Eesti Pank
Bank of Estonia

The Profitability of Simple Trading Strategies Exploiting the Forward Premium Bias in Foreign Exchange Markets and the Time Premium in Yield Curves

Andres Vesilind

Woking Paper Series

4/2006

Profitability of Simple Trading Strategies Exploiting the Forward Premium Bias in Foreign Exchange Markets and the Time Premium in Yield Curves

Andres Vesilind*

Abstract

This paper focuses on two actively studied inefficiencies in financial markets: the forward premium bias in foreign exchange markets (see, for example, Hansen and Hodrick, 1980; Fama, 1984; Bansal and Dahlquist, 2000, etc.) and the empirical finding that the time expectations theory performs relatively poorly in describing the average shape of yield curves (for a list of papers see, for example, Backus et al., 1998:1). The goal of the article is to test whether these two inefficiencies can still offer the possibilities of earning positive and stable excess return for investors. For that purpose, first two very simple trading strategies are tested based on the abovementioned inefficiencies: buying the currencies of the countries with higher short-term interest rates against the currencies of the countries with lower short-term interest rates (i.e. simple FX carry-strategy) and holding long-only positions in longer-term interest rate futures.

The results show that the two studied risk premiums are still present in the markets and enable investors to earn excess returns even with simple strategies. Additional tests show that the performance of these simple strategies can be further improved by the inclusion of a risk factor in the foreign exchange carry-strategy and by the addition of monetary policy direction and yield curve steepness filters in the long-only strategy in interest rate futures.

JEL Code: E44, E47, E58, F37, G11, G15

Keywords: trading rules, forward premium bias, time expectations theory

Author's e-mail address: vesilind@epbe.ee

The views expressed are those of the author and do not necessarily represent the official views of Eesti Pank.

*The author would like to thank his colleagues Toivo Kuus and Triin Kriisa for their valuable comments. All remaining mistakes are mine.

Non-technical summary

This paper focuses on two actively studied inefficiencies in financial markets: the forward premium bias in foreign exchange markets and the empirical finding that the time expectations theory performs relatively poorly in describing the average shape of yield curves. Historically, these inefficiencies have offered various possibilities to develop profitable trading strategies in foreign exchange and interest rate markets.

Simpler foreign exchange trading models use the short-term return of debt markets as their only input. Such models give a signal to buy the currencies of the countries with higher interest rates and sell the currencies of the countries with lower interest rates. Although the idea of using the short-term interest rate differential (also referred to as "carry") as an input is relatively old, the performance of these simple models has been positive up to the present time. In addition it has been observed that the performance of the carry-based models is closely linked to various risk measures: changes in the investors' appetite for risk (Rosenberg and Folkerts-Landau, 2002:30), changes in foreign exchange market volatility (Gaglayan and Giacomelli, 2005:4 and Mackel, 2005), changes in current account deficits (JPMorgan, 2001:4) and changes in equity market volatility (Kantor and Caglayan, 2002:3).

The empirical research on the shapes of yield curves has found that in the long run, the yield curves mostly have an upward-sloping shape. It means that long-term interest rates include not only a forecast of short-term interest rates, but also a structural risk premium. Upward-sloping yield curves offer profitable trading opportunities, which may be best executed using government bond or interest rate futures. With an upward-sloping yield curve futures' price will increase in time when all other market conditions stay constant.

The goal of the paper is to test whether these two inefficiencies can still offer the possibilities of earning positive and stable excess return for investors. For that purpose, first two very simple trading strategies are tested based on the abovementioned inefficiencies: buying the currencies of the countries with higher short-term interest rates against the currencies of the countries with lower short-term interest rates (i.e. simple FX carry-strategy) and holding long-only positions in longer-term interest rate futures.

The results show that the two studied risk premiums are still present in the markets and enable investors to earn excess return. The simple strategies produced positive excess return with Sharpe ratios reaching 0.94 in historical simulations, but they had also relatively long and sharp drawdown periods.

In order to improve the results of the models, the volatility of the exchange rates as a risk factor was added to the currency model and different filters (based on the shape of the yield curve and on the direction of the base interest rates) to the interest rate model. The final currency model had 14 currency pairs and took four monthly exchange rate positions based on the ratio of difference in carry to the historical volatility of the given exchange rate pair. The final interest rate portfolio consisted of two sub-models. The first one had long-only positions in the third 3-month interest rate futures in five regions (the USA, the euro area, the UK, Canada and Australia). These positions were held for most of the test period and taken off only during times of a tightening monetary policy. The second sub-model took long positions in US and German 5-year government bond futures during months when the spread between the 5-year government bond interest rate and 1-month deposit interest rate was equal to or greater than 136 basis points at the beginning of the month.

The three abovementioned models were combined into one portfolio. Both risk classes (foreign exchange risk and interest rate risk) were given an equal amount of risk measured as a standard deviation of monthly excess returns. The combined portfolio had relatively good risk-return statistics according to the simulated historical tests with a Sharpe ratio of 1.68 and 69% of the months giving a positive return.

All of the models were tested using derivative instruments (forward and futures contracts). In this way, the results reflect pure excess returns that can be scaled according to each investor's risk tolerance and target leverage level.

Contents

1. Introduction

There are numerous studies focusing on the possibilities of earning excess returns in financial markets. Based on their fundamental approach, the studies on active return possibilities can be divided into two sub-groups: the studies on the timing of market movements and the studies on exploiting different structural risk premiums[1]. The first group of studies focuses on different strategies, theories and models on how to predict market movements in order to benefit therefrom. The range of different approaches used is very wide, starting from the simple chart pattern analysis and ending with models using neural networks and genetic algorithms. The other group of studies is based on structural and long-lasting risk premiums in the markets and represents mostly buy-and-hold style investment decisions (preferring one asset class (or subset) to another) in different sectors.

The search for excess returns from active management has especially intensified during the last decade, when low interest rate levels and the burst of the technology bubble in the stock markets reduced the profitability of traditional passive fund management. At the same time, the amount of funds under management in different hedge funds (private investment firms that seek to gain high absolute returns by taking active positions in the markets) grew 20 times between 1990 and 2003, reaching more than 800 billion USD (Loeys and Fransolet, 2004:3). This has led to the erosion of many sources of excess returns that were present in the financial markets in the past (Loeys and Fransolet, 2004:1).

The goal of the paper is to test whether the two actively studied structural risk premiums in financial markets — the forward premium bias in foreign exchange markets (see, for example, Hansen and Hodrick, 1980; Fama, 1984; Bansal and Dahlquist, 2000, etc.) and the time premium in yield curves (for a list of papers see Backus et al., 1998:1) — can still offer possibilities of earning positive and stable excess return. For that purpose, a portfolio of trading strategies based on the two-abovementioned risk premiums is constructed in which trading signals in a 162-month period are generated, after which different return and risk statistics are calculated.

The first chapter provides a brief overview of the logic and previous tests of the models that try to exploit these inefficiencies in interest rate and for-

[1]Risk premium: a compensation for investors for tolerating extra risk (www.investopedia.com).
A structural risk premium denotes situations where a certain risk exposure is undervalued (and overcompensated) compared to its risk level for a longer period of time due to structural differences in supply and demand relationships or some other structural and long-lasting factor in the given asset class.

eign exchange markets. In the second chapter, investment models based on the two-abovementioned inefficiencies are tested. The model for taking active positions in the foreign exchange market starts with a very simple setup: buying the currencies of the countries with higher short-term interest rates against the currencies of the countries with lower short-term interest rates. Then the historical volatility in exchange rates is added as a risk factor in order to improve the performance of the simple model during riskier periods. The model for taking active positions in the interest rate market starts with simulations of holding long-only positions in longer-term interest rate futures. After that, two filters (a filter based on the shape of the yield curve and a filter based on the direction of the movements in interest rates) are added to the long-only portfolio. The chapter concludes with a combination of the models with the best performance statistics into one portfolio.

The models developed in the paper were tested with derivative instruments using forward contracts in currency markets and futures contracts in interest rate markets. This setup enables one to examine the capability of the tested models to earn pure alpha (excess return) and enables investors to choose the sizes of the positions according to their risk tolerance and target leverage level.

2. Theoretical overview of the structural risk premiums in the foreign exchange and fixed income markets

2.1. Forward premium bias in the foreign exchange markets

Interest rate levels in two countries are related with the expected and forward exchange rates through the covered and uncovered interest-rate parity conditions. According to the covered interest-rate parity condition, an investment in a foreign-currency deposit (yielding i_f) fully hedged against exchange rate risk (costing the forward discount FD) should yield exactly the same return as a comparable domestic-currency deposit (yielding i_d), since these two strategies have the same risk characteristics (Rosenberg and Folkerts-Landau, 2002:65):

$$i_f - FD = i_d \quad (1)$$

or

$$FD = i_f - i_d \quad (2)$$

The empirical evidence in support of the covered interest-rate parity is quite strong (Rosenberg and Folkerts-Landau, 2002), mainly because the differences between the returns of the two-abovementioned strategies could be directly arbitraged without risk.

According to the uncovered interest-rate parity condition, the expected return on an uncovered foreign-currency investment (yield i_f minus the expected change in the exchange rate $E(\Delta_e)$) should equal the expected return on a comparable domestic-currency investment i_d (Rosenberg and Folkerts-Landau, 2002):

$$i_f - E(\Delta_e) = i_d \tag{3}$$

or

$$E(\Delta_e) = i_f - i_d \tag{4}$$

In efficient markets both the covered and uncovered interest rate parities should hold and therefore the forward exchange rates should be unbiased predictors of future spot rates:

$$E(\Delta_e) = FD \tag{5}$$

However, this hypothesis has not found strong support in empirical research. Based on a number of studies of FX markets (Hansen and Hodrick, 1980; Fama, 1984; Bansal and Dahlquist, 2000, etc.), forward exchange rates on average are not accurate predictors of future spot exchange rates. Furthermore, the exchange rates tend to move rather in the opposite direction than predicted by the uncovered interest rate parity. For example, a survey of 75 published papers on this subject estimated the average value of coefficient β in the following equation:

$$E(\Delta_e) = \alpha + \beta(FD) \tag{6}$$

It was found that the average value of β was –0.88 (Rosenberg and Folkerts-Landau, 2002:72). In addition to being statistically different from 1, the value of β was negative and close to –1, which is almost the opposite of the value predicted by the uncovered interest rate parity.

This inefficiency (also referred to as the "forward premium bias" and "forward discount bias" in economic literature) can be caused by several factors. According to the paper by JPMorgan (JPMorgan, 2004:4–8), the level of short-term interest rates is one of the determinants of capital inflows, and with larger capital inflows domestic currency tends to appreciate as demand for domestic currency increases. At the same time, arbitrage conditions require the forward value of a currency with a higher domestic interest rate level to be lower than the currency's spot value, i.e. the currency has to depreciate for the arbitrage condition to hold. Higher capital inflows due to higher interest rates may not allow the currency to depreciate as much as predicted by the arbitrage condition, and thus in this way support the forward premium bias. Other explanations for the bias include (but are not limited to) the hypothesis that the currencies of the countries with higher short-term interest rates are riskier than the currencies of the other countries, and the view that the market simply makes repeated expectational errors (Rosenberg and Folkerts-Landau, 2002:72).

It is possible to develop a trading strategy based on this inefficiency. For example, a simple foreign exchange trading model (see Deutsche Bank, 2002:13) uses the short-term return of debt markets (1-month interest rate) as its only input. The model gives a signal to buy the currencies of the countries with higher interest rates and sell the currencies of the countries with lower interest rates. Although the idea of using the short-term interest rate differential (also referred to as "carry") as an input is relatively old, the model's performance has been positive up to the present time. Depending on the number of currency pairs traded each month (from 1 to 9 currencies on both the buy and sell sides), the strategy has produced annualized excess returns between 2.90–9.27% with Sharpe ratios[2] between 0.27–1.37 (Deutsche Bank, 2002:8).

Although historically positive, the simple models that buy the currencies with the higher short-term interest rates against the currencies with the lower short-term interest rates have had relatively long periods of poor performance. For example, the maximum drawdown of the different combinations of the Deutsche Bank's model described in the previous paragraph ranged from –8.87% up to –63.33% (Deutsche Bank, 2002:10). At the same time, it can be observed (see Rosenberg and Folkerts-Landau, 2002:30) that the performance of the carry-based models is closely linked to the changes in the investors' appetite for risk. This has led to different attempts to modify the simple carry-based model by the inclusion of risk factors.

One of the first attempts in that direction was made in 2001, when JPMorgan started testing the Liquidity and Credit Premium Index (LCPI) (JPMorgan, 2001). This index was constructed from six indicators: the US Treasury Yield Error (the difference between on-the-run and off-the-run government bond interest rates), the 10-year swap spread, the Emerging Markets Bond Index spread, the US High Yield (i.e. yield on non-investment grade debt) spread, the FX market volatility, and the Global Risk Appetite Index (Kantor

[2]A ratio developed by W. Sharpe to measure risk-adjusted performance (www.investopedia.com).

and Caglayan, 2002:1–3). Depending on whether the index is in risk seeking, risk neutral or risk averse mode, traditional carry-trades are taken either in the traditional way (buying the currency of the country where the short-term interest rate is higher) or the opposite (JPMorgan, 2001:1–3). Later on, also current account deficits (JPMorgan, 2001:4) and equity market volatility (Kantor and Caglayan, 2002:3) were tested as inputs. Besides constructing a separate index for risk appetite, JPMorgan has also used a methodology where the carry (short-term interest rate differential) is directly divided by FX market volatility as a risk factor (Gaglayan and Giacomelli, 2005:4). The latest test results indicate that this strategy by itself has an information ratio[3] between 0.45 and 1.09, depending on the currency pair (test period from January 1994 to June 2004; see Normand et al., 2004:21), and the average information ratio is as high as 2.21 when applied together with the risk appetite index (test period 1998–2004; see Gaglayan and Giacomelli, 2005:8).

Risk-adjusted carry as an input is also used in a model developed in ABN-AMRO (Mackel, 2005). In this model, the 3-month deposit interest rate spread in two countries is divided by the 3-month actual volatility of the currency pair (risk-adjusted carry). The trade is initiated when the risk-adjusted carry is above its 2-year rolling average. The model signals are re-calculated daily. The best information ratio of the strategy occurred with the AUD/USD currency pair (1.61).

2.2. Structural time premium in interest rate markets

A well-known inefficiency in interest rate markets is the empirical finding[4] that the time expectations theory[5] performs relatively poorly in describing movements in the yield curve. In the long run, the yield curves mostly have an upward-sloping shape, which means that long-term interest rates include not only a forecast of short-term interest rates, but also a structural risk premium.

The mostly upward-sloping yield curve shape is explained by different theories, such as the liquidity preference hypothesis[6] and the segmented market

[3] A measure of a portfolio management's performance against risk and return relative to a benchmark or alternative measure. The ratio was developed by Nobel laureate William Sharpe (www.investopedia.com). The ratio is also called the Sharpe ratio, if a risk-free interest rate is used as benchmark.

[4] For a list of some of the papers on this subject see, for example, Backus et al., 1998:1.

[5] The time expectations theory (or expectations hypothesis, see Reilly and Brown, 2003:759–761) is based on the hypothesis that any long-term interest rate simply represents the geometric mean of the current and future short-term interest rates expected to prevail.

[6] The theory of liquidity preference holds that long-term securities should provide higher returns than short-term obligations because investors are willing to sacrifice some yields to invest in short-maturity obligations to avoid the higher price volatility of long-maturity bonds

hypothesis (also known as the preferred habitat theory[7]). The yield curve deviations from the expectations hypothesis are the largest for shorter maturities (less than 24 months), as found, for example, in a study by Backus, Foresi, Mozumdar and Wu (see Backus et al., 1998:4).

Upward-sloping yield curves offer trading opportunities, which may be best executed using government bond or interest rate futures. The price of a financial future is described by the following equation (Hull, 2002:51):

$$F_0 = S_0 e^{(r-q)T}, \tag{7}$$

where F_0 – price of the futures contract, S_0 – cash price of the cheapest-to-delivery bond, T – time until delivery (expiration of the futures contract), r – short-term interest rate, and q – yield of underlying security.

It is evident from the equation that when a yield curve is upward-sloping, then r<q. Therefore, for the futures of longer-term debt securities before delivery $(r\text{-}q)T<0$ and $F_0<S_0$. By the time of delivery, T approaches zero and F_0 converges to S_0. If market conditions do not change, then (ceteris paribus) S_0 will stay constant and F_0 will converge (i.e. increases) to S_0.

For example, one such model for structural alpha in interest rate markets is reported by a leading global bond manager, PIMCO[8] (PIMCO, 2005). Their model has produced simulated annualized excess return over 3-month Libor in a 14-year period ending in September 2005: 9.7% in the 5th contract of US 3-month futures, 8.51% in US 5-year government bond futures, 8.05% in US 10-year government bond futures, and 6.94% in US 30-year government bond futures. It should be noted, however, that this performance was achieved during a period of declining interest rates and the interest rate trend has not been eliminated from the results shown.

Similar results have been reported by JPMorgan (Loeys and Fransolet, 2004:8). They used US 3-month forward interest rates in eight 3-month periods between maturities of 3 months and 21 months and found that the highest return to risk ratio can be achieved at the 3-month forward interest rate around a 12-month horizon of the money market yield curve, giving a return to risk ratio of 0.85. The 12-month or 1-year maturity point also reflects the conventional border between the money market and the debt market, so the given result may be caused by the relatively larger amount of money market funds

(see Reilly and Brown, 2003:761–762).

[7]The preferred habitat theory states that since investors prefer to hold short-term rather than long-term bonds, the term premium would rise as the maturity of the bond increases (Mishkin, 1992:817). The theory is further supported by borrowers preferring to borrow money for a longer rather than a shorter term (Hull; 2002:108).

[8]Pacific Investment Management Company.

(investing in bills with maturities up to 1 year) in the world over debt funds with a longer duration. This can cause the demand for debt instruments with maturities of 1 year or less to be considerably higher than the demand for debt instruments with higher maturities, which may explain why the best simulated trading results happened exactly around the 12-month maturity sector.

3. Empirical estimation of active investment models

3.1. Overview of data, methodology and investment framework

All the estimated models were tested during a period of 13.5 years (162 months) starting on December 31, 1992, and ending on June 30, 2006. The data sources were EcoWin and Bloomberg. All the models were implemented using derivative instruments (forward contracts or futures). Therefore, the results of the estimated models reflect pure excess return (alpha) that can be earned over a pre-determined benchmark: the funds invested according to the pre-determined benchmark can act just as collateral for the derivative portfolio as long as they are invested in liquid financial instruments (bonds, stocks, etc.). In this way the returns of the benchmark portfolio can be clearly separated from the returns achieved from the decisions to deviate from the pre-given benchmark. In addition, the use of derivative instruments enables the investor to minimize foreign exchange risk while taking interest rate views: as the positions are opened and closed on the same value (maturity) date, then foreign exchange movements have effect only on the profits and losses of the positions, but not on the underlying nominal amount.

The use of derivative instruments enables investors to scale the risk exactly according to their risk tolerance level. Investors who do not want to have leveraged positions may hold 100% collateral, whereas investors who want to have the maximum amount of leverage may use only the minimum margin requirements of the futures exchanges or trading partners. Therefore, the reader (investor) should pay more attention to the different risk-return ratios presented in the simulations than to the return and risk statistics alone, as these can be leveraged up to earn a higher return.

The results from the currency positions tested are calculated in percents, as this is the measurement convention used in financial literature. The results from the interest rate positions, however, are calculated in euro. There are two reasons for doing that. First, as interest rate futures are derivative instruments and enable high levels of leverage, the percentage returns depend on the amount of leverage — we can get huge returns when only the minimum margin requirements are used (for example, the minimum margin requirement for one contract of US 3-month interest rate future is only 945 USD, while the contract size is 1 million USD, and the value of 1 full point of movement in the price is 2,500 USD.)[9] and relatively small returns when the nominal contract size or contract values are used. Measuring the returns in euro at the same time gives a clear and straightforward picture of the returns available from a certain number of contracts, giving the reader (investor) the possibility of choosing its own target leverage level. The second reason for calculating the return in euro is the fact that the futures contracts have relatively large nominal contract sizes and the contracts are not divisible[10]. Therefore, it is more convenient to invest in a certain and fixed number of futures contracts than in a variable number of futures contracts in order to retain a fixed total value, which would be required for calculating a mathematically correct percentage return. As the results of the interest rate positions are calculated in euro, so too are the results of the combined portfolio calculated in euro. The sizes of the positions provided in the article are hypothetical and can be changed according to the investors' preferences.

The following test statistics are calculated for each model and later for the whole portfolio:

- Return statistics:
  - Cumulative excess return over the test period
  - Average annual excess return
  - Average monthly excess return
- Risk and volatility statistics:
  - Standard deviation of the average monthly excess return
  - Maximum monthly excess return
  - Minimum monthly excess return
  - Maximum drawdown.
- Different return and risk ratios and lengths of drawback periods:

[9]Source: Bloomberg.

[10]For example, the future of a Japanese 10-year government bond has a nominal and indivisible size of 100 million yen (Source: Bloomberg).

- Annualized Sharpe ratio. Calculated as $\sqrt{12}\frac{r_{excess}}{stdev(r_{excess})}$, where rexcess is the average monthly excess return and $stdev(r_{excess})$ is the standard deviation of the average monthly excess return. The original Sharpe ratio (see Sharpe 1994) uses the difference between the return from the active portfolio and the return from the benchmark portfolio in both the numerator and for the calculation of the standard deviation. As in our model all the positions are taken using derivative instruments, the return from the benchmark portfolio is constantly zero and in this way is cancelled out from the calculations.
- Accuracy (the number of months with a positive performance divided by the total number of months with a nonzero performance).
- Profit factor (gross profit divided by gross loss).
- Longest flat period (the length of the period without a new equity high) in months.

The given set of test statistics provides a good overview of both the return and risk side of the estimated models.

FX markets are very liquid and trading is possible 24 hours a day. The daily close prices are fixed in Bloomberg either at the New York, London or Tokyo closes. In the given paper, the prices at the New York close are used because they are the latest and by that time the daily close interest rate levels in the markets are also available.

In cases of a 24-hour market, the daily closing prices are practically the same as the opening prices for the next day (except for weekends and holidays). This fact has to be taken into account when interpreting the results of the simulations as the usual back-testing rules use close prices to calculate the signals while the trades are initiated with the next opening. However, as it is in the FX markets, the closing and the next opening occur at the same time (except after weekends and holidays). A small slippage due to the time needed to calculate and trade the positions is unavoidable. In this paper, the slippage is assumed to be zero.

The trading costs for institutional clients consist mainly of the bid-ask spreads. The average bid-ask spreads of different cross-currency pairs are presented in Table 1.

When an active currency view is implemented using forward contracts, we have to also consider the interest rate difference in the two countries to calcu-

[11] The data is based on the differences between bid-ask quotes during normal trading hours in the institutional forex trading platforms DrKW Piranha, CitiFX Trader and UBS FX Trader.

Table 1: Average bid-ask spreads of different cross-currency pairs (%)[11]

	USD	EUR	JPY	CAD	GBP	SEK	NOK	AUD	NZD	CHF
USD	X	0.008	0.018	0.025	0.011	0.026	0.031	0.039	0.042	0.024
EUR	0.008	X	0.022	0.034	0.030	0.027	0.032	0.050	0.052	0.013
JPY	0.018	0.022	X	0.043	0.025	0.055	0.061	0.059	0.064	0.023
CAD	0.025	0.034	0.043	X	0.037	0.051	0.056	0.077	0.060	0.038
GBP	0.011	0.030	0.025	0.037	X	0.036	0.043	0.063	0.058	0.022
SEK	0.026	0.027	0.055	0.051	0.036	X	0.067	0.092	0.069	0.041
NOK	0.031	0.032	0.061	0.056	0.043	0.067	X	0.096	0.076	0.049
AUD	0.039	0.050	0.059	0.077	0.063	0.092	0.096	X	0.100	0.062
NZD	0.042	0.052	0.064	0.060	0.058	0.069	0.076	0.100	X	0.068
CHF	0.024	0.013	0.023	0.038	0.022	0.041	0.049	0.062	0.068	X

late the forward exchange rates. In addition, these interest rates have bid-ask spreads that are around 1–4 bp (0.01–0.04%), depending on the currency pair.

The futures of debt instruments are the easiest to use in order to implement active views in the interest rate markets. For government bond markets of major countries the following futures are liquid, available, and tradable with the following trading times, open and close fixing times and bid-ask spreads (see Table 2).

Table 2: Trading details for available and liquid government bond futures[11]

Country	Maturity	Trading times	Open fixing	Close fixing	Average bid-ask spread
USA	30 years	03.00–00.00	15.20	22.00	0.5/32
	10 years	03.00–00.00	15.20	22.00	0.5/32
	5 years	03.00–00.00	15.20	22.00	0.5/32
	2 years	03.00–00.00	15.20	22.00	0.5/32
Canada	10 years	13.00–22.00	13.00	22.00	0.02
UK	10 years	10.00–20.00	10.00	20.00	0.01
Germany	10 years	09.00–23.00	09.00	23.00	0.01
	5 years	09.00–23.00	09.00	23.00	0.01
	2 years	09.00–23.00	09.00	23.00	0.01
Japan	10 years	03.00–05.00; 06.30–9.00; 9.30–12.00	03.00	09.00	0.02
Australia	10 years	01.32–09.30; 10.12–00.00	01.32	09.30	0.005 in price, ab 0.04 in value
	3 years	10.10–00.00; 01.30–09.30	01.30	09.30	0.005 in price, ab 0.03 in value

[11]For average bid-ask spread in the USA (30 years) the prices of US government bond futures are quoted not in the decimal system, but in 1/32nds.
For average bid-ask spread in Australia (10 years) see the specifics of calculating the value of Australian government bond futures from the price in Appendix 1.
Bloomberg data is used for trading and fixing times, and data from corresponding futures exchanges is used for bid-ask spreads. Open interest and total volume functions in Bloomberg are used for monitoring liquidity. Trading times are shown for the Helsinki-Tallinn-Riga time

Table 3: Trading details of available and liquid interest rate futures [13]

Country	Maturity	Trading times	Open fixing	Close fixing	Average bid-ask spread
USA	30 day	03.01–22.00	15.20	22.00	0.005
	90 day	01.00–22.00	15.20	22.00	0.005
Canada	90 day	15.20–22.00	15.20	22.00	0.005*
UK	90 day	09.30–20.00	09.30	20.00	0.01
Euro area	90 day	09.00–20.00	09.00	20.00	0.005
Switzerland	90 day	09.30–20.00	09.30	20.00	0.01*
Australia	90 day	10.08–00.00; 01.28–09.30	01.28	09.30	0.01 in price, ab 0.02 in value

It is evident from the table that liquid 10-year futures are available in all six countries, 5-year futures in the USA and Germany and 2–3 year futures in the USA, Germany and Australia. For shorter maturities the following futures are available in Table 3.

The settlement months for futures contracts are usually December, March, June or September of each year[12]. To back-test trading strategies based on futures, a continuous price series has to be formed from actual subsequent historical futures. The continuous futures prices can be calculated from actual historical futures prices using either the difference-adjusted methodology or the ratio-adjusted methodology. The first one preserves the movements of prices in absolute terms; the latter preserves the movements in prices in relative terms. Depending on the purpose of the back-test (i.e. whether the absolute or relative return has to be calculated), one has to use the difference-adjusted or ratio-adjusted continuous futures price, respectively. In this paper, the difference-adjusted futures prices are used.

3.2. Models exploiting the forward premium bias in foreign exchange markets

3.2.1. Simple carry-based model of 10 major currencies

The model generates monthly signals to trade three cross-currency positions out of ten major currencies (USD, EUR, CAD, CHF, SEK, NOK, JPY,

zone (GMT +2 hours) during summer.

Liquid markets for first contracts, liquidity declines sharply from 4th–5th contract

[12]For some futures there also exist contracts with different settlement months, but as a rule, they have much lower liquidity.

[13]In cases of multiple similar contracts in the same market segment, the most liquid one was chosen.

* Liquid markets for first contracts, liquidity declines sharply from 4th-5th contract.

AUD, GBP, and NZD). The signals were generated by ranking the currencies according to the value of the 1-month deposit interest rates, starting from the highest. Then cross-currency positions were initiated with 1-month forward contracts according to the following rule:

- Buy the 1st currency against the 10th
- Buy the 2nd currency against the 9th
- Buy the 3rd currency against the 8th

In historical simulations, the 1-month deposit interest rates were used to calculate the 1-month forward exchange rate. All the positions were held for one month, and then the model generated the next positions. The model has no target or stop-loss levels. The cumulative performance results of the currency model and individual currency positions (in percentage terms and trading costs deducted) are presented in Figure 1 and the performance statistics in Table 4.

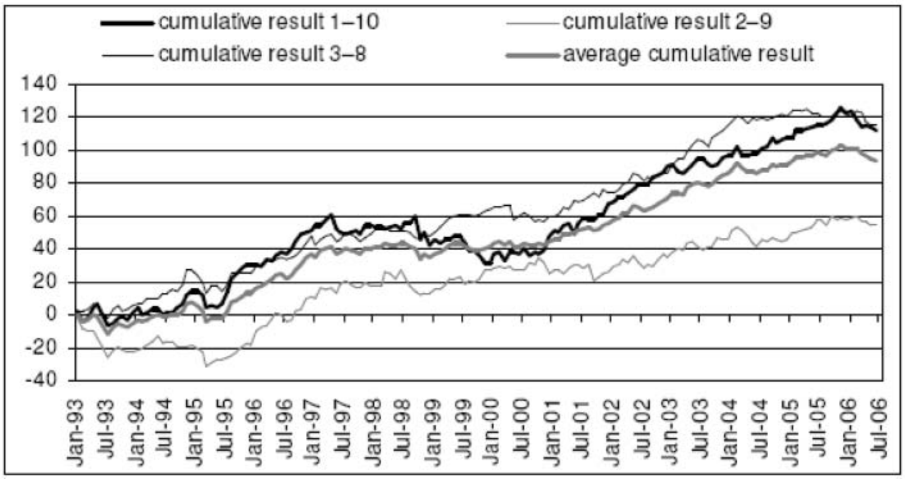

Figure 1: Simulated results of the simple carry-based currency model (%)

As can be implied from Figure 1, the carry-based currency model had relatively good performances in 1995–1997 and from 2001 to the end of 2005, and more moderate performances in the other periods. The statistics of the currency model are relatively good, especially considering the simplicity of the model. The annualized Sharpe ratio of the entire model is 0.94 and that of individual currency pairs between 0.38 and 0.95. The monthly results of individual currency pair positions range from –13.5% to +8.9% and of the entire model from –7.1% to +5.3%. The average monthly excess return in the simulations was 0.6%, the maximum drawdown –12.1%, and the longest flat period

Table 4: Simulated results and selected statistics of the currency model

Statistics	Average	1–10	2–9	3–8
Cumulative excess return (%)	93.66	111.68	54.15	115.14
Average annual excess return (%)	6.94	8.27	4.01	8.53
Average monthly excess return (%)	0.58	0.69	0.33	0.71
Standard deviation of average monthly excess return (%)	2.13	3.33	3.03	2.58
Maximum monthly return (%)	5.26	8.90	8.17	8.16
Minimum monthly return (%)	-7.07	-13.51	-9.49	-8.08
Maximum drawdown (%)	-12.07	-29.88	-29.00	-13.72
Sharpe ratio, annualized	0.94	0.72	0.38	0.95
Accuracy	0.66	0.69	0.57	0.63
Profit factor	1.96	1.71	1.32	2.04
Longest flat period (months)	20	54	38	14

20 months. It is, however, difficult to explain why the third currency position performed better than the second did, which is slightly counter-intuitive.

The results of the currency model divided by pure carry and pure exchange rate movements are presented in Figure 2[14] .

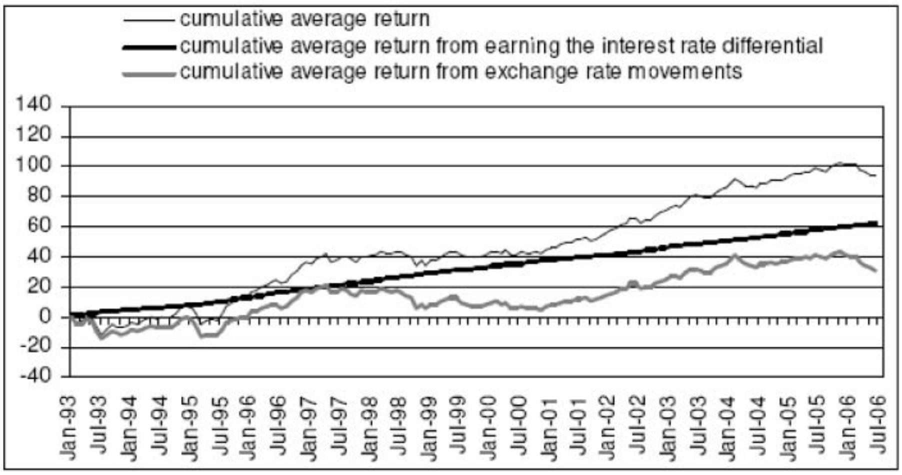

Figure 2: Performance of the currency model by pure carry and pure exchange rate movements (%)

The results indicate that more than half of the results of the carry-based foreign exchange model are achieved by earning the interest rate differential. The share of foreign exchange rate movements in the total cumulative return is approximately 40%. The exchange rate movements have been, on average, in the opposite direction of what was predicted by the uncovered interest rate parity.

[14]The bid-ask spread is added to the carry component.

3.2.2. Adding risk factors to the simple carry-based FX model

In order to achieve more stable performance, a risk factor was added to the simple carry-based model and the number of currency pairs traded was reduced based on their liquidity. The final model generated monthly signals based on the ranking of the carry-to-risk[15] ratios. Each month the model took four cross-currency positions out of fourteen liquid currency pairs: the USD exchange rate against the EUR, JPY, SEK, CAD, GBP, NOK, AUD, CHF, NZD and the EUR exchange rate against the JPY, SEK, GBP, NOK and CHF. The positions were initiated with 1-month forward contracts.

In historical simulations 1-month deposit interest rates were used to calculate the one-month forward exchange rate. All the positions were held for one month, and then the model generated the next positions. As was the case with the simple carry-based model, the carry-to-risk model also had no target or stop-loss levels. The cumulative performance results of the currency model and individual currency positions (in percentage terms and trading costs deducted) are presented in Figure 3 and the performance statistics in Table 5.

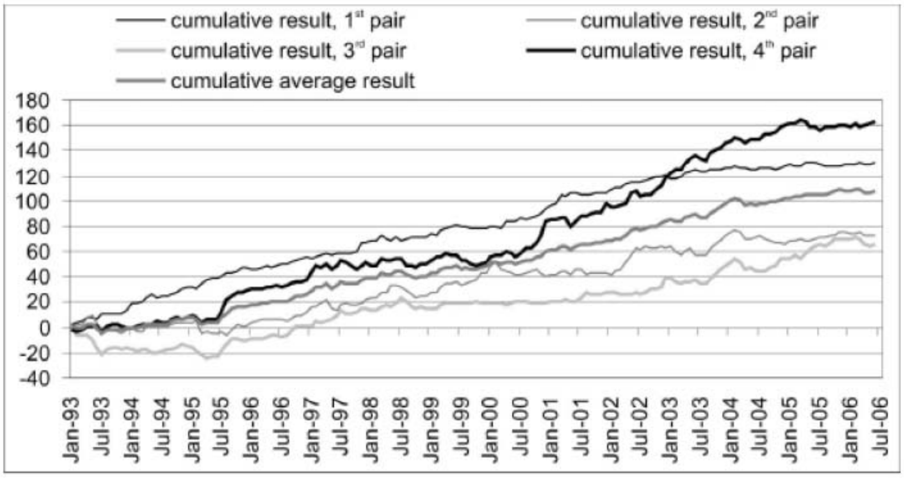

Figure 3: Simulated results of the currency model using risk-adjusted carry (%)

As can be implied from Figure 3, the model based on the risk-adjusted carry is relatively more stable than the model using only the difference in short-term interest rates. The annualized Sharpe ratio of the entire model is 1.53 and that of the individual currency pairs between 0.60 and 1.67. The monthly results of the individual currency pair positions range from –10.2% to +12.2% and of

[15]The difference in the 1-month deposit interest rate (carry) divided by the annualized daily standard deviation of the exchange rate movement within the rolling past 12-months.

Table 5: Simulated results and selected statistics of the risk-adjusted carry-based currency model

Statistics	Average	1st pair	2nd pair	3rd pair	4th pair
Cumulative excess return (%)	108.09	131.18	73.28	65.09	162.80
Average annual excess return (%)	8.01	9.72	5.43	4.82	12.06
Average monthly excess return (%)	0.67	0.81	0.45	0.40	1.00
Standard deviation of average monthly excess return (%)	1.52	1.68	2.63	2.23	2.80
Maximum monthly return (%)	4.09	8.03	6.67	6.00	12.17
Minimum monthly return (%)	-3.91	-3.07	-10.18	-6.17	-7.74
Maximum drawdown (%)	-6.89	-4.28	-15.97	-24.94	-9.21
Sharpe ratio, annualized	1.53	1.67	0.60	0.62	1.24
Accuracy	0.73	0.70	0.61	0.57	0.65
Profit factor	3.10	3.84	1.57	1.61	2.54
Longest flat period (months)	15	9	42	45	15

the entire model from –3.9% to +4.1%. The average monthly excess return in the simulations was 0.7%, the maximum drawdown –6.9%, and the longest flat period 15 months. The results are clearly better than the results of the previous model that used also less liquid currencies and only the short-term interest rate differential as an input.

The contribution to the carry-to-risk currency model from pure carry and pure exchange rate movements is presented in Figure 4.

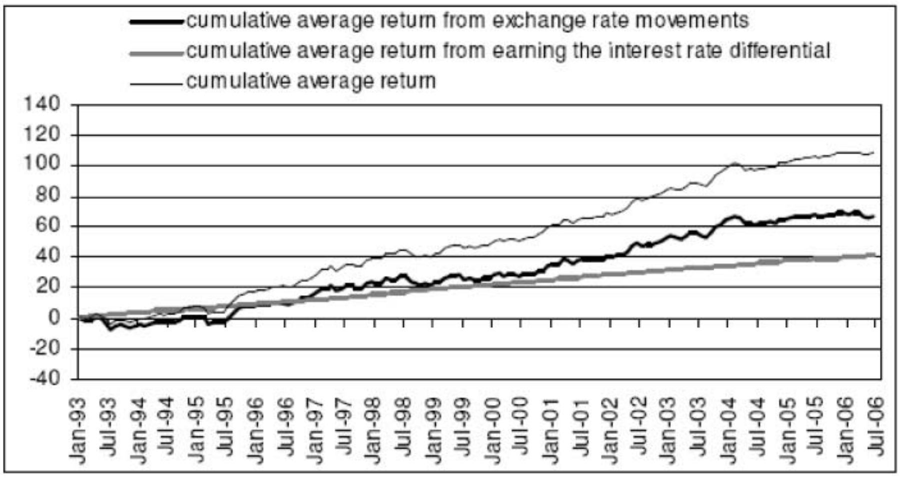

Figure 4: Performance of the risk-adjusted carry based currency model by pure carry and pure exchange rate movements (%)

According to the results, the contribution from earning the interest rate differential and the contribution from exchange rate movements to the cumulative results are somewhat different from the simple carry-based model. The contribution from earning the interest rate differential formed only about one third of the total results, and about two-thirds of the cumulative results came from foreign exchange rate movements. Here also the results indicate that the exchange rate movements on average have been in the opposite direction of what was predicted by the uncovered interest rate parity.

An attempt was also made to construct and use a risk appetite index based on the US 10-year swap spread, Emerging Markets Bond Index spread, US High Yield spread and FX market volatility (following JPMorgan, 2001; Kantor and Caglayan, 2002). The tests indicated that the use of the given risk measures does not improve the cumulative performance of the model.

3.3. Models exploiting the time premium in interest rate markets

3.3.1. Long-only positions in interest rate markets using government bond and money market futures

The goal of the model was to test if the time premium in yield curves can be profitably exploited by simply holding long positions in shorter interest rate or longer government bond futures. The model was tested in the following maturity sectors using the following futures contracts[16]:

- 10-year sector: 10-year government bond futures in the US (8 contracts), Germany (9 contracts), Japan (1 contract), the UK (5 contracts), Canada (11 contracts) and Australia (12 contracts);
- 5-year sector: 5-year government bond futures in the US (11 contracts) and Germany (14 contracts);
- 2–3 year sector: 2-year government bond futures in the US (14 contracts), Germany (34 contracts) and 3-year government bond future in Australia (27 contracts);
- 1.25-year sector: 5th 3-month interest rate futures contracts in the US (16 contracts), Germany (22 contracts), the UK (24 contracts) and Australia (26 contracts)[17];

[16] The number of contracts was calculated with the goal of having the monthly standard deviation of each individual position at around 13,600 euros. This is the smallest possible monthly volatility that can be achieved with holding Japanese 10-year government bond futures (that have an indivisible contract size of 100 million yen) in the portfolio.

[17] The 5th contract in Canadian 3-month interest rate futures was not included because of its low liquidity.

- 1-year sector: 4th 3-month interest rate futures contracts in the US (17 contracts), Germany (23 contracts), the UK (25 contracts), Australia (26 contracts) and Canada (10 contracts);
- 0.75-year sector: 3rd 3-month interest rate futures contracts in the US (18 contracts), Germany (25 contracts), the UK (26 contracts), Australia (26 contracts) and Canada (10 contracts);
- 0.5-year sector: 2nd 3-month interest rate futures contracts in the US (22 contracts), Germany (30 contracts), the UK (30 contracts), Australia (29 contracts) and Canada (11 contracts).

For each test the difference-adjusted continuous futures contract was used. The trading costs of rolling over the contract after every 3 months were deducted. As the overall level of interest rates in all the covered markets declined during the study period, the positive effect on the simulated performance from the cumulative decline in interest rate levels was also deducted from the results. The model had no target or stop-loss levels, and the long positions were held for the entire 162-month test period[18]. As the number of different contracts traded within each maturity sector was unequal, we compared the averages (not the sum) of the positions in the individual futures of the same maturity sector in order to compare different maturities.

The results (see Figure 5 and performance statistics in Table 6) indicate that a simple long-only strategy using interest rate futures is indeed capable of profitably exploiting the time premium in yield curves with annualized Sharpe ratios near 0.6 for shorter durations. The best performance can be achieved by using the 3rd or 4th contract of a 3-month interest rate future; the performance of the portfolios of 10-year and 5-year futures was considerably worse. In addition, it is evident from Figure 5 that all the cumulative performance series are highly correlated.

In spite of the positive overall performance, the strategy of having long-only positions in interest rate futures had relatively long and steep drawbacks during the test period. The longest flat periods were between 28 and 56 months and the ratios of maximum drawdown to average annual excess return between 4–10 years depending on the maturity sector.

3.3.2. Adding filters to the long-only strategy

The long and steep drawdowns in the performance of the simple long-only portfolios suggested the need for a filter that would take the positions off dur-

[18]Due to data availability, the test period for German 3-month interest rate futures begins in July 1994.

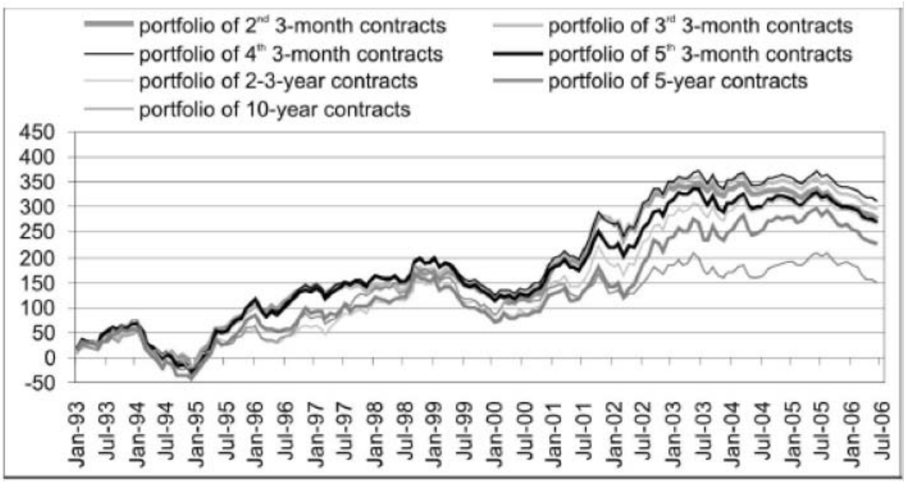

Figure 5: Simulated results of the long-only positions in government bond and interest rate futures (thousands euros)

ing unfavorable times. Two ideas for constructing such filters were tested: filters based on the shape of the yield curve and filters based on the direction of the interest rates.

The yield-curve based filter is based on the idea that the long futures positions have a higher probability of yielding positive returns during the times of steeper upward-sloping yield curves (see Equation 8). Following this idea, the differences between the interest rate of the underlying securities of the futures contracts and a 1-month deposit interest rate were calculated at the end of each month. If the difference was smaller than a certain threshold, the long futures position was taken off for the next month. Different positive threshold levels were selected for each maturity sector and finally the yield curve spread level that gave the highest Sharpe ratio for the given maturity sector as a whole were chosen. In order to get more robust results the tests were carried out with equal threshold levels for all regions within one maturity sector of futures.

As can be seen from Table 7 the filter did indeed improve the results of the tested portfolios: the profit factors improved in all maturity sectors and the Sharpe ratios improved in most maturity sectors. The best results could be achieved by applying a 136 bp filter to the portfolio of 5-year interest rate futures giving us a Sharpe ratio as high as 0.91 and a profit factor as high as 2.62.

The idea of the second set of filters was to take the long positions off during the times when the general level of interest rates was rising, as the value of the debt instruments decreases when interest rates rise[19]. The base interest rates

[19]It could be noted that the drawdown periods of the model (in 1994, 1999 and 2006)

Table 6: Simulated results and selected statistics of the long-only positions in government bond and interest rate futures

Statistics	10-year	5-year	2-3-year	5th 3-month	4th 3-month	3rd 3-month	2nd 3-month
Cumulative excess return (€)	143,404	229,788	263,932	268,990	310,977	296,308	275,367
Average annual excess return (€)	10,623	17,021	19,551	19,925	23,035	21,949	20,398
Average monthly excess return (€)	885	1,418	1,629	1,660	1,920	1,829	1,700
Standard deviation of average monthly excess return (€)	10,542	12,368	10,789	11,184	11,048	10,621	10,465
Maximum monthly return (€)	25,428	30,303	26,844	33,844	29,894	29,689	34,375
Minimum monthly return (€)	-27,622	-34,087	-26,067	-24,800	-30,884	-31,636	-32,059
Maximum drawdown (€)	-101,704	-100,310	-80,214	-98,542	-99,773	-95,837	-87,343
Sharpe ratio, annualized	0.29	0 40	0.52	0.51	0.60	0 60	0 56
Accuracy	0.57	0.57	0.56	0.56	0.54	0.55	0.52
Profit factor	1.24	1 34	1.47	1.44	1.56	1.56	1 54
Longest flat period (months)	52	36	28	37	36	36	36

of each country were chosen as filters, because these series do not have daily fluctuations. The following simple rule was applied: if the base interest rate level was raised during the previous month, then the long position in futures was taken off for the next month. Table 8 shows us that the rule increased the risk-return ratios for all positions except those in 10-year government bond futures.

According to the tests, the portfolio of the 3rd 3-month interest rate futures showed the best performance with a Sharpe ratio of 0.68 and a profit factor of 1.68. The results of the portfolios of 5-year futures with a yield curve filter and the 3rd 3-month futures with a base interest rate filter are presented graphically in Figure 6.

The figure shows that the two series have several periods with similar returns (both series had negative returns in 1994, positive returns in 1993 and 2002 and almost flat returns in 1997–2000), but also several periods when they behaved differently, for example in 2001 and in 2005–2006.

---

coincided with the periods of rising base interest rates.

Table 7: Optimal threshold levels and return-risk ratios of the portfolios with a yield curve filter

Statistics	10-year	5-year	2-3-year	5th 3-month	4th 3-month	3rd 3-month	2nd 3-month
Optimal threshold level for yield curve spread (bp)	114	136	70	91	145	112	96
Profit factor	1.80	2.62	1.79	1.92	2.98	2.49	2.87
Sharpe ratio, annualized	0.74	0.91	0.50	0.69	0.74	0.58	0.64

Table 8: The return-risk ratios of the portfolios with a base interest rate filter

Statistics	10-year	5-year	2-3-year	5th 3-month	4th 3-month	3rd 3-month	2nd 3-month
Sharpe ratio, annualized	0.28	0 50	0.62	0.59	0.65	0.68	0.67
Profit factor	1.24	1 47	1.61	1.55	1.64	1.68	1 69

3.4. Combining estimated models into one portfolio

The final portfolio included the following three models that demonstrated better performance in historical simulations in both risk classes:

- A currency model based on the risk-adjusted carry;
- A long-only portfolio of the 3rd contracts of 3-month interest rate futures with a filter attempting to eliminate losing trades during upward movements in the base interest rate;
- A long-only portfolio of 5-year interest rate futures with a filter that takes the positions off during months when at the beginning of the month the spread between 5-year government bond interest rates and 1-month deposit interest rates is less than 136 bp.

The correlation analysis (see Table 9) shows that the two estimated interest rate models have relatively low levels of correlation with the currency model, while at the same time they have relatively high levels of correlation with each other. Following that, a decision was made to scale the positions so that both the currency model and the two interest rate models together would contribute equally to the volatility of the overall investment portfolio. It was also decided to divide the volatility given to the interest rate futures' portfolio equally between the 3-month and 5-year models.

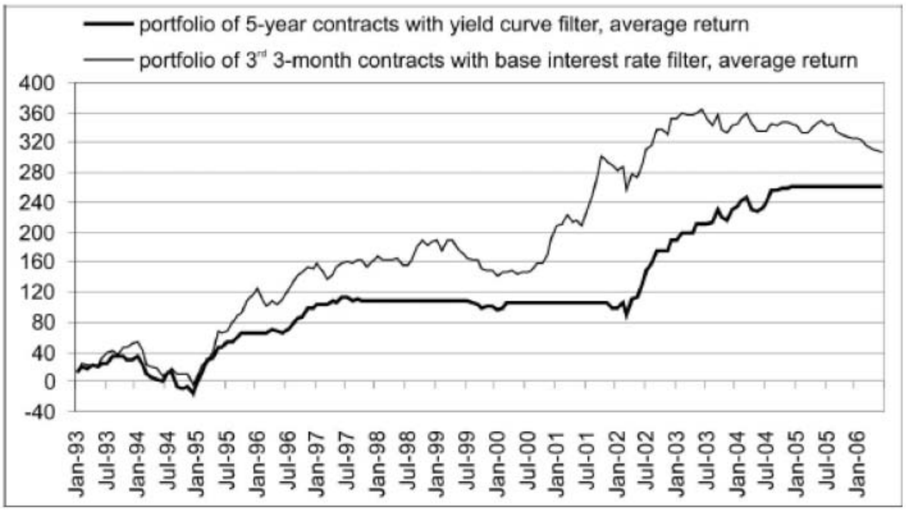

Figure 6: Simulated results of the portfolios of 5-year futures with a yield curve filter and the 3rd 3-month futures with a base interest rate filter (thousands euros)

Table 9: Correlation analysis of the estimated models

	3-month interest rate model	5-year interest rate model	Currency model
3-month interest rate model	1	0.58	0.04
5-year interest rate model	0.58	1	0.08
Currency model	0.04	0.08	1
	Two interest rate models	Currency model	
Two interest rate models	1		
Currency model	0.07		

This size of the positions is arbitrary and can be scaled to reflect the risk, return and leverage constraints of each individual investor. As an illustrative example, forex positions with a nominal size of 500,000 euro were chosen as a starting point. In this way, the monthly standard deviation of the forex portfolio was around 30,000 euro. The sizes of interest rate positions that gave us the same risk level for the interest rate positions as a whole were the following: 13 contracts of US 5-year futures, 24 contracts of German 5-year futures, 6 contracts of US 3rd 3-month futures, 8 contracts of German 3rd 3-month futures, 4 contracts of Canadian 3rd 3-month futures, 8 contracts of UK 3rd 3-month futures and 9 contracts of Australian 3rd 3-month futures.

The benefits of diversification can be clearly seen from the results (see Figure 7 and the performance statistics in Table 10). The combined portfolio has a higher Sharpe ratio (1.68), a higher profit factor (3.86) and a shorter flat period than each individual model. In addition, the combined model has a lower standard deviation and smaller maximum drawdown than the sum of the respective statistics of the individual models.

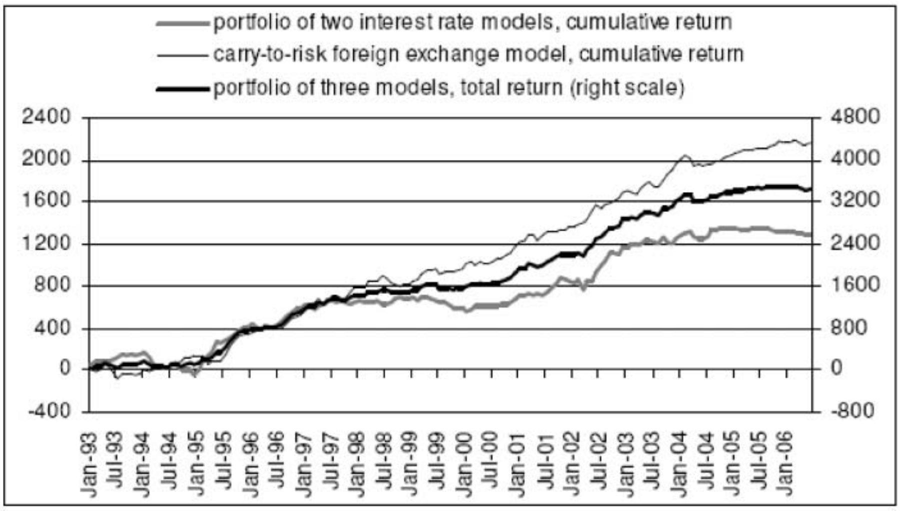

Figure 7: Simulated results of the portfolio of three models (thousands euros)

Table 10: Simulated results of the portfolio of three models

Statistics	Total portfolio	Combined portfolio of two interest rate models	Carry-to-risk FX model
Cumulative excess return (€)	3,449,116	1,287,363	2,161,753
Average annual excess return (€)	255,490	95,360	160,130
Average monthly excess return (€)	21,291	7,947	13,344
Standard deviation of average monthly excess return (€)	43,806	29,567	30,303
Maximum monthly excess return (€)	139,864	95,859	81,812
Minimum monthly excess return (€)	-141,709	-95,385	-78,152
Maximum drawdown (€)	-150,466	-218,729	-137,861
Sharpe ratio, annualized	1.68	0.93	1.53
Accuracy	0.69	0.58	0.73
Profit factor	3.71	2.10	3.10
Longest flat period (months)	12	26	15

The Sharpe ratio of the entire portfolio exceeds the median information ratio of currency overlay managers (0.5) by more than three times and the median information ratio (0.2) of global fixed income hedge funds by more than eight times (Collins et al., 2005:77). The statistics are relatively good and comparable to the performance of some more complex models (see the models developed by Vesilind and Kuus, 2005). Therefore, we can conclude that in spite of the growing number of market participants trying to exploit the existing inefficiencies and structural risk premiums, the two risk premiums studied in this article can still offer profitable trading opportunities for investors.

Since the number of optimized parameters in the tested models is quite low and their setup has a sound theoretical base, they should be sufficiently robust for an investor to expect positive performance also in the future. However, it should be noted that the performance of the money market interest rate model is largely dependent on the presence of a monetary policy easing cycle and is therefore more cyclical compared to the carry-to-risk foreign exchange model.

To give an idea about the possible percentage returns the given strategies yielded in the simulations, the returns and standard deviations for the three leverage levels were also calculated in percentage. The first two represent the two extremes — an investor having no leverage and an investor having the maximum amount of leverage. The third reflects a more reasonable choice, namely an investor with a targeted annual excess return of 10%.

For an unleveraged investor, a portfolio with a size of 26.4 million euro[20] would enable one to take the abovementioned position sizes. In that case, the average simulated annual excess return would have been 0.97% with the monthly standard deviation of 0.17%. For an investor targeting a 10% annual excess return, the monthly standard deviation would have been 1.71% and the portfolio size would have been 2.55 million euro. An investor who wants to have the maximum amount of leverage, would have needed only 208,732 euro[21] for these position sizes. Then the average annual excess return would have been as high as 122.4% with the monthly standard deviation of 21.0%.

---

[20] Calculated as 4*0.5 million euros (currency positions), plus 6 US 3-month interest rate futures contracts each with a nominal size of 1,000,000 USD (exchange rate of 1.25 USD/EUR), plus 8 German 3-month interest rate futures contracts each with a nominal size of 1,000,000 EUR, plus 4 Canadian 3-month interest rate futures contracts each with a nominal size of 1,000,000 CAD (exchange rate of 1.4 CAD/EUR), plus 9 Australian 3-month interest rate futures contracts with a nominal size of 1,000,000 AUD (exchange rate of 1.7 AUD/EUR), plus 13 US 5-year interest rate futures contracts each with a nominal size of 100,000 USD (exchange rate of 1.25 USD/EUR), plus 24 German 3-month interest rate futures contracts each with a nominal size of 100,000 EUR.

[21] Assuming 100 times leverage in forex positions (offered in forex trading platforms and giving us a minimum margin of 20,000 EUR), a 945 USD margin (data source: Bloomberg) for one 3-month US interest rate futures contract (a total minimum margin of 4,536 EUR), a 475 EUR margin for one 3-month German interest rate futures contract (a total minimum margin of 3,800 EUR), a 400 CAD margin for one Canadian 3-month interest rate futures contract (a total minimum margin of 1,143 EUR), a 750 AUD margin for one 3-month Australian interest rate futures contract (a total minimum margin of 3,971 EUR) a 540 USD margin for one 5-year US interest rate futures contract (a total minimum margin of 5,616 EUR), an 800 EUR margin for one 5-year German interest rate futures contract (a total minimum margin of 19,200 EUR) and adding the maximum drawdown the model had in the historical simulation (150,466 EUR).

4. Conclusions

The paper studied two structural risk premiums in financial markets: the forward premium bias in foreign exchange markets and the time premium in yield curves with the goal to test whether the given risk premiums can still produce stable excess returns for investors. To achieve the goal, first, previous tests and models on the given subject were studied. Then, two simple investment models were tested: buying the currencies of the countries with higher short-term interest rates against the currencies of the countries with lower short-term interest rates (i.e. simple foreign exchange carry-strategy), and holding long-only positions in longer-term interest rate futures.

Although the results demonstrated that these simple strategies did indeed produce positive excess returns with Sharpe ratios reaching 0.94 in historical simulations, the simple models had relatively long and sharp drawdown periods. In order to improve the results of the models, the volatility of the exchange rates as a risk factor was added to the currency model and different filters (based on the shape of the yield curve and on the direction of the base interest rates) to the interest rate model. The final currency model had 14 currency pairs and took four monthly exchange rate positions based on the ratio of difference in carry to the historical volatility of the given exchange rate pair. The final interest rate portfolio consisted of two sub-models. The first one had long-only positions in the third 3-month interest rate futures in five regions (the USA, the euro area, the UK, Canada and Australia). These positions were held for most of the test period and taken off only during times of a tightening monetary policy. The second sub-model took long positions in US and German 5-year government bond futures during months when the spread between the 5-year government bond interest rate and 1-month deposit interest rate was equal to or greater than 136 basis points at the beginning of the month.

The three-abovementioned models were combined into one portfolio. Both risk classes (foreign exchange risk and interest rate risk) were given an equal amount of risk measured as a standard deviation of monthly excess returns. The combined portfolio had relatively good risk-return statistics according to the simulated historical tests with a Sharpe ratio of 1.68, a profit factor of 3.71 and 69% of the months giving a positive return. The given statistics are better than the median excess return statistics of active foreign exchange and fixed income managers and show that in spite of the growing number of hedge funds and other market participants trying to exploit the existing market inefficiencies, the two studied structural risk premiums are still present and enable investors to earn stable excess returns.

All of the models were tested using derivative instruments (forward and futures contracts). In this way, the given results reflect pure excess returns that can be scaled according to each investor's risk tolerance and target leverage level. For example, for an investor with no leverage the average simulated annual excess return was 0.97% with a monthly standard deviation of 0.17%; for an investor targeting a 10% annual excess return the simulated monthly standard deviation was 1.71%; and for an investor taking the maximum amount of leverage, the average simulated annual excess return was as high as 122.4% with a monthly standard deviation of 21%[22].

[22]The simulated past performance of investment models cannot be used as an indication of future performance, because the conditions in financial markets can change and the trading rules that worked in the past may lose their effectiveness in the future. The strategies in the given article use derivative instruments that can result in the loss of trading capital due to leverage. The article is for discussion and information purposes only and is not intended as an offer or solicitation with respect to the purchase or sale of any security. Although the data used in the article is taken from Bloomberg and EcoWin and is believed to be reliable, the author does not guarantee its accuracy. The author's compensation in Eesti Pank may be related to the performance of the ideas and models presented in this article.

References

Backus, D., Foresi, S., Mozumdar, A., Wu, L., 1998. Predictable Changes in Yields and Forward Rates. NBER Working paper, 6379.

Bansal, R., Dahlquist, M., 2000. The forward premium bias: different tales from developed and emerging economies. Journal of International Economics, 51, 115–144.

Caglayan, M., Giacomelli, D., 2005. Trading JPMorgan's Carry-to-Risk Currency Model in G-10 & Emerging Markets. JPMorgan Global Currency Commodity Research, March 2.

Collins, M., Eichengreen, B., Hard, S., Whetley, T., Trenner, J., Meese, R., Arnott, S., O'Gorman, A., Mueller, B., Pietsch, B., Taylor, M., Sager, M., Mueller, M., Vandersteel, T., Huttman, M., Harris, L., Lequeux, P., Petej, I., Darnell, M., Levanomi, D., Taylor, J., Muralidhar, A., Guillo, P-Y., Schultes, R., Abele, L., Coyne, A., Hoosenally, R., 2005. Currency Alpha. An Investor's Guide. Deutsche Bank, September.

Deutsche Bank, 2002. Global Markets Research: FX Weekly. October 25.

Fama, E. F., 1984. Forward and spot exchange rates. Journal of Monetary Economics, Vol 14, Issue 3, 319–338.

Hansen, L. P., Hodrick, R. J., 1980. Forward Exchange Rates as Optimal Predictors of Future Spot Rates: An Econometric Analysis. The Journal of Political Economy, Vol 88, No 5, 829–853.

Hull, J. C., 2002. Fundamentals of Futures and Options Markets. 4th ed.

JPMorgan, 2001. New LCPI Trading Rules: Introducing FX CACI, Investment Strategies. JPMorgan Chase Bank, December 19.

JPMorgan, 2004. JPMorgan's FX Commodity Barometer. Global Currency Commodity Research, September 22.

Loeys, J., Fransolet, L., 2004. Have hedge funds eroded market opportunities? J.P. Morgan Securities Ltd., Research report, December 1.

Kantor, L., Caglayan, M., 2002. Using equities to trade FX: Introducing the LCVI. Global Foreign Exchange Research, JPMorgan Chase Bank, October 1.

Mackel, P., 2005. Remember the volatility. Global FX Strategy, ABN-AMRO, March 4.

Mishkin, F. S., 1992. Yield curve. In The New Palgrave Dictionary of Money and Finance, ed. by Newman, P., Milgate, M. and Eatwell, J.

Normand, J., Caglayan, M., Ko, D., Panigirtzoglou, N., Shen, L., 2004. JPMorgan's FX Commodity Barometer. Global Currency Commodity Research, JPMorgan, September 22.

PIMCO, 2005. Investment seminar, October 24–26.

Reilly, F. K., Brown, K. C., 2003. Investment Analysis Portfolio Management. 7th ed.

Rosenberg, M. R., Folkerts-Landau, D., 2002. The Deutsche Bank Guide to Exchange-Rate Determination: A Survey of Exchange-Rate Forecasting Models and Strategies. Deutsche Bank.

Sharpe, W. F., 1994. The Sharpe Ratio. The Journal of Portfolio Management, Fall.

Sydney Futures Exchange [http://www.sfe.com.au/content/sfe/products/pricing.pdf], Dec 30, 2005.

Vesilind, A., Kuus, T., 2005. Application of Investment Models in Foreign Exchange Reserve Management in Eesti Pank. Eesti Pank Working Paper 6/2005.

Appendix 1. Calculating the value of Australian government bond futures from their price

Source: Sydney Futures Exchange
http://www.sfe.com.au/content/sfe/products/pricing.pdf

The value of Australian 10-year or 3-year government bond futures can be calculated from their price using the following formulae:

$$V = 1000 * \left[\frac{c(1 - v^n)}{i} + 100v^n \right] v = v/(1+i)i0(100 - P)/200$$

Where: V – value of futures contract
c – coupon rate / 2 (6/2 = 3 for both 10 and 3-year futures)
n – number of half-years until maturity (20 for 10-year futures and 6 for 3-year futures)
i – yield per annum divided by 200
P – price of futures contract.

Working Papers of Eesti Pank 2006

No 1
Nektarios Aslanidis
Business Cycle Regimes in CEECs Production: A Threshold SUR Approach

No 2
Karin Jõeveer
Sources of Capital Structure: Evidence from Transition Countries

No 3
Agostino Consolo
Forecasting Measures of Inflation for the Estonian Economy