Carry Trades Performance Before and After the Financial Crisis

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Chapter 1

Introduction

There are three main goals I try to target in my thesis. First of all, I would like to introduce the reader to carry trades – popular strategies of investing in the FX markets that, despite the simplicity that stands behind their core idea, have not ceased to bring profits and puzzle the researchers for over three decades. Secondly, I want to present briefly algorithmic trading as an acclaimed way of modern trading of the financial industry that in the near future will dominate the markets. Moreover, I desire to show how carry trades can be implemented and executed by means of algorithmic trading. Finally, in my empirical research, I wish to address some questions that are still debatable in the current literature.

The unresolved issues that can be nowadays encountered in the papers are the following. There is a strong inclination of the researchers to the statement that carry trades perform poorly during the times of elevated volatility. One can observe the realization of this fear in the first few months after the fall of Lehman Brothers by means of increased currency trading which is greatly attributable to unwinding of carry trades position. I would like to examine if such behaviour was reasonable or if it could be justified by the bandwagon effect.

Additionally, almost no paper examines the possibilities of making profits by means of diversifying currency portfolios by more 'exotic' (in terms of carry trades' positions popularity) currency pairs. For instance, currencies of countries that belong to OECD (and are not in the top 10 world most trading currencies) may seem valid targets for investing currencies since their economies are rather stable and governments' or central banks' decisions not unpredictable.

Another inquiry is whether or not taking into account in a detailed way transaction costs can make the carry trades unprofitable. In many papers, the authors treat inclusion of transaction costs in a rather arbitrary way – just settling them to a constant values no matter the currency or market turbulences – and in some, they do not consider them at all. I want my analysis to be the most precise possible to the extent of what data I have access to allow.

My contributions to the prevailing research will be to examine all the above problems

and to answer the following research questions I posed to myself. First, among all strategies that were investigated which performed the best and the worst before and during the crisis separately. Did the tendencies last – are those that performed better before the crisis going to remain the better ones when the crisis lasts? Does the performance of carry trades depend somehow on the investor's funding currency? Can taking the market volatility into account make the carry trades more profitable? Is it better to enter carry trades positions on the spot or on the forward market? And finally, how carry trade type of investments perform in comparison to risk free or stock exchange investments?

The thesis is organised as follows. In chapter 2 I present summarily some rudimentary facts about algorithmic trading and how this sort of trading evolved. In addition, I included an overview of carry trades: their definition, theoretical arguments why they should not be profitable and possible explanations why they indeed are. Chapter 3 is dedicated to the description of used data and strategies. They are introduced in a detailed way with a 'step-by-step' guide how they can be applied (real applications in the form of code are enclosed in the appendix). Chapter 4 deals with answering the research questions and chapter 5 concludes all the results. The appendix consists of Matlab code, tables and figures.

Chapter 2

Algorithmic trading and carry trades

This chapter will be dedicated to providing some basic comprehension of algorithmic trading and carry trades. I will try to explain what this type of trading is about and what a carry trade is. Next, a brief overview of carry trades returns' puzzle and a track of its empirical record will be conducted.

2.1 History and handful of facts about algorithmic trading

Generally speaking, algorithmic trading is a form of electronic trading which is completely automated by means of an algorithm that settles upon various characteristics of a placed order: (among others) price, quantity and moment in time. A trader who decides to use such kind of trading determines a set of investment rules for a desired strategy and translate them into the language of standard electronic platforms that are responsible for supplying the information and executing orders. It can be applied no matter the investment purpose – market making, arbitrage or even speculation. A particular category of algorithmic trading is a so-called 'high-frequency trading'. It consists of trading at such extremely high frequencies with which human traders cannot outmatch computers in receiving and correctly processing data and as a result placing orders which can profit even from very small bid/offer spreads.

A milestone for the development of foundations of algorithmic trading was computerization of orders placing on the financial markets in the beginning of 1970s. But it was not until early 1990s when the fully-automated system of carrying out orders and electronic communication networks were introduced. Also, one of the turning points for boosting the markets liquidity and diminishing of bid/offer spreads was decimalization of minimum ticks from 1/16 to $0,01$ of the US dollar. It allowed to level the trading advantage of market makers. Finally, one of the decisive breakthroughs was the publication in 2001 an IBM's paper in which they delivered proofs for two algorithmic strategies consistently outperforming human traders during laboratory versions of financial markets' electronic auctions. When it comes to choosing a key turning point for algorithmic trading in FX markets, it certainly happenden in 2004 when the electronic broker EBS opened a service

'EBS Spot Ai' (Ai as in automated interface). It allowed algorithmic trading in spot FX markets applying the real-time prices quoted on EBS.

In the 2001 paper ([1]) on the impact of electronic trading on financial systems, the authors argue that it may have reshaped the markets in terms of widening trading possibilities. For instance, not only are traders no longer bound by geographical restraints and time zones which might have been particularly tiresome for telephone trading but also the interactions can be constant and uninterrupted (assets available at almost every time of the day). Secondly, a greater volume of transactions can be carried which immediately positively affects markets' liquidity. Finally, such automatization reduces transaction costs since there is no need for an additional trader to be paid for placing orders.

To give some impression how rapidly algorithmic trading has evolved I will cite some numbers form the Triennial Central Bank Survey from 2010 ([2]) and paper by M. King and D. Rime ([13]) that tackles with the explanation of some of the Survey's results. Bank for International Settlements reports that in April 2010 daily average foreign exchange market turnover reached $4 trillion which is 20% more than three years before (despite the recent financial crisis). This spectacular result was reached due to increased trading activity of so-called 'other financial institutions' to which belong among others: high-frequency traders, banks trading as clients of biggest dealers and retail investors trading online. They contributed 85% of the higher turnover. Other numerical examples: the share of algorithmic trading-driven transactions on EBS rose from modest 2% in 2004 up to 45% in 2010. In 2009 share of total FX volume traded electronically was around 50% in both Americas and slightly above 60% in Europe and Japan.

In my thesis, I do not apply exact algorithms that could be used in real-time trading, owing to the fact that I only make use of historical data. Nonetheless, the decision rules translated into the programming language might be easily implemented in electronic trading platforms.

2.2 Carry trades

Carry trade is a general indication for an investment strategy that consists of borrowing in low-yielding currencies and lending the high-yielding currencies. For an investor who invests his domestic currency in foreign currencies the risk of a carry trade lays in the unpredictability of exchange rate movements. In other words: he would be forced to pay back more expensive currency with the less valuable one if the exchange rate goes unfavourably for him.

2.2.1 Basic facts about carry trade speculation

According to Bank for International Settlements ([2]), ten most traded currencies in terms of percentage shares of average daily turnover in April 2010 are: the US dollar ($84,9\%$), the euro ($39,1\%$), the Japanese yen ($19,0\%$), the British pound ($12,9\%$), the Australian

dollar (7, 6%), the Swiss franc (6, 4%), the Canadian dollar (5, 3%), the Hong Kong dollar (2, 4%), the Swedish krona (2, 2%) and the New Zealand dollar (1, 6%). That accounts for 181, 4% out of 200% (currencies in currency pairs are counted separately) of global FX markets turnover at that time. It does not necessarily mean that all of the transactions are involved in carry trades, of course not, but it can somehow indicate a given currency's liquidity and how big bid/offer spreads one can expect when entering positions. Thus, it points out which currencies (combining the knowledge of countries' interes rates) may be worth to invest in a carry trade way and how to exploit in the best way exchange rates and interest rates differentials.

There exist numerous ways to apply carry trade speculation idea in the markets (this and the following paragraph are based on [12]). The simplest method is to exchanging borrowed capital to the target (in other words: investing) currency on the spot market. Obtained target currency could be invest in some kind of short-term asset (preferably a bank deposit or a government paper). A different approach consists of investing in derivative positions such as forwards, futures, interest rate swaps and possibly even more complex options. Customary, carry trades are entered by large financial institutions, hedge funds for instance. However, from the beginning of the XXI century, the fraction of retail investors that invest usually in single carry trade (not in well-diversified portfolios of currencies with elaborate strategies) has significantly grown, becoming a visible minority, comparing to large financial behemoths, that has the ability to perceivably influence some currency pairs (YEN/USD for example).

I should make a clear distinction between carry trades and other strategies that rely on exploiting interest rate differentials. Households that borrow funds in lower-yielding currencies to sponsor assets purchases such as mortgages denominated in the Swiss franc do not perform carry trades this way since these type of FX positions are not unwound instantly in case of a market turmoil. Another example: expanding portfolios by acquiring higher-yielding assets (government bonds not to look far) denominated in foreign currencies.

2.2.2 Why should carry trades not bring profits?

In order to determine why have carry trades' performance puzzled researchers since 1980s, first, I have to introduce three terms: interest rate parity, uncovered interest rate parity and covered interest parity. This subsection is derived upon texts and formulas from the book [11].

Interest rate parity is a no-arbitrage situation in which investors are indifferent to bank deposits' interest rates in two countries since the differences in profits from these interest rates are compensated by the exchange rate between two countries' currencies assuming capital mobility and perfect sustainability (in terms of riskiness and liquidity) of domestic and foreign assets. From that condition two forms of parity can be drawn:

uncovered and covered interest rate parity which have implications for forecasting the forward exchange rate and the future spot exchange rate.

Uncovered interest rate parity should hold when the no-arbitrage condition is met without entering a forward contract to hedge against the exposure to the exchange rate risk. In other words, exchange rate between two countries is supposed to adjust that domestic currency's returns on a domestic currency deposit is an equivalent of domestic currency's returns on a foreign deposit so that investors remain indifferent among those two investment opportunities. Thus, uncovered interest parity gains are nonexistent. This type of parity could be of use when explaining how the spot exchange rates are being established. The equation that depicts uncovered interest rate parity:

$$1 + i_D = \frac{E(S_{t+k})}{S_t}(1 + i_F), \tag{2.1}$$

where $E(S_{t+k})$ is the expected exchange rate (quoted as foreign/domestic currency) at time $t + k$, k is a number of periods into the future from time t, S_t is the spot exchange rate at time t, i_D is the domestic interest rate (for an investment that ends k periods ahead) and i_F is the foreign interest rate.

Covered interest parity on the other hand, should be satisfied when the no-arbitrage situation is obtained by means of using a forward contract in order to hedge against the exposure to exchange rate risk. It means that investors remain again indifferent between two interest rate investment opportunities since the forward exchange rate maintain the equilibrium that consists of domestic currency's returns on a domestic currency deposit being an equivalent of domestic currency's returns on a foreign deposit. In this case, covered interest rate parity can be applied while understanding the forward exchange rates determination. The equation illustrates covered interest rate parity:

$$1 + i_D = \frac{F_t}{S_t}(1 + i_F), \tag{2.2}$$

where F_t is the forward exchange quoted rate at time t all the previous notation retained.

If both type of the interest parity hold it can be easily deduced that in such a case:

$$F_t = E(S_{t+k}). \tag{2.3}$$

This is a representation of the unbiasedness hypothesis that the forward exchange rate is an unbiased predictor of the expected future spot exchange rate. Given the evidence that the covered interest rate parity holds, this hypothesis can serve as a test if the uncovered interest rate parity holds.

If the uncovered interest rate parity is true it should hold that any possible carry gains obtained by the interest rate differential are annihilated by the proportional depreciation of the investment currency. In reality, the opposite happens: the investment currency appreciates a little on average but with a low predictive R^2 as shown by Fama in [10].

This empirically proven violation of the uncovered interest rate parity makes the carry trades profitable on average for the last thirty years and it is known in the literature as the *forward premium puzzle*.

2.2.3 Forward premium puzzle

There are several possible explanations to the forward premium puzzle, none of which proved to be unquestionably predominant. The intuitive reason behind unhedged carry trades average high profitability is compensation for some kind of risk. However, it was confirmed, for example in [6], that there is no statistically significant unconditional correlation between the payoffs to the carry trades and traditional risk factors (such as Fama-French factors or consumption growth).

In the same paper, tha authors argue that the forward premium puzzle can be at least partially assigned to the presence of a peso problem. The term 'peso problem' was coined for a convenient way to describe the effects on inference provoked by low-probability events that do not occur in the sample. Such events do not necessarily have to be of exclusively economic nature – political or natural disasters account for it too. The reasoning behind this assertion is: let's assume that on the forward market a foreign currency is at a forward premium (the forward exchange rate is greater than the spot exchange rate). In such a situation a carry trade investor sells the currency forward. Now, suppose that an extraordinary appreciation of the foreign currency happens with low probability. Given this assumption, the investor should be compensated for the negative payoff to that carry trade.

Other general ideas for solving the forward premium puzzle are for example: differences in the costs of collecting and processing information, assuming that the conditional bias in treating the forward exchange rate as a predictor for the future spot rate is an exogenous variable that can be modelled, supposing that the exchange rates are exogenous themselves and trying to find some fundamentals that can influence them or even accepting the fact that foreign exchange markets are just inefficient.

Chapter 3

Data and strategies

In this chapter I will provide a thorough description of data used in the analysis and of implemented strategies. Regarding data: sources, definitions and extraction methodologies will be given and the chosen trading frequency explained. As far as the strategies are concerned, every algorithm will be detailed and outlined in a step-by-step manner. The MATLAB code of all applied strategies is enclosed in the appendix. Each strategy has its own variants that differ with respect to, for instance, chosen basket of currencies, time horizon or the fact of being traded either on spot or forward market.

3.1 Data

In my thesis I make use of data on: spot and forward exchange rates, risk free interest rates, consumer price indices, current accounts and a volatility index.

The 17 currencies I chose for the analysis are: the Australian dollar (AUD), the Brazilian real (BRL), the Canadian dollar (CAD), the Swiss franc (CHF), the Czech koruna (CZK), the Danish krone (DKK), the euro (EUR), the British pound (GBP), the Hungarian forint (HUF), the Icelandic krona (ISK), the Japanese yen (JPY), the Mexican peso (MXN), the Norwegian krone (NOK), the New Zealand dollar (NZD), the Polish zloty (PLN), the Swedish krona (SEK) and the US dollar (USD). All of the exchange rates come from the countries (zones) with floating exchange rate. In the tables 6.1 and 6.2 I put basic statistics for bid spot exchange rates. As it can be easily infere, there are no general rules that could be applied to consistently describing skewness and kurtosis of the exchange rates – they vary too much. Some currency pairs deviate less (those of the Swiss franc for instance) and some a lot more (those of the Japanese yen). The most 'stable' currency pair in terms of standard deviation was DKK/EUR and the least ISK/EUR. It is worth a commentary that some currency pairs change their values to the extent that at one time the underlying currency is cheaper than the base currency and at different time the other way round, for example: USD/EUR, CAD/USD or CHF/USD.

The data on spot and forward exchange rates and interest rates come from Datastream database. They were downloaded as daily time series but trading frequency was set to

1 month. In order to make the analysis more realistic from the trading point of view, the desired monthly data were sampled as daily data on the last trading day of the month (as suggested, for instance, in [4]) to avoid for example day-of-the-week bias. The transaction costs were accounted for by using offer and bid rates separately. The signs of bid-offer spread were screende across all the periods and currencies. The offer (bid) exchange rate is the price at which an investor can buy (sell) the underlying currency for 1 unit of base currency. In many papers the transaction costs are omitted or treated in an arbitrary way (for instance applying the same bid-offer spread to all currencies) and it was demonstrated clearly that such an overlooking may spectacularly diminish the performance of carry trades as shown by Burnside et al. in [5].

The actually applied risk free interest rates are only approximations of free interest rates and they differ with respect to countries. The data were retrieved from both Thomson Reuters, respective bankers or markets associations, economic institutes and national banks via Datastream. Accepted data: for Australia – 30 day Australia Dealer Bill, for Canada – 1 month Canada Treasury Bill, for Czech Republic, Denmark, Hungary, Iceland, Japan, Norway, Poland, Switzerland, the United Kingdom, the United States and the eurozone – respective Interbank 1 month offer rates, for Mexico – 1 month Treasury Bill, for Brazil – Brazil Saving Account rate, for New Zealand – New Zealand 30 Day Bank Bill, for Sweden: Sweden Treasury Bill 30 Day. All the data are annualized rates and in the fashion of Occam's razor they are divided by 12 and not taking into account how many days (28, 29, 30 or 31 actually go by. In the table 6.3 there are basic statistics concerning the mentioned interest rates. Without an effort, one can spot countries that interest rates were persistently higher than the average (even during the crisis) such as Australia, New Zealand or Poland ans some were definitely lower during the whole considered periods, for example Switzerland or Japan. Again, also in case of interest rate data, no conistent conclusions can be drawn about skewness or kurtosis. The most unfluctuating risk free interest rates were observed in Brazil. On the other side of the scale is Iceland.

The Consumer Price Index monthly data come from the OECD/Main Economic Indicators online database. In case of Australia and New Zealand data were retrieved from corresponding national banks and are on the quarterly basis, so they had to be interpolate to other months (the value of the last available period was carried forward to the next months lacking of numbers). The current account data come from the Annual Macroeconomic database of the European Comission (AMECO) on a yearly frequency. The volatility index VIX daily data were retrieved from Chicago Board Options Exchange online website.

The time span of all the data is 1st January 1999 – 31st May 2012. The reasons for such a choice are the following. First, the performance of carry trades before this period is already thoroughly examined. Second, that was not my intention to introduce unnecessary mayhem into data because of some European countries' transition to the

euro. Finally, in order to compare their realization before and after the recent crisis I felt that there is no need for such a long time horizon. However, for some currencies (the Brasilian real, the Icelandic krona and the Polish zloty) the forward exchange were not available until March 2004 so in some cases of strategies the analysis had to be carried only from 2004.

As it can be seen in the code appendix, for the sake of easiness and transparency, the data were processed in such a way, that different kinds of them are retrieved from separate spreadsheets. They were designed in such a manner that corresponding columns (within spreadsheets used for a given strategy) refer to a country's exchange rate, interest rate, CPI etc which facilitates matrices indexation.

3.2 Implemented strategies

I chose 4 basic strategies that were altered at the computation level in relation to:

- funding currency: the euro, the US dollar, the British pound,
- currency baskets: the core basket – the Australian dollar, the Canadian dollar, the Swiss franc, the Danish krone, the euro, the British pound, the Japanese yen, the Norwegian krone, the New Zealand dollar, the Swedish krona, the US dollar and the core+ basket which consists of every core currency and also the Brazilian real, the Czech koruna, the Hungarian forint, the Icelandic krona, the Mexican peso and the Polish zloty,
- transaction timing: entering positions in spot market only or also forward market,
- taking into account the volatility and level of global markets' anxiety,
- horizon of data time series, forced especially by forward exchange rates' data availability.

The composition of the core basket was suggested among others in [8]. The additional currencies were chosen in addition to data availability, the fact of being the OECD member and curiosity how carry trades perform when widening the basket by developing coutrnies like Eastern European ones, Mexico or Brazil.

I do not consider strategies that consist of investing only in one currency pair at a time since it was proven, for example in [4] that introducing diversification increases the profits and reduces risk of the investment.

3.2.1 Equal-weighted carry trade strategy

One of the most popular strategies is the equal-weighted carry trade. It is presented as first since it will be benchmark methodology from which others derive. I make use of the

P. Barroso and P. Santa-Clara 2011 paper [3] in terms of adapted formulas. I adjusted them in terms of my own indices and explicitly taking into accoung *bid* and *offer* rates. On spot market, given a currency basket and a funding currency, it consists of entering long positions in currency pairs FC/DC (where FC stands for foreign currency and DC for domestic/funding currency) in which investing in the foreign currency yields more than investing in the domestic (funding) currency. By analogy, entering short positions in currency pairs in which investing in the funding currency yields more.

Equal-weighted strategy on the spot market step by step

An investor who would like to implement such a strategy in period t should use such an algorithm:

- choose a currency basket in which he would like to invest,
- choose a frequency with which he wants to invest,
- check which foreign currencies yield more than the domestic currency for the chosen length of the investment period (which risk free interest rates are higher than the domestic one over a specific time span).

Then, there are three possibilities:

- if a foreign currency i yields more from period t to $t+1$ ($rf^{FC}_{t,t+1} > rf^{DC}_{t,t+1}$) then the investor borrows the domestic currency at the domestic interest rate ($rf^{DC}_{t,t+1}$) and buys the foreign currency i (where $S^{i,\text{offer}}_t$ is the spot offer price of 1 unit of domestic currency in terms of the foreign currency i at time t). After that, the investor invests it at a foreign interest rate ($rf^{FC}_{t,t+1}$) and when the period t is over, sells the amount of the foreign currency (where $S^{i,\text{bid}}_{t+1}$ is the spot bid price of 1 unit of domestic currency in terms of the foreign currency i at time $t+1$). The gross return in the beginning of next period $(t+1)$ is:

$$r^i_{t+1} = \frac{S^{i,\text{offer}}_t(1+rf^{FC}_{t,t+1})}{S^{i,\text{bid}}_{t+1}(1+rf^{DC}_{t,t+1})}, \tag{3.1}$$

- if a foreign currency i yields less from period t to $t+1$ ($rf^{FC}_{t,t+1} < rf^{DC}_{t,t+1}$) then the investor borrows the foreign currency i at the foreign interest rate ($rf^{FC}_{t,t+1}$) and buys the domestic currency (where now $S^{i,\text{bid}}_t$ is the spot bid price of 1 unit of foreign currency i in terms of the domestic currency at time t). After that, the investor invests it at a domestic interest rate ($rf^{DC}_{t,t+1}$) and when the period t is over, sells the amount of domestic currency (where now $S^{i,\text{offer}}_t$ is the spot offer price of 1 unit of foreign currency i in terms of the domestic currency at time $t+1$). The gross

return in the beginning of next period $(t+1)$ is:

$$r_{t+1}^{i} = \frac{S_t^{i,\text{bid}}(1 + rf_{t,t+1}^{DC})}{S_{t+1}^{i,\text{offer}}(1 + rf_{t,t+1}^{FC})}, \tag{3.2}$$

- if a foreign currency i yields the same as the domestic currency ($rf_{t,t+1}^{FC} = rf_{t,t+1}^{DC}$), investor invests in one period at the domestic interest rate.

To compute the return on the whole basket of currencies in the give period, an investor adds all the returns on each position, divides by the number of position open in this period and substract 1. An example of implementation of this strategy is put into appendix as Strategy 1*a* (for the core basket of currencies and the euro as the domestic currency).

The forward market version of this strategy is as follows. An investor makes an investment assuming that the uncovered interest rate parity does not hold (empirically proven as stated in previous chapters). He enters a long forward position if the exchange rate forward contract on currency i traded at time t and settled at time $t+1$ exceeds the spot exchange rate. Hypothesizing, if the spot exchange rate does not vary over the period, the investor realizes the forward contract buying the foreign currency for the funding currency and immediately sells the foreign currency on the spot market with a profit. If, however, spot exchange rate differs in time $t+1$ from the one of time t, an investor can occur a loss if it surpass the long position forward rate from time t. The investor eneters a short forward position if the exchange rate forward contract on currency i traded at time t and settled at time $t+1$ is below the spot exchange rate.

Equal-weighted strategy on the forward market step by step

This strategy can be translated into the algorithmic world in the following way:

- choose a currency basket in which he would like to invest,
- choose a frequency with which he wants to invest,
- for every currency i in the basket check the sign of the difference $F_{t,t+1}^{i,\text{offer}} - S_t^{i,\text{offer}}$ (where $F_{t,t+1}^{i,\text{offer}}$ is an offer forward exchange rate of currency i with respect to the funding currency traded at time t and settled at time $t+1$ and $S_t^{i,\text{offer}}$ is an offer spot exhange rate of currency i with respect to the funding currency traged at time t); if the sign is positive, enter a long position in the forward contract and if negative a short position,
- at the time $t+1$ complete the subsequent deal: if you bought a long forward contract on the currency i, realize it for the funding currency you had and exchange the obtained foreign currency for the spot exchange rate of time $t+1$; the net excess

return you acquire in time $t+1$ is as high as:

$$r^i_{t+1} = \frac{F^{i,\text{offer}}_{t,t+1}}{S^{i,\text{bid}}_{t+1}} - 1, \tag{3.3}$$

(the return may be as well negative because of the adverse market movements). If you bought a short forward contract on the currency i, first exchange the funding currency you had for the spot rate of time $t+1$ and then realize the contract; the net excess return you obtain in time $t+1$ is equal to:

$$r^i_{t+1} = \frac{F^{i,\text{bid}}_{t,t+1}}{S^{i,\text{offer}}_{t+1}} - 1, \tag{3.4}$$

- the return on the whole portfolio has to be weighted equally (the idea behind this strategy), with weights defined as follows:

$$w^i_{t,t+1} = \frac{sign(F^{i,\text{offer}}_{t,t+1} - S^{i,\text{offer}}_t)}{N}, \tag{3.5}$$

where $w^i_{t,t+1}$ is a weight put on the contract on the currency i in period t up to period $t+1$ and N is the number of currencies in the basket,

- the final payoff to this strategy can be understood as investing one unit of the funding currency ($1FC$) at the domestic risk free rate from time t up to time $t+1$ and risking one unit of the funding currency at the forward market, the payoff:

$$r_{t+1} = rf^{FC}_{t,t+1} + \sum_{i=1}^{N} w^i_{t,t+1} r^i_{t+1}. \tag{3.6}$$

Obviously, the absolute values of weights in this strategy sums to 1 with signs determining being long or short. An example of implementation of this approach is in the appendix as Strategy $1b$ (for the core basket of currencies and the euro as the domestic currency).

3.2.2 Strategies: 1 long/1 short, 2 long/2 short and 3 long/3 short

The idea behind this approach was presented in the paper by R. Clarida, J. Davies and N. Pedersen ([7]). It differs from the equal-weighted carry trade with respect to number of currencies an investor wants to invest in during a period of time.

In the most basic version, an investor chooses 1 currency to go long and 1 to go short whenever it is possible. In the spot market it means that if, for example, there is no currency that yield less than the funding currency, the investor enters only a long position and no short position at all. The mechanism how he can make a profit is similar

to the equal-weighted strategy.

1 long/1 short strategy on the spot market step by step

In order to implement such a strategy into a programme, the investor should:

- choose a currency basket in which he would like to invest,
- choose a frequency with which he wants to invest,
- check which foreign currencies yield more than the domestic currency for the chosen length of the investment period,
- check if the currency that yields the most (less) is the funding currency: if this is the case he cannot enter long (short) position, if it is not the case he makes transactions with the same logic as in the equal-weighted methodology (the spot version).

The versions 2 long/2 short and 3 long/3 short alter only in relation to the number of maximum positions entered in the period of time (4 and 6 respectively). Examples of implementation of these strategies can be found in the appendix as Strategy $2a$, $2b$ and $2c$ (for the core basket of currencies and the euro as the domestic currency).

1 long/1 short strategy on the forward market step by step

In the forward market, the rule is similar. In the basic version 1 long/1 short, an investor judges whether or not to enter a position by the differences in forward and spot exchange rates. A following algorithm can be applied:

- choose a currency basket in which you would like to invest,
- choose a frequency with which you want to invest,
- for every currency i in the basket check the magnitude of the difference $F_{t,t+1}^{i,\text{offer}} - S_t^{i,\text{offer}}$ (where $F_{t,t+1}^{i,\text{offer}}$ is an offer forward exchange rate of currency i with respect to the funding currency traded at time t and settled at time $t+1$ and $S_t^{i,\text{offer}}$ is an offer spot exhange rate of currency i with respect to the funding currency traged at time t); for the greatest positive difference enter a long position in the forward contract and for the greatest negative one a short position (if such possibilities exist; it may be a case that there is, for example, no single currency pair exchange rate for which the forward rate is smaller than the spot rate thus rendering a short position impossible to enter).

If an investor enters every position available, the denominator of the weights is revised every period and adjusted to the number of positions open so that the absolute sum of weights always equals 1. As in the spot market case, the versions 2 long/2 short and 3

long/3 short differ only with respect to the number of maximum positions entered in the period of time (4 and 6 respectively). Examples of implementation of these strategies can be found in the appendix as Strategy $2d$, $2e$ and $2f$ (for the core basket of currencies and the euro as the domestic currency).

3.2.3 Currencies and domestic returns strategies

Currencies and domestic returns strategies were constructed in a fashion of one of the carry trades presented in the paper by J. Olmo and K. Pilbeam ([14]). The core reasoning of this methodology is similar to the equal-weighted one, but it can only be implemented in the spot market. The difference is following: an investor enters only long or short positions. For a given currency basket, an investor decides if he wants to go exclusively long or exclusively short in the currency pairs and gain from the respective differences in risk free rates between domestic and foreign interest rates. Then, for a particular period of time he uses decision rules as in equal-weighted strategy to determine for which exchange rates he should enter long (short) positions and place the rest of the money at the domestic risk free interest rate. In this type of approach he resigns from possible profits of the non-entered positions but simultaneously avoids possible losses by gaining safe domestic risk free rates.

Currency/domestic strategy on the spot market step by step

In terms of the applied algorithm, the two strategies present as follows:

- choose a currency basket in which he would like to invest,
- choose a frequency with which he wants to invest,
- choose if you want to only long or only short currency positions,
- check which foreign currencies yield more than the domestic currency for the chosen length of the investment period (which risk free interest rates are higher than the domestic one over a specific time span),
- if you chose going long (short), enter long (short) positions for every currency that yields more (less) than the domestic one, for the rest currency possibilities put the money you wanted initially to invest in carry trades on a risk free domestic interest rate.

Subsequent actions are exactly the same as in the equal-weighted strategy. Its formulas for the gross returns hold here too. Examples of implementation of these strategies can be found in the appendix respectively as Strategy $3a$ (solely longing and domestic returns) and $3b$ (solely shorting and domestic returns).

3.2.4 Parametric portfolio strategy

Parametric portfolio strategy contrasts previous ones with respect to the optimization of certain parameters that takes place in every period and takes into account changing market conditions. It was designed almost the same as suggested by Barroso and Santa-Clara in [3] (the name explicitly taken from the paper). In some aspects, the paper was not clear enough and I was forced to decide on my own which steps should I take, but the whole idea and formulas used remained the same. The strategy is to be put into practice on the forward market.

As opposed to equal-weighted strategy, parametric portfolio methodology tends to put different weights on every trade in a given period. The absolute weights does not necessarily have to sum up to 1 (although it was not explicitly stated in the paper, I had to assume that) so we can treat them rather as proportions of money we put into certain long or short positions. Due to this fact, we have to scale the results (divide by the sum of weights) so that the numbers stay comparable across strategies.

Returning to the equal-weighted strategy, in order to compute the final return in the period $t+1$ I used the formula:

$$r_{t+1} = rf^{FC}_{t,t+1} + \sum_{i=1}^{N} w^i_{t,t+1} r^i_{t+1}, \tag{3.7}$$

(the symbol designations remain the same). In the parametric portfolio, authors of the paper assume that weights are a function of some currency characteristics:

$$w^i_{t,t+1} = f(x^i_t; \theta), \tag{3.8}$$

where x^i_t is a $k \times 1$ vector of a currency characteristics and θ is a $k \times 1$ parameter vector. They focus on a linear function of characteristics:

$$w^i_{t,t+1} = \theta' x^i_t / N, \tag{3.9}$$

from which it is clear that the equal-weighted portfolio is a special case of a parametric portfolio with $\theta = 1$ and $x^i_t = z^i_t$, where $z^i_t = sign(F^i_{t,t+1} - S^i_t)$ – the signs of forward-spot spread. The problem the investor solves in every period is to optimize the objective function by picking a parametric portfolio:

$$\max_{\theta} E_t[U(r_{t+1})], \tag{3.10}$$

where power utility is used as the objective function:

$$U(r) = \frac{(1+r)^{1-\gamma}}{1-\gamma}, \tag{3.11}$$

with γ being a coefficient of relative risk aversion $\gamma = 5$. I retained this value from the paper but I also tried a range of values (from 3 to 7) and it did not influence the strategy's performance almost at all. Apparently, the optimization relies far more on the additional data (x_t^i) and the coefficient of relative risk aversion is only chosen for the convenience of the utility function.

The variables x_i used in the optimization process are the following (descriptions are almost explicitly taken from the paper):

- $sign_t$ – the sign of the forward discount on a currency. It is 1 if the foreign currency yields a higher interest rate than the domestic one and -1 if it yields less,
- q_t – the real exchange rate standarized by its historical mean and standard deviation computed for n previous periods (including period t). A two-month lag is used to ensure that CPI data would be known and there is no look-ahead information. The time series standardization measures the real exchange rate in standard deviations above or below the average,
- fd_t – the interest rate spread. The forward discount on the currency standardized using the cross-section mean and standard deviation (across all countries). The cross-sectional srandardization measures the forward discount in standard deviations above or below the average across all countries,
- ca_t – the current account of the foreign economy as a percentage of Gross Domestic Product. It is standardized cross-sectionally. The optimization assumes that the previous year current account information becomes known in April of the current year,
- mom_t – momentum. The cumulative currency appreciation in the last three months period, cross-sectionally standardized.

The variable for the long term reversal was not included owing to the fact that its calculation involved very long time series of historical data and it is not fitted to the length of time series I assumed to use.

Because of the restrictions in constructing variables for optimization (lags and number of periods actually needed in the process), the first period for which the returns will be calculated is January 2002.

Optimized portfolio strategy on the forward market step by step

If an investor would like to apply this strategy he should follow the steps of the algorithm:

- choose a currency basket in which you would like to invest,
- choose a frequency with which you want to invest,

- choose the value of the relative risk aversion coefficient,
- choose number of periods you want to optimize on,
- check which foreign currencies yield more than the domestic currency for the chosen length of the investment period,
- decide for which currency pairs you enter long and short positions according to the rule and formulas given in equal-weighted strategy,
- optimize the values of weights,
- calculate the final return in the period.

An example of the implementation of these strategies can be found in the appendix marked as Strategy 4. The main loop is considerably longer than in the previous cases as first, proper data must be retrieved, processed and standardized for every investing period separately. Also, the optimization itself is written in *cvx* which is a package dedicated for optimization.

3.2.5 Volatility strategy

The so-called 'volatility strategy' is not a strategy itself. It consists rather of an additional decision rule according to which an investor decides whether or not to enter a carry trade at all in a given period. Some of researchers argue that carry trades exhibit poor performance during crisis times in which the volatility of the markets is particularly high. I encountered the volatility filters idea in the paper by C. L. Dunis and J. Miao ([9]). They use as a decision rule the historical volatility of a particular currency pair as signals to investing in carry trades or not.

Given the fact, that in my thesis I concentrate on the performance of carry trades before and after the recent crisis, I will use a measure of market's expectation of the US stock market (S&P500) volatility over the next 30-day period – the *fear index* traded as the VIX. According to the definition of Chicago Board Options Exchange, the VIX is an up-to-the-minute market estimate of expected volatility that is calculated by using real-time $S\&P$ Index bid/offer quotes and since its introduction in 1993 it has been considered to be the world's premier barometer of investor sentiment and market volatility.

In the chosen period, one can observe how brilliantly rises in the VIX synchronize first with the dot-com bubble remnants and then with the United States housing bubble that was precedent to the financial crisis that started in 2008 (figure 6.1). The third quartile of the VIX in the considered period is 25.61 so I chose 25.61 as a boundary threshold: if in period t the VIX exceeds this bound, the investor resigns from trading in this period.

Equal-weighted strategy on the spot market with the volatility filter step by step

This is an example of applying the volatility filter to the equal-weighted strategy, spot market version. An investor should:

- choose a currency basket in which he would like to invest,
- choose a frequency with which he wants to invest,
- choose a volatility filter that is desired to apply and settle a boundary level from which a carry trade will not be entered at a given period,
- check the value of the volatility filter in the period, if it exceeds the boudary level, he resigns from the carry trade and gains only the risk free interest rate of the funding currency for the length of the period and skips the rest of the steps, if the value of the volatility filter equals or is less than the chosen bounady he follows the rest of the strategy's steps.

An example of implementation of this volatility filter can be found in the appendix as Strategy 5 (adding the VIX bound decision rule to spot version of equal-weighted strategy).

Chapter 4

Results

The results will be delivered as answers to the research questions. All of the strategies are evaluated in terms of minimum, maximum, average, standard deviation, skeweness, kurtosis, Sharpe ratio of monthly performance and cumulative performance over some period of time. The tables with the most detailed results are enclosed in the appendix. Some of the comparisons are made across different strategies in the same periods of time and some are carried just as a oppositions 'before' and 'after' the recent financial crisis no matter how long the 'before' period lasted as only this contrast is taking into account.

There are some general patterns that repeat all over the tables no matter the strategy, currency basket or the funding currency. First, crushing majority of considered carry trade variants has negative skewness. In other words, it means that the left side of sample distribution is 'longer' which in this case may be translated that the median in lower than the mean. It implies that majority of the values are below the average value. However, the only set of strategies that resists this pattern consistently across all considered funding currenciec and periods is the one of optimized portfolios. They always have positive skewness which suggests that majority of return values is above the average value (even in the crisis time).

Second, surprisingly, the maximum losses (minimum returns) did not happen during the recent financial crisis. For almost every strategy no matter the currency basket, funding currency or presence of volatility filters a carry trade investor could stumble upon a significant loss even in period before September 2008. The unique exceptions of this rule are again optimized portfolios, but these strategies have very small values of maximum losses anyways (the maximum of maximum losses among them was $-6,85\%$ of annualized return). To make it even more interesting and curious, the optimized portfolios with the US dollar as the funding currency never had a negative value of returns during the crisis time. Of course it does not immediately deny the theorem that carry trades perform worse in the crisis time. All the mean returns are significantly lower during the crisis than before the crisis and standard deviations are larger which results in drastically lower sharpe ratios but it is due to the persistence in volatility of spot and forward exchange rates than the surprising changes in them.

Third, as could be expected, the maximum returns did not happen during the crisis either. However, in the most cases, the differences in maxima and minima before and after the crisis are smaller when it comes to the differences in minima. This fact together with observations about minima, means and standard deviations are somehow reflected in the data about kurtosis. Before the crisis, almost every type of strategy has kurtosis significantly more than 3 (usually twice as much) and during the crisis kurtosis oscillates regularly around 3. Nonetheless, classic interpretation of kurtosis cannot be apply here (the higher the kurtosis the more present both peakedness and heaviness of tails) as distributions are not symmetric so it is hard to say weather the kurtosis is more influenced by peakedness or by heaviness of tails although my guess is that due to the standard deviation values before and after the crisis, the kurtosis of such high values before the crisis are because of peakedness.

4.1 Which strategies performed the best and the worst over considered periods?

When considering period from January 1999 to May 2012 (tables 6.4, 6.5 and 6.6) I can only take into account strategies based on the core basket of currencies (because of the availability of data). No matter the funding currency, the best strategy in terms of cumulative return was the strategy 1 long/1 short executed on the forward market without the volatility filter and second best was the exact same strategy with the volatility filter. They allowed even to triple or quadruple initial resources. Afterwards goes the equal-weighted strategy also performed in the forward market without and with the volatility filter. Next, forward market versions of strategies 2 long/2 short and 3 long/3 short. The spot versions of those strategies yield usually similar return (around $40\% - 60\%$ return of initial investment). The worst type of strategies (in terms of cumulative return) is domestic vs currency without the volatility filter. In case of the British pound it yielded only 6% in total over 13 years. It is worth noting, that the best strategies had also the smallest minima, usually the highest maxima and the largest standard deviations when comparing within funding currencies.

If an investor cares for the values of Sharpe ratio in all considered cases they were below 1. The pattern for the best and the worst strategies with this respect is kind of analogous with comparing cumulative returns but only if the funding currency was the British pound and the US dollar. For the euro, the best strategies turned out to be the equal-weighted ones executed on the forward market.

While looking upon period January 2002 – May 2012, I can compare all the previous strategies to the optimized portfolios (tables 6.7, 6.8, 6.9 and 6.10). The hierarchy of the above mentioned strategies remains intact when it comes to cumulative returns. The optimized portfolios' performances place themselves between the best ones (1 long/1 short executed on the forward market) and the formerly second ones (equal-weighted executed

on the forward market) if the funding currency is the euro and after equal-weighted executed on the forward market if the funding currencies are the British pound or the US dollar.

However, in case of optimized portfolios, the minimum returns are highly reduced (maximum values also, but not equally as mentioned before) which dramatically decreases standard deviations and results in exceptionally (given other strategies) Sharpe ratios: minimally $0,8$ if the funding currency is the US dollar and maximally $1,15$ if it is the British pound. Although the optimized portfolio strategy did not outperform the equal-weighted strategy as it was stated in the paper [7] (the differences are probably due to considering slightly different time ranges and accounting dissimilarly for the transaction costs), if an investor would like to be relatively more immune to one-off losses, it can be argued that he should choose the optimized portfolio as the preferable strategy.

When analyzing the period from March 2004 to May 2012 I can finally compare all the strategies, including also the ones with addition of the non-core currencies (tables 6.11 – 6.17). First of all, it is interesting to mark that after excluding (more or less) the remnants of the dot-com crisis period, all of the performances (in terms of both: cumulative returns and Sharpe ratios) of previously considered strategies improved except for the optimized portfolios. Now, their cumulative returns should be ranked after the equal-weighted core basket currency strategies others positions in the ranking unchanged. Although rankings withing funding currencies remained unchanged, I can still infer that given a certain strategy, an investor who invests in the British pound as the funding currency is in almost all the cases slightly wealthier than the one who invests in the euro and certainly more wealthier than the one having the US dollar as the funding currency (in terms of cumulative returns over the whole period).

When comparing core basket strategies with their core+ basket counterparts in almost every case (except for a few ones for the euro as the funding currency) the cumulative returns and Sharpe ratios worsened. The structure from the best to the worse strategies within a funding currency stays the same as in the core basket currency variants. Surprisingly, one type of strategy – the worst one: domestic vs currency without the volatility filter – yielded even negative returns when the funding currencies were the British pound and the US dollar (both in core and core+ versions).

To give the impression how one of the best strategies performed, I included a figure of cumulative returns (figure 6.3) of the equal-weighted, 1 long/1 short and the optimized portfolio strategies (core basket of currencies, the euro as the funding currency).

4.2 Which strategies performed the best before and during the crisis separately? Did the tendencies last? Are those that performed better before the crisis going to remain the best ones during the crisis?

In general (judging by tables 6.18-6.31), the 1 long/1 short strategy executed on the forward market with and without the volatility filter won the prize for the best carry trade strategy after crisis no matter the funding currency and the elements of the currency basket with the exception of the euro as the funding currency in which case (usually the second best strategy) the equal-weighted strategy on the forward market performed the best. On the other hand, the worst strategy turned out to be again domestic vs. currency (possibly due to extremely low interest rates from which this strategy is supposed to profit). The rest of strategies gave very similar results (when comparing within the funding currency). Nevertheless, it deserves noting that the superiority of the British pound investor over the euro and especially over the US dollar investors is still valid, it is curious that as much as 6 core basket US dollar strategies yielded negative returns after the crisis. The optimized portfolio strategies can still hold the best Sharpe ratio values but they are significantly lower than before the crisis and does not exceed $0,7$.

4.3 Is the performance consistent across the funding currencies?

Yes. The relative proportions of values in terms of cumulative returns are consistent across the funding currencies when we compare within currency baskets.

4.4 Did the volatility filters secure positions in terms of limiting the losses?

Volatility filters fulfilled the expectations when it comes to limiting the maximum losses before the crisis. For every type of strategy (apart from the optimized portfolios), the minimum monthly return is greater with the volatility filter. However, they simultaneously limited the maximum returns too but this time with a few exceptions. They usually lowered the means and standard deviations of returns too, but this resulted every time in higher sharpe ratios (apparently decrease in standard deviations are relatively larger).

Nevertheless, the volatility filters did not fulfill the hopes of limiting the losses in the crisis period. In most strategies, the minimum returns are the same across the strategies volatility filters or not. On the other hand, they usually limited the maximum returns. If an investor expected to have higher sharpe ratios applying the volatility filters judging by the 'before crisis' period, those expectations were reached. But, there is no rule that could be utilised here in terms of cumulative returns.

4.5 Did spot transactions perform better or worse than the forward counterparts?

Looking at the cumulative returns without making distinctions between 'crisis', 'no crisis' periods there is a general rule, that strategies performed on the forward market are better than their counterparts (if exist) on the spot market. The differences are sometimes as high as 150 percentage points in total and predominantly in *number* long/*number* short types of strategies. When making distinctions between 'crisis' and 'no crisis' periods this regularity remains the same although the amplitudes are obviously smaller.

4.6 Did adding more 'exotic' currencies better of worsen the performance of strategies?

In the crisis period, adding 'exotic' currencies (as in core+ basket) improved in all the cases the cumulative performances of strategies when the funding currency was the euro (although not spectacularly, usually just by few percentage points which can still be treated as a significant improvement during crisis times). When considering the British pound, this statement is also true but for the equal-weighted strategy. Finally, when taking the US dollar as domestic currency there is no such a rule.

However, before the crisis, adding more 'exotic' currencies significantly worsened the strategies performance no matter the funding currency, presence of volatility filters or spot/forward variant. This means that, sadly, judging by the historical performance, an investor could not suspect that core+ basket could bring better results during the crisis.

4.7 How did carry trades perform in comparison to risk free interest rate and stock exchange investments?

In terms of cumulative returns (figure 6.2 and table 6.35 from now on) in period January 1999 – May 2012 and the euro as the funding currency only domestic vs currency startegies and equal-weighted strategy in the spot market with the volatility filter did not outperform the investment in the risk free interest euro rates. A few strategies outmatched it only by several percentage points but the majority did better than tens of percentage points during the whole period. In case of the British pound 9 out of 20 strategies underperformed but those that outperformed did that usually by tens of percentage points. Regarding the US dollar only 4 strategies did worse (including two domestic vs currency which are always the worst). It seems that even if for a given strategy British investor can receive more in terms of the cumulative return than the European or American one it is not always the case that he can get more profit investing in carry trades than just in the domestic risk free interest rate (this remains true for the rest of the periods also).

In the period March 1999 – May 2012 on average respectively 9, 10 and 11 out of 22 strategies (for the euro, the British pound and the US dollar) performed worse than the cumulative return from the risk free interest rate investments. Generally speaking those are: both (with and without the volatility filter) domestic vs currency, both equal-weighted on the spot market strategies and the spot versions of strategies of type 1 long/1 short, 2 long/2 short and 3 long/3 short. All the optimized portfolios performed significantly better, usually by $25\% - 40\%$ with the exception for the British pound-based (those only by a few percentage points).

From March 2004 to May 2012 carry trades beat the risk free interest rate no matter the funding currency and a composition of currency basket apart from the domestic vs currency strategies and spot versions of equal-weighted carry trades for the euro and the British pound. On average, they outmatched the risk free cumulative return by $10\% - 30\%$ percentage points in total (higher count of course for the best strategies).

After the crisis began, if a carry trade strategy yielded a positive cumulative return it was higher than the cumulative return from the risk free rate investment, usually by a few percentage points which given the shorter time span is a relatively good result.

Going to comparisons with the $S\&P500$ (table 6.36), as an exemplary case of a stock index, first of all it goes without saying that carry trades strategies in general underperformed the stock index in terms of the cumulative returns (when an investor starts to invest in October 2008) but usually outmatched it in terms of the Sharpe ratio (especially very safe optimized portfolios in the euro and the British pound - their $0,5 - 0,6$ to $0,18$ of the stock index). It can be say without harm that some form of carry trades (especially the optimized portfolios and forward versions of strategies) are safer investments than the passive stock index portfolio for the crisis time because of significantly lower standard deviations of returns and smaller one-off losses. However, if an investor is not highly risk-aversed, buying the stocks right after the prices plummeted and hit very low relative values would have been better in terms of cumulative returns.

When taking into account period January 1999 – May 2012, apart from domestic vs. currency, every strategy outmatched the stock index in terms of Sharp ratios and cumulative returns since it was the time when the dot-com bubble also occured. Considering the rest of periods the situation is not that obvious, but for the simplicity it can be said that the top $4 - 6$ best strategies for every currency basket in considered periods outperformed this benchmark index. All in all, I may conclude that no matter the period there was always at least one type of strategies that can easily outperform the $S\&P500$ stock index.

Chapter 5

Conclusions

To begin, the most important conclusion is that some carry trades strategies considered in my analysis remained relatively highly profitable despite the crisis time. It is an important, counterfactual result since many researchers doubt carry trades' performance during periods that are characterized by inflated volatility. Many investors liquidated their carry trades positions after the turmoil began for fear of incurring losses, unfairly as it turned out. Gains could have been obtained – it was only the matter of choosing right strategy. Massive abandoning of theses type of trades was rather a consequence of a bandwagon effent.

In every investigated period it was possible to find strategies that outperformed risk free investments and the benchmark $S\&P500$ stock index in terms of cumulative returns no matter the funding currency. Carry trades had also usually higher Sharpe ratios than the $S\&P500$ which is a good news for investors who crave for investment opportunities that are comparatively less volatile but still high-yielding. It was true especially after the crisis when carry trade strategies did not perform as spectacularly as investing in stocks when the latter hit the rock bottom and were about to grow but at the same time they exhibited far smaller instability of growth path than the stock indice.

Next, if an investor decided to adhere to the best strategies from the time before the crisis that included investing in core basket currencies, it was the most accurate predictor of the most advantageous strategies after the meltdown started no matter the funding currency. However, it could not have been expected judging only by the pre-crisis performance that strategies based on core+ basket of currencies turned out to be slightly better investment opportunities than the core ones.

It remained a consistent pattern no matter the period that version of strategies that involved trading on the forward market outmatched those performed only on the spot market. Moreover, the applied volatility filter could not have saved investors from incurring the major losses during the crisis time but it surprisingly worked all along the preceding prosperity phase. Investors who desired to rely upon it when the crunch commenced would have been disappointed. Both the above-mentioned results are true for every funding currency considered.

The strategy that evaded most of the observed patterns is the optimized portfolio. It remained relatively profitable despite the circumstances, simultaneously minimizing considerably the losses. It can be nominated as the most favourable strategy for not risk prone individuals although not to the same extent with respect to the funding currency. Its undeniable advantages stayed the same even after the crisis.

Chapter 6

Appendices

6.1 MATLAB code

Strategy $1a$ (equal-weighted, core basket, spot market, the euro as a funding currency):

```
IR=xlsread('IR_EUR_CORE.xlsx'); B=xlsread('SPOT_EUR_CORE_BID.xlsx');
O=xlsread('SPOT_EUR_CORE_OFFER.xlsx'); IR=IR/100; Brev=1./O; Orev=1./B;
[r c]=size(B); [R C]=size(IR); returns=zeros(r-1,c);

for t=1:(r-1)
    higherrates=sign(IR(t,1:(C-1))-IR(t,C));
    for i=1:c
        if higherrates(i)>0
            returns(t,i)=(O(t,i)*(1+IR(t,i)/12))/(B(t+1,i)*(1+IR(t,C)/12));
        elseif higherrates(i)<0
            returns(t,i)=(Brev(t,i)*(1+IR(t,C)/12))/(Orev(t+1,i)*(1+IR(t,i)/12));
        else returns(t,i)=1+IR(t,C)/12;
        end
    end
end
```

Strategy $1b$ (equal-weighted, core basket, forward market, the euro as a funding currency):

```
IR=xlsread('IR_EUR_CORE.xlsx'); BS=xlsread('SPOT_EUR_CORE_BID.xlsx');
OS=xlsread('SPOT_EUR_CORE_OFFER.xlsx'); BF=xlsread('FWD_EUR_CORE_BID.xlsx');
OF=xlsread('FWD_EUR_CORE_OFFER.xlsx'); IR=IR/1200; [r c]=size(BS); [R C]=size(IR);

rawreturns=zeros(r-1,c); weights=zeros(r-1,c); returns=zeros(r-1,c);

for t=1:(r-1)
    signs=sign(OF(t,:)-OS(t,:));
    weights(t,:)=signs/c;
    for i=1:c
        if signs(i)>0
        rawreturns(t,i)=OF(t,i)./BS(t+1,i)-1;
        else rawreturns(t,i)=BF(t,i)./OS(t+1,i)-1;
        end
```

```
    end
end

returns=weights.*rawreturns;
returns=sum(returns')+IR(2:R,C)';
```

Strategy $2a$ (1 long/1 short, core basket, spot market, the euro as a funding currency):

```
IR=xlsread('IR_EUR_CORE.xlsx'); B=xlsread('SPOT_EUR_CORE_BID.xlsx');
O=xlsread('SPOT_EUR_CORE_OFFER.xlsx'); IR=IR/100; Brev=1./O; Orev=1./B;
[r c]=size(B); [R C]=size(IR); returns=zeros(r-1,c); rates=IR(:,1:(C-1));

for t=1:(r-1)
    higherrates=IR(t,1:(C-1))>IR(t,C);

    [vmax1,pmax1]=max(rates(t,:));
    [vmin1,pmin1]=min(rates(t,:));
    if higherrates(pmax1)==1
        returns(t,pmax1)=(O(t,pmax1)*(1+IR(t,pmax1)/12))/(B(t+1,pmax1)*(1+IR(t,C)/12));
    else returns(t,pmax1)=0;
    end
    if higherrates(pmin1)==0
        returns(t,pmin1)=(Brev(t,pmin1)*(1+IR(t,C)/12))/(Orev(t+1,pmin1)*
 (1+IR(t,pmin1)/12));
    else returns(t,pmin1)=0;
    end
end
```

Strategy $2b$ (2 long/2 short, core basket, spot market, the euro as a funding currency):

```
IR=xlsread('IR_EUR_CORE.xlsx'); B=xlsread('SPOT_EUR_CORE_BID.xlsx');
O=xlsread('SPOT_EUR_CORE_OFFER.xlsx'); IR=IR/100; Brev=1./O; Orev=1./B;
[r c]=size(B); [R C]=size(IR); returns=zeros(r-1,c); rates=IR(:,1:(C-1));

for t=1:(r-1)
    higherrates=IR(t,1:(C-1))>IR(t,C);

    [vmax1,pmax1]=max(rates(t,:));
    [vmin1,pmin1]=min(rates(t,:));
    if higherrates(pmax1)==1
        returns(t,pmax1)=(O(t,pmax1)*(1+IR(t,pmax1)/12))/(B(t+1,pmax1)*(1+IR(t,C)/12));
    else returns(t,pmax1)=0;
    end
    if higherrates(pmin1)==0
        returns(t,pmin1)=(Brev(t,pmin1)*(1+IR(t,C)/12))/(Orev(t+1,pmin1)*
 (1+IR(t,pmin1)/12));
    else returns(t,pmin1)=0;
    end

    [vmax2,pmax2]=sort(-rates(t,:));
```

```
    [vmin2,pmin2]=sort(rates(t,:));
    if higherrates(pmax2(2))==1
        returns(t,pmax2(2))=(O(t,pmax2(2))*(1+IR(t,pmax2(2))/12))/(B(t+1,pmax2(2))*
 (1+IR(t,C)/12));
    else returns(t,pmax2(2))=0;
    end
    if higherrates(pmin2(2))==0
        returns(t,pmin2(2))=(Orev(t,pmin2(2))*(1+IR(t,C)/12))/(Brev(t+1,pmin2(2))*
 (1+IR(t,pmin2(2))/12));
    else returns(t,pmin2(2))=0;
    end
end
```

Strategy $2c$ **(3 long/3 short, core basket, spot market, the euro as a funding currency)**:

```
IR=xlsread('IR_EUR_CORE.xlsx'); B=xlsread('SPOT_EUR_CORE_BID.xlsx'); O=xlsread('SPOT_EUR_CORE_OFFER.
[r c]=size(B); [R C]=size(IR); returns=zeros(r-1,c); rates=IR(:,1:(C-1));

for t=1:(r-1)
    higherrates=IR(t,1:(C-1))>IR(t,C);

    [vmax1,pmax1]=max(rates(t,:));
    [vmin1,pmin1]=min(rates(t,:));
    if higherrates(pmax1)==1
        returns(t,pmax1)=(O(t,pmax1)*(1+IR(t,pmax1)/12))/(B(t+1,pmax1)*(1+IR(t,C)/12));
    else returns(t,pmax1)=0;
    end
    if higherrates(pmin1)==0
        returns(t,pmin1)=(Brev(t,pmin1)*(1+IR(t,C)/12))/(Orev(t+1,pmin1)*
 (1+IR(t,pmin1)/12));
    else returns(t,pmin1)=0;
    end

    [vmax2,pmax2]=sort(-rates(t,:));
    [vmin2,pmin2]=sort(rates(t,:));
    if higherrates(pmax2(2))==1
        returns(t,pmax2(2))=(O(t,pmax2(2))*(1+IR(t,pmax2(2))/12))/(B(t+1,pmax2(2))*
 (1+IR(t,C)/12));
    else returns(t,pmax2(2))=0;
    end
    if higherrates(pmin2(2))==0
        returns(t,pmin2(2))=(Orev(t,pmin2(2))*(1+IR(t,C)/12))/(Brev(t+1,pmin2(2))*
 (1+IR(t,pmin2(2))/12));
    else returns(t,pmin2(2))=0;
    end

    if higherrates(pmax2(3))==1
        returns(t,pmax2(3))=(O(t,pmax2(3))*(1+IR(t,pmax2(3))/12))/(B(t+1,pmax2(3))*
 (1+IR(t,C)/12));
```

```
    else returns(t,pmax2(3))=0;
    end
    if higherrates(pmin2(3))==0
        returns(t,pmin2(3))=(Orev(t,pmin2(3))*(1+IR(t,C)/12))/(Brev(t+1,pmin2(3))*
 (1+IR(t,pmin2(3))/12));
    else returns(t,pmin2(3))=0;
    end
end
```

Strategy $2d$ (1 long/1 short, core basket, forward market, the euro as a funding currency):

```
IR=xlsread('IR_EUR_CORE.xlsx'); BS=xlsread('SPOT_EUR_CORE_BID.xlsx');
OS=xlsread('SPOT_EUR_CORE_OFFER.xlsx'); BF=xlsread('FWD_EUR_CORE_BID.xlsx');
OF=xlsread('FWD_EUR_CORE_OFFER.xlsx'); IR=IR/1200; [r c]=size(BS); [R C]=size(IR);
returns=zeros(r-1,c);

for t=1:(r-1)
    signs=sign(OF(t,:)-OS(t,:));
    diff=OF(t,:)-OS(t,:);

    [vmax1,pmax1]=max(diff);
    [vmin1,pmin1]=min(diff);

        if signs(pmax1)>0
        returns(t,pmax1)=OF(t,pmax1)./BS(t+1,pmax1)-1;
        else returns(t,pmax1)=0;
        end
        if signs(pmin1)<0
        returns(t,pmin1)=-(BF(t,pmin1)./OS(t+1,pmin1)-1);
        else returns(t,pmin1)=0;
        end
end
```

Strategy $2e$ (2 long/2 short, core basket, forward market, the euro as a funding currency):

```
IR=xlsread('IR_EUR_CORE.xlsx'); BS=xlsread('SPOT_EUR_CORE_BID.xlsx');
OS=xlsread('SPOT_EUR_CORE_OFFER.xlsx'); BF=xlsread('FWD_EUR_CORE_BID.xlsx');
OF=xlsread('FWD_EUR_CORE_OFFER.xlsx'); IR=IR/1200; [r c]=size(BS); [R C]=size(IR);
returns=zeros(r-1,c);

for t=1:(r-1)
    signs=sign(OF(t,:)-OS(t,:));
    diff=OF(t,:)-OS(t,:);

    [vmax1,pmax1]=max(diff);
    [vmin1,pmin1]=min(diff);

        if signs(pmax1)>0
        returns(t,pmax1)=OF(t,pmax1)./BS(t+1,pmax1)-1;
        else returns(t,pmax1)=0;
```

```
        end
        if signs(pmin1)<0
        returns(t,pmin1)=-(BF(t,pmax1)./OS(t+1,pmax1)-1);
        else returns(t,pmin1)=0;
        end

    [vmax2,pmax2]=sort(-diff);
    [vmin2,pmin2]=sort(diff);

        if signs(pmax2(2))>0
        returns(t,pmax2(2))=OF(t,pmax2(2))./OS(t+1,pmax2(2))-1;
        else returns(t,pmax2(2))=0;
        end
        if signs(pmin2(2))<0
        returns(t,pmin2(2))=-(BF(t,pmin2(2))./BS(t+1,pmin2(2))-1);
        else returns(t,pmin2(2))=0;
        end
end
```

Strategy $2f$ (3 long/3 short, core basket, forward market, the euro as a funding currency):

```
IR=xlsread('IR_EUR_CORE.xlsx'); BS=xlsread('SPOT_EUR_CORE_BID.xlsx');
OS=xlsread('SPOT_EUR_CORE_OFFER.xlsx'); BF=xlsread('FWD_EUR_CORE_BID.xlsx');
OF=xlsread('FWD_EUR_CORE_OFFER.xlsx'); IR=IR/1200; [r c]=size(BS); [R C]=size(IR);
returns=zeros(r-1,c);

for t=1:(r-1)
    signs=sign(OF(t,:)-OS(t,:));
    diff=OF(t,:)-OS(t,:);

    [vmax1,pmax1]=max(diff);
    [vmin1,pmin1]=min(diff);

        if signs(pmax1)>0
        returns(t,pmax1)=OF(t,pmax1)./BS(t+1,pmax1)-1;
        else returns(t,pmax1)=0;
        end
        if signs(pmin1)<0
        returns(t,pmin1)=-(BF(t,pmax1)./OS(t+1,pmax1)-1);
        else returns(t,pmin1)=0;
        end

    [vmax2,pmax2]=sort(-diff);
    [vmin2,pmin2]=sort(diff);

        if signs(pmax2(2))>0
        returns(t,pmax2(2))=OF(t,pmax2(2))./OS(t+1,pmax2(2))-1;
        else returns(t,pmax2(2))=0;
        end
```

```
        if signs(pmin2(2))<0
        returns(t,pmin2(2))=-(BF(t,pmin2(2))./BS(t+1,pmin2(2))-1);
        else returns(t,pmin2(2))=0;
        end

        if signs(pmax2(3))>0
        returns(t,pmax2(3))=OF(t,pmax2(3))./OS(t+1,pmax2(3))-1;
        else returns(t,pmax2(3))=0;
        end
        if signs(pmin2(3))<0
        returns(t,pmin2(3))=-(BF(t,pmin2(3))./BS(t+1,pmin2(3))-1);
        else returns(t,pmin2(3))=0;
        end
end
```

Strategy $3a$ **(currency vs domestic, core basket, spot market, the euro as a funding currency)**:

```
IR=xlsread('IR_EUR_CORE.xlsx'); B=xlsread('SPOT_EUR_CORE_BID.xlsx');
O=xlsread('SPOT_EUR_CORE_OFFER.xlsx'); IR=IR/100; Brev=1./O; Orev=1./B;
[r c]=size(B); [R C]=size(IR); returns=zeros(r-1,c);

for t=1:(r-1)
    higherrates=IR(t,1:(C-1))>IR(t,C);
    for i=1:c
        if higherrates(i)>0
            returns(t,i)=(O(t,i)*(1+IR(t,i)/12))/(B(t+1,i)*(1+IR(t,C)/12));
        else returns(t,i)=IR(t,C)/12+1;
        end
    end
end

monthlyreturns=sum(returns')./c-1;
```

Strategy $3b$ **(domestic vs currency, core basket, spot market, the euro as a funding currency)**:

```
IR=xlsread('IR_EUR_CORE.xlsx'); B=xlsread('SPOT_EUR_CORE_BID.xlsx');
O=xlsread('SPOT_EUR_CORE_OFFER.xlsx'); IR=IR/100; Brev=1./O; Orev=1./B;
[r c]=size(B); [R C]=size(IR); returns=zeros(r-1,c);

for t=1:(r-1)
    higherrates=IR(t,1:(C-1))>IR(t,C);
    for i=1:c
        if higherrates(i)>0
            returns(t,i)=IR(t,C)/12+1;
        else returns(t,i)=(Brev(t,i)*(1+IR(t,C)/12))/(Orev(t+1,i)*(1+IR(t,i)/12));
        end
    end
end
```

```
monthlyreturns=sum(returns')./c-1;
```

Strategy 4 (optimized portfolio, core basket, spot market, the euro as a funding currency):

```
CPI=xlsread('CPI_EUR_CORE.xlsx'); CACC=xlsread('CURRACC_EUR_CORE.xlsx');
BF=xlsread('FWD_EUR_CORE_BID.xlsx'); OF=xlsread('FWD_EUR_CORE_OFFER.xlsx');
IR=xlsread('IR_EUR_CORE.xlsx'); IR=IR/1200;
BS=xlsread('SPOT_EUR_CORE_BID.xlsx'); OS=xlsread('SPOT_EUR_CORE_OFFER.xlsx');
[r c]=size(BS); [R C]=size(IR);
n=34; % number of periods I standardize on
p=161-3-n; % number of periods in the analysis
gamma=5; % coefficient of relative risk aversion
[x y]=size(OF);

% rawreturns matrix
rawreturns=zeros(r-1,c);
for g=1:(r-1)
    signs=sign(OF(g,:)-OS(g,:));
    for i=1:c
        if signs(i)>0
        rawreturns(g,c)=OF(g,c)./BS(g+1,c)-1;
        else rawreturns(g,c)=BF(g,c)./OS(g+1,c)-1;
        end
    end
end

for t=1:p
    % momentum
    month3lag=OS(t+3:t+2+n,:)./OS(t:(t-1+n),:);
    mean3lag=mean(mean(month3lag));
    [e f]=size(month3lag);
    res3lag=reshape(month3lag,e*f,1);
    std3lag=std(res3lag);
    stdzedmonth3lag=(month3lag-mean3lag)./std3lag;

    % sign of the forward discount
    BFn=BF(t+3:t+2+n,:);
    OFn=OF(t+3:t+2+n,:);
    OSn=OS(t+3:t+2+n,:);
    BSn=BS(t+3:t+2+n,:);

    SIGNO=sign(OFn-OSn);

    % standardized current account
    CACCn=CACC(t+3:(t+2+n),1:y);

    mcacc=mean(mean(CACCn));
    [a b]=size(CACCn);
```

```
    resCACC=reshape(CACCn,a*b,1);
    stdCACC=std(resCACC);
    stdzedCACC=(CACCn-mcacc)./stdCACC;

    % interest rate spread
    IRspread=OFn-OSn;
    mIRspread=mean(mean(IRspread));
    [c d]=size(IRspread);
    resIRspread=reshape(IRspread,c*d,1);
    stdIRspread=std(resIRspread);
    stdzedIRspread=(IRspread-mIRspread)./stdIRspread;

    % real exchange rate
    CPIn=CPI(t+3:(t+2+n),:);
    stdzedRER=zeros(n,y);
    OSrer=zscore(OSn);

    for k=1:n
        stdzedRER(k,:)=OSrer(k,:).*CPIn(k,1:y)./CPIn(k,y+1);
    end

    for d=1:n
        data(:,:,d)=[stdzedmonth3lag(d,1) SIGNO(d,1) stdzedCACC(d,1)
  stdzedIRspread(d,1) stdzedRER(d,1);
                     stdzedmonth3lag(d,2) SIGNO(d,2) stdzedCACC(d,2)
  stdzedIRspread(d,2) stdzedRER(d,2);
                     stdzedmonth3lag(d,3) SIGNO(d,3) stdzedCACC(d,3)
  stdzedIRspread(d,3) stdzedRER(d,3);
                     stdzedmonth3lag(d,4) SIGNO(d,4) stdzedCACC(d,4)
  stdzedIRspread(d,4) stdzedRER(d,4);
                     stdzedmonth3lag(d,5) SIGNO(d,5) stdzedCACC(d,5)
  stdzedIRspread(d,5) stdzedRER(d,5);
                     stdzedmonth3lag(d,6) SIGNO(d,6) stdzedCACC(d,6)
  stdzedIRspread(d,6) stdzedRER(d,6);
                     stdzedmonth3lag(d,7) SIGNO(d,7) stdzedCACC(d,7)
  stdzedIRspread(d,7) stdzedRER(d,7);
                     stdzedmonth3lag(d,8) SIGNO(d,8) stdzedCACC(d,8)
  stdzedIRspread(d,8) stdzedRER(d,8);
                     stdzedmonth3lag(d,9) SIGNO(d,9) stdzedCACC(d,9)
  stdzedIRspread(d,9) stdzedRER(d,9);
                     stdzedmonth3lag(d,10) SIGNO(d,10) stdzedCACC(d,10)
  stdzedIRspread(d,10) stdzedRER(d,10)];
    end

    [Nc Nch Np]=size(data);
    Np=Np-1;

cvx_begin
```

```
    variables w(Nc,Np) theta(Nch) l rokr(Np)
    maximize(l)
    subject to
        for i=1:Np
            w(:,i)==data(:,:,i)*theta/Nc;
            sum(abs(w(:,i))) <=5;
            rokr(i)==(rawreturns(t-1+i,:))*w(:,i)+1;
        end
        l<=sum(pow_p(rokr,1-gamma)/(1-gamma));
cvx_end

weights=data(:,:,n)*theta/y;
returns(t,:)=IR(t-1+n,C)+rawreturns(t+n,:)*weights/(sum(abs(weights)));

end
```

Strategy 5 (equal-weighted with the volatility filter, core basket, spot market, the euro as a funding currency):

```
IR=xlsread('IR_EUR_CORE.xlsx'); B=xlsread('SPOT_EUR_CORE_BID.xlsx');
O=xlsread('SPOT_EUR_CORE_OFFER.xlsx'); VIX=xlsread('VIX.xlsx');
bound=25; IR=IR/100; Brev=1./O; Orev=1./B;
[r c]=size(B); [R C]=size(IR); returns=zeros(r-1,c);

for t=1:(r-1)
    if VIX(t)<bound
        higherrates=sign(IR(t,1:(C-1))-IR(t,C));
        for i=1:c
            if higherrates(i)>0
                returns(t,i)=(O(t,i)*(1+IR(t,i)/12))/(B(t+1,i)*(1+IR(t,C)/12));
            elseif higherrates(i)<0
                returns(t,i)=(Brev(t,i)*(1+IR(t,C)/12))/(Orev(t+1,i)*(1+IR(t,i)/12));
            else returns(t,i)=1+IR(t,C)/12;
            end
        end
    else returns(t,i)=1+IR(t,C)/12;
    end
end

monthlyreturns=sum(returns')./c-1;
annualreturns=monthlyreturns*1200;
```

6.2 Figures

Figure 6.1: Chicago Board Options Exchange Volatility Index: VIX, January 1999-May 2012

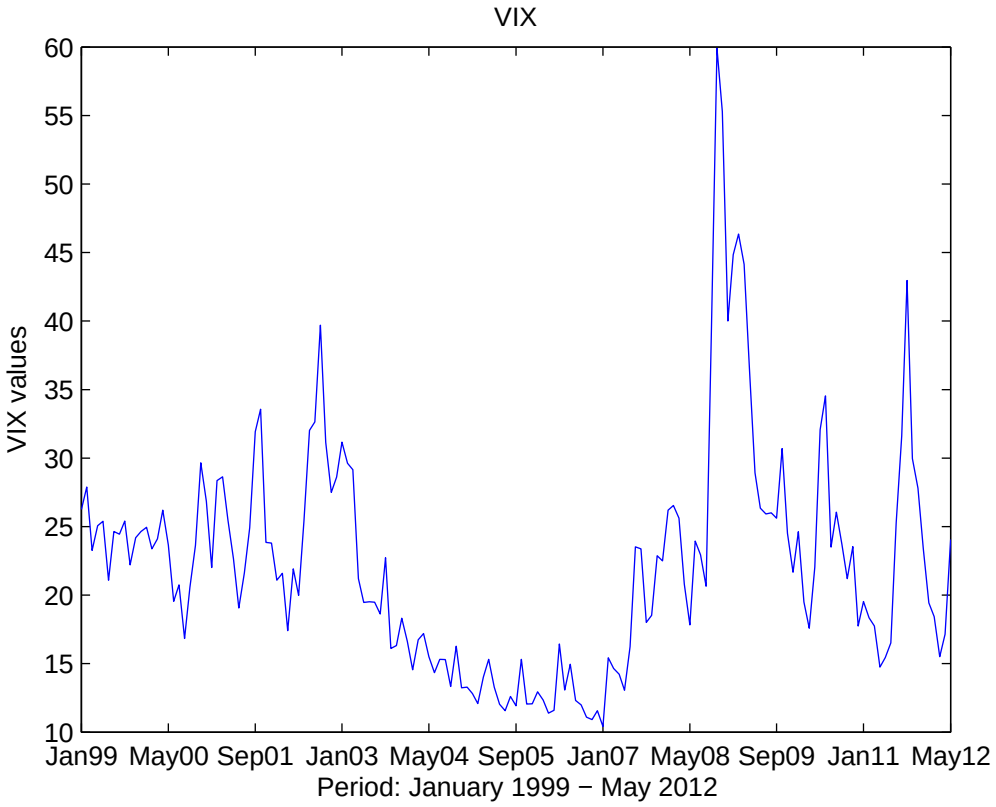


Figure 6.2: Cumulative returns of risk free investments in Eurozone, in the UK and in the US and S&P500 index , January 1999-May 2012

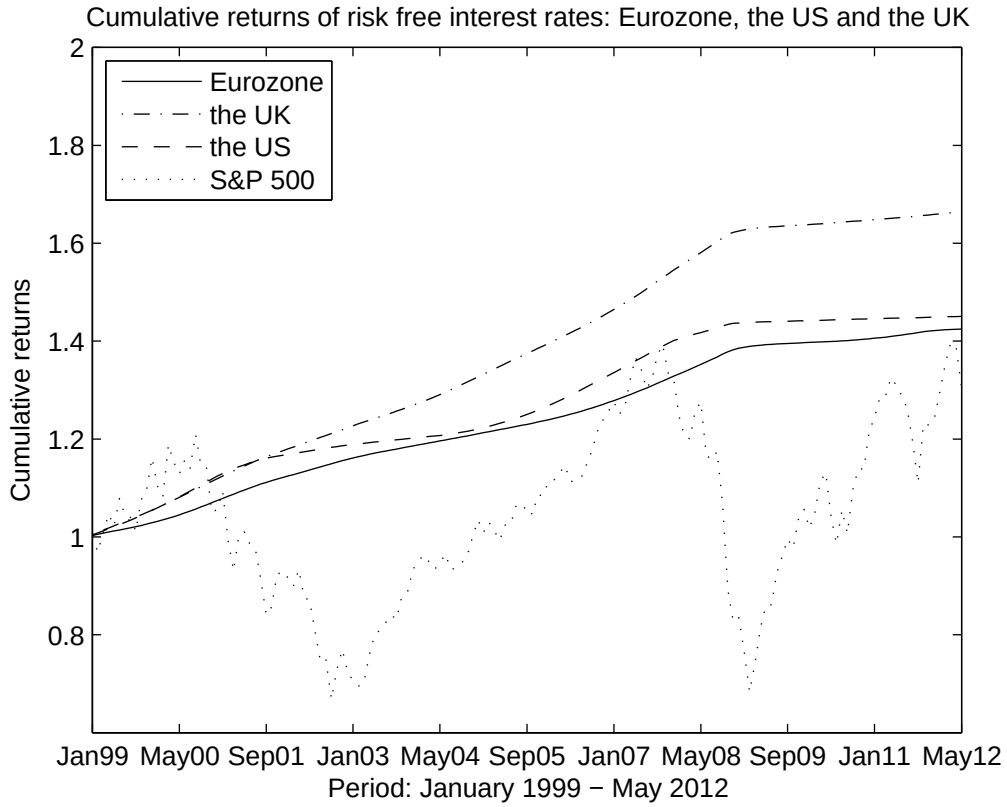
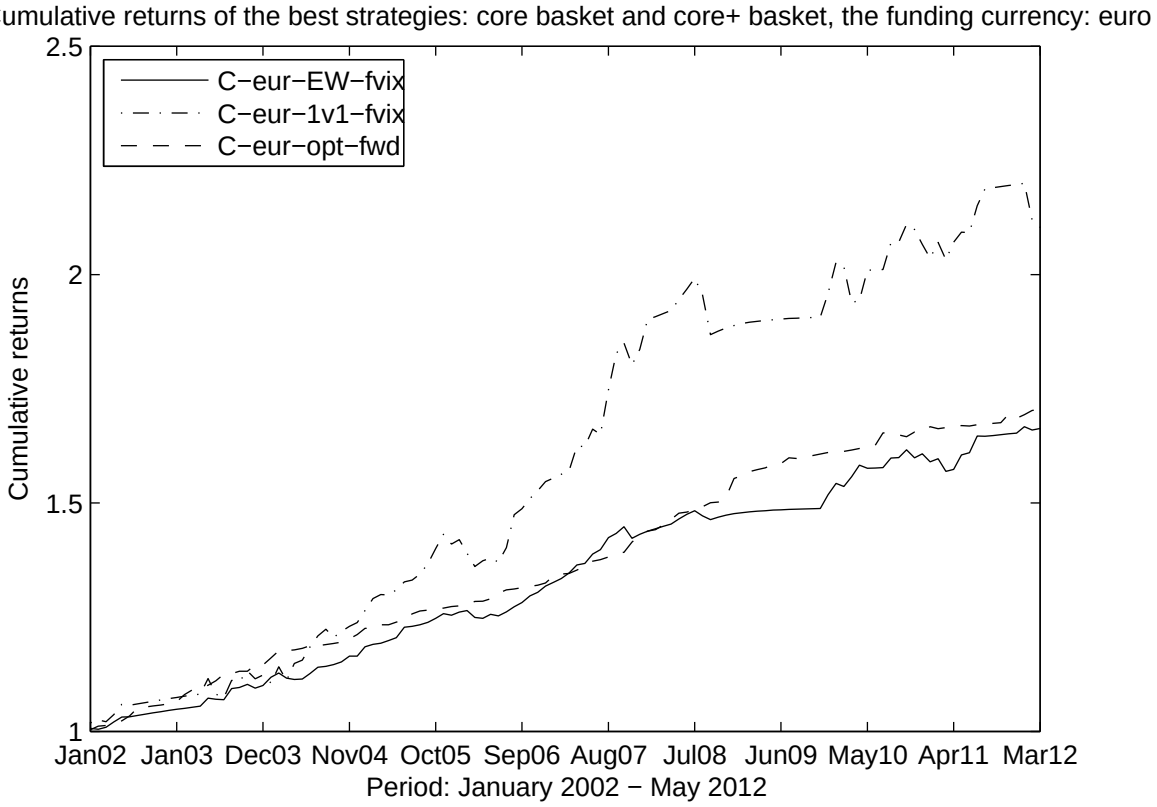


Figure 6.3: Cumulative returns of some of the best strategies: core basket and core+ basket, the funding currency: euro, January 2002-May 2012



6.3 Tables

The content of the tables is following: minimum, maximum, mean, standard deviation, skewness and kurtosis of annualized (as percentage) monthly returns and cumulative return calculated as a product of monthly returns (for instace $1,45 = 145\%$ during the whole period).

Table 6.1: Exchange rates core basket currencies basic statistics, spot bid rates, January 1999–May 2012

currency pair	min	max	mean	std	skew	kurt
AUD/EUR	1,2314	2,0116	1,631029	0,153502	-0,610264	3,519879
CAD/EUR	1,2767	1,7158	1,478796	0,108314	0,076815	1,866371
CHF/EUR	1,1303	1,677	1,501606	0,120137	-1,369096	4,180367
DKK/EUR	7,4024	7,4785	7,443125	0,013072	-0,306406	2,861062
GBP/EUR	0,5856	0,9554	0,722455	0,097451	0,659632	2,051164
JPY/EUR	92,46999	168,17	127,4383	18,95869	0,345427	2,327531
NOK/EUR	7,2704	9,7088	8,068074	0,360501	0,772102	5,40385
NZD/EUR	1,5843	2,528	1,948247	0,170291	0,489833	3,749187
SEK/EUR	8,1307	11,4044	9,250469	0,522982	1,430796	6,135354
USD/EUR	0,84631	1,577287	1,209819	0,195261	-0,292612	2,051278
AUD/GBP	1,4824	2,9992	2,30482	0,401686	-0,723363	2,451315
CAD/GBP	1,519	2,5331	2,080286	0,292486	-0,563311	2,031139
CHF/GBP	1,2891	2,6767	2,124255	0,368187	-0,796004	2,272091
DKK/GBP	7,7692	12,705	10,47433	1,316482	-0,403362	1,894764
EUR/GBP	1,0445	1,7042	1,406684	0,176793	-0,404088	1,890223
JPY/GBP	119,53	247,42	179,0019	32,37222	-0,145899	2,178398
NOK/GBP	8,636	13,8418	11,34068	1,413055	-0,390562	1,92111
NZD/GBP	1,8663	3,6334	2,745968	0,444268	-0,093613	2,288385
SEK/GBP	10,0717	15,7401	12,96452	1,36288	-0,493626	2,441188
USD/GBP	1,4104	2,0813	1,674424	0,181915	0,499258	2,122831
AUD/USD	0,90851	2,05846	1,393346	0,304247	0,383722	2,158396
CAD/USD	0,9436	1,601	1,253836	0,210603	0,210889	1,557153
CHF/USD	0,7852	1,797	1,279636	0,255488	0,299586	2,166915
DKK/USD	4,7269	8,8122	6,331223	1,113898	0,740018	2,352321
EUR/USD	0,634	1,1816	0,850281	0,149651	0,731532	2,33677
GBP/USD	0,480469	0,709019	0,604007	0,063183	-0,212195	1,977846
JPY/USD	76,18999	134,56	106,7212	14,44901	-0,586667	2,412051
NOK/USD	5,0832	9,3841	6,852964	1,177838	0,619992	2,321519
NZD/USD	1,14771	2,51826	1,665939	0,375111	0,771691	2,38516
SEK/USD	5,9421	10,8456	7,835532	1,249353	0,760932	2,772255

Table 6.2: Exchange rates core+ basket currencies basic statistics, spot bid rates, March 2004–May 2012

currency pair	min	max	mean	std	skew	kurt
BRL/EUR	2,2068	3,8843	2,728011	0,406979	1,07619	3,46666
CZK/EUR	23,86299	32,80699	27,11789	2,374888	0,553543	2,276921
HUF/EUR	233,58	314,8298	263,918	18,00074	0,717778	2,865915
ISK/EUR	72,93999	184,92	123,5121	39,29774	0,140331	1,268772
MXN/EUR	12,4418	19,756	15,84318	1,924069	0,148628	2,042755
PLN/EUR	3,2111	4,7844	4,013569	0,318902	0,024435	3,101403
BRL/GBP	2,5056	5,8385	3,61089	0,852578	0,734547	2,6856
CZK/GBP	26,85999	49,17899	35,84135	6,909033	0,283481	1,469591
HUF/GBP	274,7798	411,5198	344,4449	31,01249	-0,136229	2,064814
ISK/GBP	107,66	219,22	156,3628	33,60982	0,1483	1,437484
MXN/GBP	18,25679	22,43059	20,52223	1,102195	-0,327207	2,061055
PLN/GBP	4,0995	7,1257	5,26967	0,70709	0,503594	2,677566
BRL/USD	1,5485	3,188	2,055486	0,396128	0,973835	3,249057
CZK/USD	15,158	27,18399	20,42947	2,980737	0,393334	2,195266
HUF/USD	149,64	243,88	198,7156	19,64106	-0,085799	2,933389
ISK/USD	59,67999	142,34	91,80505	27,47252	0,201473	1,239122
MXN/USD	10,03	15,2465	11,82825	1,184188	0,674536	2,395508
PLN/USD	2,0585	3,994	3,019448	0,384127	-0,209506	3,269616

Table 6.3: Risk free interest rates, January 1999–May 2012 for core currencies, March 2004–May 2012 for core+ currencies

country	min	max	mean	std	skew	kurt
Australia	2,90	7,65	5,176071	0,965305	0,312753	3,251333
Canada	0,12	5,46	2,663789	1,574432	0,004148	1,885204
Switzerland	-0,26	3,4	1,105846	1,05732	0,746155	2,254572
Denmark	0,46	6,05	2,977461	1,412683	0,124987	2,018657
Euro zone	0,386	5,05	2,641398	1,360649	-0,066988	1,944614
Great Britain	0,475	6,575	3,80428	1,963333	-0,716849	1,991684
Japan	0,054	0,854	0,248488	0,226709	1,155327	3,055255
Norway	1,58	7,85	4,29354	2,092109	0,247408	1,402322
New Zealand	2,53	8,88	5,540932	1,909396	-0,165757	1,932901
Sweden	0,121	4,294	2,576202	1,251385	-0,396671	2,038121
USA	0,186	6,804	2,777071	2,161156	0,300155	1,630183
Brazil	0,5	0,803	0,623576	0,07574	0,287911	2,373254
Czech Republic	0,775	4,2	1,997374	0,984959	0,444809	2,246716
Hungary	5,23	12,29	7,633636	1,796659	0,830676	3,006638
Iceland	4	18,47	9,86303	4,333928	0,303446	1,897914
Mexico	3,84	9,64	6,423232	1,741672	0,0285	1,743521
Poland	3,42	6,61	4,654747	0,98031	0,591694	2,146252

Table 6.4: Core basket, the funding currency: the euro, January 1999–May 2012

strategy	min	max	mean	std	skew	kurt	sharpe	cumul
C_eur_EW_spot	-49,0648	35,86369	2,85187	12,10733	-0,69411	5,354907	0,235549	1,450204
C_eur_EW_svix	-27,286	30,14101	2,577232	8,677055	-0,41785	4,57058	0,297017	1,403704
C_eur_EW_fwd	-48,4871	36,47798	6,183231	11,54691	-0,63412	5,477966	0,535488	2,259169
C_eur_EW_fvix	-21,1441	36,47798	5,479966	8,990373	0,156026	4,15984	0,609537	2,063864
C_eur_1v1_spot	-116,282	65,01872	3,221929	22,7295	-0,87881	7,378412	0,141751	1,492262
C_eur_1v1_svix	-56,4445	55,35895	3,040233	16,15703	-0,21771	4,832095	0,188168	1,477687
C_eur_1v1_fwd	-119,919	71,90446	8,033259	25,62417	-0,84737	6,136574	0,313503	2,804663
C_eur_1v1_fvix	-53,975	70,66456	7,122776	20,45911	0,054622	3,82794	0,348147	2,519501
C_eur_2v2_spot	-57,8118	50,2887	3,266672	16,76576	-0,44885	3,793047	0,194842	1,52114
C_eur_2v2_svix	-36,9874	37,63172	2,865559	12,76546	-0,38701	4,007205	0,224478	1,45156
C_eur_2v2_fwd	-19,5814	29,16245	4,238674	8,257321	0,033896	3,157409	0,513323	1,751414
C_eur_2v2_fvix	-19,5814	22,73933	3,692304	7,145685	-0,02019	3,734094	0,516718	1,630276
C_eur_3v3_spot	-64,4019	43,48543	4,019518	14,70221	-1,03751	6,21406	0,273395	1,687217
C_eur_3v3_svix	-37,2061	25,85714	3,212172	10,37915	-0,66896	4,583065	0,309483	1,52467
C_eur_3v3_fwd	-26,2464	34,28367	5,032447	8,884613	-0,14086	3,727121	0,566423	1,945006
C_eur_3v3_fvix	-14,069	24,80275	4,477183	7,393847	0,187364	3,544826	0,605528	1,809143
C_eur_CvD_spot	-29,5597	31,43831	3,78036	10,19988	-0,28574	3,672566	0,370628	1,644667
C_eur_CvD_svix	-23,6971	31,43831	3,788003	8,498939	0,067183	4,374072	0,445703	1,649232
C_eur_DvC_spot	-41,9821	52,50387	1,727004	10,73621	-0,28412	7,49057	0,160858	1,25075
C_eur_DvC_svix	-28,403	18,65892	1,444722	7,314112	-1,32634	6,308607	0,197525	1,208707

Table 6.5: Core basket, funding currency: the British pound, January 1999–May 2012

strategy	min	max	mean	std	skew	kurt	sharpe	cumul
C_gbp_EW_spot	-49,0841	45,45269	1,579371	13,51789	-0,19669	4,209647	0,116836	1,221849
C_gbp_EW_svix	-26,957	36,49629	2,138288	10,23166	-0,05092	3,928155	0,208987	1,321926
C_gbp_EW_fwd	-53,3497	57,35828	7,77391	17,51813	-0,37432	4,520728	0,443764	2,763187
C_gbp_EW_fvix	-32,0287	56,76391	7,335015	13,16997	0,128841	5,108713	0,55695	2,626288
C_gbp_1v1_spot	-116,442	65,06013	3,29545	23,14991	-0,94883	7,342219	0,142353	1,505262
C_gbp_1v1_svix	-66,6526	54,86041	3,081679	16,89421	-0,56763	5,735514	0,18241	1,483783
C_gbp_1v1_fwd	-119,246	109,3516	13,61782	28,4337	-0,36343	6,150721	0,478932	5,821296
C_gbp_1v1_fvix	-54,6129	78,79036	11,46502	21,53762	0,411968	3,913586	0,532325	4,465555
C_gbp_2v2_spot	-57,6765	50,35411	3,32119	16,85399	-0,4125	3,707693	0,197057	1,531966
C_gbp_2v2_svix	-36,046	37,6729	2,951709	12,95338	-0,43099	3,936633	0,227872	1,467895
C_gbp_2v2_fwd	-74,2849	75,23339	6,924465	15,00218	0,270126	12,2738	0,461564	2,480204
C_gbp_2v2_fvix	-27,6633	75,23339	6,005971	11,03047	2,061538	16,21711	0,544489	2,208309
C_gbp_3v3_spot	-64,3259	45,08998	4,345167	15,37665	-0,91187	5,439928	0,282582	1,759876
C_gbp_3v3_svix	-37,2107	26,46922	3,557413	11,23937	-0,5772	4,158088	0,316514	1,594661
C_gbp_3v3_fwd	-64,9258	65,58958	7,027807	15,35503	0,141402	8,225338	0,457688	2,512929
C_gbp_3v3_fvix	-30,5298	65,58958	6,378857	11,03042	1,260642	10,5798	0,578297	2,320223
C_gbp_CvD_spot	-41,9867	91,99638	4,865819	12,79435	1,801912	16,89464	0,38031	1,893838
C_gbp_CvD_svix	-21,1409	38,06249	3,771462	7,605264	0,700422	7,279477	0,495902	1,646923
C_gbp_DvC_spot	-43,5437	36,23716	0,533902	14,55725	-0,37274	3,548204	0,036676	1,061246
C_gbp_DvC_svix	-38,4005	36,23716	2,187176	11,4749	-0,26039	4,69027	0,190605	1,328568

Table 6.6: Core basket, funding currency: the US dollar, January 1999–May 2012

strategy	min	max	mean	std	skew	kurt	sharpe	cumul
C_usd_EW_spot	-83,4899	57,88108	3,415314	21,30301	-0,52015	4,711448	0,160321	1,536711
C_usd_EW_svix	-53,7919	47,08065	2,524242	15,71806	-0,21104	4,386511	0,160595	1,380712
C_usd_EW_fwd	-77,8693	60,09209	7,769291	20,76986	-0,73031	5,226723	0,374066	2,74242
C_usd_EW_fvix	-59,9455	54,70231	6,946291	16,72475	-0,12961	5,272478	0,41533	2,47988
C_usd_1v1_spot	-115,067	68,2781	3,5885	23,38741	-0,7119	7,07626	0,153437	1,564267
C_usd_1v1_svix	-64,5354	68,2781	3,058506	17,09914	-0,00081	5,934393	0,178869	1,478773
C_usd_1v1_fwd	-109,622	63,77604	10,79614	23,86927	-0,83731	6,427238	0,452303	4,062394
C_usd_1v1_fvix	-30,9239	62,65692	8,888072	18,46789	0,547731	3,500409	0,481272	3,197122
C_usd_2v2_spot	-52,2799	67,65705	3,541014	18,46019	-0,01379	4,404581	0,191819	1,572591
C_usd_2v2_svix	-43,9364	55,17088	2,758944	13,99579	-0,04649	4,792885	0,197127	1,428557
C_usd_2v2_fwd	-33,1245	55,39347	4,274558	12,14295	0,307697	4,995093	0,35202	1,752179
C_usd_2v2_fvix	-33,1245	55,39347	3,737441	10,42557	0,582127	7,476264	0,358488	1,63494
C_usd_3v3_spot	-64,4185	69,71133	4,657927	18,48097	-0,17029	5,763575	0,252039	1,824122
C_usd_3v3_svix	-37,6148	56,90963	3,553544	13,18729	0,037122	5,099751	0,269467	1,589725
C_usd_3v3_fwd	-46,4741	55,74299	5,166637	14,69066	-0,16238	5,100768	0,351695	1,965159
C_usd_3v3_fvix	-40,7279	55,74299	4,54995	12,6082	0,158264	6,721309	0,360872	1,816314
C_usd_CvD_spot	-94,8665	71,0947	4,967056	23,18126	-0,62263	5,975677	0,21427	1,879896
C_usd_CvD_svix	-60,0541	54,10728	3,42586	16,15636	-0,35115	6,446332	0,212044	1,555424
C_usd_DvC_spot	-50,8242	47,08065	1,241194	13,61459	-0,07049	5,272809	0,091166	1,167875
C_usd_DvC_svix	-42,7433	47,08065	1,891317	11,70654	0,209329	6,255061	0,161561	1,27691

Table 6.7: Core basket, optimized portfolio, January 2002–May 2012

strategy	min	max	mean	std	skew	kurt	sharpe	cumul
C_eur_opt_fwd	-6,02534	32,3215	5,220789	5,569975	1,562265	6,969634	0,937309	1,710874
C_eur_opt_fvix	-3,50311	32,3215	4,847852	5,326529	1,983502	8,450968	0,910133	1,646646
C_gbp_opt_fwd	-5,36104	19,64157	5,127789	4,590632	0,778684	3,593969	1,117012	1,695287
C_gbp_opt_fvix	-3,19894	19,64157	5,012674	4,326934	1,079243	4,264966	1,158482	1,675491
C_usd_opt_fwd	-6,850071	13,7137	3,375225	4,15787	0,071026	2,822788	0,811768	1,415594
C_usd_opt_fvix	-6,850071	13,7137	3,129852	3,883282	0,266386	3,349483	0,805981	1,380377

Table 6.8: Core basket, funding currency: the euro, January 2002–May 2012

strategy	min	max	mean	std	skew	kurt	sharpe	cumul
C_eur_EW_spot	-49,0648	35,86369	2,165674	12,04464	-0,74857	5,862966	0,179804	1,242814
C_eur_EW_svix	-24,7686	20,68453	1,887474	8,06368	-0,52925	4,212395	0,234071	1,211805
C_eur_EW_fwd	-48,4871	32,425	5,706202	11,62586	-0,83259	6,002262	0,49082	1,790497
C_eur_EW_fvix	-21,1441	27,49705	5,003655	8,714771	0,02896	4,062805	0,574158	1,669882
C_eur_1v1_spot	-116,282	65,01872	3,49378	23,03279	-1,18648	8,398449	0,151687	1,401576
C_eur_1v1_svix	-56,4445	55,35895	3,715099	15,77211	-0,2681	5,471723	0,235549	1,451667
C_eur_1v1_fwd	-119,919	70,66456	7,504782	26,48566	-1,03298	6,379605	0,283353	2,102228
C_eur_1v1_fvix	-53,975	70,66456	7,639808	21,03431	0,022849	3,930025	0,363207	2,156056
C_eur_2v2_spot	-57,8118	50,2887	3,255606	17,85666	-0,42825	3,633862	0,182319	1,380368
C_eur_2v2_svix	-36,9874	37,63172	2,939861	13,26667	-0,37116	3,958468	0,221598	1,344352
C_eur_2v2_fwd	-19,5814	29,16245	3,614169	8,554957	0,103114	3,203342	0,422465	1,447441
C_eur_2v2_fvix	-19,5814	22,73933	2,91516	7,222287	-0,01807	3,841266	0,403634	1,348039
C_eur_3v3_spot	-64,4019	43,48543	3,624181	15,98089	-0,95826	5,577071	0,226782	1,43763
C_eur_3v3_svix	-37,2061	25,85714	2,920243	11,04431	-0,60549	4,27125	0,264411	1,344722
C_eur_3v3_fwd	-26,2464	34,28367	4,845599	9,069052	-0,12644	3,97607	0,5343	1,642495
C_eur_3v3_fvix	-14,069	24,80275	3,984998	7,395861	0,268787	3,786487	0,538815	1,504985
C_eur_CvD_spot	-23,6971	24,25117	2,972427	8,685202	-0,2593	2,990108	0,34224	1,354674
C_eur_CvD_svix	-23,6971	24,25117	2,982225	7,483929	-0,06158	4,132845	0,398484	1,357168
C_eur_DvC_spot	-41,9821	52,50387	1,51177	11,45217	-0,21067	7,12976	0,132007	1,16244
C_eur_DvC_svix	-28,403	18,65892	1,223773	7,396318	-1,31787	6,075885	0,165457	1,13207

Table 6.9: Core basket, funding currency: the British pound, January 2002–May 2012

strategy	min	max	mean	std	skew	kurt	sharpe	cumul
C_gbp_EW_spot	-49,0841	45,45269	1,307782	14,36949	-0,13708	4,005157	0,091011	1,134569
C_gbp_EW_svix	-26,957	36,49629	1,616105	10,77457	0,075885	3,793832	0,149993	1,175792
C_gbp_EW_fwd	-53,3497	56,76391	7,29619	17,4049	-0,70299	4,65696	0,419203	2,093386
C_gbp_EW_fvix	-32,0287	56,76391	6,975759	12,62372	-0,11782	5,296317	0,552591	2,038076
C_gbp_1v1_spot	-116,442	65,06013	3,770467	22,89304	-1,181	8,641396	0,164699	1,442522
C_gbp_1v1_svix	-55,2525	54,86041	3,848112	15,75967	-0,29048	5,37505	0,244175	1,471719
C_gbp_1v1_fwd	-119,246	99,6849	12,24989	28,47442	-0,69538	6,377334	0,430207	3,404313
C_gbp_1v1_fvix	-54,6129	78,79036	11,55531	21,55622	0,369988	4,088873	0,536055	3,218581
C_gbp_2v2_spot	-57,6765	50,35411	3,387705	17,76973	-0,39912	3,646059	0,190645	1,399482
C_gbp_2v2_svix	-36,046	37,6729	3,041609	13,2922	-0,39566	3,955685	0,228827	1,358486
C_gbp_2v2_fwd	-74,2849	75,23339	5,949605	14,60793	-0,29875	13,90378	0,407286	1,829822
C_gbp_2v2_fvix	-27,6633	75,23339	5,052516	10,32405	2,186713	19,91606	0,489393	1,676212
C_gbp_3v3_spot	-64,3259	45,08998	4,024393	16,59819	-0,87792	5,006054	0,24246	1,496862
C_gbp_3v3_svix	-37,2107	26,46922	3,288054	11,95104	-0,51978	3,900957	0,275127	1,395444
C_gbp_3v3_fwd	-64,9258	65,58958	6,17428	14,82373	-0,26169	9,396987	0,416513	1,872094
C_gbp_3v3_fvix	-30,5298	65,58958	5,384023	10,15942	1,350015	13,0959	0,529954	1,734583
C_gbp_CvD_spot	-41,9867	91,99638	4,898347	14,06072	1,777226	14,90826	0,348371	1,64356
C_gbp_CvD_svix	-21,1409	38,06249	3,652545	7,97655	0,953212	7,282225	0,45791	1,453779
C_gbp_DvC_spot	-43,5437	36,23716	-0,23215	14,50565	-0,50429	3,722905	-0,016	0,967519
C_gbp_DvC_svix	-38,4005	36,23716	1,321971	11,25872	-0,41703	5,192043	0,117418	1,140095

Table 6.10: Core basket, funding currency: the US dollar, January 2002–May 2012

strategy	min	max	mean	std	skew	kurt	sharpe	cumul
C_usd_EW_spot	-83,4899	57,88108	3,153173	22,31814	-0,54269	4,641629	0,141283	1,355378
C_usd_EW_svix	-53,7919	41,36519	1,599197	15,85132	-0,34031	4,481219	0,100887	1,16696
C_usd_EW_fwd	-77,8693	54,70231	7,016116	21,00005	-1,02422	5,618897	0,3341	2,021894
C_usd_EW_fvix	-59,9455	54,70231	6,011774	16,7083	-0,30298	5,888848	0,359808	1,836427
C_usd_1v1_spot	-115,067	65,81277	3,743269	23,26856	-1,12935	8,263963	0,160872	1,437424
C_usd_1v1_svix	-64,5354	56,06569	3,439045	16,10363	-0,3763	6,292795	0,213557	1,410303
C_usd_1v1_fwd	-109,622	62,65692	10,44571	24,62386	-0,9982	6,851896	0,424211	2,854475
C_usd_1v1_fvix	-30,9239	62,65692	9,10213	18,61782	0,657729	3,614233	0,488894	2,515608
C_usd_2v2_spot	-52,2799	67,65705	3,557813	19,05596	-0,08622	4,357449	0,186703	1,421421
C_usd_2v2_svix	-43,9364	39,79119	2,684468	13,62107	-0,31699	4,391439	0,197082	1,308885
C_usd_2v2_fwd	-33,1245	55,39347	3,678264	12,833	0,394257	5,001043	0,286625	1,451406
C_usd_2v2_fvix	-33,1245	55,39347	2,668439	10,85462	0,757961	8,039532	0,245834	1,310546
C_usd_3v3_spot	-64,4185	69,71133	4,162913	19,25029	-0,23801	5,678255	0,216252	1,512335
C_usd_3v3_svix	-37,6148	35,97479	2,875143	12,70806	-0,30846	4,152491	0,226246	1,336243
C_usd_3v3_fwd	-46,4741	55,74299	4,564839	15,2303	-0,19796	5,278006	0,299721	1,585584
C_usd_3v3_fvix	-40,7279	55,74299	3,482393	12,87037	0,160764	7,259071	0,270574	1,422332
C_usd_CvD_spot	-94,8665	71,0947	5,719994	25,74498	-0,6557	5,11809	0,222179	1,752999
C_usd_CvD_svix	-60,0541	54,10728	3,482882	17,78588	-0,34706	5,586053	0,195823	1,413248
C_usd_DvC_spot	-42,7433	32,74129	-0,45848	11,09364	-0,43923	5,237236	-0,04133	0,948702
C_usd_DvC_svix	-42,7433	32,74129	0,224654	10,05374	-0,65426	7,321642	0,022345	1,019059

Table 6.11: Core+ basket, funding currency: the euro, March 2004–May 2012

strategy	min	max	mean	std	skew	kurt	sharpe	cumul
C+_eur_EW_spot	-41,27127	20,69325	2,281681	10,86369	-1,066612	4,931494	0,210028	1,199823
C+_eur_EW_svix	-26,14266	20,69325	2,43101	8,21638	-0,640964	4,278498	0,295874	1,2166
C+_eur_EW_fwd	-34,32044	64,30998	15,25469	19,6431	0,67274	3,473307	0,776593	3,405399
C+_eur_EW_fvix	-21,36742	64,30998	12,48687	16,99318	1,208956	4,474798	0,734816	2,732094
C+_eur_1v1_spot	-49,08961	103,5631	4,566329	25,07152	0,33723	4,441869	0,182132	1,420881
C+_eur_1v1_svix	-49,08961	51,45021	5,079335	18,90042	0,001011	3,522784	0,268742	1,494814
C+_eur_1v1_fwd	-136,6923	126,3647	8,924698	32,99544	-1,216995	10,76209	0,270483	1,991874
C+_eur_1v1_fvix	-136,6923	126,3647	8,428004	29,60655	-1,464652	14,73457	0,284667	1,926953
C+_eur_2v2_spot	-58,75264	47,44878	2,995251	20,47881	-0,157899	3,118458	0,146261	1,258878
C+_eur_2v2_svix	-37,65772	46,89163	3,735098	15,9568	0,020026	3,686806	0,234076	1,344518
C+_eur_2v2_fwd	-29,92531	68,00703	5,083911	14,79748	0,777846	6,266145	0,343566	1,502363
C+_eur_2v2_fvix	-26,35212	37,49898	3,521679	10,46679	-0,135056	4,392652	0,336462	1,327783
C+_eur_3v3_spot	-47,16445	49,3679	2,767562	16,96311	-0,473367	3,454494	0,163152	1,241182
C+_eur_3v3_svix	-40,21662	36,20352	3,388022	13,27999	-0,539727	3,909356	0,255122	1,310446
C+_eur_3v3_fwd	-33,61076	48,4665	4,417977	13,12846	0,119609	4,105018	0,336519	1,425297
C+_eur_3v3_fvix	-24,23666	26,46512	3,744016	9,1382	-0,193544	3,222528	0,40971	1,35322
C+_eur_C+vD_spot	-30,60313	25,35254	3,778587	10,82649	-0,648209	3,738653	0,349013	1,355487
C+_eur_CvD_svix	-30,60313	25,35254	4,027907	8,914854	-0,330617	4,844964	0,45182	1,385043
C+_eur_DvC_spot	-31,48892	42,15593	0,706533	8,952848	0,393092	8,02664	0,078917	1,056532
C+_eur_DvC_svix	-17,65489	10,9873	0,606542	5,443927	-1,147261	4,832075	0,111416	1,049718

Table 6.12: Core+ basket, funding currency: the British pound, March 2004–May 2012

strategy	min	max	mean	std	skew	kurt	sharpe	cumul
C+_gbp_EW_spot	-44,30218	70,8475	1,058649	15,35572	0,469743	6,970296	0,068942	1,081682
C+_gbp_EW_svix	-24,28773	26,26754	1,155496	9,845326	-0,184978	3,294193	0,117365	1,095333
C+_gbp_EW_fwd	-47,26121	60,5716	7,870584	15,66941	-0,650194	5,25554	0,50229	1,882224
C+_gbp_EW_fvix	-30,32044	30,05941	7,565618	10,78171	-0,54521	4,481988	0,701709	1,844189
C+_gbp_1v1_spot	-51,40936	101,1555	4,652052	25,66897	0,234709	4,159624	0,181233	1,429343
C+_gbp_1v1_svix	-49,58989	51,00399	5,116832	18,87675	-0,035243	3,517604	0,271065	1,499418
C+_gbp_1v1_fwd	-133,4636	120,6923	12,05103	36,65385	-1,179028	7,762502	0,328779	2,543874
C+_gbp_1v1_fvix	-133,4636	99,18936	11,76557	25,98021	-1,288943	12,75431	0,452867	2,543147
C+_gbp_2v2_spot	-59,23386	58,88302	3,175382	20,95816	-0,07473	3,278431	0,151511	1,276656
C+_gbp_2v2_svix	-37,23565	46,50994	3,827377	15,96931	0,003865	3,630546	0,239671	1,354639
C+_gbp_2v2_fwd	-24,90639	79,26384	7,154211	14,5826	1,235448	8,657049	0,490599	1,778044
C+_gbp_2v2_fvix	-24,90639	50,0375	6,325848	11,20095	0,704083	5,809601	0,56476	1,667107
C+_gbp_3v3_spot	-46,2737	49,90863	2,890151	17,15471	-0,453346	3,3805	0,168476	1,253369
C+_gbp_3v3_svix	-40,59638	35,933	3,500727	13,35573	-0,558148	3,887001	0,262114	1,322439
C+_gbp_3v3_fwd	-34,75674	44,74104	6,742166	13,01908	0,002861	3,997588	0,517868	1,721891
C+_gbp_3v3_fvix	-22,94834	41,18635	6,644393	10,683	0,415058	4,175234	0,621959	1,711441
C+_gbp_CvD_spot	-52,3441	103,565	4,93502	18,39027	1,266315	11,10394	0,26835	1,478508
C+_gbp_CvD_svix	-27,89362	44,46563	4,052364	10,56327	0,591344	5,665678	0,383628	1,386336
C+_gbp_DvC_spot	-29,71753	20,00437	-0,659209	10,45632	-0,494827	3,025913	-0,063044	0,944077
C+_gbp_DvC_svix	-26,01597	20,00437	0,320295	8,498602	-0,658456	4,376419	0,037688	1,023998

Table 6.13: Core+ basket, funding currency: the US dollar, March 2004–May 2012

strategy	min	max	mean	std	skew	kurt	sharpe	cumul
C+_usd_EW_spot	-83,23291	71,44839	1,388395	26,5348	-0,464575	4,571856	0,052324	1,093598
C+_usd_EW_svix	-70,1224	47,14286	0,191356	17,02658	-0,954203	6,56976	0,011239	1,005788
C+_usd_EW_fwd	-88,16927	62,75116	6,543622	20,85344	-1,222517	7,247354	0,313791	1,679064
C+_usd_EW_fvix	-47,82877	62,75116	6,956136	15,08384	-0,198948	6,601916	0,461165	1,748665
C+_usd_1v1_spot	-51,91774	100,0229	4,128215	25,22038	0,246391	4,234845	0,163686	1,37072
C+_usd_1v1_svix	-50,50182	51,16671	4,390225	18,76263	0,034119	3,609719	0,233988	1,413557
C+_usd_1v1_fwd	-134,1718	97,64074	9,091987	34,35198	-1,218172	7,290797	0,264671	2,012832
C+_usd_1v1_fvix	-134,1718	65,66326	9,034427	26,23436	-1,419114	11,30482	0,344374	2,037414
C+_usd_2v2_spot	-56,20464	62,75106	2,572653	21,28019	0,0633	3,207889	0,120894	1,214937
C+_usd_2v2_svix	-37,78514	62,75106	3,268276	16,63329	0,343691	4,441229	0,19649	1,293438
C+_usd_2v2_fwd	-68,02971	75,6514	5,862506	19,03186	0,283232	6,956299	0,308036	1,59289
C+_usd_2v2_fvix	-21,41797	75,6514	5,890389	13,73343	2,030692	10,10044	0,428909	1,605883
C+_usd_3v3_spot	-52,50887	59,70519	2,294192	19,3446	0,004478	3,949471	0,118596	1,190792
C+_usd_3v3_svix	-47,12282	59,70519	2,975	14,92841	-0,040389	5,325594	0,199285	1,265141
C+_usd_3v3_fwd	-58,07211	63,20937	5,194302	16,57615	-0,308871	5,96238	0,31336	1,512978
C+_usd_3v3_fvix	-23,88741	63,20937	5,205985	12,95533	1,173128	6,532206	0,401841	1,519949
C+_usd_CvD_spot	-98,66697	79,02405	3,650751	30,36473	-0,728699	4,964751	0,12023	1,305257
C+_usd_CvD_svix	-74,0363	53,32773	2,168549	19,33882	-1,129826	6,704503	0,112134	1,17848
C+_usd_DvC_spot	-35,65956	27,19231	0,019734	9,778305	-0,726403	5,588862	0,002018	0,998379
C+_usd_DvC_svix	-35,65956	19,92488	0,304896	8,865937	-1,302621	7,335166	0,03439	1,022482

Table 6.14: Core basket, the funding currency: the euro, March 2004–May 2012

strategy	min	max	mean	std	skew	kurt	sharpe	cumul
C_eur_EW_spot	-49,0648	35,86369	1,364773	12,98312	-0,61115	5,287685	0,105119	1,111491
C_eur_EW_svix	-24,7686	20,68453	1,277281	8,452315	-0,47225	4,010633	0,151116	1,107217
C_eur_EW_fwd	-48,4871	32,425	5,267159	12,23384	-0,85602	5,861011	0,43054	1,528341
C_eur_EW_fvix	-21,1441	27,26076	4,96925	8,818942	-0,11314	4,089717	0,563475	1,495386
C_eur_1v1_spot	-116,282	65,01872	2,542067	24,46667	-1,11148	8,027857	0,103899	1,205591
C_eur_1v1_svix	-56,4445	55,35895	3,273335	16,24098	-0,1271	5,464362	0,201548	1,294479
C_eur_1v1_fwd	-119,919	70,66456	7,750293	27,5854	-1,13965	6,701859	0,280956	1,831473
C_eur_1v1_fvix	-53,975	70,66456	8,332008	21,45613	0,013393	4,073565	0,388328	1,94021
C_eur_2v2_spot	-57,8118	50,2887	2,213467	19,04097	-0,32508	3,38241	0,116248	1,183394
C_eur_2v2_svix	-36,9874	37,63172	2,456812	13,93261	-0,36379	3,796649	0,176335	1,213979
C_eur_2v2_fwd	-19,5814	29,16245	3,565365	8,808912	0,130604	3,285079	0,404745	1,333948
C_eur_2v2_fvix	-19,5814	22,73933	2,784177	7,365772	-0,0739	3,87747	0,377988	1,252688
C_eur_3v3_spot	-64,4019	43,48543	2,234038	16,80238	-0,86933	5,323008	0,13296	1,188536
C_eur_3v3_svix	-37,2061	25,85714	2,066107	11,15297	-0,68702	4,377661	0,185252	1,178678
C_eur_3v3_fwd	-26,2464	34,28367	4,459499	9,39616	-0,1541	3,945614	0,474609	1,434137
C_eur_3v3_fvix	-14,069	23,83538	3,703424	7,460978	0,136702	3,59043	0,496372	1,350018
C_eur_CvD_spot	-23,6971	24,25117	3,018502	8,928402	-0,31461	3,039962	0,338079	1,275739
C_eur_CvD_svix	-23,6971	24,25117	2,945587	7,605616	-0,09175	4,287937	0,387291	1,269118
C_eur_DvC_spot	-41,9821	52,50387	0,54971	12,11168	-0,06569	7,036266	0,045387	1,040751
C_eur_DvC_svix	-28,403	15,59228	0,535133	7,419697	-1,60086	6,172713	0,072123	1,042715

Table 6.15: Core basket, the funding currency: the British pound, March 2004–May 2012

strategy	min	max	mean	std	skew	kurt	sharpe	cumul
C_gbp_EW_spot	-49,0841	45,45269	0,314723	14,70901	-0,17257	3,904611	0,021397	1,018574
C_gbp_EW_svix	-26,957	26,93768	0,530948	10,51511	-0,25276	3,014502	0,050494	1,04042
C_gbp_EW_fwd	-53,3497	49,4988	6,717563	18,10443	-0,90097	4,261526	0,371045	1,709244
C_gbp_EW_fvix	-32,0287	29,08861	6,789145	12,34177	-0,76778	4,191784	0,550095	1,729417
C_gbp_1v1_spot	-116,442	65,06013	2,84945	24,30978	-1,10839	8,281606	0,117214	1,236506
C_gbp_1v1_svix	-55,2525	54,86041	3,336813	16,22315	-0,13938	5,345497	0,205682	1,301214
C_gbp_1v1_fwd	-119,246	99,6849	13,29262	29,82429	-0,73236	6,483962	0,445698	2,857307
C_gbp_1v1_fvix	-40,3083	78,79036	12,79206	21,86621	0,558287	3,725207	0,585015	2,78288
C_gbp_2v2_spot	-57,6765	50,35411	2,335352	18,94202	-0,29356	3,401967	0,123289	1,19537
C_gbp_2v2_svix	-36,046	37,6729	2,481743	13,94781	-0,37855	3,789197	0,177931	1,21643
C_gbp_2v2_fwd	-74,2849	56,9364	5,7659	14,15635	-1,4413	13,61356	0,407301	1,588813
C_gbp_2v2_fvix	-26,5692	28,10763	4,73022	8,108596	-0,17076	4,952708	0,583359	1,467181
C_gbp_3v3_spot	-64,3259	45,08998	2,585905	17,38534	-0,79517	4,807597	0,148741	1,222303
C_gbp_3v3_svix	-37,2107	25,61426	2,316645	12,01289	-0,59294	3,954659	0,192847	1,202194
C_gbp_3v3_fwd	-64,9258	60,19891	5,658214	14,55845	-0,81472	9,335187	0,388655	1,574407
C_gbp_3v3_fvix	-24,4683	26,6823	4,858701	8,25294	-0,00638	4,369921	0,588724	1,482481
C_gbp_CvD_spot	-41,9867	91,99638	4,602553	15,00595	1,881987	14,49872	0,306715	1,444465
C_gbp_CvD_svix	-13,4205	38,06249	3,520519	7,907117	1,114018	6,75556	0,445234	1,329768
C_gbp_DvC_spot	-43,5437	24,38496	-1,0526	13,82128	-0,70532	3,439429	-0,07616	0,911666
C_gbp_DvC_svix	-38,4005	21,68626	0,245655	10,4633	-1,17065	5,449642	0,023478	1,016483

Table 6.16: Core basket, the funding currency: the US dollar, March 2004–May 2012

strategy	min	max	mean	std	skew	kurt	sharpe	cumul
C_usd_EW_spot	-83,4899	57,88108	0,533401	22,87894	-0,47825	4,734441	0,023314	1,026151
C_usd_EW_svix	-53,7919	38,54345	-0,22403	15,16212	-0,73907	4,759202	-0,01478	0,974244
C_usd_EW_fwd	-77,8693	54,70231	5,279811	21,7548	-1,10887	5,391169	0,242696	1,513181
C_usd_EW_fvix	-59,9455	54,70231	5,369187	16,73412	-0,65543	6,116741	0,320853	1,534333
C_usd_1v1_spot	-115,067	65,81277	2,883944	24,68395	-1,05369	7,937157	0,116835	1,239227
C_usd_1v1_svix	-64,5354	56,06569	3,082733	16,5237	-0,25082	6,378179	0,186564	1,274123
C_usd_1v1_fwd	-109,622	62,65692	10,8946	26,29572	-1,10738	6,597242	0,414311	2,368926
C_usd_1v1_fvix	-30,9239	62,65692	9,798533	19,47931	0,519893	3,255275	0,503022	2,191213
C_usd_2v2_spot	-52,2799	67,65705	2,638602	20,47253	0,025888	4,06969	0,128885	1,222858
C_usd_2v2_svix	-43,9364	39,79119	2,299821	14,32552	-0,30982	4,240725	0,16054	1,198097
C_usd_2v2_fwd	-33,1245	55,39347	3,304398	12,78626	0,429725	5,694696	0,258434	1,302163
C_usd_2v2_fvix	-33,1245	55,39347	2,396008	10,5642	0,781632	9,829533	0,226805	1,211368
C_usd_3v3_spot	-64,4185	69,71133	2,580967	20,25323	-0,08733	5,676369	0,127435	1,217466
C_usd_3v3_svix	-37,6148	35,97479	1,9716	12,63751	-0,39197	4,43327	0,156012	1,168247
C_usd_3v3_fwd	-46,4741	55,74299	3,574358	14,89233	-0,17333	5,803778	0,240013	1,328476
C_usd_3v3_fvix	-40,7279	55,74299	2,942522	11,99819	0,134839	8,816455	0,245247	1,265148
C_usd_CvD_spot	-94,8665	71,0947	3,066989	26,46256	-0,65446	5,16966	0,115899	1,254117
C_usd_CvD_svix	-60,0541	48,43925	1,578997	16,67362	-0,99034	6,386422	0,0947	1,126862
C_usd_DvC_spot	-42,7433	32,74129	-0,2515	12,23913	-0,44809	4,501727	-0,02055	0,97472
C_usd_DvC_svix	-42,7433	32,74129	0,479066	11,08205	-0,66489	6,334493	0,043229	1,035583

Table 6.17: Core basket, optimized portfolio, March 2004–May 2012

strategy	min	max	mean	std	skew	kurt	sharpe	cumul
C_eur_opt_fwd	-6,02534	32,3215	4,598774	5,2774	1,987121	10,16161	0,871409	1,453425
C_eur_opt_fvix	-3,50311	32,3215	4,344438	5,088262	2,430524	11,90667	0,853816	1,423751
C_gbp_opt_fwd	-5,36104	17,59488	4,80922	4,428542	0,556984	3,036333	1,08596	1,478922
C_gbp_opt_fvix	-3,19894	17,59488	4,78477	4,169748	0,778219	3,390921	1,147496	1,476094
C_usd_opt_fwd	-6,670413	13,10493	3,489829	3,863665	-0,028242	2,775543	0,903243	1,328551
C_usd_opt_fvix	-6,670413	13,10493	3,227677	3,620052	0,170192	3,163172	0,891611	1,300568

Table 6.18: Core basket, the funding currency: the euro, January 1999-September 2008

strategy	min	max	mean	std	skew	kurt	sharpe	cum
C_eur_EW_spot	-49,0648	35,86369	3,377361	12,06118	-0,83564	6,175239	0,280019	1,431681
C_eur_EW_svix	-27,286	30,14101	3,084689	8,569469	-0,37055	4,738041	0,359963	1,391618
C_eur_EW_fwd	-48,4871	36,47798	6,570576	10,9202	-0,93752	7,320837	0,60169	2,022948
C_eur_EW_fvix	-21,1441	36,47798	5,666462	8,348813	0,221088	4,694077	0,678715	1,839202
C_eur_1v1_spot	-116,282	61,37195	3,215258	23,45487	-1,06534	7,472927	0,137083	1,381223
C_eur_1v1_svix	-56,4445	55,35895	3,504805	17,20666	-0,24907	4,53641	0,203689	1,441829
C_eur_1v1_fwd	-119,919	71,90446	8,886505	24,68767	-1,0463	7,937985	0,359957	2,539149
C_eur_1v1_fvix	-53,975	70,66456	7,575536	19,53381	0,143351	4,171778	0,387817	2,228309
C_eur_2v2_spot	-57,8118	42,80655	3,561589	16,4446	-0,72649	4,103989	0,216581	1,452291
C_eur_2v2_svix	-36,9874	37,63172	3,380782	12,75342	-0,41611	4,138258	0,265088	1,431137
C_eur_2v2_fwd	-10,5936	29,16245	4,692589	7,701115	0,276094	2,898033	0,609339	1,656554
C_eur_2v2_fvix	-9,88743	20,12919	4,100712	6,381849	0,259379	2,99824	0,642559	1,555312
C_eur_3v3_spot	-64,4019	43,48543	4,423835	14,05942	-1,43921	7,867187	0,314653	1,599156
C_eur_3v3_svix	-37,2061	25,44906	3,579057	9,960529	-0,72821	4,745025	0,359324	1,466265
C_eur_3v3_fwd	-26,2464	34,28367	5,281615	8,56121	-0,15863	4,421092	0,616924	1,764138
C_eur_3v3_fvix	-12,6469	24,80275	4,742226	6,803907	0,23924	3,977198	0,696986	1,666413
C_eur_CvD_spot	-29,5597	31,43831	3,478358	10,43532	-0,31105	3,782559	0,333326	1,449789
C_eur_CvD_svix	-23,6971	31,43831	3,594095	8,574648	0,016171	4,626341	0,419154	1,470356
C_eur_DvC_spot	-41,9821	52,50387	2,98131	9,615326	-0,2041	11,97597	0,310058	1,374992
C_eur_DvC_svix	-24,5759	18,65892	2,572901	5,598092	-0,96212	7,923423	0,459603	1,319207

Table 6.19: Core basket, the funding currency: the British pound, January 1999-September 2008

strategy	min	max	mean	std	skew	kurt	sharpe	cumul
C_gbp_EW_spot	-49,0841	45,45269	1,786959	13,27344	-0,22473	4,729511	0,134627	1,203892
C_gbp_EW_svix	-26,957	36,49629	2,459466	9,984563	-0,08193	4,328851	0,246327	1,299162
C_gbp_EW_fwd	-53,3497	57,35828	8,324881	17,70881	-0,22956	4,570587	0,470098	2,422637
C_gbp_EW_fvix	-32,0287	56,76391	7,40229	13,20219	0,393446	5,301855	0,560687	2,207277
C_gbp_1v1_spot	-116,442	59,87824	3,292924	23,91754	-1,13169	7,426126	0,137678	1,391444
C_gbp_1v1_svix	-66,6526	54,86041	3,560042	18,03958	-0,60471	5,395786	0,197346	1,448479
C_gbp_1v1_fwd	-119,246	109,3516	13,01846	28,03869	-0,41103	7,203348	0,464304	3,92745
C_gbp_1v1_fvix	-54,6129	71,22902	10,48693	20,36904	0,34073	4,129121	0,514846	3,043304
C_gbp_2v2_spot	-57,6765	44,56574	3,637567	16,54451	-0,66805	3,982359	0,219866	1,464053
C_gbp_2v2_svix	-36,046	37,6729	3,510855	12,95808	-0,46269	4,04646	0,270939	1,451044
C_gbp_2v2_fwd	-74,2849	75,23339	7,938716	15,89154	0,198661	11,7643	0,499556	2,330399
C_gbp_2v2_fvix	-27,6633	75,23339	6,674419	11,70024	2,009834	15,23468	0,570451	2,044327
C_gbp_3v3_spot	-64,3259	45,08998	4,828128	14,8952	-1,21918	6,604649	0,32414	1,668685
C_gbp_3v3_svix	-37,2107	26,46922	4,022584	10,99846	-0,61297	4,241413	0,365741	1,536717
C_gbp_3v3_fwd	-64,9258	65,58958	8,028728	16,29212	0,089997	7,716073	0,492798	2,351731
C_gbp_3v3_fvix	-30,5298	65,58958	7,024052	11,74859	1,187959	9,764088	0,597863	2,122626
C_gbp_CvD_spot	-41,9867	91,99638	5,44031	12,18641	2,520682	23,21822	0,446424	1,788804
C_gbp_CvD_svix	-21,1409	32,533	4,035158	6,217444	-0,0651	8,237797	0,649006	1,544482
C_gbp_DvC_spot	-43,5437	36,23716	0,901602	15,40923	-0,32765	3,177202	0,058511	1,09088
C_gbp_DvC_svix	-33,9409	36,23716	2,979262	11,79713	-0,13802	4,036665	0,252541	1,371827

Table 6.20: Core basket, the funding currency: the US dollar, January 1999-September 2008

strategy	min	max	mean	std	skew	kurt	sharpe	cumul
C_usd_EW_spot	-83,4899	50,03379	4,190749	19,41818	-0,77972	5,768068	0,215816	1,546945
C_usd_EW_svix	-41,3176	47,08065	3,343911	14,64741	0,058309	4,191841	0,228294	1,42219
C_usd_EW_fwd	-77,8693	60,09209	8,809385	20,9406	-0,7602	5,58847	0,420684	2,537862
C_usd_EW_fvix	-59,9455	54,70231	7,973431	16,57535	0,145594	4,970009	0,481041	2,336835
C_usd_1v1_spot	-115,067	68,2781	3,534823	24,16539	-0,86502	7,135207	0,146276	1,427656
C_usd_1v1_svix	-64,5354	68,2781	3,506125	18,30147	-0,02794	5,482345	0,191576	1,439574
C_usd_1v1_fwd	-109,622	63,77604	9,963205	23,00274	-1,04393	8,010778	0,433131	2,861187
C_usd_1v1_fvix	-30,9239	62,65692	7,66277	17,33769	0,570683	3,961692	0,441972	2,257521
C_usd_2v2_spot	-52,2799	60,76622	3,719426	17,96218	-0,34249	4,359664	0,20707	1,473877
C_usd_2v2_svix	-43,9364	55,17088	3,226673	14,11959	-0,09669	4,941987	0,228525	1,405222
C_usd_2v2_fwd	-33,1245	55,39347	4,988738	12,01923	0,302361	5,302081	0,415063	1,703901
C_usd_2v2_fvix	-33,1245	55,39347	4,668871	10,50265	0,72987	7,87242	0,444542	1,648605
C_usd_3v3_spot	-64,4185	68,633	4,970971	17,23394	-0,55123	6,743113	0,288441	1,689001
C_usd_3v3_svix	-37,6148	56,90963	3,931819	12,7326	0,098057	5,4296	0,308799	1,51898
C_usd_3v3_fwd	-46,4741	55,74299	6,14959	14,66104	-0,1629	5,01761	0,419451	1,925062
C_usd_3v3_fvix	-37,6116	55,74299	5,618557	12,66761	0,447973	6,277722	0,443537	1,822402
C_usd_CvD_spot	-94,8665	71,0947	5,953838	20,32266	-0,77507	8,196092	0,292966	1,868071
C_usd_CvD_svix	-51,1158	54,10728	4,433536	13,95285	0,180684	6,813971	0,317751	1,601221
C_usd_DvC_spot	-50,8242	47,08065	1,616303	14,59281	-0,12464	4,866503	0,11076	1,179931
C_usd_DvC_svix	-42,7433	47,08065	2,289767	12,61815	0,128557	5,639286	0,181466	1,272167

Table 6.21: Core basket, optimized portfolio, January 2002-September 2008

strategy	min	max	mean	std	skew	kurt	sharpe	cumul
C_eur_opt_fwd	-1,12653	32,3215	6,085818	5,484251	1,744986	7,520446	1,10969	1,607309
C_eur_opt_fvix	-1,12653	32,3215	5,733003	5,383702	1,969329	8,420012	1,064881	1,563762
C_gbp_opt_fwd	-2,76187	19,64157	6,249066	4,478388	0,772404	3,388597	1,395383	1,628404
C_gbp_opt_fvix	-2,76187	19,64157	6,123542	4,237311	1,068364	4,130938	1,445148	1,61266
C_usd_opt_fwd	-6,850071	13,7137	4,242956	3,913925	-0,143257	3,126451	1,084067	1,39276
C_usd_opt_fvix	-6,850071	13,7137	3,985284	3,682827	0,031436	3,603434	1,082126	1,365101

Table 6.22: Core+ basket, the funding currency: the euro, March 2004-September 2008

strategy	min	max	mean	std	skew	kurt	sharpe	cumul
C+_eur_EW_spot	-41,27127	20,69325	1,850501	11,42441	-1,24232	5,218781	0,161978	1,107084
C+_eur_EW_svix	-26,14266	20,69325	2,206679	8,405044	-0,853818	4,654718	0,262542	1,131208
C+_eur_EW_fwd	-34,32044	59,06681	8,486375	13,08158	-0,000324	6,647268	0,648727	1,608457
C+_eur_EW_fvix	-21,36742	27,09259	6,783776	9,460819	-0,532338	4,276167	0,717039	1,464138
C+_eur_1v1_spot	-45,88197	103,5631	4,908348	25,55657	0,571366	4,978027	0,192058	1,300315
C+_eur_1v1_svix	-38,33962	51,45021	4,959512	18,42692	0,064331	3,210701	0,269145	1,313411
C+_eur_1v1_fwd	-136,6923	53,27989	8,655956	33,39251	-2,574592	11,77372	0,259219	1,586999
C+_eur_1v1_fvix	-136,6923	48,46984	9,910989	23,53656	-3,341057	23,32508	0,421089	1,72639
C+_eur_2v2_spot	-58,75264	45,01278	3,057789	19,78365	-0,481068	3,528177	0,154561	1,178148
C+_eur_2v2_svix	-37,65772	41,66111	4,380649	15,69634	-0,234929	3,493337	0,279087	1,273898
C+_eur_2v2_fwd	-24,60636	68,00703	7,281306	14,54614	1,079994	7,382193	0,500566	1,501608
C+_eur_2v2_fvix	-24,60636	25,92412	4,858058	9,510817	-0,520721	4,195959	0,510793	1,313428
C+_eur_3v3_spot	-39,57228	29,84123	2,892793	14,82208	-0,700057	2,940695	0,195168	1,171882
C+_eur_3v3_svix	-28,406	29,84123	3,666763	12,55515	-0,577642	3,301629	0,292052	1,226061
C+_eur_3v3_fwd	-33,61076	48,4665	5,902475	13,89817	0,012801	4,014258	0,424694	1,38986
C+_eur_3v3_fvix	-24,23666	20,59595	4,725065	9,148795	-0,645017	3,413081	0,516469	1,303808
C+_eur_C+vD_spot	-30,60313	21,53987	2,805347	11,22906	-0,764823	3,675468	0,249829	1,168651
C+_eur_CvD_svix	-30,60313	20,7122	3,223846	8,85632	-0,707831	5,52559	0,364016	1,197958
C+_eur_DvC_spot	-31,48892	42,15593	1,865125	8,711673	0,589736	11,26925	0,214095	1,109437
C+_eur_DvC_svix	-8,544557	10,13374	1,802804	3,549178	-0,35405	3,278291	0,50795	1,107151

Table 6.23: Core+ basket, the funding currency: the British pound, March 2004-September 2008

strategy	min	max	mean	std	skew	kurt	sharpe	cumul
C+_gbp_EW_spot	-44,30218	70,8475	0,731942	15,00629	0,813068	9,897626	0,048776	1,036929
C+_gbp_EW_svix	-20,91642	17,69108	0,852923	8,295485	-0,442792	2,889436	0,102818	1,047821
C+_gbp_EW_fwd	-35,17692	60,5716	9,586212	14,50038	-0,263564	5,508176	0,661101	1,709557
C+_gbp_EW_fvix	-26,93403	27,47715	8,321953	9,61794	-0,669426	4,438785	0,865253	1,596509
C+_gbp_1v1_spot	-51,40936	101,1555	4,930867	26,39655	0,427334	4,53249	0,1868	1,30063
C+_gbp_1v1_svix	-39,93346	51,00399	4,979184	18,3924	0,03312	3,2088	0,27072	1,314906
C+_gbp_1v1_fwd	-133,4636	120,6923	10,90641	37,4373	-1,576465	8,842169	0,291325	1,789688
C+_gbp_1v1_fvix	-133,4636	49,89891	10,00846	25,38992	-2,568556	16,21571	0,394191	1,732319
C+_gbp_2v2_spot	-59,23386	58,88302	3,27626	20,49535	-0,316149	3,764975	0,159854	1,192012
C+_gbp_2v2_svix	-37,23565	42,05918	4,544072	15,69973	-0,228131	3,448953	0,289436	1,285705
C+_gbp_2v2_fwd	-24,90639	79,26384	7,631076	15,4135	1,402756	9,157495	0,49509	1,530603
C+_gbp_2v2_fvix	-24,90639	50,0375	7,13651	11,00389	0,617448	6,185711	0,648544	1,492467
C+_gbp_3v3_spot	-40,00875	29,8362	3,067141	15,0746	-0,661877	2,959278	0,203464	1,183283
C+_gbp_3v3_svix	-29,38528	29,8362	3,859878	12,59511	-0,577758	3,302557	0,306459	1,239482
C+_gbp_3v3_fwd	-34,75674	44,74104	7,30196	14,23083	-0,048293	3,777816	0,513108	1,503606
C+_gbp_3v3_fvix	-22,94834	41,18635	7,225124	11,35194	0,415299	4,057174	0,636466	1,499664
C+_gbp_CvD_spot	-52,3441	103,565	5,992332	17,797	1,904827	16,11459	0,336705	1,393124
C+_gbp_CvD_svix	-27,89362	19,95885	4,458	7,652564	-1,021725	6,370591	0,58255	1,285045
C+_gbp_DvC_spot	-29,71753	20,00437	-0,878916	11,5747	-0,392234	2,58261	-0,075934	0,948425
C+_gbp_DvC_svix	-26,01597	20,00437	0,776397	9,183846	-0,63132	3,938886	0,084539	1,042911

Table 6.24: Core+ basket, the funding currency: the US dollar, March 2004-September 2008

strategy	min	max	mean	std	skew	kurt	sharpe	cumul
C+_usd_EW_spot	-75,40086	65,02886	1,972966	21,39527	-0,70522	5,918898	0,092215	1,106273
C+_usd_EW_svix	-43,95727	25,26711	0,605503	12,24055	-1,295265	6,6518	0,049467	1,031268
C+_usd_EW_fwd	-88,16927	62,75116	8,624477	21,18459	-1,579612	8,942381	0,407111	1,610391
C+_usd_EW_fvix	-23,46779	62,75116	9,115	13,85879	0,810802	5,586214	0,657705	1,665606
C+_usd_1v1_spot	-51,91774	100,0229	4,515323	25,81551	0,438521	4,640462	0,174907	1,271351
C+_usd_1v1_svix	-39,25611	51,16671	4,321118	18,27137	0,119822	3,268664	0,236497	1,267085
C+_usd_1v1_fwd	-134,1718	97,64074	9,91622	35,2808	-1,502117	8,538989	0,281066	1,699254
C+_usd_1v1_fvix	-134,1718	65,66326	9,451435	27,26272	-1,832438	12,98283	0,34668	1,675205
C+_usd_2v2_spot	-56,20464	44,95957	2,427668	20,07646	-0,403334	3,267026	0,120921	1,136603
C+_usd_2v2_svix	-37,78514	42,7292	3,83296	15,86465	-0,157965	3,466303	0,241604	1,234946
C+_usd_2v2_fwd	-68,02971	75,6514	6,95168	20,62437	0,140585	7,01234	0,337061	1,466701
C+_usd_2v2_fvix	-21,41797	75,6514	7,60274	14,28202	2,323505	10,75276	0,532329	1,529375
C+_usd_3v3_spot	-33,69163	30,39298	2,044132	14,83214	-0,489843	2,492127	0,137818	1,116963
C+_usd_3v3_svix	-29,26114	30,39298	3,028985	12,63761	-0,484325	3,199009	0,23968	1,182601
C+_usd_3v3_fwd	-58,07211	63,20937	6,084161	18,3451	-0,438702	5,642872	0,33165	1,399491
C+_usd_3v3_fvix	-23,88741	63,20937	6,303514	13,93779	1,195546	6,188209	0,452261	1,421668
C+_usd_CvD_spot	-98,66697	79,02405	5,058079	25,76886	-1,072223	7,150932	0,196286	1,310548
C+_usd_CvD_svix	-53,95336	39,98824	3,43102	14,62917	-1,457992	8,530717	0,234533	1,208205
C+_usd_DvC_spot	-35,65956	27,19231	0,092771	11,28399	-0,701928	4,545202	0,008221	1,002284
C+_usd_DvC_svix	-35,65956	19,92488	0,352366	10,35065	-1,204882	5,728669	0,034043	1,017609

Table 6.25: Core basket, the funding currency: the euro, October 2008-May 2012

strategy	min	max	mean	std	skew	kurt	sharpe	cumul
C_eur_EW_spot	-24,7686	24,32172	0,574745	12,24749	-0,1218	2,573927	0,046928	1,012938
C_eur_EW_svix	-24,7686	15,97825	0,378251	8,943412	-0,5943	3,873368	0,042294	1,008685
C_eur_EW_fwd	-20,9985	32,425	4,504736	14,03476	0,167053	2,097445	0,32097	1,116771
C_eur_EW_fvix	-20,9985	27,26076	4,671818	11,50068	0,131916	2,781074	0,406221	1,122152
C_eur_1v1_spot	-42,5848	65,01872	3,250837	19,63219	0,608186	5,186819	0,165587	1,080392
C_eur_1v1_svix	-22,4689	20,50989	1,027087	10,44579	-0,50407	3,512746	0,098325	1,02487
C_eur_1v1_fwd	-52,9086	55,25045	4,335861	29,51987	-0,21292	2,00766	0,146879	1,104568
C_eur_1v1_fvix	-46,9007	55,25045	5,160819	24,34579	-0,06959	2,770835	0,21198	1,130678
C_eur_2v2_spot	-28,2905	50,2887	1,988699	18,33435	0,491958	3,079143	0,108468	1,047408
C_eur_2v2_svix	-28,2905	28,68022	0,632926	12,79044	-0,28539	3,598888	0,049484	1,014271
C_eur_2v2_fwd	-19,5814	22,73933	2,27171	10,25145	-0,17571	2,783973	0,221599	1,057263
C_eur_2v2_fvix	-19,5814	22,73933	1,92254	9,736374	-0,05757	3,253206	0,19746	1,048199
C_eur_3v3_spot	-32,4273	39,24274	2,267477	17,3764	0,044179	2,82434	0,130492	1,055068
C_eur_3v3_svix	-30,4081	25,85714	1,622335	12,08712	-0,39416	3,943878	0,13422	1,039833
C_eur_3v3_fwd	-14,069	21,53166	3,952719	10,26018	-0,00032	1,986109	0,385248	1,102524
C_eur_3v3_fvix	-14,069	21,53166	3,328664	9,598571	0,270539	2,438595	0,346787	1,085651
C_eur_CvD_spot	-10,6773	24,25117	5,089036	9,156071	0,021883	2,279203	0,55581	1,134418
C_eur_CvD_svix	-10,6773	24,25117	4,628272	8,250683	0,359134	2,892206	0,560956	1,121655
C_eur_DvC_spot	-28,403	23,95131	-3,70832	13,53141	0,196049	2,084304	-0,27405	0,909642
C_eur_DvC_svix	-28,403	15,59228	-3,44405	11,11189	-0,47072	2,416169	-0,30994	0,916238

Table 6.26: Core basket, the funding currency: the British pound, October 2008-May 2012

strategy	min	max	mean	std	skew	kurt	sharpe	cumul
C_gbp_EW_spot	-33,3788	29,35072	0,679824	14,73556	-0,0725	2,582687	0,046135	1,014915
C_gbp_EW_svix	-22,0121	26,93768	0,746517	11,31596	0,121625	2,796039	0,06597	1,017522
C_gbp_EW_fwd	-40,3162	25,48005	5,386368	16,74305	-1,22093	3,713286	0,321708	1,14057
C_gbp_EW_fvix	-30,596	25,48005	7,043491	13,24922	-1,05222	4,109947	0,531616	1,189832
C_gbp_1v1_spot	-43,4051	65,06013	3,3064	19,84135	0,557025	5,085505	0,166642	1,081799
C_gbp_1v1_svix	-22,4212	20,40152	1,008774	10,57357	-0,51837	3,605428	0,095405	1,024374
C_gbp_1v1_fwd	-52,0126	78,79036	16,21504	30,44659	-0,23303	2,622703	0,532573	1,482207
C_gbp_1v1_fvix	-40,3083	78,79036	15,70345	25,97751	0,376896	2,968674	0,604502	1,467338
C_gbp_2v2_spot	-28,6932	50,35411	1,950221	18,36946	0,467062	3,098268	0,106166	1,046388
C_gbp_2v2_svix	-28,6932	28,68062	0,528742	12,86698	-0,33157	3,63241	0,041093	1,011613
C_gbp_2v2_fwd	-25,6066	18,17058	2,529376	9,274281	-0,95464	4,310688	0,27273	1,064283
C_gbp_2v2_fvix	-10,1959	18,17058	3,109364	6,889304	0,225746	2,952072	0,451332	1,080213
C_gbp_3v3_spot	-31,9047	39,28498	2,252336	17,43125	0,042272	2,788367	0,129213	1,054649
C_gbp_3v3_svix	-30,8099	25,61426	1,541668	12,22035	-0,39306	3,908145	0,126156	1,037706
C_gbp_3v3_fwd	-30,0695	16,14074	2,690484	9,382738	-1,53493	6,108934	0,286748	1,068544
C_gbp_3v3_fvix	-11,6199	16,14074	3,583012	6,56835	-0,33898	3,057044	0,545497	1,093091
C_gbp_CvD_spot	-33,5817	38,06249	2,376358	15,13288	0,293198	3,154271	0,157033	1,058718
C_gbp_CvD_svix	-13,4205	38,06249	2,62878	11,97937	1,248779	4,363938	0,219442	1,066327
C_gbp_DvC_spot	-38,4005	12,56782	-1,05947	10,12032	-1,61337	7,138323	-0,10469	0,972835
C_gbp_DvC_svix	-38,4005	12,56782	-1,2452	9,373188	-2,06635	9,311269	-0,13285	0,968466

Table 6.27: Core basket, the funding currency: the US dollar, October 2008-May 2012

strategy	min	max	mean	std	skew	kurt	sharpe	cumul
C_usd_EW_spot	-56,0309	57,88108	0,055097	28,22245	0,089479	2,791191	0,001952	0,993385
C_usd_EW_svix	-53,7919	38,54345	-1,02766	19,59925	-0,47295	3,65677	-0,05243	0,970835
C_usd_EW_fwd	-49,6814	38,68375	3,262218	19,71597	-0,73954	3,587014	0,165461	1,080603
C_usd_EW_fvix	-49,6814	28,11265	2,495351	16,9195	-1,28282	5,411622	0,147484	1,061213
C_usd_1v1_spot	-42,8468	65,81277	3,821098	20,02994	0,56383	5,003003	0,190769	1,095689
C_usd_1v1_svix	-22,435	20,58392	1,118821	10,40864	-0,56518	3,653594	0,10749	1,027229
C_usd_1v1_fwd	-50,8686	58,30957	14,40551	27,44945	-0,40605	2,423745	0,524801	1,419828
C_usd_1v1_fvix	-24,7977	58,30957	14,19772	22,29213	0,232299	2,313818	0,636894	1,416209
C_usd_2v2_spot	-28,9514	67,65705	2,767893	20,79557	0,967685	4,506082	0,1331	1,066975
C_usd_2v2_svix	-28,9514	37,55455	0,732118	13,48791	0,157296	4,208395	0,05428	1,016606
C_usd_2v2_fwd	-24,6722	37,69285	1,17978	12,39509	0,407768	4,172887	0,095181	1,028334
C_usd_2v2_fvix	-24,6722	16,74957	-0,29875	9,193635	-0,55573	3,840601	-0,0325	0,991711
C_usd_3v3_spot	-35,787	69,71133	3,301402	23,4328	0,602649	3,732244	0,140888	1,080001
C_usd_3v3_svix	-35,787	35,97479	1,914353	15,12962	-0,03524	4,026768	0,12653	1,046574
C_usd_3v3_fwd	-40,7279	42,64129	0,907174	14,28373	-0,23586	5,976316	0,063511	1,020829
C_usd_3v3_fvix	-40,7279	18,57095	-0,08068	11,42228	-1,82909	7,46558	-0,00706	0,996659
C_usd_CvD_spot	-71,8415	62,76701	0,691	32,95165	-0,14207	2,745276	0,02097	1,00633
C_usd_CvD_svix	-60,0541	48,43925	-0,94074	23,25675	-0,46249	3,808195	-0,04045	0,971399
C_usd_DvC_spot	-19,3401	17,87268	-0,38428	8,102066	0,004316	3,281894	-0,04743	0,989783
C_usd_DvC_svix	-13,4427	17,87268	0,164702	6,27177	0,219514	4,143413	0,026261	1,003728

Table 6.28: Core basket, optimized portfolio, October 2008-May 2012

strategy	min	max	mean	std	skew	kurt	sharpe	cumul
C_eur_opt_fwd	-6,02534	19,88944	2,510368	5,010808	1,57349	6,522014	0,500991	1,064434
C_eur_opt_fvix	-3,50311	19,88944	2,074377	4,109689	2,92393	13,20396	0,504753	1,053003
C_gbp_opt_fwd	-5,36104	8,282439	1,614455	2,867159	0,324083	3,777777	0,563085	1,041073
C_gbp_opt_fvix	-3,19894	8,282439	1,531954	2,301367	1,055745	4,440831	0,665671	1,038961
C_usd_opt_fwd	-6,670413	12,8296	0,656335	3,756429	1,0525	5,232106	0,174723	1,016395
C_usd_opt_fvix	-6,670413	12,8296	0,449501	3,26492	1,545098	8,607204	0,137676	1,011191

Table 6.29: Core+ basket, the funding currency: the euro, October 2008-May 2012

strategy	min	max	mean	std	skew	kurt	sharpe	cumul
C+_eur_EW_spot	-16,04917	17,15717	3,259022	9,580806	-0,211102	2,15615	0,340162	1,083769
C+_eur_EW_svix	-15,79006	17,0254	2,939494	7,887104	-0,011652	2,806251	0,372696	1,075488
C+_eur_EW_fwd	-9,49389	64,30998	30,59621	23,33125	-0,245408	1,80586	1,311383	2,117184
C+_eur_EW_fvix	-4,768232	64,30998	25,41389	22,58211	0,241755	1,627901	1,125399	1,866009
C+_eur_1v1_spot	-49,08961	48,9563	3,791085	24,34389	-0,307095	2,738631	0,15573	1,09272
C+_eur_1v1_svix	-49,08961	48,9563	5,350933	20,25507	-0,1166	3,975611	0,264177	1,138116
C+_eur_1v1_fwd	-26,73646	70,31045	8,987157	22,09153	1,142612	4,679593	0,406815	1,24491
C+_eur_1v1_fvix	-26,73646	70,31045	8,987157	22,09153	1,142612	4,679593	0,406815	1,24491
C+_eur_2v2_spot	-32,12006	47,44878	2,853496	22,3266	0,372147	2,455841	0,127807	1,068523
C+_eur_2v2_svix	-29,05672	46,89163	2,271849	16,71092	0,540596	4,291422	0,13595	1,055436
C+_eur_2v2_fwd	-29,92531	37,49898	0,103148	14,37252	0,25041	3,497353	0,007177	1,000503
C+_eur_2v2_fvix	-26,35212	37,49898	0,492551	11,99061	0,59225	5,194372	0,041078	1,010929
C+_eur_3v3_spot	-47,16445	49,3679	2,483704	21,32546	-0,237478	3,11931	0,116467	1,059136
C+_eur_3v3_svix	-40,21662	36,20352	2,75621	15,00362	-0,440386	4,375141	0,183703	1,068826
C+_eur_3v3_fwd	-26,74662	26,46512	1,053114	10,64699	0,008801	3,921769	0,098912	1,025496
C+_eur_3v3_fvix	-14,63776	26,46512	1,520306	8,863771	0,88418	4,41122	0,171519	1,037898
C+_eur_CvD_spot	-15,95432	25,35254	5,984599	9,668798	-0,034838	2,748828	0,61896	1,159873
C+_eur_CvD_svix	-9,661968	25,35254	5,850446	8,925596	0,492867	2,524914	0,655468	1,15617
C+_eur_DvC_spot	-17,65489	17,69597	-1,91961	9,081743	0,135741	2,28068	-0,21137	0,952313
C+_eur_DvC_svix	-17,65489	10,9873	-2,104985	7,685333	-0,419045	2,400661	-0,273896	0,948125

Table 6.30: Core+ basket, the funding currency: the British pound, October 2008-May 2012

strategy	min	max	mean	std	skew	kurt	sharpe	cumul
C+_gbp_EW_spot	-32,77423	28,83137	1,799184	16,3592	-0,16864	2,162443	0,10998	1,04316
C+_gbp_EW_svix	-24,28773	26,26754	1,841329	12,82684	-0,097463	2,698884	0,143553	1,045343
C+_gbp_EW_fwd	-47,26121	30,05941	3,981826	17,68999	-0,970443	4,097193	0,225089	1,101001
C+_gbp_EW_fvix	-30,32044	30,05941	5,85126	13,06601	-0,232881	3,937107	0,447823	1,155139
C+_gbp_1v1_spot	-49,58989	47,6678	4,020072	24,36188	-0,354243	2,744484	0,165015	1,098962
C+_gbp_1v1_svix	-49,58989	47,6678	5,428833	20,25288	-0,161937	3,962138	0,268052	1,140324
C+_gbp_1v1_fwd	-77,16591	99,18936	14,6455	35,29433	-0,048703	3,950904	0,414953	1,421407
C+_gbp_1v1_fvix	-47,6168	99,18936	15,74834	27,28837	1,005942	5,225357	0,577108	1,468059
C+_gbp_2v2_spot	-30,88257	48,25999	2,946726	22,33018	0,365469	2,445617	0,131962	1,071009
C+_gbp_2v2_svix	-29,82779	46,50994	2,202869	16,72131	0,482677	4,217794	0,13174	1,053615
C+_gbp_2v2_fwd	-21,72951	42,10251	6,073319	12,67521	0,352507	3,935201	0,47915	1,161662
C+_gbp_2v2_fvix	-21,72951	42,10251	4,488347	11,61305	0,957328	5,526663	0,386491	1,117014
C+_gbp_3v3_spot	-46,2737	49,90863	2,488973	21,42611	-0,221543	3,048581	0,116165	1,05923
C+_gbp_3v3_svix	-40,59638	35,933	2,68665	15,13742	-0,472781	4,287598	0,177484	1,066929
C+_gbp_3v3_fwd	-16,83491	27,12048	5,473297	9,83121	-0,081289	2,883226	0,556727	1,145174
C+_gbp_3v3_fvix	-16,83491	27,12048	5,328067	9,023523	0,132146	3,50816	0,590464	1,141216
C+_gbp_CvD_spot	-42,81482	44,46563	2,538445	19,77124	0,27454	2,858756	0,128391	1,06129
C+_gbp_CvD_svix	-19,04692	44,46563	3,132922	15,38396	1,077836	3,663693	0,203649	1,078823
C+_gbp_DvC_spot	-23,82216	10,71059	-0,161204	7,470642	-0,895522	4,505412	-0,021578	0,995416
C+_gbp_DvC_svix	-23,82216	10,52202	-0,713536	6,717839	-1,171722	6,027653	-0,106215	0,981866

Table 6.31: Core+ basket, the funding currency: the US dollar, October 2008-May 2012

strategy	min	max	mean	std	skew	kurt	sharpe	cumul
C+_usd_EW_spot	-83,23291	71,44839	0,063367	35,9845	-0,212816	2,868874	0,001761	0,988542
C+_usd_EW_svix	-70,1224	47,14286	-0,747378	24,94405	-0,58344	3,901377	-0,029962	0,975292
C+_usd_EW_fwd	-47,82877	45,4282	1,827017	19,60949	-0,458036	4,066672	0,09317	1,042644
C+_usd_EW_fvix	-47,82877	36,16461	2,062713	16,78045	-1,262253	5,888446	0,122924	1,049867
C+_usd_1v1_spot	-50,50182	48,06455	3,250768	24,22152	-0,314355	2,808337	0,13421	1,07816
C+_usd_1v1_svix	-50,50182	48,06455	4,546868	20,15369	-0,118927	4,093096	0,22561	1,115598
C+_usd_1v1_fwd	-76,17006	67,78496	7,223727	32,65154	-0,414276	3,50852	0,221237	1,184538
C+_usd_1v1_fvix	-51,57966	64,6563	8,089209	24,15659	-0,043754	4,668448	0,334865	1,216217
C+_usd_2v2_spot	-29,89227	62,75106	2,901288	24,15191	0,674642	2,896133	0,120127	1,068919
C+_usd_2v2_svix	-29,89227	62,75106	1,988327	18,47904	1,134346	5,859384	0,107599	1,047364
C+_usd_2v2_fwd	-16,73674	39,52396	3,393711	14,82259	0,655093	2,713231	0,228955	1,086036
C+_usd_2v2_fvix	-16,48159	34,25959	2,009059	11,71084	0,763414	3,441771	0,171556	1,050026
C+_usd_3v3_spot	-52,50887	59,70519	2,860993	27,25697	0,145212	2,894942	0,104964	1,066098
C+_usd_3v3_svix	-47,12282	59,70519	2,852635	19,40139	0,260862	5,0472	0,147033	1,069795
C+_usd_3v3_fwd	-23,61143	26,92791	3,177286	11,63865	0,18119	2,976005	0,272994	1,081092
C+_usd_3v3_fvix	-23,61143	26,92791	2,718253	10,16657	0,359689	4,028703	0,267372	1,06913
C+_usd_CvD_spot	-93,11454	74,55016	0,460806	39,17484	-0,29737	2,941085	0,011763	0,995963
C+_usd_CvD_svix	-74,0363	53,32773	-0,693052	27,28151	-0,610496	3,897686	-0,025404	0,975397
C+_usd_DvC_spot	-11,95691	11,27543	-0,145816	5,059929	0,008182	3,280039	-0,028818	0,996104
C+_usd_DvC_svix	-8,332102	11,27543	0,197297	3,921934	0,217939	4,150754	0,050306	1,004789

Table 6.32: Free rates investment statistics, January 1999 – May 2012

strategy	min	max	mean	std	skew	kurt	sharpe	cum
IR_EUR	0,386	5,05	2,641398	1,360649	-0,066988	1,944614	1,941278	1,424606
IR_GBP	0,475	6,575	3,80428	1,963333	-0,716849	1,991684	1,937664	1,664271
IR_USD	0,1855	6,8037	2,777071	2,161156	0,300155	1,630183	1,284993	1,45049

Table 6.33: Free rates investment statistics, January 2002 – May 2012

strategy	min	max	mean	std	skew	kurt	sharpe	cum
IR_EUR	0,397	5,05	2,318524	1,286569	0,160403	1,997081	1,802099	1,270333
IR_GBP	0,475	6,575	3,36271	1,972607	-0,413724	1,60788	1,704704	1,414574
IR_USD	0,1855	5,72	2,108339	1,839383	0,652595	2,010644	1,14622	1,242999

Table 6.34: Free rates investment statistics, March 2004 – May 2012

strategy	min	max	mean	std	skew	kurt	sharpe	cum
IR_EUR	0,397	5,05	2,203439	1,398551	0,36231	1,863626	1,575516	1,196878
IR_GBP	0,475	6,575	3,240665	2,203164	-0,213202	1,246087	1,470914	1,302304
IR_USD	0,1855	5,72	2,28209	2,029447	0,372952	1,544496	1,124488	1,204489

Table 6.35: Free rates investment statistics, October 2008 – May 2012

strategy	min	max	mean	std	skew	kurt	sharpe	cum
IR_EUR	0,397	1,433	0,805967	0,360335	0,420408	1,719095	2,236714	1,020345
IR_GBP	0,475	0,85	0,654833	0,103428	0,269712	2,682669	6,331286	1,016501
IR_USD	0,1855	0,3512	0,251623	0,038296	0,801311	4,143837	6,570447	1,00631

Table 6.36: S&P monthly returns statistics over different time periods

S&P 500	min	max	mean	std	skew	kurt	sharpe	cum
01.1999–05.2012	-201,5371	131,1517	3,299448	55,68264	-0,441913	3,548271	0,059255	1,304848
01.2002–05.2012	-201,5371	131,1517	4,698236	55,1132	-0,627032	4,067395	0,085247	1,423024
03.2004–05.2012	-201,5371	131,1517	5,149075	54,22207	-0,714485	4,568294	0,094963	1,375544
10.2008–05.2012	-95,82093	131,1517	10,57456	57,30018	-0,012156	2,391931	0,184547	1,259385

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