UNIVERSITÄT LEIPZIG

Wirtschaftswissenschaftliche Fakultät
Faculty of Economics and Management Science

Working Paper, No. 102

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November 2011

ISSN 1437-9384

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Abstract

In this paper, I analyze determinants of carry trade returns in Central and Eastern Europe (CEE). I show that carry trades to CEE were lucrative due to interest rate spreads between the funding and investment currency from 2004 to 2006. They became unprofitable when liquidity risk and exchange rate volatility increased after 2007. The analysis suggests that the exchange rate regime of the CEE economy matters for carry trade returns. Overall, exchange rate stabilization, particularly via managed floats, seems to allow for the highest profit opportunities.

Keywords: Carry trades, emerging markets, exchange rates.
JEL: E32, E44, F31, G11.

1 Introduction

Carry trades are investments where investors borrow from low interest rate capital markets and invest in high yield markets to profit from the interest rate differential. Investors take the risk of devaluation of the investment currency. The volume of these speculative investments increased substantially in emerging markets prior to the 2007-8 financial crisis. Especially Central and Eastern Europe (CEE) attracted a surge of un-hedged cross-border investment and lending. As this involves the purchase of assets using foreign currency, carry trades might have contributed to asset market booms in CEE (Galati et al., 2007). The aim of this paper is to analyze if and why carry trades to CEE were lucrative in the run-up to the latest crisis.

To analyze determinants of carry trade returns in CEE, I apply the findings of the most recent empirical carry trades literature to my sample of CEE economies. Following Brunnermeier et al. (2009) carry trades are lucrative as long as liquidity conditions are favorable. Interest rate differentials fuel returns but also increase the crash risk of the investment currency. An unwinding of carry trades is caused by risk aversion in financial markets and the resulting funding constraints. Clarida et al. (2009) add that carry trade returns are related to periods of low exchange rate volatility.

My contribution to the literature is twofold. First, I test the main determinants found in the carry trade literature for the CEE economies. Here, I follow the idea of Minsky (1986) that risk-taking is most pronounced in an upswing of a business cycle. Therefore, in contrast to previous studies, I distinguish between boom and bust in my analysis. Second, I discuss whether exchange rate strategies in CEE affect carry trade returns. To my knowledge the impact of the exchange rate regime has not yet been examined in the carry trade literature.

The paper is organized as follows. I start with an explanation of carry trades and analyze excess returns and risks of carry trades to CEE from 1999 to 2009. Then I investigate determinants of carry trades. I find that liquidity conditions, interest rate differentials, risk appetite and exchange rate stability fuel carry trade returns (and therefore short-term asset markets). The last section concludes.

2 Carry Trades and Exchange Rate Risk

2.1 Uncovered Interest Rate Parity and Carry Trade Returns

There are two prominent ways of carry trading. First, investors borrow from a low interest rate capital market and invest in a (mostly) short-term asset (bank deposits, government papers or risky assets such as *stocks*) in high yield markets to seek for arbitrage profits that stem from the interest rate differential. As long as the investment currency does not depreciate against the funding currency profits are positive (Galati et al., 2007).

A second strategy is to exploit the forward premium (Brunnermeier et. al., 2009; Burnside et al., 2009). This is the difference between the forward exchange rate and the spot exchange rate of two currencies. If a currency is assumed to depreciate against another currency because the forward rate is higher than the spot rate, it has a forward premium and is likely to be sold or becoming the funding currency. Contrary, if a currency is assumed to appreciate having a forward exchange rate that is below the spot exchange rate, it has a forward discount and may become the target of investors. This is then the investment currency.

Both strategies lead to similar outcomes. Currencies with low interest rates should have a forward premium and currencies with high interest rates should have a forward discount for the carry trade to be lucrative. Then borrowing in currencies with low interest rates and lending in currencies with high interest rates is similar to buying currencies at a forward discount and selling them on forward premium.

Carry trades are commonly used by hedge funds and other financial institutions in form of leveraged portfolios to make high short-term profits (Galati and Melvin, 2004). On the other hand, also private households and investors bet on the interest differential without leverage to diversify portfolios or finance domestic assets. Especially in emerging markets the private sector often sets up carry trades through the bank-lending channel. Then foreign denominated borrowing increases. While leveraged carry trades of large institutions may be unwound quickly in case of rising depreciation expectations, household's foreign exposure may not if used to invest in illiquid assets such as housing. Households or firms default on loans in case of sudden depreciation (Galati et al., 2007).

To model the returns of a carry trade strategy, I let e_t be the natural logarithm of the nominal exchange rate (units of investment currency in terms of funding currency). Let i_t be the natural logarithm of the funding interest rate and i_t^* the natural logarithm of the CEE investment interest rate in time t. Then r_{t+1} is the return on investment in $t+1$ from borrowing at i_t in one currency and investing at i_t^* in the other currency.[1]

$$r_{t+1} \equiv (i_t^* - i_t) - \Delta e_{t+1}, \text{ with } \Delta e_{t+1} \equiv e_{t+1} - e_t$$

A positive Δe_{t+1} represents a depreciation of the investment currency. According to the uncovered interest rate parity (UIP) condition, which assumes perfect capital market transmission, the interest rate differential of two countries is equal to the expected exchange rate changes between the respective currencies. For instance, when investors expect an appreciation of the Hungarian forint HUF against the Swiss franc CHF, they are indifferent

[1] i_t is the nominal interest rate.

between investment in Hungary and Switzerland if the interest rate in Switzerland is higher than in Hungary to compensate for the expected appreciation of the HUF.

If, for any reason, the Hungarian interest rate was higher than the Swiss interest rate despite the appreciation expectations of the HUF against the CHF, investment would be made in Hungary. Due to capital inflows Hungarian interest rates would converge (instantly) towards the Swiss interest rates and the exchange rate would appreciate towards its expected value. Therefore, the expected returns of investment in Hungary and Switzerland should be equal because, given UIP, the higher-yielding currency always tends to depreciate against the lower-yielding currency.

Following UIP $E_t[r_{t+1}] = 0$, which means that the expected returns of the carry trade strategy are zero. But to engage in carry trades investors expect that a given interest rate differential between two countries is not offset by the exchange rate movements. Thus, carry traders expect a higher yield from the riskier currency speculation than from risk-less investment. Then $E_t[r_{t+1}] > 0$ in t. If $r_{t+1} > 0$, there is actually an *ex post* excess return from carry trade in $t+1$.

Empirically UIP can hold in the long-run (Flood and Rose, 2002; Chinn and Meredith, 2004). But many studies found that in the short-run excess returns are possible and UIP fails (Flood and Rose, 2002; McBrady, 2005). In fact, high-yielding currencies often appreciate against low-yielding currencies. Thus, currency carry trades can bring about excess returns. Empirically carry trade returns are even positive on average. This is referred to as *forward premium puzzle* in the carry trade literature (Burnside et al., 2009).

2.2 Carry Trade Returns and Crash Risk: Descriptive Statistics and UIP

Investment currencies are currencies of high yielding emerging market economies such as the Hungarian forint (HUF) or the Polish zloty (PLN) in CEE. The funding currencies are low interest rate currencies such as the Swiss franc (CHF), Japanese yen (JPY), the euro (EUR) or the US dollar (USD).

For institutional investors large interest spreads to the USD and JPY may have been of interest in CEE. However, I focus on the CHF and EUR in my analysis. Particularly, CEE households and investors speculated on the interest rate differential using EUR or CHF from 2003 to 2007 (Galati et al., 2007; Saunders, 2007; and Rosenberg and Tirpak, 2008). I see mainly two reasons: First, the CEE interest rate spreads to the euro area and Swiss interest rates were considerable. Second, the dominance of European (e.g. Austrian, German and Swiss) banks in the markets and the geographical proximity allowed for an easy access to these currencies.

To analyze excess returns from EUR and CHF carry trades to Estonia (EE), Bulgaria (BU), Latvia (LV), Lithuania (LT), Romania (RO), Slovenia (SI), Slovakia (SK), Czech Republic (CZ), Poland (PL) and Hungary (HU), I take daily exchange rates for each country's currency to the EUR and CHF from Datastream and monthly money market rates (3-month interest rates) from the International Monetary Fund's International Financial Statistics (IFS). The dataset starts in January 1999 and ends in December 2009.

Table 1 shows the averages of quarterly indicators for excess returns and risks of carry trade from 1999 to 2009. Column 2 of Table 1 indicates that for Hungary, Slovakia, Romania and Poland the average interest rate differentials $(i_t^* - i_t)$ with respect to interest rates in the funding economies are the largest of the group of CEE economies. Column 3 shows the average quarterly exchange rate changes. If the investment currency depreciates on average, Δe_{t+1} is positive (and vice versa).

The average excess returns r_{t+1} from borrowing in CHF or EUR and investing in CEE currencies can be found in Column 4. The calculations of these carry trade returns are based upon log daily exchange rate changes to the EUR or CHF in each quarter to compare interest rate differentials (per quarter) and exchange rate data at the same frequency. In general, the returns are higher with respect to the CHF. Average carry trade returns are particularly high for Hungary, Romania, Slovakia and Poland. For these countries the descriptive statistics suggest that trades had a profit opportunity by buying CEE assets using foreign currency. Only Slovenia's average excess return per quarter with respect to the euro area is negative, because its average interest rate differential is smaller than the depreciation of the tolar against the EUR.

The Sharpe (1994) ratio[2] is a commonly used indicator to calculate the *ex ante* and *ex post* attractiveness of investment (Burnside et al., 2007). Investors use Sharpe ratios to decide on profitability by estimating expected excess returns per units of risk in an investment. The *ex ante* Sharpe ratio S is defined as

$$S = \frac{E(r_{t+1})}{s(E(r_{t+1}))},$$

with $E(r_{t+1})$ being the expected excess returns from carry trade. $s(r_{t+1})$ is the standard deviation of the expected excess returns r_{t+1}. The Sharpe ratio indicates that when excess

[2] According to Eling and Schuhmacher (2007), the Sharpe ratio is an efficient measure to evaluate investment strategies.

returns are high carry trades are attractive given that the volatility of excess returns is low in this period.

Ex post Sharpe ratios can be calculated using *ex post* data to evaluate whether the carry trade was profitable. In Table 1 *ex post* Sharpe ratios S are calculated as ratios of average quarterly excess returns (Column 4) and the standard deviations of quarterly excess returns (Column 5) as observed in the data from 1999 to 2009. The data indicates that Hungary, Slovakia, Estonia and Romania were the most lucrative markets for carry traders in CEE in this period. Sharpe ratios are larger than in other countries because excess returns are high and relatively stable (Column 6). While Estonia has low excess returns, Sharpe ratios are high due to low volatility of returns. Because average excess returns of carry trades from the euro area to Slovenia are negative, the Sharpe ratio is negative as well.

An analysis of skewness[3] of exchange rate changes provides evidence of how exchange rate changes are distributed and is an indication of risks of carry trades. For univariate data $\Delta e_1, \Delta e_2, ..., \Delta e_T$ skewness for each quarter $skew$ is defined as

$$skew = \frac{\sum_{t=1}^{T} (\Delta e_t - \overline{\Delta e})^3}{(T-1) \cdot s^3},$$

with $\overline{\Delta e}$ being the mean of exchange rate changes in the quarter, s the standard deviation of daily changes, and T the total number of daily exchange rate changes in the quarter. Symmetric data, e.g. which is normally distributed, would have a skewness of zero. Thus the average and median of exchange rate changes is equal. A negative skewness implies that a

[3] Skewness is the third standardized moment of a random variable and a standard measure to describe probability distributions.

currency appreciates over a long time while depreciations are less common. Exchange rate developments that are negatively skewed are said to *"go up by the stairs and come down by the elevator"* (Brunnermeier et al., 2009, p. 327). Therefore investment may be profitable for a long time, while a risk of sudden depreciation is at hands.

Table 1: Currency carry trade - Descriptive statistics

CHF Country	$(i_t^* - i_t)$	Δe_{t+1}	r_{t+1}	$s(r_{t+1})$	S	$skew$
BU	0.004	0.002	0.002	0.018	0.111	-0.090
CZ	0.005	-0.005	0.010	0.042	0.238	-0.151
EE	0.007	0.002	0.005	0.018	0.278	-0.161
HU	0.019	0.003	0.016	0.055	0.291	-0.309
LT	0.004	-0.005	0.009	0.033	0.273	-0.027
LV	0.006	0.003	0.003	0.029	0.103	-0.058
PL	0.016	0.002	0.014	0.069	0.203	-0.146
RO	0.050	0.028	0.022	0.059	0.373	-0.192
SI	0.008	0.006	0.002	0.018	0.111	-0.147
SK	0.009	-0.006	0.015	0.036	0.417	-0.052
EUR Country	$(i_t^* - i_t)$	Δe_{t+1}	r_{t+1}	$s(r_{t+1})$	S	$skew$
BU	-0.000	0.000	-0.000	0.003	0.000	-
CZ	0.001	-0.006	0.007	0.035	0.200	0.045
EE	0.003	0.000	0.003	0.005	0.600	-
HU	0.016	0.001	0.015	0.050	0.300	-0.327
LT	-0.000	-0.006	0.006	0.031	0.194	-
LV	0.002	0.001	0.001	0.028	0.036	-
PL	0.013	-0.000	0.013	0.062	0.210	-0.248
RO	0.046	0.027	0.019	0.053	0.358	-0.435
SI	0.004	0.005	-0.001	0.006	-0.167	-0.001
SK	0.006	-0.009	0.015	0.026	0.577	-0.159

Source: Datastream 2010. Averages of quarterly indicators of non-overlapping data (1999-2009).

Table 1 shows the averages of quarterly skewness of daily exchange rate changes from 1999 to 2009 for the CEE currencies with respect to the EUR or CHF (Column 7). Skewness is mostly negative. Exchange rates appreciated over a long period, while they depreciated suddenly. Hungary, Romania and Poland have the "highest" negative values of average skewness. Because of exchange rate stabilization against the EUR over the whole period, the skewness of exchange rate changes for Latvia, Estonia, Lithuania and Bulgaria cannot be calculated (the denominator would be zero as the standard deviation of exchange rate changes is zero).

Carry trades are lucrative if the interest rate differential between the investment and funding currency is – on average – not offset by a depreciation of the investment currency as suggested by UIP and allows for carry trade returns.

To test this econometrically for the CEE countries from 1999 to 2009 I analyze whether interest rate spreads between CEE and the euro area or Switzerland in quarter t have predictive power for the excess returns on investment r_k, in quarter $t+\tau$. This regression is known to signal profitability throughout the entire carry trade literature. With respect to each funding currency f, I estimate a panel regression model with fixed-effects that account for country-specific unobserved heterogeneity in CEE.[4] The regression takes the form

$$r^f_{k,t+\tau} = b^f_0 + b^f_1 (i_{k,t} - i^f_t) + u^f_k + \varepsilon^f_{k,t}, \qquad (1)$$

where $r^f_{k,t+\tau}$ is the excess return in quarter $t+\tau$ from borrowing at interest rate i^f_t in the funding currency f (CHF or EUR) and investing at interest rate $i_{k,t}$ in the CEE countries' currencies k in quarter t. Further, b^f_0 is the constant, u^f_k captures the fixed effect and $\varepsilon^f_{k,t}$ is the error term.

[4] The standard panel unit root tests (Pesaran-Shin, Levin–Lin–Chu, Breitung, Fisher-type) confirm that the data used in this paper (excess returns, stock movements, interest rate spreads, skewness, vix as well as dvix) is stationary. Thus, I can use least squares regressions.

Table 2: Carry trade returns regressed on interest rate differentials

	$r^f_{k,t+1}$	$r^f_{k,t+2}$	$r^f_{k,t+3}$	$r^f_{k,t+4}$	$r^f_{k,t+6}$	$r^f_{k,t+8}$
b_1^{CHF}	0.485 (0.302)	0.477 (0.269)	0.294 (0.189)	0.210 (0.225)	-0.018 (0.232)	0.006 (0.218)
b_1^{EUR}	0.549 (0.223)	0.409 (0.135)	0.332 (0.127)	0.289 (0.130)	0.146 (0.116)	0.067 (0.114)

Source: Datastream 2010. Standard errors in parentheses. Quarterly data.

Table 2 shows the impact of the interest rate differential on carry trade returns in τ periods ahead. The coefficients b_1^f on the interest rate differential are positive and significant as indicated by the standard errors in parentheses. Following UIP the coefficients should be zero or insignificant. However, the data suggests that interest rate differentials are on average positive predictors for *CHF* and *EUR* carry trade returns for up to one year with respect to the euro area interest rate, and up to nine months with respect to the Swiss interest rate. This is a violation of UIP. Thus, interest rate spreads to the euro area and Switzerland made purchases of CEE assets (bonds, stocks, equity) using *CHF* or *EUR* more lucrative than using CEE currencies.

There are three plausible explanations. First, the CEE economies were expected to catch-up to the EU, which typically goes along with a productivity-driven appreciation of their currencies (DeGrauwe and Schnabl, 2005). Second, many CEE countries intervene in the foreign exchange rate market to stabilize exchange rates against the *EUR*. Hence, investors did not expect sharp depreciations over this period. And third, Swiss and EMU nominal interest rates (and inflation) were relatively low from 2002 to 2006.

In this respect, Hoffmann and Schnabl (2011) and Hoffmann (2010) argue that easy monetary policies in advanced economies contributed to buoyant capital inflows and investment booms in emerging market economies which caused an appreciation of their currencies. As higher inflation in CEE prevented nominal interest rates to fully converge with the capital inflows, an interest rate spread remained, which made the carry trade lucrative.

Following Brunnermeier et al. (2009) skewness, the measure of crash risk, is closely related to carry trade returns. Therefore, a large interest rate spread that triggers excess carry trade returns should have an effect on the future crash risk of the CEE currencies since this return comes from relatively overvalued currencies. To test this, skewness of CEE exchange rate changes against either the CHF or the EUR in quarter $t+\tau$ is regressed on the interest rate differentials in quarter t. Thus, with respect to each funding currency the following panel regression model with country specific fixed-effects is estimated

$$skew^f_{k,t+\tau} = b^f_0 + b^f_1 (i_{k,t} - i^f_t) + u^f_k + \varepsilon^f_{k,t}, \quad (2)$$

where $skew^f_{k,t+\tau}$ is the skewness of exchange rate changes in quarter $t+\tau$ between the CEE investment currencies k and the funding currency f (CHF or EUR). $i_{k,t}$ is the interest rate in the investment currencies k and i^f_t is the interest rate in funding currency f in quarter t. b^f_0 is the constant, u^f_k captures the fixed effect and $\varepsilon^f_{k,t}$ is the error term.

Table 3: Skewness regressed on interest rate differentials

	$skew^f_{k,t+1}$	$skew^f_{k,t+2}$	$skew^f_{k,t+3}$	$skew^f_{k,t+4}$	$skew^f_{k,t+6}$	$skew^f_{k,t+8}$
b^{CHF}_1	-2.880 (2.345)	-1.507 (1.371)	-2.487 (1.413)	-3.651 (1.299)	-2.198 (1.473)	-2.351 (1.802)
b^{EUR}_1	-5.480 (2.752)	-4.708 (2.041)	-6.608 (1.771)	-5.856 (1.919)	-5.132 (2.037)	-1.438 (2.157)

Source: Datastream 2010. Standard errors in parentheses. Quarterly data.

Table 3 illustrates the coefficients b^f_1 with respect to $skew^f_{k,t+\tau}$. b^f_1 signals that a larger interest rate spread will increase the (negative) skewness of exchange rate changes in the next quarter from 1999 to 2009 with respect to both currencies. With larger interest rate differentials, exchange rate changes are further way from a normal distribution – which is assumed to be a sign of crash risk. The predictability falls with the length of the prediction horizon. Thus, high interest rate spreads contribute to carry trade returns, while they increase the crash risk (skewness) of CEE currencies.

3 Risk Aversion and Business Cycle

In times of financial distress when risk-taking is depressed and investors face losses in financial markets (e.g. the recent financial crisis), the reallocation of capital restricts funding on markets (Minsky, 1986). Then, carry trade unwinds and short-term assets are sold (Brunnermeier et al., 2009; Clarida et al., 2009).

I use the *VIX* as indicator for risk aversion and funding constraints in financial markets. The *VIX* is the *Chicago Board Options Exchange Market Volatility Index* which captures expectations for S&P 500 stock market volatility. The *VIX* in t_0 is high when investors anticipate large movements in the S&P 500 in either direction until t_1 (which is a month later). Investors actively hedge (via sell and put options) expected market volatility so that option price volatility and with it the *VIX* increase. Therefore, the *VIX* is considered an index for expected financial market (volatility) risk. It is referred to as fear index (Brunnermeier et al., 2009). The *VIX* is only low when investors perceive neither significant downside risk nor significant upside potential in the S&P. Then US markets are relatively stable.

Although the *VIX* seems to be unrelated to the markets in CEE, previous studies have shown that it is a good indicator for global risk-taking on equity as well as credit markets (Collin-Dufresne et al., 2001). The indicator rises in periods of financial turbulences and crisis such as the Russian flu of 1998 and is highly correlated with the risk premium in sovereign credit default swaps (Brunnermeier et al., 2009; Pan and Singleton, 2008). The rationale for using this measure is that an increase in expected US financial market volatility spills over to other markets, e.g. the euro area or Switzerland or a common factor drives volatility in both markets. When US markets hike or fall, capital redemption restricts funding of investment elsewhere.

The reasoning is as follows. Assuming a carry trader holds an investment currency in form of a short-term asset, a rise in expected financial market volatility as expressed by an increase of the VIX creates uncertainty in markets and leads to asset sales. On the one hand, when stark increases of the S&P are expected, CEE investment may be less lucrative relative to e.g. US investment. On the other hand, when the S&P is expected to fall sharply, this signals a possible crisis and drying up liquidity.

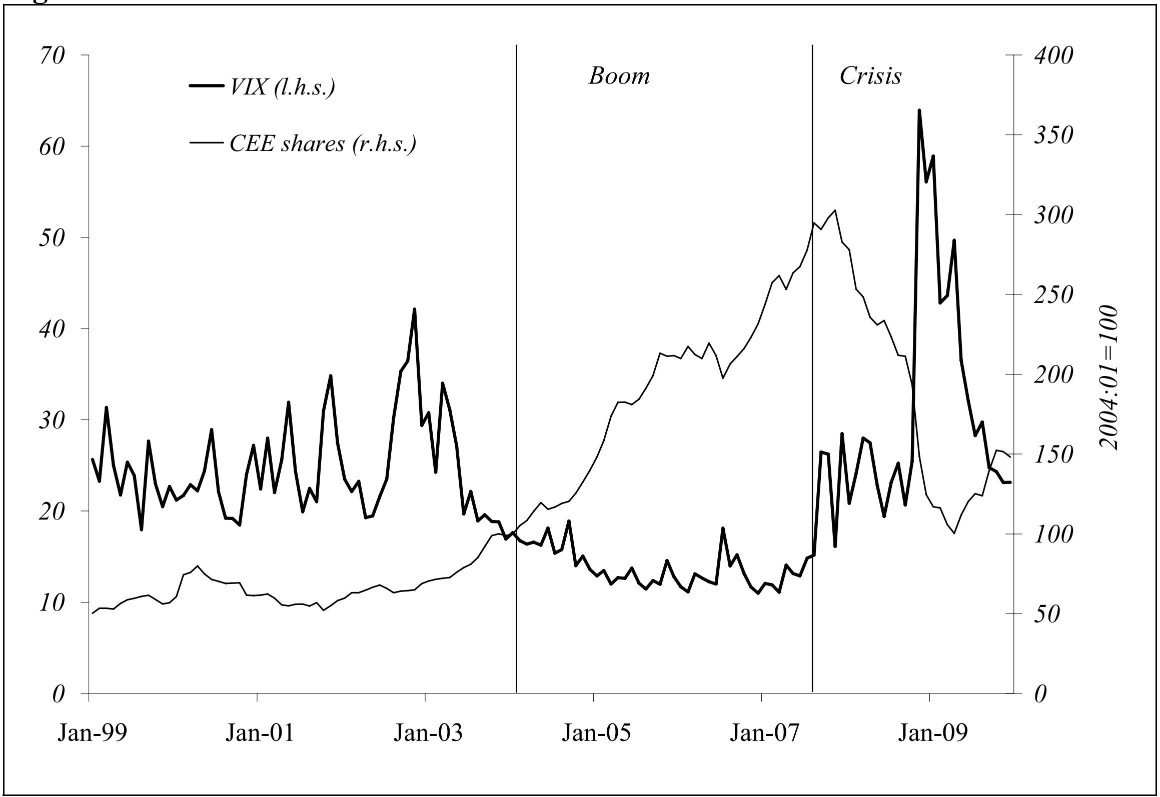
Therefore, a higher VIX signals depressed risk appetite in international financial markets. Investors reassess the profitability of investment projects and lenders restrict funding (especially when financial markets anticipate a downside risk). Then capital flows to CEE can reverse and foreign borrowing in CEE is restricted. Carry trades unwind. This can trigger a devaluation of the CEE currency and losses from carry trades. Thus, carry trades unwind endogenously as a result of reallocation and reorganization of investment projects in the market. The building up of carry trade during periods of easy liquidity conditions is followed by a crash when liquidity conditions dry up because risk appetite in financial markets is depressed.

Following Minsky (1986)'s "theory of financial instability" risk appetite of financial markets is particularly pronounced during the upswing of a business cycle. Therefore, risky investment such as carry trades has to be related to the business cycle. Returns are large when the country with the investment currency is in the upswing of a business cycle or the country with the funding currency experiences a bust. In both cases funding interest rates are relatively low and interest rate differentials are high (Clarida et al., 2009).

Therefore, it is sensible to distinguish different periods in the analysis. To do so, Figure 1 illustrates the development of CEE stock markets and the VIX. The data is taken from Datastream. Except for a small spike in 2000, CEE stock markets were relatively stable from 1999 to 2003. The all shares indices started to hike in 2003 or 2004, shortly before the first CEE countries joined the EU. Depending on the CEE country, the stock market boom came to an end in early (e.g. in EE) or late 2007 (e.g. in CZ). Then, all shares stagnate until they dropped sharply in mid or late 2007.

The VIX went along with the stock market in CEE. The fear index started to fall in mid 2003 until the end of 2006. During this period it was at a low level. In early 2007, the VIX rose slowly. This was a first sign of the coming turn-around. The VIX climbed until late 2007 when it moved up heavily. It remained at high levels until the end of 2009 and fluctuated more strongly.

Figure 1: *VIX* and stock markets in CEE from 1999 to 2009



Source: Datastream 2010. CBOE VIX, CEE all shares data (2004:01=100).

Thus, in the following I concentrate on four different periods. I analyze the full sample ranging from 1999 to 2009. Second, I focus on the period from 2004 to 2009. This period is of particular interest in this paper as it covers the latest CEE asset and credit boom-and-bust cycle (Figure 1). This period can also be seen as EU period as most economies in my sample joined the EU in May 2004. Next, I distinguish between boom and bust period. To make sure the latter period captures the turn-around in every CEE economy I "generously" split the sample in half. Thus, the third estimation period represents the CEE boom period ranging from 2004 to 2006 and the forth period covers the global financial turmoil that started in early 2007.[5] I do not further consider the 1999 – 2003 period because it can neither be considered a

[5] The results remain unchanged when splitting the sample one or two quarters earlier and later, depending on when you might consider the start of the boom or crisis period.

stable boom period nor a bust period. There was uncertainty due to the burst of the dot-com bubble in 2000 and institutional changes in CEE in preparation for EU membership.[6]

To estimate the effect of the VIX on carry trade returns in CEE, I use quarterly averages of the VIX (in line with the other data). Excess carry trade returns with respect to each funding currency (CHF and EUR) are regressed on changes in the VIX and the lagged interest rate differentials. Thus, the VIX is assumed to explain parts of UIP failure. The fixed-effect panel regressions take the form

$$r_{k,t}^f = b_0^{\,f} + b_1^f (i_{k,t-1} - i_{t-1}^f) + b_2^f \Delta VIX_t + u_k^f + \varepsilon_{k,t}^f, \tag{3}$$

where $r_{k,t}^f$ is the excess return in quarter t from borrowing at interest rate i_{t-1}^f in the funding currency f (CHF or EUR) and investing at interest rate $i_{k,t-1}$ in the CEE countries' currencies k in quarter $t-1$. ΔVIX_t is the change in the VIX from quarter $t-1$ to t. b_0^f is the constant, u_k^f captures the fixed effect and $\varepsilon_{k,t}^f$ is the error term.

Table 4 shows the results for an impact of risk appetite in financial markets and interest rate differentials on carry trade returns with respect to the CHF and EUR for the different estimation periods. First, the results in the third column of Table 3 reconfirm the findings in Table 2. For the whole sample, interest rate differentials have a significant impact on carry trade returns as explained in section 3.3.1. The impact of the interest differential is larger after 2004 as seen in the 2004 – 2009 period.

[6] The 1999 – 2003 period yields results similar to those of the full sample (1999 – 2009) which also includes booms and busts.

Table 4: Carry trade returns, risk-taking (in boom and bust)

f	*Period*	$i_{k,t-1} - i_{t-1}$	ΔVIX_t	*Constant*	*Obs.*	*Adj.R²*
EUR	1999 – 2009	0.510*	-0.033***	0.004	432	0.111
	Full sample	(0.282)	(0.011)	(0.003)		
	2004 – 2009	1.165**	-0.024**	0.002	236	0.076
	EU	(0.518)	(0.010)	(0.004)		
	2004 – 2006	1.336**	-0.042***	0.003	120	0.329
	Stability/Boom	(0.600)	(0.018)	(0.005)		
	2007 – 2009	-0.117	-0.027*	0.006	116	0.045
	Turmoil/Crisis	(1.263)	(0.014)	(0.005)		
CHF	1999 – 2009	0.451*	-0.034***	0.005	432	0.110
	Full sample	(0.253)	(0.011)	(0.004)		
	2004 – 2009	0.807	-0.046***	0.004	236	0.069
	EU	(0.549)	(0.012)	(0.006)		
	2004 – 2006	0.791*	-0.053***	0.009**	120	0.249
	Stability/Boom	(0.446)	(0.017)	(0.005)		
	2007 – 2009	-0.916	-0.045***	0.012	116	0.028
	Turmoil/Crisis	(1.319)	(0.017)	(0.012)		

Source: Datastream 2010. Standard errors in parentheses. ***,**,* denote significance at 1, 5 and 10 percent levels.

This result is driven by the boom period (2004 – 2006). The coefficients of the interest rate spreads b_1^f are particularly high and significant. With respect to the EUR, they are even larger than 1 from 2004 to 2006. This is only possible if the high-yielding CEE currencies appreciated (on average) against the funding currencies. During the turmoil period, however, the interest rate differential did not affect carry trade returns. The coefficient is negative but not significant.

The third column of Table 4 indicates that changes in the expected financial market risk and thus increases in risk aversion (ΔVIX_t) affected carry trade returns. In all specifications, the coefficient b_2^f is negative and significant. During the boom, when financial markets were stable, ΔVIX_t is significant. Lower expected financial market volatility is associated with a fall in the VIX (Figure 1). When risk appetite is high, funding conditions are loose and carry trade returns rise. Financing CEE assets using foreign currency was profitable.

In the bust period, expected financial market volatility increased. Thus, the coefficient on ΔVIX_t was widely positive from 2007 to 2009 (Figure 1). Investors started to reassess the risk of investment and lenders restricted funding. This contributed to an unwinding of speculative carry trades and led to negative carry trade returns due to depreciation of the investment currency. Along with the lower carry trade returns, financing CEE assets using foreign currency was not as lucrative anymore.

3 Exchange rates and Carry Trade Returns

Clarida et al. (2009) find that carry trades returns are related to exchange rate volatility. Therefore, I add quarterly standard deviations of CEE log exchange rates $Stdev_{k,t}^{f}$ with respect to the CHF or EUR to equation (3) to test this for my sample of countries. I run a fixed-effects panel regression for each funding currency f, where k indicates the cross sections of the ten CEE countries used in the sample in both cases.

$$r_{k,t}^{f} = b_0^{\ f} + b_1^{f}(i_{k,t-1} - i_{t-1}^{f}) + b_2^{f}\Delta VIX_t + b_3^{f} stdev_{k,t}^{f} + u_k^{f} + \varepsilon_{k,t}^{f}, \quad (4)$$

where $r_{k,t}^{f}$ is the excess return in quarter t from borrowing at interest rate i_{t-1}^{f} in the funding currency f (CHF or EUR) and investing at interest rate $i_{k,t-1}$ in the CEE countries' currencies k in quarter $t-1$. ΔVIX_t is the change in the VIX from quarter $t-1$ to t. $Stdev_{k,t}^{f}$ represents the CEE exchange rate volatilities with respect to f in quarter t. b_0^{f} is the constant, u_k^{f} captures the fixed effect and $\varepsilon_{k,t}^{f}$ is the error term.

Table 5 provides the regression results. The coefficients b_1^f and b_2^f indicate that the impact of the interest rate differential and changes in the VIX on carry trade returns remain widely unchanged. Earlier results are reconfirmed.

Table 5: Carry trade returns and exchange rate volatility

f	*Period*	$i_{k,t-1} - i_{t-1}$	ΔVIX_t	$Stdev_{k,t}$	*Constant*	*Obs.*	*Adj.R²*
EUR	1999 – 2009	0.686***	-0.032***	-3.031**	0.014***	420	0.194
	Full sample	(0.207)	(0.010)	(1.222)	(0.004)		
	2004 – 2009	1.206**	-0.026**	-4.008***	0.015**	224	0.189
	EU	(0.610)	(0.010)	(1.577)	(0.008)		
	2004 – 2006	1.318***	-0.047***	3.983**	-0.007*	120	0.413
	Stability/Boom	(0.485)	(0.012)	(2.001)	(0.004)		
	2007 – 2009	0.354	-0.031**	-6.400***	0.030***	104	0.264
	Turmoil/Crisis	(0.844)	(0.014)	(2.209)	(0.009)		
CHF	1999 – 2009	0.674***	-0.043***	-2.139***	0.028***	419	0.278
	Full sample	(0.215)	(0.012)	(0.674)	(0.005)		
	2004 – 2009	0.923	-0.038**	-2.379**	0.031**	224	0.248
	EU	(0.706)	(0.014)	(1.163)	(0.012)		
	2004 – 2006	0.705*	-0.055***	1.422	-0.003	120	0.294
	Stability/Boom	(0.433)	(0.017)	(1.148)	(0.010)		
	2007 – 2009	-0.105	-0.038*	-3.179***	0.051**	104	0.301
	Turmoil/Crisis	(1.419)	(0.023)	(1.103)	(0.020)		

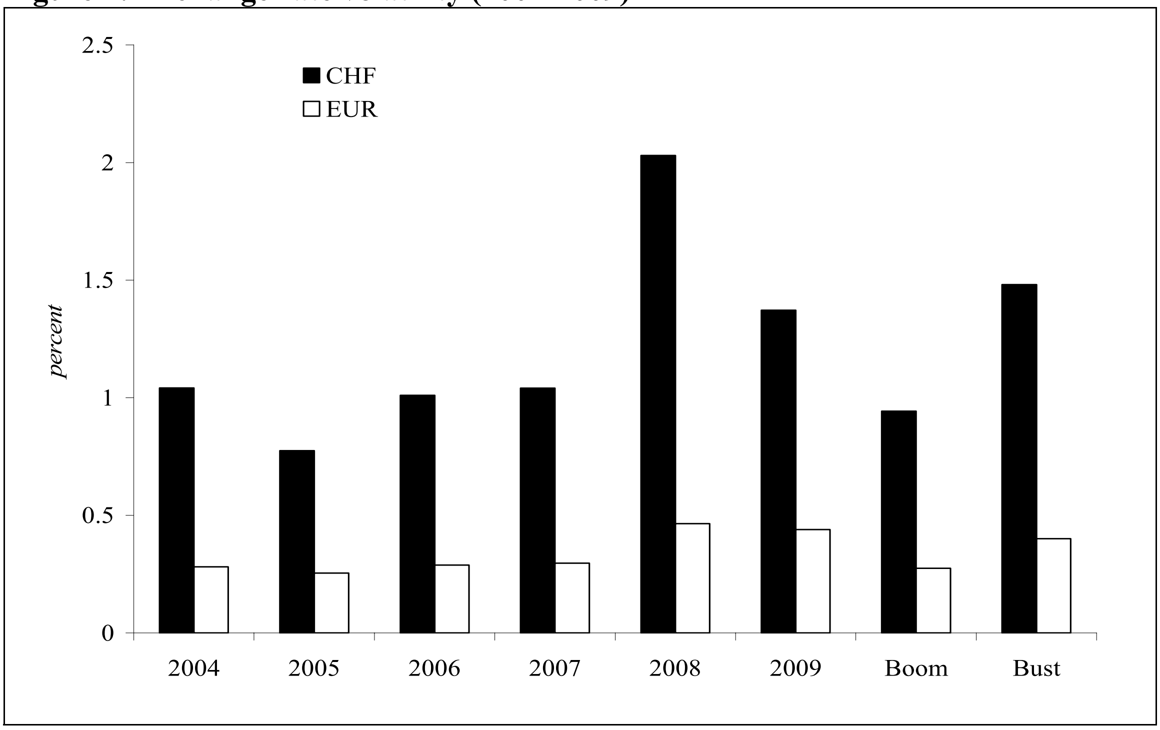
Source: Datastream 2010. Standard errors in parentheses. ***,**,* denote significance at 1, 5 and 10 percent levels.

The coefficient on the standard deviation of exchange rates b_3^f turns out to have a negative significant impact on carry trade returns with respect to both funding currencies over the full sample. The sub-periods are of special interest. The estimation of the crisis period suggests that exchange rate volatility negatively affects carry trade returns. But the period of financial stability yields a positive coefficient b_3^f for the impact of exchange rate volatility on carry trade returns in CEE, particularly with respect to the EUR. Thus, carry trade returns are related to the volatility of exchange rates in one or the other direction.

I explain this finding as follows. During the boom period, when risk-appetite in financial markets was pronounced and interest rate differentials had a large impact on the returns, particularly with regard to the euro area, capital inflows appreciated some CEE currencies against the funding currencies. Exchange rate volatility allowed for higher returns. CEE assets were more lucrative for carry traders. However, during the period of financial turmoil from 2007-2009, risks and uncertainty about returns increased (Figure 1). When capital was withdrawn from the CEE countries (assets were sold), this depreciated the CEE currencies and had a negative impact on carry trade returns.

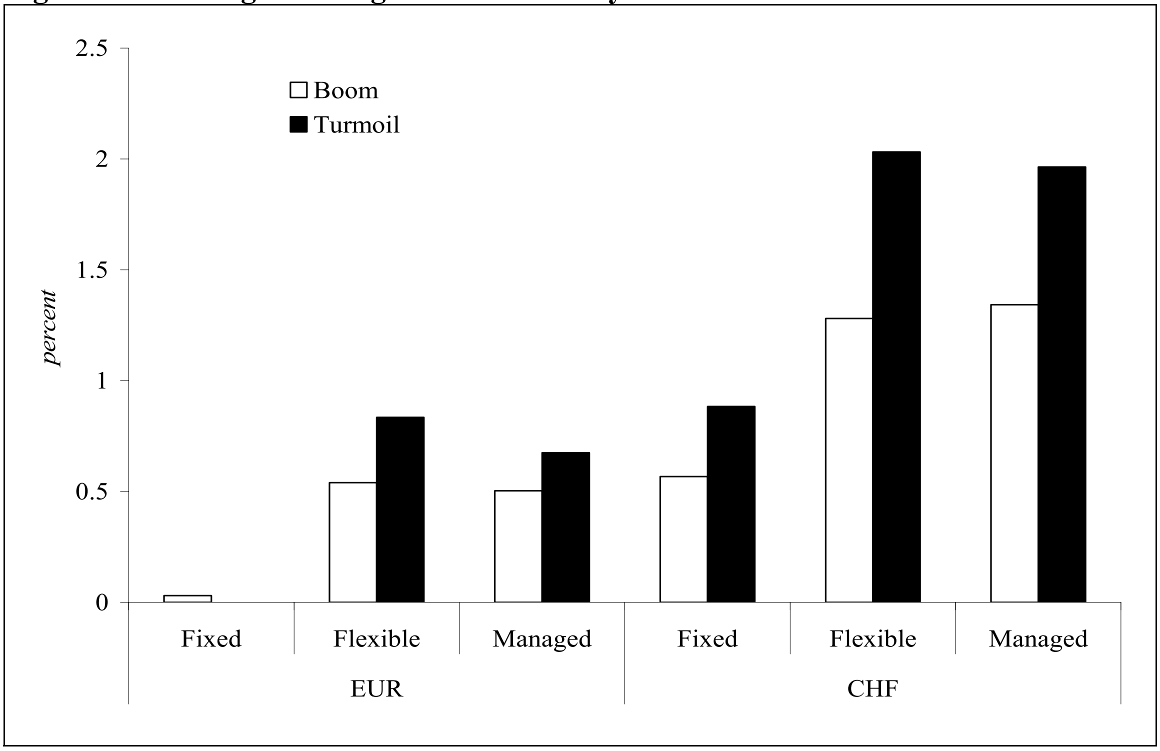
Therefore, large exchange rate swings are associated with a dismantling of carry trades (Clarida et al., 2009). Figure 2 provides further evidence for this finding. The bars represent averages of quarterly exchange rate volatility in the respective periods. Exchange rate volatility was particularly high in 2008 and 2009. In the bust period, average volatility was 1.5 percent per quarter against the CHF. Because many CEE countries stabilize exchange rates against the EUR, volatility with respect to the EUR was lower.

Figure 2: Exchange rate volatility (2004-2009)



Source: Datastream 2010. Averages of quarterly standard deviations of log exchange rates.

Figure 3: Exchange rate regime and volatility in boom and turmoil



Source: Datastream 2010. Averages of quarterly standard deviations of log exchange rates. Boom period: 2004 – 2006. Turmoil period: 2007 – 2009.

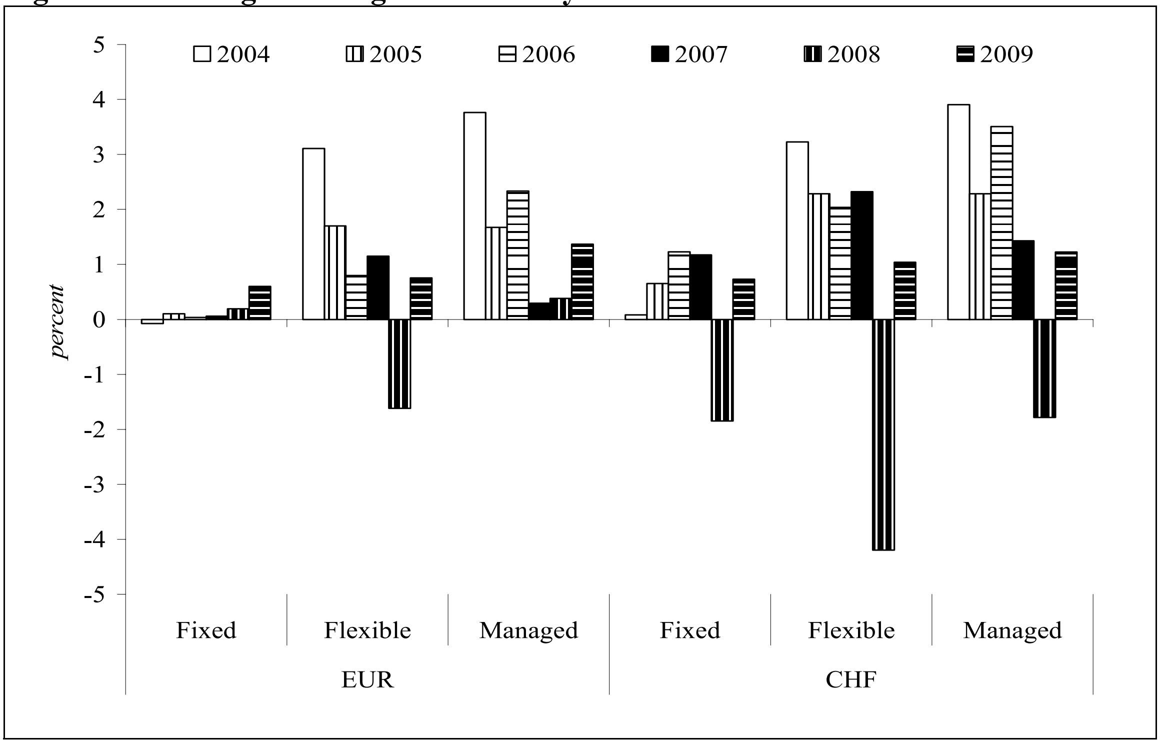
Figure 3 further illustrates exchange rate volatility for different exchange rate regimes in CEE. Exchange rates fluctuated less against both the EUR and CHF in countries with fixed exchange rates (currency boards) or managed floats to the EUR. It is clear that exchange rate fluctuated more strongly in countries with more flexible exchange rates to the EUR. Volatility in the bust was much higher than in the boom period (Figure 3).

This suggests that the exchange rate regime may be an institutional determinant for carry trades returns in CEE. Indeed, holding other variables constant, more stable exchange rates to the funding currencies allowed for larger average carry trade returns overall (Table 5). Because the CHF was relatively stable with respect to the EUR[7], stable exchange rates to

[7] Between 1999 and 2009 the euro/franc rate fluctuated by less than 10 percent around 0.65 euro per franc. From 2004 to 2006 the euro/franc exchange rate was widely stable at around 0.65 euro/franc. With the beginning of the financial crisis in 2007 the franc depreciated slightly to 0.60 euro/franc. From late 2008 to end 2009 the franc won against the euro and went up to 0.67 euro/franc.

the *EUR* must have allowed for relatively stable average returns from both *EUR* and *CHF* carry trades from 2004 to 2009.

Figure 4: Exchange rate regime and carry trade returns



Source: Datastream 2010. Averages of quarterly excess returns from carry trade.

However, Figure 4 indicates that allowing for exchange rate flexibility from 2004 to 2006 contributed to larger carry trade returns. Average excess returns in countries with managed floats or flexible exchange rates exceed those in countries with fixed exchange rates when markets are stable. Given that depreciations seemed unlikely, particularly in countries with managed floats, flexible exchange rates fuelled carry trades during the boom.[8] For instance, Hungary stabilized the *HUF* against the *EUR* until 2008. The managed float did not allow for strong depreciations against the *EUR* which provided a safety net against depreciation with respect to the *CHF* as well. Thus, also *CHF* carry trades to Hungary were

[8] Indeed the effects on returns are larger (individual effects are positive) in countries that manage the float than in countries with more or less flexible exchange rates in the boom period.

lucrative. Hence, exchange rate flexibility in Poland, Romania, Hungary, the Czech Republic and Slovakia made speculation lucrative during the boom.

This does not imply a higher volume of carry trades because countries with fixed exchange rates allowed for safe returns. In the latest crisis, fixed exchange rates helped secure returns and made carry trades more profitable as exchange rates could not depreciate. Thus, investors that bought e.g. safe Estonian assets financed in foreign currency did not face devaluation losses. Larger returns per unit went along with increased crash risk due to exchange rate misalignments in countries with flexible exchange rates. The more flexible the exchange rates, the smaller the returns during the crisis (Figure 4).

The analysis makes sense in the context of the descriptive statistics presented in Table 1. While the average returns on carry trade are the highest for countries with flexible exchange rates (PL) and managed floats (HU, RO, SK), the Sharpe ratios are high for managed floaters (HU, SK, RO) and countries with fixed exchange rates (EE, LT).

5 Summary

In this study, I have analyzed determinants of currency carry trade in CEE. The study is supportive to the empirical findings of Clarida et al. (2009) and Brunnermeier et al. (2009). I have presented a robust empirical relationship between carry trade excess returns, interest rate spreads, risk-taking and exchange rate volatility during the boom period. In particular, I have documented that carry trades built up due to high interest rate spreads and risk appetite. The unwinding can be explained by a fear of financial market distress (depressed risk-taking) and funding constraints. Exchange rate stability increased carry trade returns overall, while the effect stems from the period when global financial turmoil and exchange rate volatility deteriorate carry trade returns.

Further, I have provided evidence of that CEE countries with credibly fixed exchanges rates against the euro as well as countries with managed floats allowed for larger carry trade returns. In line with this, the Sharpe ratios for countries with managed floats and fixed exchange rates are higher than for countries with flexible exchange rates. The combination of a safety net, e.g. interventions in case depreciation and large interest rate spreads made carry trades profitable for both investments in anchor currency and third currencies (Swiss franc). Volatility was low but returns were high. In the latest crisis, fixed exchange rates helped secure returns and made carry trades from e.g. Switzerland more lucrative as exchange rate stability was more or less guaranteed. Therefore the exchange rate regime is likely to be an institutional determinant of carry trades. Further research is necessary to explore the impact of different exchange rate arrangements on carry trade profitability and activity.

Following Galati et al, (2007) carry trades to CEE were often initiated by households and private investors and included the purchase of an asset denominated in a CEE currency. Therefore, given its high profitability and the favorable conditions in the boom period, it is likely that carry trades fuelled the lucrative CEE asset markets in the run-up to the latest crisis.

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