different from the main strategy of this work which includes moment orders up to 100. In economic terms, however, using moments of orders ten and higher is meaningful. Third, consider a low-risk strategy which is based on moments that are exclusively estimated from the most extreme daily return observation in a month. The excess payoffs associated with the corresponding long-short portfolio are statistically different from RISK at the 10% level only. In economic terms, however, the estimation of the higher moments from all about 22 daily return observations in a month is, again, meaningful.

The remainder of the paper is organized as follows. I give an overview about related literature in Section 2. Section 3 elaborates on the data of this study. I construct a low-risk strategy which is based on higher return moments in Section 4. In Section 5, I analyze the characteristics of the strategy in detail and in the context of other currency strategies. Section 6 explores explanations for the tendency of currency pairs with low moment risk to outperform currency pairs with high moment risk. Section 7 provides robustness checks, Section 8 discusses nearby alternative strategy specifications, and Section 9 concludes.

2 Related Literature

My work is related to the empirical literature that is concerned with the so-called low-risk anomaly.[7] Fama and MacBeth (1973), Ang et al. (2006), Blitz and Vliet (2007), Ang et al. (2009), Baker, Bradley, and Wurgler (2011) and Baker and Haugen (2012) provide evidence on the low-risk anomaly in equity markets. Here, risk is typically measured as volatility or exposure to a market factor. In fixed income markets, quantile portfolios are formed on the basis of risk measures like bond maturity, yield elasticity, modified duration, yield-to-maturity, duration-times-spread, and option-adjusted spread (see de Carvalho et al. (2014) and Frazzini and Pedersen (2014)). In commodity markets, Blitz and Groot (2014) form portfolios on volatility. In equity option markets, Cao and Han (2013) form quintile portfolios on risk. The authors employ risk measures like volatility of the residuals of the Fama-French three-factor-model.

This paper is particularly related to the empirical literature that investigates the low-risk anomaly and where risk metrics are based on higher-order moments.[8] The risk metrics considered here are risk-neutral or physical moments, functions of moments or moments themselves, as well as asset-specific moments or loadings on market moments. As an example, Chang, Christoffersen, and Jacobs (2013) find that stocks with high exposures to innovations in risk-neutral market skewness exhibit low returns on average. They also find that there is no predictive power of innovations in implied market volatility and innovations in risk-neutral market kurtosis for the cross-section of stock returns. Amaya et al. (2015) provide evidence for a negative relationship between realized skewness and stock returns. They also find that the relationship between realized kurtosis and stock returns is positive and insignificant. In equity markets, further portfolio sorts based on higher moments are performed by Xing, Zhang, and Zhao (2010) and Conrad, Dittmar,

[7] My brief and non-exhaustive literature overview excludes literature on the low-risk anomaly that is not concerned with sort-based investment approaches but with optimization-based approaches. For an overview about both sub-strands within the low-risk literature, I refer to Ang (2014).

[8] My brief and non-exhaustive literature overview excludes literature on the three- and four-factor CAPM that builds on the seminal work of Kraus and Litzenberger (1976). A brief overview about the literature on the three- and four-factor CAPM is presented in Chang, Christoffersen, and Jacobs (2013).

and Ghysels (2013).

My paper is close to the empirical literature where portfolio sorts are carried out in currency markets.[9] Lustig, Roussanov, and Verdelhan (2011) establish the existence of the so-called dollar factor which measures the overall appreciation or depreciation of USD against a broad basket of currencies. Next, carry trade portfolios are set up by Lustig and Verdelhan (2007), Lustig, Roussanov, and Verdelhan (2011), and Brunnermeier, Nagel, and Pedersen (2008). Besides being exposed to carry trade and dollar risk, exchange rates have shown to load on value factors. Barroso and Santa-Clara (2015) find that value reversal explains the cross-section of excess payoffs whereas the real exchange rate and the current account do not. Further evidence for a priced value factor in currency markets is provided by Asness, Moskowitz, and Pedersen (2013). Next, momentum is priced in the cross-section of currencies as documented by Asness, Moskowitz, and Pedersen (2013) and Menkhoff et al. (2012b). With regard to the methodology, my work is closest to Menkhoff et al. (2012b). Moreover, Della Corte, Ramadorai, and Sarno (2014) provide evidence for the cross-sectional link between volatility risk premiums of exchange rates and movements of currency rates. Next, Menkhoff et al. (2012a) sort currency pairs based on their exposure to the global volatility innovations factor in order to understand the cross-section of excess payoffs. Frazzini and Pedersen (2014) detect that the performance difference between currency pairs with low beta and high beta is statistically insignificant. Cazzaniga (2011) finds that global skewness, which is proxied by the aggregate asymmetry of daily changes in currency rates involved in carry trade portfolios, is related to the cross-section of individual currencies. Out-of-sample, however, there is no evidence of statistical significance.

My work contributes as follows to the existing literature. First, this paper is first to establish profound evidence on the existence of a low-risk anomaly in currency markets. Second, this is the first piece of work to construct an out-of-sample strategy in currency

[9] My brief and non-exhaustive literature overview excludes literature that is restricted to examine the cross-sectional link between currency portfolios and risk factors. My interest is in the cross-sectional link between individual currency rates and risk factors.

forward markets that exploits the predictive information of higher return moments for the cross-section of currencies. Third, I establish a novel strategy in currency forward markets which has more attractive performance and risk characteristics than established carry and momentum strategies and that is not spanned by them.

3 Data

I collect currency spot and forward rates with maturities of one, two, three, six and twelve months. My sample of currencies follows Della Corte, Ramadorai, and Sarno (2014). In particular, it comprises 20 of the most liquid developed and emerging market currencies that belong to the countries or currency unions Australia, Brazil, Canada, Czech Republic, Denmark, euro area, Hungary, Japan, Mexico, New Zealand, Norway, Poland, Singapore, South Africa, Sweden, Switzerland, South Korea, Taiwan, Turkey and the United Kingdom. All currencies are quoted against USD. For the currency pairs and currency rates under study, I collect bid, ask and mid quotes. The data stems from three alternative data sources that are Barclays, WM/Reuters and Thomson Reuters. For each currency pair, I employ the data source that provides the largest number of cleaned observations with all mid forward rates and the mid spot rate being simultaneously available.

I clean the data as follows. First, I remove the observations that are obviously subject to large failures of covered interest parity as in Lustig, Roussanov, and Verdelhan (2011).[10] Second, I handle obvious outliers. Whenever there is an obvious outlier, I replace all spot and forward rates for the respective currency pair on that day with the data from the previous day without error. Third, I follow Darvas (2009) and clean observations where (i) the bid is greater than or equal to the ask exchange rate, (ii) the bid-ask spread of the forward exchange rate is less than the bid-ask spread of the spot exchange rate, and (iii)

[10] I delete all forward rates for Turkey from Feb. 19, 2001 to Dec. 25, 2001 from the WM/Reuters data. From the Thomson Reuters data, I remove one-month forward rates for Taiwan from Jun. 21, 2013 onwards.

the spot rate moves but the forward rate stays constant or vice versa. In such cases, I replace all spot and forward rates for the respective currency pair on that day with the data from the last day without error.[11]

4 Constructing the Low-Risk Strategy

In this section, I construct a low-risk strategy in currency forward markets which is based on higher moments of returns of currency spot rates.

Let S_t^i denote the mid spot exchange rate at time t for the i-th currency pair that gives the number of units of the foreign currency that are needed to buy one unit of the domestic currency which is USD.[12] Next, $F_{t,\tau}^i$ is the time-t mid forward exchange rate for delivery at time $t+\tau$. An investor who sells USD and buys the foreign currency in forward markets receives a payoff, denominated in USD, of

$$\pi_{t,\tau}^i = \frac{F_{t,\tau}^i - S_{t+\tau}^i}{S_{t+\tau}^i}\gamma \quad \forall \tau \in \Xi \tag{1}$$

where $\Xi = \left\{\frac{1}{12}, \frac{2}{12}, \frac{3}{12}, \frac{6}{12}, \frac{12}{12}\right\}$ denotes the set of contract maturities of interest and γ is the USD-notional which I set to $\gamma = 100$. I refer to $\pi_{t,\tau}^i$ as excess payoff.

I consider a metric that depends on two parameters and that is linked to higher moments of returns. It reads

$$\begin{aligned} \mu_{t,\beta}^{i,\alpha} &= M_t^{i,\alpha} - \frac{1}{\beta}\sum_{l=0}^{\beta-1} M_{t-\frac{l}{12}}^{i,\alpha} \\ M_t^{i,\alpha} &= \frac{1}{R_t^i}\sum_{t-\frac{1}{12}\le s<t}\left(r_s^i\right)^\alpha \end{aligned} \tag{2}$$

[11] As it is outlined by Darvas (2009), (i) and (ii) are errors by definition whereas (iii) is only likely an error. I redo the analysis and do not clean in case (iii). My main results and conclusions do not change.

[12] Throughout this work, I use the attributes foreign and domestic to describe the domicile of the investor. In other pieces of literature, the terms domestic and foreign are used to label the quotation convention which means that one unit of the foreign currency costs a specific number of units of the domestic currency (see e.g. Wystup (2006)).

where r_s^i denotes the daily discrete return with return start date s for the i-th currency pair. $M_t^{i,\alpha}$ indicates the non-central, non-standardized moment of currency returns $\mathrm{E}_t\left[\left(r_s^i\right)^\alpha\right]$ where the power α indicates the moment order. The moment is estimated from the R_t^i daily returns of currency pair i that fall within the calendar month that precedes time t. Next, β is the formation period that is expressed in months and that is used in order to calculate the mean-adjusted moment of order α for currency pair i and time t, denoted by $\mu_{t,\beta}^{i,\alpha}$.

I use a concrete example and visualize the relation between a higher-order mean-adjusted moment and excess payoffs. For USD-GBP, Figure 1 plots the cumulative excess payoffs for the contracts with a monthly maturity (line). We observe that the cumulative excess payoffs are subject to three large downward jumps in the periods Jan. 31, 1991 to Jun. 28, 1991 (-55%), Aug. 31, 1992 to Feb. 26, 1993 (-71%), and Oct. 31, 2007 to Feb. 27, 2009 (-48%). Figure 1 also plots the 10-th moment that is mean-adjusted over 60 months $\mu_{t,60}^{i,10}$ (area) for USD-GBP. From the chart, we observe that the three large downward jumps of excess payoffs of USD-GBP are preceded by a huge positive jump in $\mu_{t,60}^{i,10}$. This finding indicates that the 10^{th} non-central, non-standardized moment of returns that is mean-adjusted over 60 months contains valuable information for the prediction of USD-GBP excess payoffs.

I investigate the predictive power of the mean-adjusted moment for the overall cross-section of currencies. At each month end, I allocate the currency pairs to five portfolios based on the ranking of the mean-adjusted moments $\mu_{t,60}^{i,10}$. Denote the 20 percent of currency pairs with the highest mean-adjusted moments as bottom portfolio (B), the next 20 percent as second quintile portfolio (2), the following fifth as third quintile portfolio (3), the thereafter following fifth as fourth quintile portfolio (4) and, finally, the one-fifth of currency pairs with the lowest $\mu_{t,60}^{i,10}$ as top portfolio (T). I weight the currency pairs equally in each quintile portfolio. The excess payoffs of the quintile portfolios at time $t+\tau$

are then given by

$$\pi^q_{t,\tau} = \frac{1}{N^q_{t,\tau}} \sum_{i \in q} \pi^i_{t,\tau} \quad \forall q \in Q \tag{3}$$

where $Q \equiv \{B, 2, 3, 4, T\}$ denotes the set of portfolios, $N^q_{t,\tau}$ is the number of currency pairs in the quintile portfolio q, and $\pi^i_{t,\tau}$ is the excess payoff of the individual currency pair defined in (1). I also consider excess payoffs of the associated long-short portfolio (T-B) given by

$$\phi_{t,\tau} = \pi^T_{t,\tau} - \pi^B_{t,\tau}$$

Table 1 shows statistics for monthly excess payoffs of the portfolios. I report the mean together with p-values for a two-sided test of the null of a mean zero excess payoff. I base the statistical tests on the stationary bootstrapping of Politis and Romano (1994) and set the number of bootstrap samples equal to 10,000. The choice of the block length follows Politis and White (2004). The bootstrapped p-values are referred to as $\widetilde{p}$ in the table. For robustness, I also report p-values based on Newey and West (1987) where the lag length is computed as suggested by Newey and West (1994). These p-values are referred to as $\widehat{p}$ in the table. Next, the table indicates the standard deviation, Sharpe ratio, skewness and kurtosis. Finally, I report the maximum annual drawdown.[13] The long-short portfolio yields an average excess payoff of 7.13 USD p.a. which is statistically significant at the 1% level. The average excess payoffs of the quintile portfolios show the tendency to increase as we move from the bottom portfolio to the top portfolio. To sum up, there is considerable forecasting power of the mean-adjusted moment $\mu^{i,10}_{t,60}$ for the cross-section of excess payoffs.

I investigate a variation of the moment order α and the formation period β in (2). Methodologically, I redo the portfolio formation exercise but now I consider moment orders between 4 and 100 and I employ formation periods that range between 12 months and an expanding

[13] I obtain the maximum annual drawdown as the biggest loss of cumulative one-month excess payoffs over a period of one year.

window ∞. More specifically, I set $\alpha \in A \equiv \{4,6,8,10,20,30,40,50,60,70,80,90,100\}$ and $\beta \in B \equiv \{12,24,36,48,60,\infty\}$ when I calculate the mean-adjusted moments.

Table 2 reports the results for the monthly contracts. All 78 long-short portfolios (13 moment orders × 6 formation periods) deliver positive excess payoffs on average and 71 of them are significant at the 1% level. The excess payoffs of the other 7 strategies are significant at the 5% level. The average excess payoffs range between 3.57 USD p.a. and 9.19 USD p.a. Further, Sharpe ratios fluctuate between 0.42 p.a. and 1.11 p.a. Skewness is sometimes positive and sometimes negative and maximum annual drawdowns range from 9.72 USD to 23.50 USD. The highest means, highest Sharpe ratios, highest skewness, and smallest maximum annual drawdowns tend to cluster at formation periods of 36 to 60 months and moment orders of 8 and higher. To conclude, there is distinct forecasting power of mean-adjusted higher moments for the cross-section of currency excess payoffs and this finding is valid across various moment orders and formation periods.

The framework in this work is clearly out-of-sample because I form portfolios at time t based on information that is available at time t. However, the information that e.g. sorting currency pairs based on $\mu_{t,60}^{i,4}$ delivers an average excess payoff for the long-short portfolio of 3.57 USD p.a. whereas portfolio sorts based on $\mu_{t,36}^{i,8}$ result in an average excess payoff of 9.19 USD p.a. is available only now and an investor could not have conditioned on it on Nov. 30, 1989 (first date of portfolio formation). Put differently, the choice of the moment order α and formation period β influences the strategy performance considerably. Against this background, I define a strategy where the parameters α and β are not required to be set again and again by the investor at each rebalancing date. Instead, the investor employs a rule in order to select one out of the 78 strategies which I refer to as underlying strategies in that context. More specifically, he employs α^* and β^* in the calculation of the mean-adjusted moment in (2). He sets α^* and β^* equal to α and β of the long-short portfolio that delivered the highest mean excess payoffs over the three previous months.[14] I denote the metric with adaptive moment order and formation period as μ_t^i and refer to it as moment risk. I form quintile portfolios on moment risk and denote the excess payoffs of the associated long-short portfolio as RISK throughout this work.

I report portfolio statistics for the monthly contracts in Table 3. RISK amounts to 11.07 USD p.a. and is highly significant. Thus, investors can exploit the characteristics of moment risk strategies, even though there is ex ante uncertainty about the impact of the moment order and the formation period. Even more, the mean (Sharpe ratio) of RISK is higher than any mean (Sharpe ratio) of the excess payoffs of the long-short portfolios with constant α and β.

5 Characterizing the Low-Risk Strategy

In this section, I explore the characteristics of the low-risk strategy in greater detail and in the context of other currency strategies. The purpose is threefold. First, I get a better understanding about the strategy itself. Second, I see how the low-risk strategy based on higher moments compares to other currency strategies. Third, I find out whether the low-risk strategy can be regarded as a novel phenomena or whether it largely captures information that is already contained in well-known currency strategies.

I set up traditional currency strategies. First, I look at a momentum strategy which exploits that currencies having faced an appreciation in the recent past tend to appreciate further, and vice versa. More specifically, momentum is defined as the excess payoff of a currency pair over a formation period which I define as the past month. This decision follows Menkhoff et al. (2012b) who find that this formation period works best. They

[14] Momentum is a natural mechanism to choose among the various strategies. Menkhoff et al. (2012b) perform a similar analysis in order to choose from a set of momentum strategies with different formation periods and contract maturities. In order to choose between the various momentum strategies, they rely on momentum in lagged momentum returns. In a similar fashion, I make use of momentum in lagged excess payoffs associated with low-risk strategies based on higher moments.

establish this result in a sample of 34 years and employ a broad basket of 48 currency pairs. I form quintile portfolios on momentum. High-momentum currency pairs enter the top portfolio and low-momentum currencies enter the bottom portfolio. I denote the excess payoffs of the associated long-short portfolio as MOME.

Second, I consider a carry trade strategy in the spirit of Lustig, Roussanov, and Verdelhan (2011). Carry trade strategies are long in high-interest rate currencies and short in low-interest rate currencies. More detailed, currency pairs are ranked on the time-t forward discount given by $\log F^i_{t,\tau} - \log S^i_t$.[15] I form quintile portfolios. Currency pairs with high forward discounts are allocated to the top portfolio and currency pairs with low forward discounts are found in the bottom portfolio. The excess payoffs of the corresponding long-short portfolio are denoted by CARR.

Third, currency pairs with low exposure to innovations in market volatility tend to outperform currency pairs with high exposure to innovations in market volatility. In that context, I estimate betas in rolling time series regressions of individual monthly excess payoffs on contemporaneous realizations of the global volatility innovations factor of Menkhoff et al. (2012a).[16] Following Menkhoff et al. (2012a), the rolling window includes the 36 months that precede the rebalancing date. Then, I form quintile portfolios whereas the high-beta currency pairs enter the bottom portfolio and the low-beta currencies enter the top portfolio. I denote the excess payoffs of the long-short portfolio as GVOL.

The upper part of Table 4 reports summary statistics for monthly excess payoffs of the currency portfolios formed on moment risk, forward discounts, momentum, and volatility betas. For now, I consider the long-short portfolios only and make the following

[15] According to covered interest rate parity, forward discounts are equal to the respective interest rate differentials.

[16] The construction of the global volatility innovations factor of Menkhoff et al. (2012a) is as follows. First, calculate absolute daily log returns of all currency spot rates in the basket, which I define as the sample of currency pairs that is employed. Second, average across currency pairs and obtain a time series of the daily global volatility level. In a third step, average the observations of that time series for each calendar month. Fourth, estimate an AR(1) process for the time series of monthly non-overlapping volatility levels. The global volatility innovations factor is then given by the residuals of that AR(1) process. The result is one factor realization for each calendar month.

observations. First, on average, RISK amounts to 11.07 USD p.a., MOME to 7.18 USD p.a., CARR to 10.48 USD p.a. and GVOL to 4.01 USD p.a. The p-values based on Politis and Romano (1994) for the null of a zero mean excess payoff amount to 0.05 for GVOL and are exactly equal to zero for RISK, CARR and MOME. Put differently, the long-short portfolios formed on moment risk, forward discounts, and momentum deliver a positive mean negative excess payoff in each of the 10,000 bootstrap samples. Based on Newey and West (1987), the p-values are 2×10^{-8} for RISK, 7×10^{-5} for MOME, 4×10^{-5} for CARR and 0.06 for GVOL. Second, RISK not only delivers the highest mean excess payoff with the highest statistical significance but also the lowest risk in terms of standard deviation. Therefore, the Sharpe ratio of RISK exceeds those of the other strategies. Third, the long-short portfolio formed on moment risk delivers stable excess payoffs across the overall sample period.[17] Along with that, RISK has a maximum annual drawdown of 11.65 USD and this number is much lower than the equivalent values for the other currency strategies that provide less stable excess payoffs. Cumulative MOME peaks on Dec. 31, 2008 as shown in Figure 2. Since that point in time, MOME has continuously lost huge parts of its past performance over a period of roughly seven years. From Aug. 29, 2008 to Dec. 31, 2008, CARR and GVOL suffer losses of 23.42 USD and 20.84 USD, respectively, which is clearly visible in Figure 2. At the same time, cumulative RISK increases by 9.62 USD. In line with the findings, CARR and GVOL are considerably negatively skewed, and their respective kurtosis is high which contrasts these strategies with RISK. To conclude, the performance and the riskiness of RISK compare favourably to other long-short currency portfolios.

I contrast the quintile portfolios formed on moment risk with the respective portfolios that result from traditional sorts. First, mean excess payoffs of the moment risk, forward discounts, and momentum portfolios are monotonically increasing as we move from the bottom portfolio to the top portfolio. Average means of excess payoffs of the portfolios formed on volatility betas also tend to increase from B to T, however, the relation is not

[17] This finding is explored in greater detail in Section 6.

monotonic. Second, the standard deviations of the portfolios formed on moment risk, forward discounts, and volatility betas increase from B to T. However, the difference in standard deviations of the top and the bottom portfolio formed on moment risk is small relative to the portfolios formed on forward discounts and volatility betas. Standard deviations of the quintile portfolios formed on momentum have a U-shaped pattern. Third, the skewness of the portfolios formed on moment risk and momentum tends to increase as we move from B to T whereas the skewness of the quintile portfolios formed on forward discounts and volatility betas tends to decrease. Fourth, the kurtosis and the maximum annual drawdown of the moment risk portfolios have the tendency to decrease as we move from B to T whereas the kurtosis of momentum portfolios exhibits an inverted U-shaped pattern. Maximum annual drawdowns of the momentum portfolios as well as kurtosis and maximum annual drawdowns of the quintile portfolios formed on forward discounts and volatility betas do not show a clear pattern. In conclusion, there are patterns across the quintile portfolios formed on moment risk that we do not find, in a body, in the portfolios of well-known currency strategies. This finding indicates that moment risk portfolios are structurally different from other currency strategies.

The excess payoffs of the top portfolios of all four strategies are highly statistically significant. In contrast, the excess payoffs of the bottom portfolios are insignificant. In order to see if the performances of the long-short portfolios are purely driven by the top portfolios, I look into the alphas of excess payoffs relative the dollar factor given by

$$\alpha^q_{t,\tau} = \pi^q_{t,\tau} - \pi^D_{t,\tau} \quad \forall q \in Q$$
$$\pi^D_{t,\tau} = \frac{1}{N_{t,\tau}} \sum_i \pi^i_{t,\tau}$$

where $\pi^q_{t,\tau}$ denotes the excess payoff of quintile portfolio q as defined in (3), $\pi^i_{t,\tau}$ is the excess payoff of the individual currency pair as defined in (1) and $N_{t,\tau}$ denotes the number of available currency pairs on the rebalancing date. Then, $\pi^D_{t,\tau}$ is the excess payoff of the equally weighted portfolio of all currency pairs. This portfolio is called the dollar risk factor in Lustig, Roussanov, and Verdelhan (2011) and can be interpreted as a market factor. I refer to its excess payoffs as DOLL.

The bottom part of Table 4 reveals that the alphas of the monthly excess payoffs of both the top and the bottom portfolio are highly significant for RISK, MOME, and CARR. Put differently, the top and the bottom portfolios contribute significantly to the performance of the long-short portfolio which gives evidence on the robustness of the three mentioned long-short strategies. For the low-risk strategy based on higher moments, Figure 3 visualizes again that the top portfolio outperforms the dollar factor permanently whereas the bottom portfolio keeps underperforming the dollar factor over time.[18] In contrast, for the portfolios formed on volatility betas, neither the alpha of the excess payoff of the top portfolio nor the alpha of the excess payoff of the bottom portfolio is significant at the 5%-level. This finding indicates that the predictive power of volatility betas for the cross-section of currencies is less profound.

I explore holding periods that are longer than one month. In that context, the investor enters forward contracts with maturities that range from one to twelve months. As I set up portfolios on a month-end basis, the holding periods of the contracts are overlapping now.[19] The moment risk, momentum and volatility beta portfolios are created exactly as before. In particular, I do not change the formation period of the momentum portfolios

[18] In the context of market risk, one might wonder whether the outperformance of the top portfolio formed on moment risk relative to the associated bottom portfolio is purely driven by a particularly high exposure of the top portfolios to the dollar risk factor. Against this background, I calculate the loadings of the quintile portfolios on the dollar factor and find that they, indeed, increase monotonically from $\beta_\tau^B = 0.91$ to $\beta_\tau^T = 1.11$ as we move from B to T (not reported in Table 4). However, the adjusted alpha of excess payoffs of the top portfolio given by $\pi_{t,\tau}^T - \pi_{t,\tau}^D \beta_\tau^T$ is, for the monthly contracts, 7.00 USD p.a. on average and highly statistically significant (not reported in Table 4). Further, the adjusted alpha of excess payoffs of the bottom portfolio is given by $\pi_{t,\tau}^B - \pi_{t,\tau}^D \beta_\tau^B$. For the monthly contracts, it amounts to −3.45 USD p.a. on average and is highly statistically significant alike (not reported in Table 4). Thus, the outperformance of the top portfolio and the underperformance of the bottom portfolio formed on moment risk cannot be explained with exposures to market risk.

[19] Whenever the contract maturity exceeds one month, I modify the calculation of the p-values based on Newey and West (1987) $\hat{p}$. In particular, the lag length is set to the maximum that results from the method of Newey and West (1994) and the number of overlaps. Moreover, I compute the maximum annual drawdown as follows when the contract maturities are overlapping. I calculate 2 (3, 6 and 12) preliminary maximum annual drawdowns that result from the 2 (3, 6 and 12) time series of cumulative excess payoffs of non-overlapping periods with monthly-shifted start dates. The maximum annual drawdown is finally obtained as the maximum of these 2 (3, 6, 12) preliminary maximum annual drawdowns.

because Menkhoff et al. (2012b) find that a formation period of one month works best for all contract maturities under study. For the portfolios formed on forward discounts, however, I set the formation period equal to the holding period as said above.

The results are illustrated in the left part of Table 5. Basically, means of RISK decrease as the contract maturity increases and range between 6.46 USD p.a. and 11.19 USD p.a. No matter which contract maturity is concerned, RISK is highly statistically significant. Thus, moment risk forecasts the cross-section of excess payoffs and this finding is valid for contract maturities up to twelve months. I consider the other strategies and find that there is a general tendency of mean excess payoffs to decrease as the holding period increases. This effect is most pronounced for the momentum portfolios which indicates that the momentum performance highly depends on a frequent rebalancing.

The excess payoffs studied so far depend on changes of currency spot rates and on interest rate differentials. I now disentangle whether the strategies are primary driven by changes in currency spot rates, interest rate differentials, or both. Against this background, I am interested in the synthetic payoff of the long-short portfolio that would arise if all currency pairs had a zero interest rate differential. This payoff is denoted by $\widehat{\phi}_{t,\tau}$ and amounts to

$$\widehat{\phi}_{t,\tau} = \widehat{\pi}^{T}_{t,\tau} - \widehat{\pi}^{B}_{t,\tau}$$

where

$$\widehat{\pi}^{q}_{t,\tau} = \frac{1}{N^{q}_{t,\tau}} \sum_{i \in q} \widehat{\pi}^{i}_{t,\tau} \quad \forall q \in \{B, T\}$$
$$\widehat{\pi}^{i}_{t,\tau} = \frac{S^{i}_{t} - S^{i}_{t+\tau}}{S^{i}_{t+\tau}} \gamma$$

Due to the fact that payoffs (rather than excess payoffs) are tracked in the holding period, the formation of the moment risk portfolios changes as follows. In order to select from the 78 strategies that correspond to different formation periods and moment orders, I rely on average payoffs (rather than excess payoffs) of the long-short portfolios over the three last monthly holding periods. Further, I modify the creation of the momentum portfolios via tracking payoffs (rather than excess payoffs) in the formation period. Volatility betas are, next, obtained from the regression of payoffs (rather than excess payoffs) on the contemporaneous realizations of the global volatility innovations factor. The construction of the carry trade portfolios is unaltered.

The results are illustrated in the right part of Table 5. First, consider the long-short portfolios formed on moment risk. Mean payoffs are generally lower than mean excess payoffs. To give an example, the mean excess payoff of the bimonthly contracts is 11.19 USD p.a. and the corresponding mean payoff is 4.15 USD p.a. However, the economic and the statistical significance is maintained for the short-term payoffs which implies that RISK is driven by, both, interest rate differentials and spot rate changes. I consider the other strategies. The average excess payoffs of the long-short portfolios formed on momentum are close in magnitudes to the corresponding average payoffs. As an example, the mean excess payoff of the bimonthly contracts amounts to 5.10 USD p.a. whereas the payoffs are 5.64 USD p.a. on average. This result indicates that the performance of MOME is almost exclusively driven by movements in currency rates which contrasts MOME with RISK. Next, mean excess payoffs of the carry trade portfolios with bimonthly maturities amount to 10.42 USD p.a. and are highly significant whereas mean payoffs are −5.29 USD p.a. and highly significant alike. This result indicates that high-interest rate currencies do, on average, depreciate and that the performance of CARR is positively driven by interest rate differentials and negatively by movements of spot rates. This characteristic of CARR stands in contrast to the characteristics of RISK where the performance is positively driven by both spot rate changes and interest rate differentials. The same finding, but less pronounced, holds when RISK and GVOL are compared. To sum up, the low-risk strategy is positively driven by both interest rate differentials and changes in currency spot rates which discriminates it from traditional strategies in currency markets.

The previous paragraphs clearly show that the low-risk strategy based on higher moments employed in this work is very different from well-known currency strategies with regard to overall performance, drivers of performance, and riskiness. Now, I compare the turnover of the low-risk strategy based on higher moments to the turnover of the other currency strategies. In particular, I look into the frequency at which currency pairs enter an exit the quintile portfolios.

For each of the currency strategies under study, Table 6 reports the probability that a currency pair migrates from portfolio r (indicated in table rows) to portfolio s (indicated in table columns) from one monthly rebalancing date to another. The currency portfolios are constructed to predict monthly excess payoffs. The results indicate that the quintile portfolios formed on forward discounts and volatility betas exhibit the lowest transition activity. For instance, the probability that a currency pair stays in the top portfolio formed on forward discounts is 89% and the probability that a currency pair stays in the associated bottom portfolio is 88%. In contrast, the portfolios formed on momentum are subject to a lot of rebalancing activity. On average, only about a quarter of the currency pairs stay in the top- and bottom-portfolios on the monthly rebalancing dates. The transition activity from one portfolio formed on moment risk to another one is somewhere in-between. In particular, a currency pair stays in the top portfolio with a probability of 54% and it stays in the bottom portfolio with a probability of 67%. Overall, the results imply that the predictability associated with moment risk does not stem from cross-sectional differentials in the signal that are as short-lived as it is the case when momentum portfolios are created. The predictability of moment risk does, however, also not stem from long-lived cross-sectional differentials in the signal as it is the case for the portfolios formed on forward discounts and volatility betas. Besides the fact that moment risk is subject to a certain time variation, the results reveal that the transition activity from one quintile portfolio to another discriminates RISK from the other currency strategies.

I look for more evidence on the independence of RISK from other currency strategies and analyze double-sorted portfolios that are, again, rebalanced monthly. In particular, currency pairs are allocated into two sub-sets based on the ranking of their momentum (forward discount, volatility beta). Next, currency pairs within each of the two sub-sets are then sorted on moment risk and put into tertile portfolios. Basing the first sort on two portfolios and the second one on tertile portfolios is due to the small cross-section and follows Menkhoff et al. (2012b).

Table 7 reports statistics on excess payoffs for the long-short portfolios that result from the tertiles for the currency pairs of the bottom portfolio from the first sort (indicated by rows with B), for the long-short portfolios that result from the tertiles for the currency pairs of the top portfolio from the first sort (indicated by rows with T) as well as for the difference of both aforementioned excess payoffs (indicated by rows with Δ). The results are as follows. First, average RISK is positive no matter which of the six baskets of currency pairs is employed and this is true for all contract maturities under study. RISK is statistically significant at conventional levels in 23 out of the 30 (5 maturities $\times$ 6 time-varying baskets of currency pairs) cases. Second, RISK is generally larger when currency pairs with high momentum, high forward discounts, or low volatility betas are employed. Statistically, however, it does not matter whether RISK is created from currency pairs with low or high forward discounts, because the differences in excess payoffs are insignificant. The same holds for the portfolios formed on volatility betas and 3 out of 5 cases for momentum. To conclude, RISK is largely independent from the other currency strategies.

I explore the correlations between RISK and the other currency strategies in order to assess potential common movements in a more direct way. Correlations for monthly excess payoffs are depicted in Figure 4 and amount to 0.19 for RISK and MOME, 0.28 for RISK and CARR and 0.17 for RISK and GVOL. These numbers are much lower than the correlation between CARR and GVOL and higher than the correlations between MOME and GVOL as well as between MOME and CARR.[20] In order to better understand the level of linear dependence of the currency strategies, I calculate correlations between well-

[20] The high correlation of GVOL and CARR is in line with Menkhoff et al. (2012a) who establish that portfolio sorts based on volatility betas are related but not identical to sorts on forward discounts.

known factors in equity markets. In particular, I consider the seminal three-factor-model of Fama and French (1993) that explains the cross-section of stock returns with an overall market factor, a factor related to firm size as well as a factor related to book-to-market equity. These factors are often combined in the construction of real equity portfolios which implies that their degree of correlation provides a decent comparative value for the correlations in-between the currency strategies of interest. I obtain the three equity factors from the homepage of Kenneth R. French. The sample covers US data from Jul. 1926 to Jan. 2015 (1063 observations). The market factor has a correlation of 0.33 with the size factor which is higher than any of the correlations of RISK with the other currency factors.

RISK has favourable performance and risk characteristics on its own and it is only mildly correlated with the other currency strategies. In order to better understand the merits of the low-risk strategy based on higher moments for a currency investor, I explore the role of RISK in multi-factor currency portfolios. There are $N = 4$ assets which are RISK, MOME, CARR and GVOL. The creation of these single-factor long-short portfolios is subject to a monthly rebalancing and clearly out-of-sample as it is throughout the whole paper. I go to a multi-factor level and construct the portfolio frontier that is defined as the set of all portfolios with minimal variance for a given expected excess payoff, i.e.

$$\min_{w} \frac{1}{2} w' \Sigma w \quad \text{s.t.} \quad w'e = \mathrm{E}[\Phi], \quad w'\iota = 1$$

where w is an $N \times 1$ vector of portfolio weights, ι is an $N \times 1$ vector of ones, e is an $N \times 1$ vector of expected excess payoffs, Σ denotes the $N \times N$ covariance matrix of the excess payoffs and $\mathrm{E}[\Phi]$ is the exogenously given expected excess payoff of the portfolio. The $N \times 1$ vector of portfolio weights w^* is available in closed form and given by

$$w^* = \frac{C\mathrm{E}[\Phi] - A}{D} \Sigma^{-1} e + \frac{B - A\mathrm{E}[\Phi]}{D} \Sigma^{-1} \iota$$

$$A = e' \Sigma^{-1} \iota, \quad B = e' \Sigma^{-1} e, \quad C = \iota' \Sigma^{-1} \iota, \quad D = BC - A^2$$

For the single-factor currency strategies, I estimate the expected excess payoffs e and the covariance matrix Σ from the one-month excess payoffs. Then, I calculate the multi-factor portfolios.[21]

The left chart of Figure 5 visualizes the resulting efficient frontier for $N = 4$ (dark-gray line) as well as for $N = 3$ (light-gray line) whereas RISK is excluded in the latter case. There is a considerable shift of the efficient frontier when RISK is included. To give an example, an efficient portfolio with a mean excess payoff of 10.00 USD p.a. has a standard deviation as high as 7.09 USD p.a. However, the standard deviation decreases to 5.87 USD p.a. if we include RISK in the portfolio. The right chart of Figure 5 plots mean excess payoffs against Sharpe ratios and reveals that the maximum available Sharpe ratio increases from 1.41 p.a. to 1.71 p.a. when RISK is included in the portfolio. The results substantiate the merits of the low-risk strategy based on higher moments for a currency investor.

6 Exploring What Is behind the Low-Risk Strategy

In this section, I study possible explanations for the tendency of currency pairs with low moment risk to outperform currency pairs with high moment risk. I investigate whether the profitability of the strategy is explained by standard risk factors or limits-to-arbitrage.

At first, I investigate whether significant RISK vanishes when transaction costs are taken into consideration. In order to look into this, I consider the excess payoffs of the long-short portfolio formed on moment risk when transaction costs are present given by

$$\widetilde{\phi}_{t,\tau} = \widetilde{\pi}^{T}_{t,\tau} - \widetilde{\pi}^{B}_{t,\tau}$$

[21] The allocation of the dynamic, out-of-sample single-factor portfolios to the multi-factor level is static and subject to a look-ahead-bias. The multi-factor portfolios employed here are, nevertheless, informative to the extend of what role RISK plays in multi-factor currency portfolios. Della Corte, Ramadorai, and Sarno (2014) use a similar approach.

with

$$\widetilde{\pi}^{T}_{t,\tau} = \frac{1}{N^{T}_{t,\tau}} \sum_{i\in T} \widetilde{\pi}^{i,T}_{t,\tau}$$

$$\widetilde{\pi}^{B}_{t,\tau} = \frac{1}{N^{B}_{t,\tau}} \sum_{i\in B} \widetilde{\pi}^{i,B}_{t,\tau}$$

$$\widetilde{\pi}^{i,T}_{t,\tau} = \frac{\underline{F}^{i}_{t,\tau} - \overline{S}^{i}_{t+\tau}}{\overline{S}^{i}_{t+\tau} \mathbb{1}_{\left\{\underline{F}^{i}_{t,\tau} - \overline{S}^{i}_{t+\tau} > 0\right\}} + \underline{S}^{i}_{t+\tau} \mathbb{1}_{\left\{\underline{F}^{i}_{t,\tau} - \overline{S}^{i}_{t+\tau} \leq 0\right\}}} \gamma$$

$$\widetilde{\pi}^{i,B}_{t,\tau} = -\frac{\underline{S}^{i}_{t+\tau} - \overline{F}^{i}_{t,\tau}}{\overline{S}^{i}_{t+\tau} \mathbb{1}_{\left\{\underline{S}^{i}_{t+\tau} - \overline{F}^{i}_{t,\tau} > 0\right\}} + \underline{S}^{i}_{t+\tau} \mathbb{1}_{\left\{\underline{S}^{i}_{t+\tau} - \overline{F}^{i}_{t,\tau} \leq 0\right\}}} \gamma$$

where $\overline{S}^{i}_{t+\tau}$ and $\overline{F}^{i}_{t,\tau}$ denote ask quotes of the spot and forward rates, respectively, $\underline{S}^{i}_{t+\tau}$ and $\underline{F}^{i}_{t,\tau}$ are the equivalent bid quotes and $\mathbb{1}_{\{c\}}$ is an indicator function that takes the value 1 in case that condition c is fulfilled and 0 otherwise. The results are presented in Table 8. For the various contract maturities, average RISK after transaction costs ranges from 5.66 USD p.a. to 8.70 USD p.a. The excess payoffs remain highly statistically significant when transaction costs are taken into consideration no matter which contract maturity is concerned. I compare the results with transaction costs to the results without transaction costs in Table 5. The average excess payoff of the best long-short strategy drops from 11.19 USD p.a. to 8.70 USD p.a. Overall, the results clearly suggest that transaction costs explain only minor parts of RISK.

Second, I consider risk-based explanations and test the pricing power of standard risk factors. In particular, I run in-sample time series regressions of one-month RISK on several risk factors that are proposed in the literature. First, consider monthly DOLL, CARR, MOME and GVOL as right-hand-side variables. Table 9 shows that GVOL is insignificant and so is DOLL, as we would have expected because RISK is USD-neutral. Next, MOME and CARR have some explanatory power for RISK. However, the adjusted R-Squared is small and the regression alpha is highly statistically significant and amounts to

7.06 USD p.a.[22] This result confirms the finding of Section 5 that RISK is not spanned by the other currency strategies. Second, I consider four US equity factors. I employ the three factors of Fama and French (1993) that are related to the overall equity market (mkt), firm size (size) and book-to-market equity (value). I add a momentum factor for equity markets (mome) and obtain a four-factor model as in Carhart (1997). The four equity factors are taken from the homepage of Kenneth R. French and expressed as monthly returns in percent. The four equity factor are insignificant in the regression and the adjusted R-Squared is negative. Third, I employ seven hedge fund factors that follow Fung and Hsieh (2004). These factors have been used for asset pricing tests in various studies (see Della Corte, Ramadorai, and Sarno (2014) and the references cited therein). Three of the hedge fund factors are given by returns of portfolios of lookback straddle options on bonds (bond trend), currency pairs (curr trend) and commodities (comm trend). Fung and Hsieh (2001) and Fung and Hsieh (2004) show that the portfolios of lookback straddle options mimic the returns of trend-following funds. I take the trend-following factors from the homepage of David A. Hsieh.[23] Further, I employ the month-end change of the yield of 10-year Treasury CMS (bond mkt) and the month-end change of the difference of the yields of Moody's BAA corporate bond and 10-year Treasury CMS (credit spread). According to Fung and Hsieh (2004), these two factors were shown to mimic the returns of fixed-income hedge funds. The data for the factor construction of the two fixed-income factors is taken from the homepage of the Federal Reserve Bank of St. Louis. Moreover, the hedge fund factors include the total return of S&P 500 (mkt2) as well as the difference of the total returns of Russell 2000 and S&P 500 (size2). According to Fung and Hsieh (2004), these two factors were shown to explain the returns of merger-arbitrage funds as well as of long-short equity funds. I obtain the data for their construction from S&P and Russell via Datastream. The seven hedge fund factors are expressed as (differences) of monthly returns in percent. Running the regression, I find that the seven hedge fund factors are

[22] This value can be interpreted as a risk-adjusted excess payoff because all regressors are expressed in terms of excess payoffs. This is not true for the following regressions that involve equity, hedge fund and macro factors.

[23] In particular, the data can be accessed via `https://faculty.fuqua.duke.edu/~dah7/HFRFData.htm`.

statistically insignificant and the adjusted R-Squared is close to zero. Finally, I check whether RISK is related to US business cycle factors. The macro variables employed here follow Menkhoff et al. (2012b). The regressors are real personal consumption expenditures (cons), number of total nonfarm employees (emp), ISM manufacturing index (ism), real industry production (ip), consumer prices (cpi), money stock M2 (m2), real disposable personal income (inc), monthly average TED-spread (ted) and monthly average term spread that is calculated from 10-year Treasury CMS and 3-month Treasury CMS (term). All macro variables are expressed as percentage change from the previous month. The data for the construction of the macro factors is taken from the homepage of the Federal Reserve Bank of St. Louis. The regression results reveal that the business cycle factors are largely insignificant, the regression intercept remains highly significant and the adjusted R-Squared is tiny. To conclude, there is no evidence that currency, equity, hedge fund, or macro factors are able to explain the excess payoffs of the long-short portfolio formed on moment risk.

Third, market participants could refrain from the low-risk strategy if it was the case that excess payoffs are subject to considerable time variation and investment horizons are short. Therefore, I investigate the time variation of RISK. Figure 6 shows means of monthly RISK that are calculated over rolling windows of one year (area), three years (gray line) and five years (black line). For the rolling window of one year, average monthly RISK varies substantially across time. Next, consider the rolling window of three years. Here, average monthly RISK is negative for 5 out of 238 rolling windows, i.e. for 2.10% of the observations only, and has a minimum of −2.72 USD p.a. Average monthly RISK is positive in all cases when a rolling window of five years is employed. Overall, the results suggest that time variation in RISK might be a limit-to-arbitrage for investors with rather short investment horizons but should not constitute an obstacle for investors with intermediate investment horizons of several years. To put these results into context, I look into the time variation of excess payoffs of the other currency strategies. Consider the rolling window of three years again. Here, average monthly MOME is negative for

19.33% of the observations and reaches a minimum of −8.71 USD p.a. Further, average monthly CARR is negative for 8.40% of the observations and reaches values down to −7.74 USD p.a. whereas mean monthly GVOL is negative for 18.49% of observations and has a minimum of −9.90 USD p.a. To sum up, RISK goes along with more stable excess payoffs than MOME, CARR and GVOL and these strategies are (partly) implemented in real portfolios.[24]

Fourth, if it was the case that the low-risk strategy requires explicit position taking in riskier currencies, country limits could triggered. Position taking in risky currencies would then be restricted and, as a consequence, investors would refrain from the low-risk strategy. In order to look into this, I consider a metric of country risk which comprises sovereign risk, currency risk, and banking sector risk. This metric is obtained from Economist Intelligence Unit via Bloomberg. My sample reduces to 19 currency pairs as there is no data on country risk for the euro area. The data on country risk starts between Feb. 28, 1997 and Mar. 31, 2007 and is updated on month ends in intervals that range from one month to six months.[25] I set up again double-sorted portfolios which are rebalanced at each month end. First, currency pairs are allocated into two sub-sets based on the latest available metric of country risk. Second, currency pairs within each of the two sub-sets are then sorted on moment risk and put into tertile portfolios. The results are illustrated in Table 10. Average RISK is more pronounced in economic terms when currency pairs that belong to the riskier countries are employed. However, the differences in excess payoffs between high- and low-country risk strategies are statistically insignificant for four out of five maturities. For comparison, I perform double sorts on country risk for the other currency strategies alike. Look at the long-short portfolios formed on volatility betas.

[24] With regard to the implementation of carry trade and momentum strategies in currency portfolios, I refer again to footnote 20 in Menkhoff et al. (2012b).

[25] In particular, country risk data for Hungary, Mexico, New Zealand, Singapore, South Africa and Taiwan starts on Feb. 28, 1997 and is updated monthly. Next, country risk data for Australia, Brazil, Poland, South Korea, Czech Republic and Turkey starts on Feb. 28, 1997 and is updated either monthly or bimonthly. Further, the start dates of country risk data for Canada, Denmark, Japan, Norway, Sweden, Switzerland and UK range from May. 31, 2006 to March. 31, 2007 and the data is updated in intervals between one month and six months.

Here, the differences in excess payoffs between the equivalent high- and low-country risk strategies are statistically significant for four out of five contract maturities maturities. For the long-short portfolio formed on forward discounts, the differences in excess payoffs between the respective high- and low-country risk strategies are highly significant for four out of five contract maturities. Even more, we cannot reject that excess payoffs are equal to zero when the currency pairs that belong to the less risky countries are employed and this is true for all five contract maturities. The same holds for the five long-short portfolios formed on momentum. To conclude, momentum and carry trade strategies require explicit engagements in riskier countries in order to obtain an average excess payoffs which is non-zero in statistical terms. This is not true for the low-risk strategy based on higher moments.

7 Checking Robustness

I provide robustness checks for my main result that currency pairs with low moment risk tend to outperform currency pairs with high moment risk. In particular, I show that the predictability of moment risk for the cross-section of excess payoffs holds when different sample periods are employed, when the basket of currency pairs changes, and when we change the viewpoint from a USD-investor to a GBP- or JPY-investor.

I split the sample period and consider the first half and the second half of the full sample separately. Table 11 indicates that RISK is highly significant in both sub-samples and this is true for all contract maturities under study. MOME and CARR remain significant alike in both sub-samples. In contrast, GVOL becomes largely insignificant.

So far, I have employed a basket of 20 currencies against USD. Now, I consider two other baskets of currencies against USD. First, I make use of a sample of 10 developed currencies belonging to Australia, Canada, Denmark, euro area, Japan, New Zealand, Norway, Sweden, Switzerland as well as the United Kingdom. This sample follows Della

Corte, Ramadorai, and Sarno (2014). Second, I employ a broader basket of 49 developed and emerging market currencies that belong to Australia, Austria, Belgium, Brazil, Bulgaria, Canada, Croatia, Cyprus, Czech Republic, Denmark, Egypt, euro area, Finland, France, Germany, Greece, Hong Kong, Hungary, Iceland, India, Indonesia, Ireland, Israel, Italy, Japan, Kuwait, Malaysia, Mexico, Netherlands, New Zealand, Norway, Philippines, Poland, Portugal, Russia, Saudi Arabia, Singapore, Slovakia, Slovenia, South Africa, Spain, Sweden, Switzerland, South Korea, Taiwan, Thailand, Turkey, Ukraine and the United Kingdom. This cross-section results from the intersection of the 20 currency pairs employed in this work and taken from Della Corte, Ramadorai, and Sarno (2014) and the 48 currency pairs employed by Menkhoff et al. (2012b). The spot and forward rates for the additional currency pairs stem again from Barclays, WM/Reuters and Thomson Reuters and are obtained via Datastream. For the additional data, I perform the steps of cleaning that are explained in Section 3.[26] I construct excess payoffs. As Figure 7 illustrates, the effective size of the cross-sections of available excess payoffs varies considerably across time. Specifically, currency pairs exit due to the implementation of the Euro.[27] Turning to the results in Table 12, I find that RISK remains highly significant in the sample of 49 currency pairs no matter which maturity is considered. In the smaller sample with 10 currency pairs, the long-short portfolio formed on moment risk becomes insignificant for the yearly contracts whereas the long-short portfolios of the other maturities remain (highly) significant. In contrast, MOME and GVOL become insignificant no matter which contract maturity is considered.

[26] I do not consider observations that are obviously subject to large failures of covered interest parity. From the WM/Reuters data, this concerns all forward rates for Indonesia from Feb. 16, 2001 to Jun. 1, 2007, annual forward rates for Ukraine from Sept. 24, 2010 onwards, all forward rates for Turkey from Feb. 19, 2001 to Dec. 25, 2001 as well as all forward and spot rates for Malaysia from Sept. 2, 1998 to Jul. 21, 2005. From the Barclays data, I delete spot rates for Malaysia from Sept. 2, 1998 to Jul. 21, 2005. The removals from the Thomson Reuters data concern spot rates for Malaysia from Sept. 2, 1998 onwards, monthly forward rates for Taiwan from Jun. 21, 2013 onwards, spot rates for Slovakia from Jan. 1, 2009 onwards and all forward and spot rates for Kuwait from Aug. 1, 1990 to Jan. 15, 1992. Further, I delete the bimonthly, quarterly, and annual forward rates for Kuwait from Aug. 25, 1994 to Aug. 26, 1994, from Sept. 1, 1994 to Sept. 9, 1994, and from Sept. 22, 1994 to Nov. 24, 1994.

[27] I remove excess payoffs for Austria, Belgium, Finland, France, Germany, Ireland, Italy, Netherlands, Portugal, and Spain from t equal to Dec. 31, 1998 onwards. I delete excess payoffs for Greek from t equal to Dec. 29, 2000 onwards, for Slovenia from t equal to Dec. 29, 2006 onwards, for Cyprus from t equal to Dec. 31, 2007 onwards, and for Slovakia from t equal to Dec. 31, 2008 onwards.

So far, I have employed a basket of currencies against USD. Now, I construct the portfolios from the perspective of a GBP-investor (JPY-investor). I compute cross rates such that all spot and forward rates are quoted against 1 GBP (JPY). Excess payoffs are denominated in GBP (JPY) now and the contract notional is set to $\gamma = 100$ GBP (JPY). The size of the basket of currencies does not change because we loose a currency in the basket which is GBP (JPY) and we include another currency that is USD. Table 13 gives the results. RISK remains highly significant and this is true for all maturities under study.

8 Exploring Alternative Strategies

In this section, I explore three nearby alternative specifications of the low-risk strategy proposed in this work. The purpose is twofold. First, the reader might be interested in whether obviously alternative strategies work out or not. Second, it is interesting to see whether nearby alternative strategy specifications yield portfolios with excess payoffs that are significantly different from RISK or not. From that perspective, the analysis reveals which steps within the formation procedure of the low-risk strategy suggested in this work are crucial and which are not.

The low-risk strategy suggested in this paper makes use of higher moments only. An obvious alternative strategy is one that is exclusively based on mean-adjusted second moments. Against this background, I form portfolios on the mean-adjusted second moment.[28] For the mean-adjustment, I consider the usual six formation periods and have, thus, six long-short portfolios under study. At each rebalancing date, an investor enters one out of these six strategies. In particular, he enters the long-short portfolio that delivered the highest mean excess payoffs over the three previous months. I refer to the resulting strategy as RISK_2 because it is constructed exactly in the same way as RISK, except that

[28] All portfolios created in this section are from the perspective of a US investor, created from a basket of 20 developed and emerging market currencies, and equally weighted. Further, I track excess payoffs of long-short portfolios that are based on quintiles and disregard transaction costs. I consider the monthly forward contracts here and employ the overall sample period.

the set of underlying strategies is different as it considers only moments up to order 2. Statistics for the resulting long-short portfolio are provided in Table 14.

First, $RISK_2$ amounts to 4.29 USD p.a. and is highly significant (upper part of second column). I conclude that second-moment based sorts work out. Second, I compare $RISK_2$ to RISK which amounts to 11.07 USD p.a. on average (upper part of first column). The results reveal that $RISK_2$ is less meaningful in economic terms than RISK. Moreover, RISK is significantly different from $RISK_2$ in statistical terms (bottom part of second column). The results show that the employment of higher moments is a crucial characteristic of the low-risk strategy suggested in my work.

The low-risk strategy established in this paper uses moments with considerably high orders. The various moments are probably hard to interpret and it is not clear how they actually differ from each other. Moreover, it is questionable if the consideration of all these high moments really adds to the performance of RISK because, as Table 2 shows, the performance characteristics of the strategies with particular high moments are very similar when the formation period is fixed. Against this background, it is interesting to see how portfolios perform that are restricted to employ higher moments up to a specific order only. In order to look into this, I set up alternative strategies that are constructed exactly in the same way as RISK except for one modification within the procedure of portfolio formation. The alternative strategies are restricted to select only the strategies in Table 2 that are based on moments up to an order of α. I refer to the associated excess payoffs of the long-short portfolios as $RISK_\alpha$ and provide statistics on $RISK_\alpha$ with α ranging between 4 and 90 in Table 14.

First, depending on the parameter α, the excess payoffs of the alternative strategies range between 6.50 USD p.a. and 11.22 USD p.a. and are highly significant (upper part of columns three to fourteen). I conclude that sorts which are restricted to involve moments up a specific order α work out, which confirms the results in Table 2. Second, and more interesting, I compare the twelve alternative strategies to RISK. RISK is significantly different from $RISK_4$ and $RISK_6$ (bottom part of columns three and four). However, the differences in RISK and $RISK_8$, RISK and $RISK_{10}$, ..., RISK and $RISK_{90}$ are insignificant in statistical terms (bottom part of columns five to fourteen). Put differently, the employment of moments with orders four, six, and eight is a crucial characteristic of the low-risk strategy suggested in this work whereas the inclusion of moments with orders ten and higher does not matter statistically.

The low-risk strategy suggested in this work makes use of higher moments that are estimated from about 22 daily return observations of a given month, respectively. The larger the order of a moment, the more weight is allocated to the extreme daily return observations, i.e. to the ones that are large in absolute value. In the extreme case, all weight is allocated to the most extreme daily return observation in a month. Therefore, an alternative construction method is to make exclusively use of the most extreme daily currency return in a month. Against this background, I set up two alternative strategies that are both constructed exactly in the same way as RISK except for one respective modification within the procedure of portfolio formation. In a first sorting procedure, higher moments are now estimated from a single return observation only instead from about 22 return observations. In particular, it is the most extreme daily return observation that enters the moment estimate of the respective month. In a second procedure of portfolio formation, higher moments are replaced by the absolute values of the most extreme daily return. The motivation for the second sorting procedure is as follows. It is only a single daily return that enters the moment estimates in the first sorting procedure such that we do not need to allocate weights in-between the daily return observations of a given month. For this reason, it appears that there is no need to raise this single return observation to a higher power as it is done the first sorting procedure. Thus, in a second procedure of portfolio formation, I simply take the absolute value of the most extreme return observation in order to eliminate the directional information of the return. In the second sorting procedure, the investor enters one out of six underlying strategies (corresponding to six different formation periods) at each rebalancing date whereas there are 78 underlying strategies in the first procedure of portfolio formation. Statistics for the long-short portfolios that result from the two sorting procedures are provided by Table 14.

First, the excess payoffs that result from the first sorting procedure amount to 9.94 USD p.a. and are highly significant (upper part of second-last column). In contrast, the excess payoffs associated with the second procedure of portfolio formation are 1.67 USD p.a. on average and statistically insignificant (upper part of last column). Put differently, portfolio sorts that are restricted to use the most extreme daily currency return in each month work well as long as the most extreme daily return observation is raised to a high power before the mean-adjustment is carried out. In contrast, the sorts do not work out when the absolute value is applied to the most extreme return observation before the mean-adjustment is calculated. The results imply that the purpose of raising returns to a higher power is not only to allocate weights in-between the daily currency returns of a specific month but also to ensure a sensible mean-adjustment of the monthly risk metrics across time. Second, the findings reveal again that the functional form of a higher moment is a crucial feature of the low-risk strategy suggested in this work. Moreover, comparing RISK to the excess payoffs that result from the first sorting procedure, I find that the differences in excess payoffs are statistically significant at the 10% confidence level only (bottom part of second-last column). This result shows that the estimation of higher moments from about 22 monthly return observations is not a crucial feature of the low-risk strategy suggested in this work.

I conclude as follows. First, it is possible to set up profitable low-risk strategies that are exclusively based on lower-order moments. Nevertheless, I do not make use of second-moment based sorts in the main strategy suggested in this work for the following reason. A look into the six underlying strategies of $RISK_2$ reveals that four out of the six underlying strategies yield long-short portfolios with insignificant excess payoffs.[29] I conclude that second-moment based sorts are not as robust as sorts based on higher moments are.

[29] The results for the six underlying strategies are not reported here but available upon request.

Second, it is comprehensible to construct a low-risk strategy which makes use of higher moments with orders four, six, and eight only. However, I employ moments of order ten and higher in the main strategy of this work because the performance gains are economically meaningful, though not statistically significant. Third, is is reasonable to set up a low-risk strategy based on moments that are estimated from the most extreme return observation only. Anyway, I estimate the higher moments from all daily return observations of a month in my main strategy which is, again, due to performance gains.

9 Conclusion

Given the distinct pricing power of functions of higher return moments for the cross-section of excess payoffs in currency markets, three areas of further research emerge. First, it is important to know whether a suchlike predictability is present in other asset classes. If this was the case, this suggests that it might further apply that higher moments across asset classes are driven by a common state variable. Second, it is of interest to understand the drivers of higher moments themselves in greater detail. Third, it is necessary to better understand the relationship between returns and their higher moments. In that context, the following particular questions arise. Disentangling a moment of an asset into one component that is related to the market moment and into another specific component, does the predictability of the moment stem from the market component, or from the specific component, or both? Is the predictability of higher moments purely cross-sectional or does it work in the time-series dimension, for single assets only, as well? What about the predictive power of higher moments with odd orders? Ultimately, it would be useful to have a formal model that answers these questions and deepens our understanding about the relationship between returns and their higher moments.

In this work, I find that the top portfolios formed on moment risk typically have low kurtosis and high standard deviations whereas the bottom portfolios have high kurtosis and low standard standard deviations. Put differently, portfolios with low standard deviations go along with high kurtosis and vice versa. Based on this finding, a potential explanation for the widely discussed low-risk anomaly in equity markets emerges. Equities with low risk, whereas risk is defined as a lower-order moment as it is typically the case in the low-risk literature, might earn abnormally high returns because they systematically tend to have large higher-order moments which investors demand a premium for. This hypothetical risk-based explanation for the low-risk anomaly needs further investigation.

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	B	2	3	4	T	T-B
mean (USD p.a.)	-0.17	2.13	2.81	2.66	6.96	7.13
$\widetilde{p}$	[0.93]	[0.25]	[0.14]	[0.12]	[0.01]	[0.00]
$\widehat{p}$	[0.92]	[0.28]	[0.13]	[0.13]	[0.01]	[0.00]
standard deviation (USD p.a.)	7.93	8.60	9.40	8.55	10.23	8.41
Sharpe ratio (p.a.)	-0.02	0.25	0.30	0.31	0.68	0.85
skewness	-0.29	-0.89	-0.09	-0.39	-0.36	-0.20
kurtosis	7.92	7.89	4.40	5.03	4.09	4.48
maximum annual drawdown (USD)	29.38	33.37	15.70	15.78	21.90	14.52

Table 1: Portfolios Formed on the Moment of Order 10 That Is Mean-Adjusted over 60 Months - Summary Statistics. The table reports portfolio statistics. The portfolios are formed on the moment of order 10 that is mean-adjusted over 60 months. The moment is calculated out of all daily currency returns over the last month. The portfolios are created out of a basket of 20 developed and emerging market currencies against USD. B, 2, 3, 4 and T are equally weighted quintile portfolios and T-B denotes the long-short portfolio. Rebalancing is monthly from Nov. 30, 1989 to Oct. 31, 2014 (300 observations). The statistics in the table refer to excess payoffs of portfolios $\pi_{t,\tau}^{q} \forall q \in Q$ and $\phi_{t,\tau}$ for $\tau = \frac{1}{12}$. Transaction costs are excluded. The table contains information on means together with p-values for a two-sided test. $\widetilde{p}$ refers to tests based on the stationary bootstrapping of Politis and Romano (1994) whereas the number of bootstrap samples is set to 10,000 and the block length is chosen in accordance with Politis and White (2004). $\widehat{p}$ indicates that the statistical tests are based on Newey and West (1987) whereas the lag length is computed as in Newey and West (1994). Shaded p-values are smaller than 0.05. Next, the table contains information on standard deviations, Sharpe ratios, skewness, kurtosis and maximum annual drawdowns.

	4	6	8	10	20	30	40	50	60	70	80	90	100
							mean (USD p.a.)						
12	5.55	6.14	6.98	6.82	6.51	6.49	6.57	6.24	6.43	6.37	6.39	6.22	6.10
$\widetilde{p}$	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
$\widehat{p}$	[0.01]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
24	4.74	6.14	7.51	8.06	7.77	7.58	7.58	7.38	6.82	6.60	6.60	6.69	6.66
$\widetilde{p}$	[0.01]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]
$\widehat{p}$	[0.02]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
36	5.95	7.88	9.19	8.75	7.92	7.58	7.72	7.67	7.16	7.28	7.08	7.14	7.21
$\widetilde{p}$	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.01]	[0.00]	[0.00]	[0.01]	[0.01]
$\widehat{p}$	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
48	4.65	6.95	7.61	8.48	8.67	8.16	8.31	8.37	8.40	8.36	8.27	8.26	8.26
$\widetilde{p}$	[0.01]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
$\widehat{p}$	[0.01]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
60	3.57	5.94	6.52	7.13	7.70	7.45	7.67	7.73	7.72	7.54	7.57	7.55	7.64
$\widetilde{p}$	[0.03]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
$\widehat{p}$	[0.04]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
∞	4.10	5.38	4.24	4.04	4.22	4.04	4.32	4.29	4.38	4.38	4.38	4.38	4.38
$\widetilde{p}$	[0.01]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
$\widehat{p}$	[0.01]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
							Sharpe ratio (p.a.)						
12	0.64	0.72	0.80	0.78	0.75	0.75	0.75	0.72	0.75	0.74	0.74	0.73	0.71
24	0.52	0.69	0.84	0.90	0.90	0.88	0.87	0.84	0.80	0.78	0.78	0.79	0.79
36	0.69	0.96	1.07	1.02	0.95	0.88	0.90	0.89	0.84	0.86	0.85	0.85	0.86
48	0.55	0.84	0.92	1.05	1.11	1.04	1.06	1.06	1.06	1.05	1.05	1.05	1.05
60	0.42	0.71	0.77	0.85	0.95	0.94	0.95	0.96	0.96	0.93	0.93	0.93	0.95
∞	0.54	0.76	0.66	0.65	0.64	0.60	0.64	0.64	0.65	0.65	0.65	0.65	0.65
							skewness						
12	-0.28	-0.24	-0.18	-0.25	-0.37	-0.40	-0.36	-0.39	-0.40	-0.39	-0.39	-0.38	-0.36
24	-0.46	-0.41	-0.27	-0.31	-0.06	-0.13	-0.08	-0.10	-0.09	-0.10	-0.10	-0.11	-0.12
36	-0.43	-0.16	0.06	0.04	0.16	0.12	0.13	0.13	0.15	0.18	0.15	0.16	0.15
48	-0.29	-0.29	-0.09	-0.02	0.10	0.06	0.03	0.03	0.04	0.03	0.03	0.07	0.07
60	-0.48	-0.55	-0.24	-0.20	-0.07	0.12	0.14	0.09	0.09	0.06	0.05	0.09	0.11
∞	-0.15	-0.20	-0.70	-0.85	-0.88	-0.87	-0.87	-0.88	-0.83	-0.83	-0.83	-0.83	-0.83
							maximum annual drawdown (USD)						
12	21.58	19.69	23.50	23.50	22.23	22.23	22.52	22.52	21.07	21.05	21.05	21.05	21.05
24	19.00	19.77	17.84	21.55	21.66	21.55	21.55	21.55	22.26	22.26	22.26	22.26	22.26
36	16.88	13.08	11.91	16.83	18.39	20.96	20.96	20.96	22.09	22.09	22.09	22.09	22.09
48	14.58	20.32	15.58	14.98	11.59	12.25	12.25	12.25	12.25	12.25	12.25	12.25	12.25
60	15.20	15.75	13.85	14.52	12.64	12.64	12.64	12.64	12.64	12.64	12.64	12.64	12.64
∞	17.98	11.25	11.98	9.72	11.69	12.61	12.61	12.61	11.85	11.85	11.85	11.85	11.85

Table 2: Portfolios Formed on Moments of Various Orders That Are Mean-Adjusted over Various Formation Periods - Summary Statistics. The tables report portfolio statistics. The portfolios are formed on moments of various orders (indicated by columns) that are mean-adjusted over various formation periods in months (indicated by rows). The moments are calculated out of all daily currency returns over the last month. The portfolios are created out of a basket of 20 developed and emerging market currencies against USD. The statistics refer to long-short portfolios that result from equally weighted quintile portfolios. Rebalancing is monthly from Nov. 30, 1989 to Oct. 31, 2014 (300 observations). The statistics refer to excess payoffs of portfolios $\phi_{t,\tau}$ for $\tau = \frac{1}{12}$. Transaction costs are excluded. The tables contain information on means together with p-values for a two-sided test. $\widetilde{p}$ refers to tests based on the stationary bootstrapping of Politis and Romano (1994) whereas the number of bootstrap samples is set to 10,000 and the block length is chosen in accordance with to Politis and White (2004). $\widehat{p}$ indicates that the statistical tests are based on Newey and West (1987) whereas the lag length is computed as in Newey and West (1994). Shaded p-values are smaller than 0.05. Next, the tables contain information on Sharpe ratios, skewness and maximum annual drawdowns.

	B	2	3	4	T	T-B
mean (USD p.a.)	-0.61	0.42	1.87	3.06	10.46	11.07
$\widetilde{p}$	[0.74]	[0.81]	[0.28]	[0.09]	[0.00]	[0.00]
$\widehat{p}$	[0.74]	[0.83]	[0.32]	[0.10]	[0.00]	[0.00]
standard deviation (USD p.a.)	8.38	8.45	8.59	8.77	9.99	8.00
Sharpe ratio (p.a.)	-0.07	0.05	0.22	0.35	1.05	1.38
skewness	-0.69	-0.92	-0.26	-0.23	-0.18	-0.10
kurtosis	7.82	7.43	4.28	3.48	3.63	3.66
maximum annual drawdown (USD)	26.03	33.89	24.30	17.58	16.00	11.65

Table 3: Portfolios Formed on Moment Risk - Summary Statistics. The table reports portfolio statistics. The portfolios are formed on moment risk. They are created out of a basket of 20 developed and emerging market currencies against USD. B, 2, 3, 4 and T are equally weighted quintile portfolios and T-B denotes the long-short portfolio. Rebalancing is monthly from Feb. 28, 1990 to Oct. 31, 2014 (297 observations). The statistics in the table refer to excess payoffs of portfolios $\pi^{q}_{t,\tau}\,\forall q \in Q$ and $\phi_{t,\tau}$ for $\tau = \frac{1}{12}$. Transaction costs are excluded. The table contains information on means together with p-values for a two-sided test. $\widetilde{p}$ refers to tests based on the stationary bootstrapping of Politis and Romano (1994) whereas the number of bootstrap samples is set to 10,000 and the block length is chosen accordance with Politis and White (2004). $\widehat{p}$ indicates that the statistical tests are based on Newey and West (1987) whereas the lag length is computed as in Newey and West (1994). Shaded p-values are smaller than 0.05. Next, the table contains information on standard deviations, Sharpe ratios, skewness, kurtosis and maximum annual drawdowns.

	B	2	3	4	T	T-B	B	2	3	4	T	T-B
	moment risk						**momentum**					
mean (USD p.a.)	-0.61	0.42	1.87	3.06	10.46	11.07	-0.30	1.55	2.75	3.92	6.87	7.18
$\widetilde{p}$	[0.74]	[0.81]	[0.28]	[0.09]	[0.00]	[0.00]	[0.87]	[0.42]	[0.13]	[0.03]	[0.00]	[0.00]
$\widehat{p}$	[0.74]	[0.83]	[0.32]	[0.10]	[0.00]	[0.00]	[0.88]	[0.45]	[0.16]	[0.04]	[0.00]	[0.00]
standard deviation (USD p.a.)	8.38	8.45	8.59	8.77	9.99	8.00	9.34	9.03	8.46	8.49	9.27	8.54
Sharpe ratio (p.a.)	-0.07	0.05	0.22	0.35	1.05	1.38	-0.03	0.17	0.32	0.46	0.74	0.84
skewness	-0.69	-0.92	-0.26	-0.23	-0.18	-0.10	-0.45	-0.84	-0.72	-0.46	0.20	0.45
kurtosis	7.82	7.43	4.28	3.48	3.63	3.66	5.09	6.26	6.61	4.97	3.93	3.99
maximum annual drawdown (USD)	26.03	33.89	24.30	17.58	16.00	11.65	23.60	27.13	26.40	29.77	11.24	18.12
mean$_\alpha$ (USD p.a.)	-3.73	-2.70	-1.25	-0.06	7.34	11.07	-3.42	-1.57	-0.37	0.80	3.76	7.18
$\widetilde{p}_\alpha$	[0.00]	[0.00]	[0.12]	[0.96]	[0.00]	[0.00]	[0.00]	[0.07]	[0.63]	[0.35]	[0.01]	[0.00]
$\widehat{p}_\alpha$	[0.00]	[0.01]	[0.16]	[0.95]	[0.00]	[0.00]	[0.00]	[0.07]	[0.61]	[0.37]	[0.00]	[0.00]
	forward discounts						**volatility betas**					
mean (USD p.a.)	-0.83	0.56	1.99	4.18	9.64	10.48	1.26	0.88	2.73	2.29	5.27	4.01
$\widetilde{p}$	[0.59]	[0.75]	[0.23]	[0.04]	[0.00]	[0.00]	[0.47]	[0.60]	[0.11]	[0.28]	[0.02]	[0.05]
$\widehat{p}$	[0.61]	[0.76]	[0.27]	[0.06]	[0.00]	[0.00]	[0.50]	[0.62]	[0.12]	[0.33]	[0.03]	[0.06]
standard deviation (USD p.a.)	7.54	8.23	8.30	9.95	10.47	9.73	8.41	8.24	8.30	9.84	10.59	9.91
Sharpe ratio (p.a.)	-0.11	0.07	0.24	0.42	0.92	1.08	0.15	0.11	0.33	0.23	0.50	0.40
skewness	0.29	-0.04	-0.37	-0.93	-0.74	-0.52	0.39	-0.47	-0.43	-0.74	-0.50	-0.62
kurtosis	4.70	3.96	4.78	6.59	5.56	4.49	4.64	4.95	5.72	5.78	4.93	4.82
maximum annual drawdown (USD)	20.53	26.41	19.49	31.64	24.02	29.69	23.73	23.81	24.81	37.78	21.02	27.25
mean$_\alpha$ (USD p.a.)	-3.95	-2.56	-1.13	1.06	6.52	10.48	-1.86	-2.24	-0.39	-0.83	2.15	4.01
$\widetilde{p}_\alpha$	[0.00]	[0.00]	[0.07]	[0.26]	[0.00]	[0.00]	[0.14]	[0.01]	[0.63]	[0.39]	[0.05]	[0.05]
$\widehat{p}_\alpha$	[0.00]	[0.00]	[0.07]	[0.32]	[0.00]	[0.00]	[0.17]	[0.00]	[0.64]	[0.38]	[0.07]	[0.06]

Table 4: Currency Portfolios - Summary Statistics. The tables report portfolio statistics. The portfolios are formed on moment risk, momentum, forward discounts and volatility betas. They are created out of a basket of 20 developed and emerging market currencies against USD. B, 2, 3, 4 and T are equally weighted quintile portfolios and T-B denotes the long-short portfolio. Rebalancing is monthly from Feb. 28, 1990 to Oct. 31, 2014 (297 observations). The statistics in the upper parts of the tables refer to excess payoffs of portfolios $\pi^q_{t,\tau}\,\forall q \in Q$ and $\phi_{t,\tau}$ for $\tau = \frac{1}{12}$ (no subscript in name of statistic). The statistics in the bottom parts of the tables refer to the alpha of excess payoffs of the quintile portfolios relative to the dollar factor $\alpha^q_{t,\tau}$ $\forall q \in Q$ for $\tau = \frac{1}{12}$ as well as to differences of the alphas for the top and the bottom portfolio $\alpha^T_{t,\tau} - \alpha^B_{t,\tau} = \phi_{t,\tau}$ for $\tau = \frac{1}{12}$ (subscript α in the name of the statistic). Transaction costs are excluded. The tables contain information on means together with p-values for a two-sided test. $\widetilde{p}$ refers to tests based on the stationary bootstrapping of Politis and Romano (1994) whereas the number of bootstrap samples is set to 10,000 and the block length is chosen accordance with Politis and White (2004). $\widehat{p}$ indicates that the statistical tests are based on Newey and West (1987) whereas the lag length is computed as in Newey and West (1994). Shaded p-values are smaller than 0.05. Next, the tables contain information on standard deviations, Sharpe ratios, skewness, kurtosis and maximum annual drawdowns.

	$\frac{1}{12}$	$\frac{2}{12}$	$\frac{3}{12}$	$\frac{6}{12}$	$\frac{12}{12}$	$\frac{1}{12}$	$\frac{2}{12}$	$\frac{3}{12}$	$\frac{6}{12}$	$\frac{12}{12}$
	moment risk, [excess payoffs]					**moment risk, [payoffs]**				
mean (USD p.a.)	11.17	11.19	9.93	8.52	6.46	3.44	4.15	2.81	1.41	0.27
$\tilde{p}$	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.06]	[0.00]	[0.02]	[0.17]	[0.75]
$\hat{p}$	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.06]	[0.01]	[0.03]	[0.18]	[0.75]
standard deviation (USD p.a.)	8.11	8.46	8.97	10.80	12.49	8.91	8.99	8.73	8.90	8.91
Sharpe ratio (p.a.)	1.38	1.32	1.11	0.79	0.52	0.39	0.46	0.32	0.16	0.03
skewness	-0.11	0.36	0.43	1.17	1.01	0.13	0.07	-0.35	-0.09	0.15
kurtosis	3.59	4.14	4.04	5.89	5.14	4.39	5.39	4.82	3.52	3.57
maximum annual drawdown (USD)	11.65	14.66	11.95	13.68	21.05	14.79	12.59	18.11	28.64	30.65
	momentum, [excess payoffs]					**momentum, [payoffs]**				
mean (USD p.a.)	7.56	5.10	5.43	3.31	3.28	7.15	5.64	5.92	3.04	2.90
$\tilde{p}$	[0.00]	[0.00]	[0.00]	[0.06]	[0.01]	[0.00]	[0.00]	[0.00]	[0.08]	[0.06]
$\hat{p}$	[0.00]	[0.00]	[0.00]	[0.01]	[0.01]	[0.00]	[0.00]	[0.00]	[0.00]	[0.01]
standard deviation (USD p.a.)	8.63	9.41	9.86	11.35	12.53	9.63	10.18	10.31	9.77	10.79
Sharpe ratio (p.a.)	0.88	0.54	0.55	0.29	0.26	0.74	0.55	0.57	0.31	0.27
skewness	0.43	0.26	0.27	0.75	1.12	0.65	0.90	0.72	0.21	0.73
kurtosis	3.94	3.21	3.36	6.14	7.55	4.42	4.63	4.37	3.53	4.23
maximum annual drawdown (USD)	18.12	15.23	19.36	31.67	31.62	17.70	18.90	20.17	30.31	21.99
	forward discounts, [excess payoffs]					**forward discounts, [payoffs]**				
mean (USD p.a.)	10.55	10.42	10.18	9.77	7.99	-5.50	-5.29	-5.26	-5.32	-5.89
$\tilde{p}$	[0.00]	[0.00]	[0.00]	[0.01]	[0.02]	[0.01]	[0.01]	[0.00]	[0.00]	[0.00]
$\hat{p}$	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.02]	[0.01]	[0.01]	[0.00]	[0.00]
standard deviation (USD p.a.)	9.85	10.74	11.87	13.93	15.03	9.49	9.85	10.52	11.00	10.39
Sharpe ratio (p.a.)	1.07	0.97	0.86	0.70	0.53	-0.58	-0.54	-0.50	-0.48	-0.57
skewness	-0.52	-0.43	-0.47	0.19	0.55	-0.66	-0.61	-0.73	-0.51	-0.33
kurtosis	4.44	4.69	4.40	4.07	4.28	4.27	4.64	4.58	3.54	3.06
maximum annual drawdown (USD)	29.69	27.67	30.00	32.10	33.02	41.23	37.03	37.89	40.15	39.04
	volatility betas, [excess payoffs]					**volatility betas, [payoffs]**				
mean (USD p.a.)	4.17	3.80	3.99	3.97	3.90	-0.01	-0.23	-0.03	0.09	-0.26
$\tilde{p}$	[0.05]	[0.06]	[0.03]	[0.02]	[0.01]	[0.99]	[0.91]	[0.98]	[0.97]	[0.85]
$\hat{p}$	[0.06]	[0.07]	[0.04]	[0.02]	[0.02]	[1.00]	[0.91]	[0.99]	[0.96]	[0.88]
standard deviation (USD p.a.)	10.02	10.39	10.42	10.97	11.28	10.40	10.91	11.01	10.90	10.76
Sharpe ratio (p.a.)	0.42	0.37	0.38	0.36	0.35	-0.00	-0.02	-0.00	0.01	-0.02
skewness	-0.63	-0.30	-0.07	0.56	0.96	-0.65	-0.54	-0.50	-0.11	-0.39
kurtosis	4.79	4.15	4.16	4.17	4.99	4.63	3.83	3.81	3.15	2.93
maximum annual drawdown (USD)	27.25	25.07	22.30	20.41	23.13	29.99	30.54	31.21	29.56	34.12

Table 5: Currency Portfolios - Varying the Contract Maturity and Isolating the Impact of Movements of Spot Rates. The tables report portfolio statistics. The portfolios are formed on moment risk, momentum, forward discounts and volatility betas. They are created out of a basket of 20 developed and emerging market currencies against USD. The statistics refer to long-short portfolios that result from equally weighted quintile portfolios. Rebalancing is monthly from Feb. 28, 1990 to Nov. 29, 2013 (286 observations). The statistics refer either to excess payoffs of portfolios $\phi_{t,\tau}$ $\forall \tau \in \Xi$ [excess payoffs] or to payoffs of portfolios $\widehat{\phi}_{t,\tau}$ $\forall \tau \in \Xi$ [payoffs]. Transaction costs are excluded. The tables contain information on means together with p-values for a two-sided test. $\tilde{p}$ refers to tests based on the stationary bootstrapping of Politis and Romano (1994) whereas the number of bootstrap samples is set to $10,000$ and the block length is chosen accordance with Politis and White (2004). $\hat{p}$ indicates that the statistical tests are based on Newey and West (1987) whereas the lag length is computed as the maximum that results from the method of Newey and West (1994) and the number of overlaps. Shaded p-values are smaller than 0.05. Next, the tables contain information on standard deviations, Sharpe ratios, skewness, kurtosis and maximum annual drawdowns.

	B	2	3	4	T	B	2	3	4	T
	moment risk					**momentum**				
B	0.54	0.17	0.13	0.09	0.07	0.26	0.20	0.17	0.16	0.21
2	0.21	0.49	0.18	0.09	0.04	0.18	0.23	0.23	0.21	0.16
3	0.11	0.19	0.46	0.17	0.07	0.17	0.18	0.27	0.20	0.17
4	0.09	0.09	0.19	0.50	0.15	0.18	0.18	0.24	0.21	0.19
T	0.04	0.06	0.08	0.15	0.67	0.19	0.20	0.18	0.19	0.25
	forward discounts					**volatility betas**				
B	0.88	0.10	0.02	0.01	0.00	0.91	0.09	0.00	0.00	0.00
2	0.10	0.76	0.12	0.01	0.00	0.08	0.81	0.10	0.01	0.00
3	0.01	0.12	0.76	0.10	0.01	0.01	0.09	0.79	0.11	0.00
4	0.00	0.01	0.11	0.77	0.10	0.00	0.01	0.12	0.79	0.08
T	0.00	0.00	0.01	0.10	0.89	0.00	0.00	0.01	0.08	0.91

Table 6: Currency Portfolios - Transition Matrices. The tables contain information on the probability that a currency migrates from portfolio r (indicated by rows) at time t to portfolio s (indicated by columns) at time $t + \frac{1}{12}$. The portfolios are formed on moment risk, momentum, forward discounts and volatility betas. They are created out of a basket of 20 developed and emerging market currencies against USD. B, 2, 3, 4 and T are equally weighted quintile portfolios. Rebalancing is monthly from Feb. 28, 1990 to Oct. 31, 2014 (297 observations). The factors are constructed to predict excess payoffs $\phi_{t,\tau}$ for $\tau = \frac{1}{12}$.

	$\frac{1}{12}$	$\frac{2}{12}$	$\frac{3}{12}$	$\frac{6}{12}$	$\frac{12}{12}$	$\frac{1}{12}$	$\frac{2}{12}$	$\frac{3}{12}$	$\frac{6}{12}$	$\frac{12}{12}$
	momentum					**forward discounts**				
B: mean (USD p.a.)	1.53	2.59	2.76	2.07	1.79	2.17	3.04	2.21	1.55	1.47
$\tilde{p}$	[0.38]	[0.05]	[0.01]	[0.01]	[0.00]	[0.17]	[0.01]	[0.04]	[0.10]	[0.07]
$\hat{p}$	[0.39]	[0.06]	[0.01]	[0.01]	[0.02]	[0.09]	[0.01]	[0.05]	[0.09]	[0.09]
T: mean (USD p.a.)	5.50	6.26	5.54	4.69	3.11	6.34	5.66	5.41	4.14	2.64
$\tilde{p}$	[0.00]	[0.00]	[0.00]	[0.00]	[0.01]	[0.00]	[0.00]	[0.00]	[0.00]	[0.06]
$\hat{p}$	[0.00]	[0.00]	[0.00]	[0.00]	[0.02]	[0.00]	[0.00]	[0.00]	[0.01]	[0.06]
Δ: mean (USD p.a.)	3.97	3.67	2.77	2.62	1.32	4.17	2.62	3.20	2.58	1.17
$\tilde{p}$	[0.09]	[0.04]	[0.06]	[0.03]	[0.24]	[0.09]	[0.23]	[0.10]	[0.18]	[0.46]
$\hat{p}$	[0.08]	[0.05]	[0.07]	[0.06]	[0.30]	[0.07]	[0.24]	[0.11]	[0.15]	[0.44]
	volatility betas									
B: mean (USD p.a.)	3.19	3.23	2.81	2.07	1.23					
$\tilde{p}$	[0.03]	[0.00]	[0.00]	[0.00]	[0.09]					
$\hat{p}$	[0.02]	[0.00]	[0.00]	[0.01]	[0.12]					
T: mean (USD p.a.)	5.37	6.09	5.92	5.01	3.95					
$\tilde{p}$	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]					
$\hat{p}$	[0.01]	[0.00]	[0.00]	[0.01]	[0.02]					
Δ: mean (USD p.a.)	2.18	2.85	3.11	2.93	2.71					
$\tilde{p}$	[0.34]	[0.14]	[0.30]	[0.29]	[0.11]					
$\hat{p}$	[0.36]	[0.19]	[0.14]	[0.13]	[0.13]					

Table 7: Portfolios Formed on Moment Risk - Double Sorts on Momentum, Forward Discounts and Volatility Betas. The tables report statistics on double-sorted portfolios that are obtained as follows. First, currency pairs are allocated into two sub-sets based on momentum (forward discounts, volatility betas). Second, currency pairs within each of the two sub-sets are then sorted on moment risk and put into equally weighted tertile portfolios. I consider the long-short portfolio that results from these tertiles for the currency pairs of the bottom portfolio from the first sort (indicated by rows with B), for the long-short portfolio that results from these tertiles for the currency pairs of the top portfolio from the first sort (indicated by rows with T) as well as for a portfolio that is long in the first mentioned long-short portfolio and short in the last mentioned long-short portfolio (indicated by rows with Δ). The portfolios are created out of a basket of 20 developed and emerging dollar currencies against USD. Rebalancing is monthly from Feb. 28, 1990 to Nov. 29, 2013 (286 observations). The statistics refer to excess payoffs of portfolios $\phi_{t,\tau}$ $\forall \tau \in \Xi$. Transaction costs are excluded. The tables contain information on means together with p-values for a two-sided test. $\tilde{p}$ refers to tests based on the stationary bootstrapping of Politis and Romano (1994) whereas the number of bootstrap samples is set to 10,000 and the block length is chosen accordance with Politis and White (2004). $\hat{p}$ indicates that the statistical tests are based on Newey and West (1987) whereas the lag length is computed as the maximum that results from the method of Newey and West (1994) and the number of overlaps. Shaded p-values are smaller than 0.05.

	$\frac{1}{12}$	$\frac{2}{12}$	$\frac{3}{12}$	$\frac{6}{12}$	$\frac{12}{12}$
mean (USD p.a.)	6.83	8.70	8.12	7.35	5.66
$\widetilde{p}$	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
$\widehat{p}$	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
standard deviation (USD p.a.)	8.03	8.30	8.86	10.56	12.21
Sharpe ratio (p.a.)	0.85	1.05	0.92	0.70	0.46
skewness	-0.15	0.28	0.33	1.07	0.94
kurtosis	3.61	4.08	3.92	5.66	5.01
maximum annual drawdown (USD)	15.79	16.25	13.64	15.02	22.17

Table 8: Portfolios Formed on Moment Risk - Transaction Costs. The table reports portfolio statistics. The portfolios are formed on moment risk. They are created out of a basket of 20 developed and emerging market currencies against USD. The statistics refer to long-short portfolios that result from equally weighted quintile portfolios. Rebalancing is monthly from Feb. 28, 1990 to Nov. 29, 2013 (286 observations). The statistics refer to excess payoffs of portfolios $\widetilde{\phi}_{t,\tau}$ $\forall \tau \in \Xi$. Transaction costs are included. The table contains information on means together with p-values for a two-sided test. $\widetilde{p}$ refers to tests based on the stationary bootstrapping of Politis and Romano (1994) whereas the number of bootstrap samples is set to 10,000 and the block length is chosen accordance with Politis and White (2004). $\widehat{p}$ indicates that the statistical tests are based on Newey and West (1987) whereas the lag length is computed as the maximum that results from the method of Newey and West (1994) and the number of overlaps. Shaded p-values are smaller than 0.05. Next, the table contains information on standard deviations, Sharpe ratios, skewness, kurtosis and maximum annual drawdowns.

currency factors

α	DOLL	MOME	CARR	GVOL	R^2
7.06	0.12	0.20	0.21	0.01	0.12
[0.00]	[0.18]	[0.01]	[0.01]	[0.92]	

equity factors

α	mkt	size	value	mome	R^2
10.74	0.03	0.05	0.03	-0.02	-0.00
[0.00]	[0.26]	[0.22]	[0.43]	[0.44]	

hedge fund factors

α	bond trend	curr trend	comm trend	bond mkt	credit spread	mkt2	size2	R^2
11.51	-0.01	0.01	0.00	-0.86	-1.57	0.04	-0.05	0.02
[0.00]	[0.59]	[0.15]	[0.86]	[0.17]	[0.13]	[0.32]	[0.18]	

macro factors

α	cons	emp	ism	ip	cpi	m2	inc	ted	term	R^2
14.05	-1.31	-0.11	0.09	-0.06	-0.83	0.11	0.05	-0.00	-0.00	0.02
[0.00]	[0.19]	[0.76]	[0.01]	[0.81]	[0.06]	[0.73]	[0.70]	[0.81]	[0.28]	

Table 9: Portfolios Formed on Moment Risk - Time Series Tests. The tables report results for four regressions. The left-hand side variable is the excess payoff of the long-short portfolio formed on moment risk (RISK). In the first regression, I use currency factors as right-hand side variables that are the dollar risk factor (DOLL) as well as the long-short portfolios formed on momentum (MOME), forward discounts (CARR) and volatility betas (GVOL). All currency long-short portfolios used in the regressions are created out of a basket of 20 developed and emerging market currencies against USD, result from equally weighted quintile portfolios and employ excess payoffs $\phi_{t,\tau}$ for $\tau = \frac{1}{12}$ that exclude transaction costs. In the second regression, I make use of US equity factors that are related to the overall equity market (mkt), firm size (size), book-to-market equity (value) and momentum in equity markets (mome). The equity factors are expressed as monthly returns in percent. In the third regression, I employ hedge fund factors as explanatory variables that are returns on portfolios of lookback straddle options on bonds (bond trend), currency pairs (curr trend) and commodities (comm trend) as well as the month-end change of the yield of 10-year Treasury CMS (bond mkt) and the month-end change of the difference of the yields of Moody's BAA corporate bond and 10-year Treasury CMS (credit spread). Further, the hedge fund factors include the total return of S&P 500 (mkt2) as well as the difference of the total returns of Russell 2000 and S&P 500 (size2). The hedge fund factors are expressed as (differences of) monthly returns in percent. In the fourth regression, I consider US macro factors which are real personal consumption expenditures (cons), number of total nonfarm employees (emp), ISM manufacturing index (ism), real industry production (ip), consumer prices (cpi), money stock M2 (m2), real disposable personal income (inc), monthly average TED-spread (ted) and monthly average term spread that is calculated from 10-year Treasury CMS and 3-month Treasury CMS (term). All macro variables are expressed as monthly growth rates in percent. For the regressions with currency, equity and macro factors, I employ monthly data from Mar. 1990 to Nov. 2014 (297 observations). For the regression with hedge fund factors, I employ monthly data from Jan. 1994 to Nov. 2014 (251 observations). The tables contain information on the regression intercepts being multiplied by 12 denoted by α, the slope coefficients as well as the adjusted R-Squared denoted by R^2. Further, the tables report p-values in brackets which are based on Newey and West (1987) whereas the lag length is computed as in Newey and West (1994). Shaded p-values are smaller than 0.05.

	$\frac{1}{12}$	$\frac{2}{12}$	$\frac{3}{12}$	$\frac{6}{12}$	$\frac{12}{12}$	$\frac{1}{12}$	$\frac{2}{12}$	$\frac{3}{12}$	$\frac{6}{12}$	$\frac{12}{12}$
	moment risk					**momentum**				
B: mean (USD p.a.)	4.59	3.97	2.80	1.70	3.28	3.17	1.96	1.61	0.42	1.44
$\widetilde{p}$	[0.02]	[0.02]	[0.07]	[0.22]	[0.00]	[0.17]	[0.25]	[0.23]	[0.67]	[0.06]
$\widehat{p}$	[0.03]	[0.03]	[0.08]	[0.22]	[0.02]	[0.19]	[0.27]	[0.25]	[0.70]	[0.17]
T: mean (USD p.a.)	10.55	10.36	9.18	8.66	7.91	8.94	7.89	8.37	6.66	3.76
$\widetilde{p}$	[0.00]	[0.00]	[0.01]	[0.02]	[0.01]	[0.11]	[0.00]	[0.00]	[0.01]	[0.08]
$\widehat{p}$	[0.01]	[0.00]	[0.00]	[0.02]	[0.05]	[0.02]	[0.02]	[0.01]	[0.03]	[0.17]
Δ: mean (USD p.a.)	5.96	6.39	6.37	6.97	4.63	5.78	5.93	6.76	6.24	2.32
$\widetilde{p}$	[0.15]	[0.05]	[0.07]	[0.05]	[0.08]	[0.15]	[0.04]	[0.01]	[0.00]	[0.16]
$\widehat{p}$	[0.19]	[0.09]	[0.04]	[0.02]	[0.11]	[0.15]	[0.07]	[0.02]	[0.02]	[0.25]
	forward discounts					**volatility betas**				
B: mean (USD p.a.)	1.98	2.44	1.90	1.99	2.38	5.18	5.60	5.77	5.32	4.94
$\widetilde{p}$	[0.39]	[0.27]	[0.39]	[0.30]	[0.16]	[0.04]	[0.03]	[0.02]	[0.01]	[0.02]
$\widehat{p}$	[0.46]	[0.29]	[0.40]	[0.30]	[0.18]	[0.06]	[0.03]	[0.02]	[0.01]	[0.03]
T: mean (USD p.a.)	14.42	15.29	15.54	15.09	11.83	13.97	14.04	13.22	13.48	10.26
$\widetilde{p}$	[0.00]	[0.00]	[0.00]	[0.00]	[0.01]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
$\widehat{p}$	[0.00]	[0.00]	[0.00]	[0.00]	[0.04]	[0.00]	[0.00]	[0.00]	[0.00]	[0.01]
Δ: mean (USD p.a.)	12.44	12.86	13.65	13.10	9.44	8.80	8.44	7.45	8.16	5.32
$\widetilde{p}$	[0.00]	[0.01]	[0.01]	[0.01]	[0.04]	[0.03]	[0.03]	[0.02]	[0.03]	[0.09]
$\widehat{p}$	[0.01]	[0.01]	[0.00]	[0.01]	[0.06]	[0.04]	[0.05]	[0.05]	[0.03]	[0.16]

Table 10: Currency Portfolios - Double Sorts on Country Risk. The tables report statistics on double-sorted portfolios that are obtained as follows. First, currency pairs are allocated into two sub-sets based on country risk. Second, currency pairs within each of the two sub-sets are then sorted on moment risk (momentum, forward discounts, volatility betas) and put into equally weighted tertile portfolios. I consider the long-short portfolio that results from these tertiles for the currency pairs of the bottom portfolio from the first sort (indicated by rows with B), for the long-short portfolio that results from these tertiles for the currency pairs of the top portfolio from the first sort (indicated by rows with T) as well as for a portfolio that is long in the first mentioned long-short portfolio and short in the last mentioned long-short portfolio (indicated by rows with Δ). The portfolios are created out of a basket of 20 developed and emerging market currencies against USD. Rebalancing is monthly from Dec. 31, 1999 to Nov. 29, 2013 (168 observations). The statistics refer to excess payoffs of portfolios $\phi_{t,\tau}$ $\forall \tau \in \Xi$. Transaction costs are excluded. The tables contain information on means together with p-values for a two-sided test. $\widetilde{p}$ refers to tests based on the stationary bootstrapping of Politis and Romano (1994) whereas the number of bootstrap samples is set to 10,000 and the block length is chosen accordance with Politis and White (2004). $\widehat{p}$ indicates that the statistical tests are based on Newey and West (1987) whereas the lag length is computed as the maximum that results from the method of Newey and West (1994) and the number of overlaps. Shaded p-values are smaller than 0.05.

	$\frac{1}{12}$	$\frac{2}{12}$	$\frac{3}{12}$	$\frac{6}{12}$	$\frac{12}{12}$	$\frac{1}{12}$	$\frac{2}{12}$	$\frac{3}{12}$	$\frac{6}{12}$	$\frac{12}{12}$
	moment risk, [1^{st} Half]					**moment risk, [2^{nd} Half]**				
mean (USD p.a.)	8.93	8.20	6.73	5.49	3.05	13.42	14.17	13.14	11.54	9.88
$\tilde{p}$	[0.00]	[0.00]	[0.00]	[0.00]	[0.02]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
$\hat{p}$	[0.00]	[0.00]	[0.00]	[0.00]	[0.03]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
standard deviation (USD p.a.)	8.25	8.01	8.34	8.68	10.06	7.95	8.74	9.33	12.23	13.74
Sharpe ratio (p.a.)	1.08	1.02	0.81	0.63	0.30	1.69	1.62	1.41	0.94	0.72
skewness	0.03	0.38	0.20	0.31	0.13	-0.26	0.30	0.53	1.25	1.12
kurtosis	3.42	5.15	3.65	3.01	2.71	3.88	3.46	4.06	5.37	4.65
maximum annual drawdown (USD)	11.65	14.66	11.95	13.68	21.05	6.24	8.12	5.14	12.35	19.88
	momentum, [1^{st} Half]					**momentum, [2^{nd} Half]**				
mean (USD p.a.)	10.59	5.53	5.18	2.06	2.86	4.53	4.68	5.67	4.56	3.70
$\tilde{p}$	[0.00]	[0.00]	[0.00]	[0.08]	[0.00]	[0.06]	[0.02]	[0.00]	[0.01]	[0.10]
$\hat{p}$	[0.00]	[0.00]	[0.00]	[0.08]	[0.01]	[0.10]	[0.04]	[0.01]	[0.06]	[0.11]
standard deviation (USD p.a.)	8.91	9.46	9.60	9.73	9.99	8.29	9.39	10.15	12.74	14.65
Sharpe ratio (p.a.)	1.19	0.58	0.54	0.21	0.29	0.55	0.50	0.56	0.36	0.25
skewness	0.53	0.19	0.17	-0.35	-0.24	0.27	0.33	0.35	1.14	1.44
kurtosis	3.49	3.00	2.60	3.69	3.58	4.37	3.44	3.93	6.13	7.17
maximum annual drawdown (USD)	2.76	15.23	14.27	31.67	26.87	18.12	13.93	19.36	28.28	31.62
	forward discounts, [1^{st} Half]					**forward discounts, [2^{nd} Half]**				
mean (USD p.a.)	8.57	8.30	8.35	7.16	5.17	12.54	12.54	12.01	12.37	10.82
$\tilde{p}$	[0.00]	[0.00]	[0.01]	[0.06]	[0.19]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
$\hat{p}$	[0.01]	[0.00]	[0.00]	[0.01]	[0.10]	[0.00]	[0.00]	[0.00]	[0.00]	[0.01]
standard deviation (USD p.a.)	8.64	9.00	10.40	11.78	12.43	10.93	12.20	13.15	15.62	16.81
Sharpe ratio (p.a.)	0.99	0.92	0.80	0.61	0.42	1.15	1.03	0.91	0.79	0.64
skewness	-0.53	-0.45	-0.58	-0.46	-0.56	-0.56	-0.50	-0.49	0.31	0.79
kurtosis	3.19	2.96	3.24	3.22	3.38	4.69	4.83	4.63	3.78	3.54
maximum annual drawdown (USD)	29.69	27.67	30.00	32.10	33.02	20.48	20.14	17.85	21.68	23.34
	volatility betas, [1^{st} Half]					**volatility betas, [2^{nd} Half]**				
mean (USD p.a.)	2.71	2.36	2.77	2.41	1.91	5.64	5.24	5.22	5.53	5.88
$\tilde{p}$	[0.32]	[0.34]	[0.25]	[0.28]	[0.33]	[0.07]	[0.07]	[0.05]	[0.02]	[0.00]
$\hat{p}$	[0.36]	[0.38]	[0.27]	[0.28]	[0.38]	[0.09]	[0.10]	[0.07]	[0.03]	[0.02]
standard deviation (USD p.a.)	9.68	9.74	9.73	9.95	9.89	10.36	11.00	11.07	11.84	12.22
Sharpe ratio (p.a.)	0.28	0.24	0.28	0.24	0.19	0.54	0.48	0.47	0.47	0.48
skewness	-0.60	-0.34	0.01	0.12	0.11	-0.67	-0.30	-0.17	0.74	1.29
kurtosis	4.22	3.60	3.10	2.75	2.70	5.22	4.41	4.73	4.49	5.06
maximum annual drawdown (USD)	27.25	25.07	20.41	20.41	23.13	19.30	21.69	22.30	20.34	18.29

Table 11: Currency Portfolios - Varying the Sample Period. The tables report portfolio statistics. The portfolios are formed on moment risk, momentum, forward discounts and volatility betas. They are created out of a basket of 20 developed and emerging market currencies against USD. The statistics refer to long-short portfolios that result from equally weighted quintile portfolios. Rebalancing in the first half of the full sample [1^{st} Half] is monthly from Feb. 28, 1990 to Dec. 31, 2001 (143 observations). Rebalancing in the second half of the full sample [2^{nd} Half] is monthly from Jan. 31, 2002 to Nov. 29, 2013 (143 observations). The statistics refer to excess payoffs of portfolios $\phi_{t,\tau}$ $\forall \tau \in \Xi$. Transaction costs are excluded. The tables contain information on means together with p-values for a two-sided test. $\tilde{p}$ refers to tests based on the stationary bootstrapping of Politis and Romano (1994) whereas the number of bootstrap samples is set to 10,000 and the block length is chosen accordance with Politis and White (2004). $\hat{p}$ indicates that the statistical tests are based on Newey and West (1987) whereas the lag length is computed as the maximum that results from the method of Newey and West (1994) and the number of overlaps. Shaded p-values are smaller than 0.05. Next, the tables contain information on standard deviations, Sharpe ratios, skewness, kurtosis and maximum annual drawdowns.

	$\frac{1}{12}$	$\frac{2}{12}$	$\frac{3}{12}$	$\frac{6}{12}$	$\frac{12}{12}$	$\frac{1}{12}$	$\frac{2}{12}$	$\frac{3}{12}$	$\frac{6}{12}$	$\frac{12}{12}$
	moment risk, [DM]^{10}					**moment risk, [DM+EM]^{49}**				
mean (USD p.a.)	3.41	4.33	3.67	2.47	1.38	8.24	7.98	8.22	6.82	5.11
$\tilde{p}$	[0.04]	[0.00]	[0.00]	[0.02]	[0.13]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
$\hat{p}$	[0.04]	[0.00]	[0.00]	[0.01]	[0.14]	[0.00]	[0.00]	[0.00]	[0.00]	[0.01]
standard deviation (USD p.a.)	8.05	8.23	8.47	8.54	8.70	8.52	8.82	9.28	10.57	11.93
Sharpe ratio (p.a.)	0.42	0.53	0.43	0.29	0.16	0.97	0.90	0.89	0.65	0.43
skewness	0.06	0.48	0.35	0.31	0.35	-0.10	0.16	0.50	0.85	1.14
kurtosis	5.23	4.91	3.48	3.45	3.28	4.30	4.42	3.88	4.66	4.90
maximum annual drawdown (USD)	15.14	18.92	26.60	19.43	20.73	15.86	14.91	14.78	22.11	18.26
	momentum, [DM]^{10}					**momentum, [DM+EM]^{49}**				
mean (USD p.a.)	1.54	0.67	1.26	-0.40	0.43	9.53	5.94	5.83	3.32	3.05
$\tilde{p}$	[0.43]	[0.62]	[0.28]	[0.61]	[0.45]	[0.00]	[0.00]	[0.00]	[0.02]	[0.01]
$\hat{p}$	[0.41]	[0.61]	[0.27]	[0.57]	[0.42]	[0.00]	[0.00]	[0.00]	[0.01]	[0.01]
standard deviation (USD p.a.)	9.44	9.36	9.56	9.31	9.47	9.09	9.35	9.54	10.63	11.41
Sharpe ratio (p.a.)	0.16	0.07	0.13	-0.04	0.05	1.05	0.64	0.61	0.31	0.27
skewness	0.31	0.35	0.44	-0.35	-0.06	0.19	0.10	0.23	0.51	0.87
kurtosis	4.36	4.55	4.06	3.88	3.44	4.89	4.69	3.92	5.09	6.47
maximum annual drawdown (USD)	21.11	19.59	30.38	31.67	28.51	13.50	15.64	18.24	28.18	38.11
	forward discounts, [DM]^{10}					**forward discounts, [DM+EM]^{49}**				
mean (USD p.a.)	4.88	5.31	4.72	4.26	4.18	10.34	8.95	9.09	8.40	7.14
$\tilde{p}$	[0.03]	[0.02]	[0.03]	[0.04]	[0.02]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
$\hat{p}$	[0.04]	[0.02]	[0.03]	[0.03]	[0.03]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
standard deviation (USD p.a.)	10.32	10.94	11.51	11.77	11.53	8.50	9.98	10.84	12.00	13.51
Sharpe ratio (p.a.)	0.47	0.49	0.41	0.36	0.36	1.22	0.90	0.84	0.70	0.53
skewness	-0.84	-0.82	-0.98	-0.72	-0.43	-0.35	-0.68	-0.70	0.19	0.60
kurtosis	5.09	5.57	5.95	5.68	4.00	4.28	5.22	5.71	4.24	3.71
maximum annual drawdown (USD)	35.19	33.45	34.75	33.19	33.35	22.39	23.49	20.33	24.36	27.02
	volatility betas, [DM]^{10}					**volatility betas, [DM+EM]^{49}**				
mean (USD p.a.)	2.37	2.33	2.45	2.58	2.53	3.97	4.00	3.95	4.27	3.64
$\tilde{p}$	[0.24]	[0.17]	[0.15]	[0.09]	[0.06]	[0.04]	[0.02]	[0.01]	[0.00]	[0.00]
$\hat{p}$	[0.27]	[0.24]	[0.20]	[0.11]	[0.10]	[0.04]	[0.03]	[0.02]	[0.01]	[0.01]
standard deviation (USD p.a.)	9.87	10.05	10.27	10.25	9.93	9.54	9.57	9.39	9.58	9.91
Sharpe ratio (p.a.)	0.24	0.23	0.24	0.25	0.25	0.42	0.42	0.42	0.45	0.37
skewness	-0.86	-0.78	-0.66	-0.24	-0.21	-0.70	-0.41	-0.08	0.22	0.32
kurtosis	6.23	6.67	6.15	5.70	4.86	4.33	4.73	4.28	3.82	3.65
maximum annual drawdown (USD)	36.16	32.11	29.83	29.95	33.35	24.17	22.02	21.35	18.65	23.13

Table 12: Currency Portfolios - Varying the Basket of Currency Pairs. The tables report portfolio statistics. The portfolios are formed on moment risk, momentum, forward discounts and volatility betas. They are either created out of a basket of 10 developed market currencies [DM]^{10} against USD or they are created out of a basket of 49 developed and emerging market currencies [DM+EM]^{49} against USD. The statistics refer to long-short portfolios that result from equally weighted quintile portfolios. Rebalancing is monthly from Feb. 28, 1990 to Nov. 29, 2013 (286 observations). The statistics refer to excess payoffs of portfolios $\phi_{t,\tau}$ $\forall \tau \in \Xi$. Transaction costs are excluded. The tables contain information on means together with p-values for a two-sided test. $\tilde{p}$ refers to tests based on the stationary bootstrapping of Politis and Romano (1994) whereas the number of bootstrap samples is set to 10,000 and the block length is chosen accordance with Politis and White (2004). $\hat{p}$ indicates that the statistical tests are based on Newey and West (1987) whereas the lag length is computed as the maximum that results from the method of Newey and West (1994) and the number of overlaps. Shaded p-values are smaller than 0.05. Next, the tables contain information on standard deviations, Sharpe ratios, skewness, kurtosis and maximum annual drawdowns.

	$\frac{1}{12}$	$\frac{2}{12}$	$\frac{3}{12}$	$\frac{6}{12}$	$\frac{12}{12}$	$\frac{1}{12}$	$\frac{2}{12}$	$\frac{3}{12}$	$\frac{6}{12}$	$\frac{12}{12}$
	moment risk, [GBP]					**moment risk, [JPY]**				
mean (GBP/JPY p.a.)	6.97	6.46	6.20	6.14	5.40	7.12	6.54	6.15	5.46	5.17
$\widetilde{p}$	[0.00]	[0.03]	[0.01]	[0.02]	[0.01]	[0.00]	[0.00]	[0.01]	[0.04]	[0.02]
$\widehat{p}$	[0.00]	[0.00]	[0.00]	[0.00]	[0.01]	[0.00]	[0.00]	[0.00]	[0.01]	[0.01]
standard deviation (GBP/JPY p.a.)	8.14	9.48	10.35	11.66	12.77	9.30	10.23	10.74	12.14	13.26
Sharpe ratio (p.a.)	0.86	0.68	0.60	0.53	0.42	0.77	0.64	0.57	0.45	0.39
skewness	-0.11	-0.13	-0.10	0.82	0.94	-0.24	-0.10	0.08	0.74	0.82
kurtosis	3.83	4.27	4.06	4.81	4.20	3.62	3.61	3.34	4.70	4.54
maximum annual drawdown (GBP/JPY)	20.91	19.38	23.00	22.78	21.41	18.82	25.69	27.13	26.94	28.25
	momentum, [GBP]					**momentum, [JPY]**				
mean (GBP/JPY p.a.)	8.68	6.08	6.03	3.55	3.19	6.81	4.83	5.41	3.27	3.11
$\widetilde{p}$	[0.00]	[0.00]	[0.00]	[0.04]	[0.02]	[0.00]	[0.00]	[0.00]	[0.08]	[0.02]
$\widehat{p}$	[0.00]	[0.00]	[0.00]	[0.01]	[0.01]	[0.00]	[0.00]	[0.00]	[0.01]	[0.01]
standard deviation (GBP/JPY p.a.)	9.03	9.71	10.24	11.57	12.23	8.86	9.64	9.73	11.09	12.02
Sharpe ratio (p.a.)	0.96	0.63	0.59	0.31	0.26	0.77	0.50	0.56	0.29	0.26
skewness	0.50	0.40	0.32	0.56	0.79	0.26	0.07	0.19	0.80	1.12
kurtosis	4.07	3.38	3.48	5.57	5.62	4.02	3.07	3.31	6.19	7.02
maximum annual drawdown (GBP/JPY)	16.78	16.02	20.87	35.92	29.80	19.01	22.98	20.36	37.45	31.42
	forward discounts, [GBP]					**forward discounts, [JPY]**				
mean (GBP/JPY p.a.)	10.86	10.45	10.08	9.56	7.74	11.24	11.02	10.61	10.33	8.40
$\widetilde{p}$	[0.00]	[0.00]	[0.00]	[0.01]	[0.02]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
$\widehat{p}$	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
standard deviation (GBP/JPY p.a.)	10.03	10.99	12.22	14.03	14.46	8.95	9.98	10.80	12.87	14.07
Sharpe ratio (p.a.)	1.08	0.95	0.82	0.68	0.54	1.26	1.10	0.98	0.80	0.60
skewness	-0.69	-0.74	-0.81	-0.15	0.13	-0.45	-0.29	-0.23	0.50	0.90
kurtosis	4.83	5.97	5.63	4.66	3.91	4.71	4.25	4.15	4.33	3.89
maximum annual drawdown (GBP/JPY)	25.44	24.26	28.52	35.78	41.19	21.41	19.12	19.89	22.23	20.44
	volatility betas, [GBP]					**volatility betas, [JPY]**				
mean (GBP/JPY p.a.)	4.04	4.14	4.22	4.61	4.76	7.22	7.84	7.75	7.39	5.31
$\widetilde{p}$	[0.07]	[0.04]	[0.02]	[0.01]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
$\widehat{p}$	[0.08]	[0.05]	[0.03]	[0.01]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
standard deviation (GBP/JPY p.a.)	10.53	10.94	10.88	11.11	10.73	9.66	10.45	10.58	11.68	11.74
Sharpe ratio (p.a.)	0.38	0.38	0.39	0.41	0.44	0.75	0.75	0.73	0.63	0.45
skewness	-0.82	-0.82	-0.76	-0.31	0.33	-0.16	0.32	0.53	1.35	1.25
kurtosis	5.54	5.43	5.24	4.08	4.38	3.97	3.88	4.39	6.72	6.01
maximum annual drawdown (GBP/JPY)	29.25	28.69	30.37	31.11	30.76	16.06	15.64	19.67	18.94	21.53

Table 13: Currency Portfolios - Varying the Investor's Perspective. The tables report portfolio statistics. The portfolios are formed on moment risk, momentum, forward discounts and volatility betas. They are created out of a basket of 20 developed and emerging market currencies, either against GBP [GBP] or against JPY [JPY]. The statistics refer to long-short portfolios that result from equally weighted quintile portfolios. Rebalancing is monthly from Feb. 28, 1990 to Nov. 29, 2013 (286 observations). The statistics refer to excess payoffs of portfolios $\phi_{t,\tau}$ $\forall \tau \in \Xi$. Transaction costs are excluded. The tables contain information on means together with p-values for a two-sided test. $\widetilde{p}$ refers to tests based on the stationary bootstrapping of Politis and Romano (1994) whereas the number of bootstrap samples is set to 10,000 and the block length is chosen accordance with Politis and White (2004). $\widehat{p}$ indicates that the statistical tests are based on Newey and West (1987) whereas the lag length is computed as the maximum that results from the method of Newey and West (1994) and the number of overlaps. Shaded p-values are smaller than 0.05. Next, the tables contain information on standard deviations, Sharpe ratios, skewness, kurtosis and maximum annual drawdowns.

	100	2	4	6	8	10	20	30	40	50	60	70	80	90	100*	1*
mean (USD p.a.)	11.07	4.29	6.50	8.54	10.22	10.59	10.64	10.81	11.07	11.22	11.17	11.15	11.14	11.07	9.94	1.67
$\tilde{p}$	[0.00]	[0.01]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.26]
$\hat{p}$	[0.00]	[0.01]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.29]
standard deviation (USD p.a.)	8.00	8.61	8.28	8.50	7.94	8.22	8.09	7.97	7.99	7.89	8.00	8.00	8.00	8.00	8.41	7.54
Sharpe ratio (p.a.)	1.38	0.50	0.79	1.00	1.29	1.29	1.31	1.36	1.38	1.42	1.40	1.39	1.39	1.38	1.18	0.22
skewness	-0.10	-0.11	-0.33	-0.36	-0.15	-0.04	-0.23	-0.13	-0.12	-0.03	-0.11	-0.11	-0.11	-0.10	-0.37	0.20
kurtosis	3.66	3.60	4.17	4.24	3.69	3.80	3.93	3.69	3.73	3.53	3.66	3.65	3.65	3.66	4.78	3.90
maximum annual drawdown (USD)	11.65	14.05	9.72	8.06	7.76	7.58	7.58	11.65	11.65	11.65	11.65	11.65	11.65	11.65	12.49	18.84
mean_ρ (USD p.a.)	0.00	6.78	4.56	2.53	0.84	0.48	0.42	0.26	-0.00	-0.15	-0.11	-0.08	-0.07	0.00	1.12	9.40
$\tilde{p}_\rho$	-	[0.00]	[0.00]	[0.01]	[0.23]	[0.51]	[0.30]	[0.33]	[0.95]	[0.37]	[0.09]	[0.27]	[0.72]	-	[0.09]	[0.00]
$\hat{p}_\rho$	-	[0.00]	[0.00]	[0.03]	[0.27]	[0.54]	[0.38]	[0.32]	[1.00]	[0.35]	[0.15]	[0.24]	[0.31]	-	[0.13]	[0.00]

Table 14: Portfolios Formed on Moment Risk and Alternative Moment Risk - Summary Statistics. The table reports portfolio statistics. The portfolios are formed on moment risk which considers moments of orders up to 100 (as usual throughout this work, column denoted by 100) as well as on alternative moment risk which considers moments of orders up to α (columns denoted by various values for α). The moments considered within the sorts are either estimated from all about 22 daily currency returns within a month (as usual throughout this work, no superscript of number in column) or from the absolute value of the single return observation within a month which is biggest in absolute value (superscript $*$ of number in column). The portfolios are created out of a basket of 20 developed and emerging market currencies against USD. The statistics refer to long-short portfolios that result from equally weighted quintile portfolios. Rebalancing is monthly from Feb. 28, 1990 to Oct. 31, 2014 (297 observations). The statistics in the upper part of the table refer to excess payoffs of portfolios $\phi_{t,\tau}$ for $\tau = \frac{1}{12}$ (no subscript in name of statistic). The statistics in the bottom part of the table refer to differences in excess payoffs of the portfolios just mentioned and RISK (subscript ρ in the name of the statistic). Transaction costs are excluded. The table contains information on means together with p-values for a two-sided test. $\tilde{p}$ refers to tests based on the stationary bootstrapping of Politis and Romano (1994) whereas the number of bootstrap samples is set to $10,000$ and the block length is chosen accordance with Politis and White (2004). $\hat{p}$ indicates that the statistical tests are based on Newey and West (1987) whereas the lag length is computed as in Newey and West (1994). Missing p-values in the table are not defined due to a zero variance of observations. Shaded p-values are smaller than 0.05. Next, the table contains information on standard deviations, Sharpe ratios, skewness, kurtosis and maximum annual drawdowns.

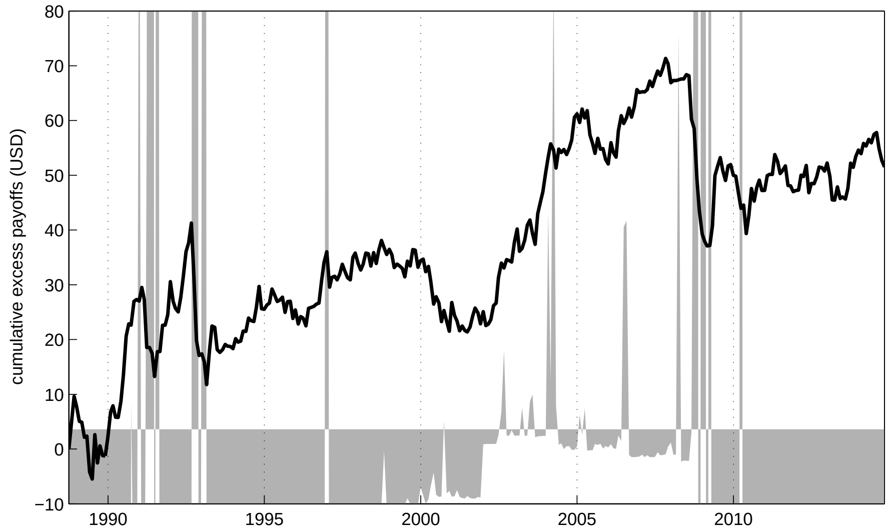

Figure 1: Cumulative Excess Payoffs and Moment of Order 10 That Is Mean-Adjusted over 60 Months for USD-GBP. For USD-GBP, the plot indicates the cumulative excess payoffs $\pi^{i}_{t,\tau}$ for $\tau = \frac{1}{12}$ (line, y-axis). Transaction costs are excluded. Rebalancing is monthly from Sept. 30, 1988 to Sept. 30, 2014 (313 observations). Further, the plot visualizes the moment of order 10 that is mean-adjusted over 60 months for USD-GBP (area, no y-axis, the closer the area is to top of the chart, the higher is the mean-adjusted moment). The moment is calculated out of all daily currency returns over the last month.

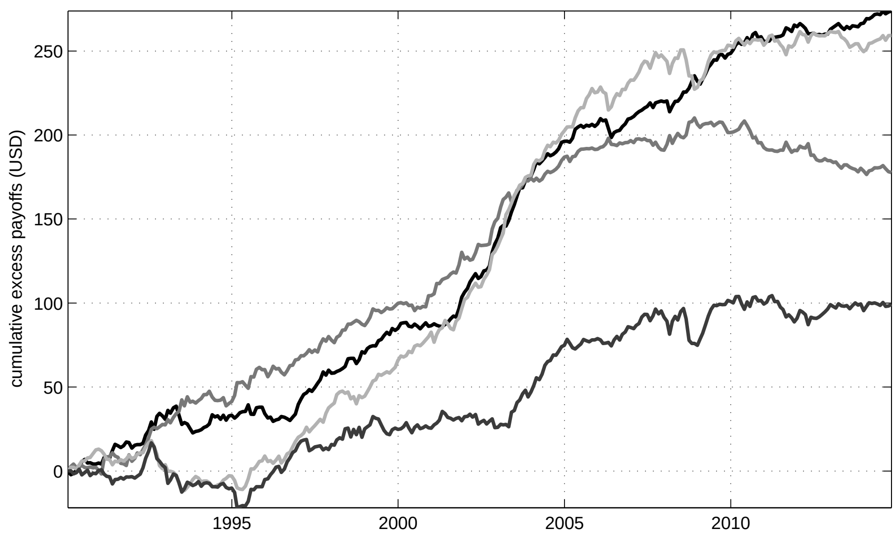

Figure 2: Currency Portfolios - Cumulative Excess Payoffs. For long-short portfolios, the figure shows cumulative excess payoffs $\phi_{t,\tau}$ for $\tau = \frac{1}{12}$. The portfolios are formed on moment risk (black line), momentum (medium-gray line), forward discounts (light-gray line) and volatility betas (dark-gray line). They are created out of a basket of 20 developed and emerging market currencies against USD. The long-short portfolios result from equally weighted quintile portfolios. Rebalancing is monthly from Feb. 28, 1990 to Oct. 31, 2014 (297 observations). Transaction costs are excluded.

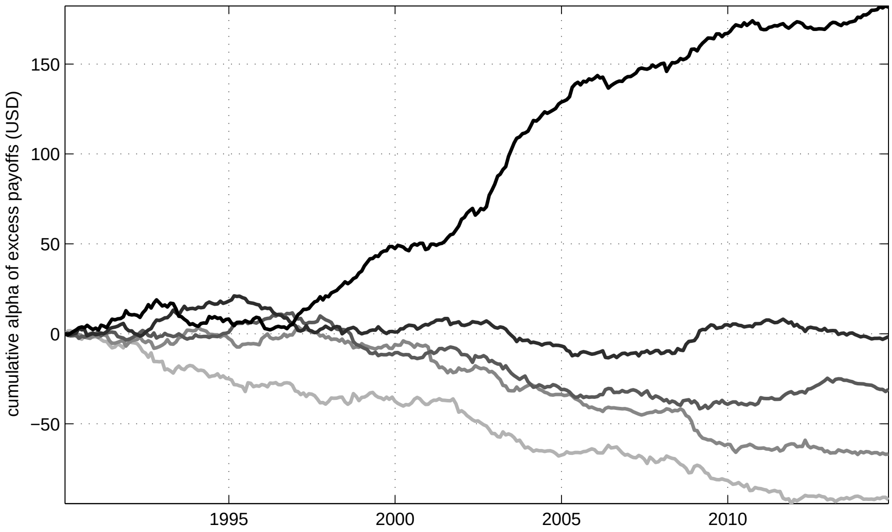

Figure 3: Portfolios Formed on Moment Risk - Cumulative Alphas of Excess Payoffs. For quintile portfolios, the figure shows cumulative alphas of excess payoffs $\alpha^{q}_{t,\tau}$ $\forall q \in Q$, for $\tau = \frac{1}{12}$. The portfolios are formed on moment risk. They are created out of a basket of 20 developed and emerging market currencies against USD. B (light-gray line), 2 (light medium-gray line), 3 (dark medium-gray line), 4 (dark-gray line) and T (black line) are equally weighted quintile portfolios. Rebalancing is monthly from Feb. 28, 1990 to Oct. 31, 2014 (297 observations). Transaction costs are excluded.

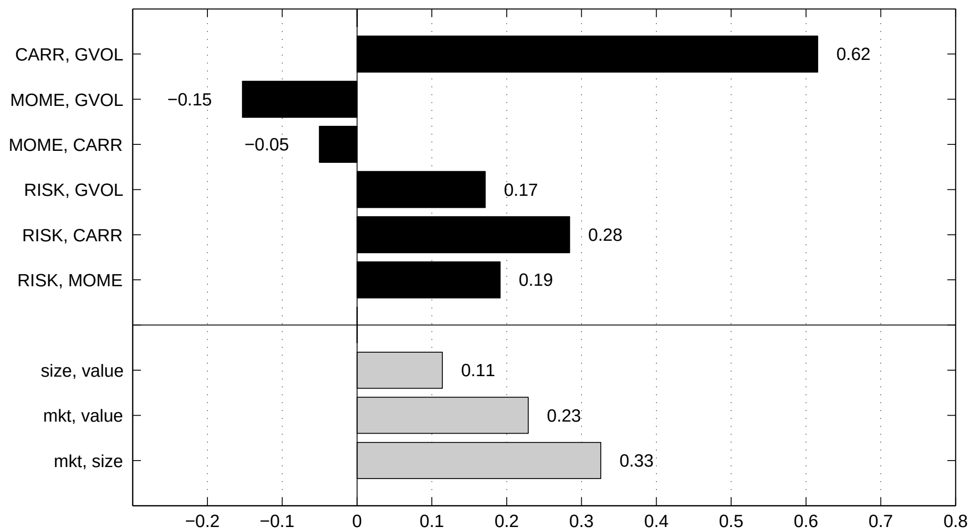

Figure 4: Currency and Equity Portfolios - Correlations. The figure shows pairwise correlations of long-short portfolios in currency markets (black bars) and equity markets (gray bars) as indicated on the y-axis. The currency portfolios are formed on moment risk, momentum, forward discounts and volatility betas. They are created out of a basket of 20 developed and emerging market currencies against USD. The long-short portfolios result from equally weighted quintile portfolios. Rebalancing is monthly from Feb. 28, 1990 to Oct. 31, 2014 (297 observations). The correlations are calculated from excess payoffs of portfolios $\phi_{t,\tau}$ for $\tau = \frac{1}{12}$. Transaction costs are excluded. The equity portfolios correspond to factors in US equity markets that are related to the overall equity market (mkt), firm size (size) and book-to-market equity (value). The factors are taken from the homepage of Kenneth R. French. The monthly equity return data ranges from Jul. 1926 to Jan. 2015 (1063 observations).

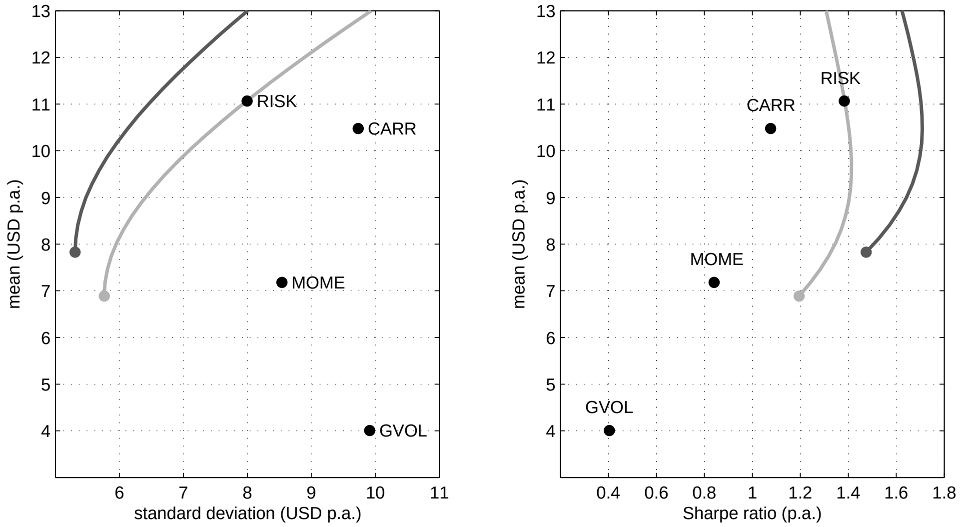

Figure 5: Multi-Factor Currency Portfolios. For various currency portfolios, the figures visualize the mean, standard deviation and the Sharpe ratio for excess payoffs $\phi_{t,\tau}$ for $\tau = \frac{1}{12}$. First, the plots include single-factor long-short portfolios (black bullets) that are formed on moment risk, volatility betas, momentum and forward discounts. They are created out of a basket of 20 developed and emerging market currencies against USD and result from equally weighted quintile portfolios. Rebalancing is monthly from Feb. 28, 1990 to Oct. 31, 2014 (297 observations). Second, the plots visualize efficient multi-factor portfolios that are created from the four aforementioned long-short single-factor portfolios. In particular, the figures indicate the upper part of the efficient frontier (lines) and the corresponding minimum variance portfolios (bullet at the end of the line). Multi-factor portfolios include either GVOL, MOME and CARR (light-gray lines and bullets) or GVOL, MOME and CARR as well as RISK (dark-gray lines and bullets). Transaction costs are excluded.

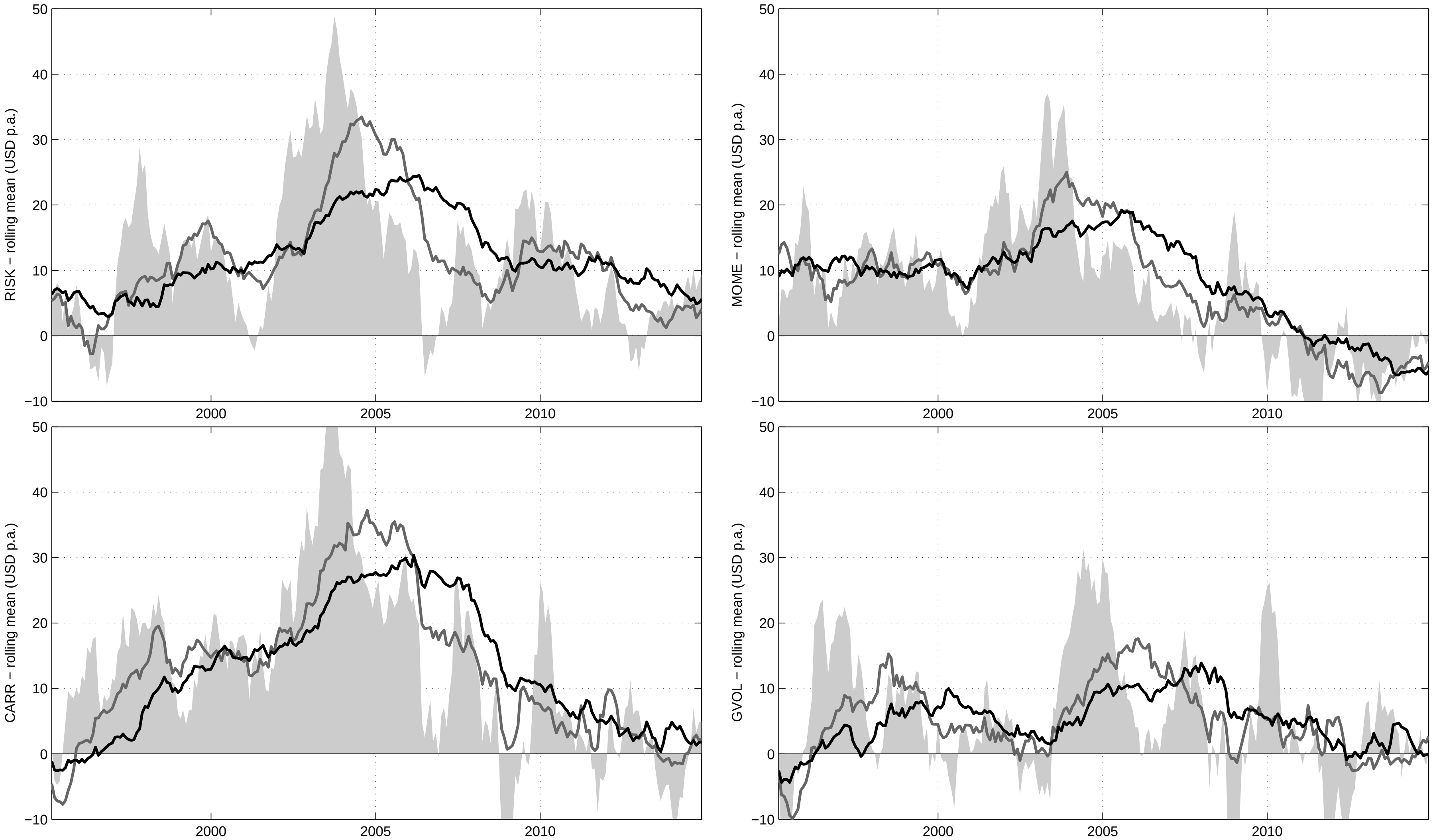

Figure 6: Currency Portfolios - Time Variation. For long-short portfolios, the figures show rolling means of excess payoffs $\phi_{t,\tau}$ for $\tau = \frac{1}{12}$. The rolling window includes the past year (area), the past three years (gray line) as well as the past five years (black line). The sample includes averages of past data from Feb. 28, 1995 to Nov. 28, 2014 (238 observations) The portfolios are formed on moment risk, momentum, forward discounts and volatility betas. They are created out of a basket of 20 developed and emerging market currencies against USD. They result from equally weighted quintile portfolios. Rebalancing is monthly. Transaction costs are excluded.

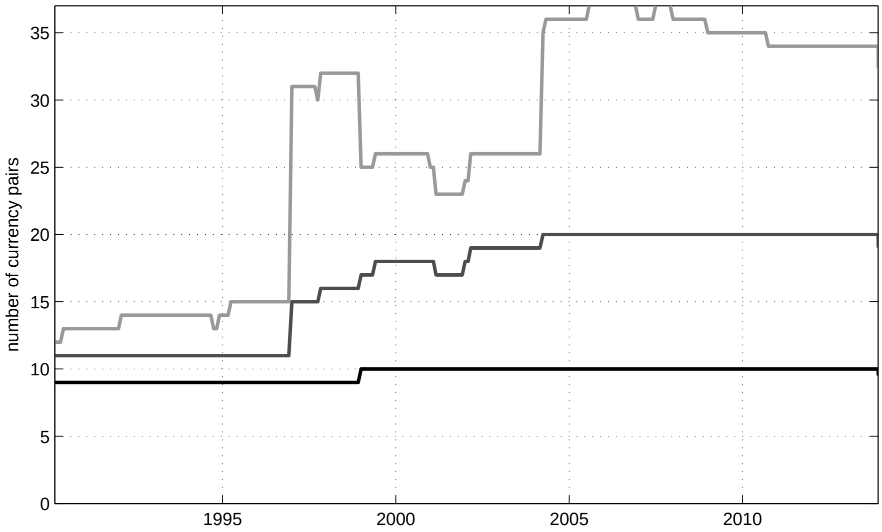

Figure 7: Number of Available Currency Pairs. Across time, the figure indicates the number of currency pairs with simultaneously available excess payoffs $\pi^i_{t,\tau}$ $\forall \tau \in \Xi$. The information corresponds to a sample of 10 developed currencies (black line), to a sample of 20 developed and emerging market currencies (dark-gray line) as well as to a sample of 49 developed and emerging market currencies (light-gray line) against USD. Rebalancing is monthly from Feb. 28, 1990 to Nov. 29, 2013 (286 observations).