Kornél Kisgergely: Carry trade*

This study summarises the basic facts related to the investment strategy known as carry trade. Carry trade is a leveraged investment transaction limited to the foreign exchange market. Foreign investors can only realise extra return if they also assume the risk of exchange rate fluctuations. Carry trade produces high returns for years, but in turbulent periods the accumulated profits of several years can be lost within a matter of weeks. High yielding currencies go through a long period of appreciation, interrupted by sudden strong weakening episodes. Theoretical economists explain stylised facts with the volatility of the risk premium or the liquidity constraints of investors, or with exchange rate bubbles. Foreign investors financing the Hungarian economy did not increase, on aggregate, their exposure to Hungarian forints during the last decade. Consequently, the underlying cause of Hungary's external indebtedness is most probably not the carry trade activity of foreigners. However, the role of carry trade in the exchange rate dynamics of Hungarian forint may have increased in the last couple of years.

INTRODUCTION

In recent years, the investment strategy called carry trade (hereinafter referred to as CT) has become a focus of economic policy and theoretical economic literature. CT is frequently associated with the extreme appreciation and volatility of currencies in emerging markets, and with increased correlation amongst these currencies. CT may be an important factor in the contagion of crises through the exchange rate channel. Additionally, many blame CT for the credit cycles seen in emerging markets so frequently, the resulting indebtedness of these countries which often end up in economic crises or recession. On the whole, economic policy decision-makers uniformly feel that CT inflow is clearly non-desirable, and is to be prevented by administrative means if necessary.

By contrast, the assessment of CT in the theoretical literature is substantially more complex. Numerous studies are built on the assumption that high carry returns may be sustained over longer periods of time, because high interest rate currency instruments are purchased by only a few. According to this view, CT flows should even be encouraged. At the same time, the correlation between CT and sudden weakening of the exchange rates is clear. Such investors finance themselves with the use of loans and when their leverage must be cut back they are compelled to sell their high yielding currencies against low yielding currencies. When such transactions are conducted by many economic agents simultaneously, it may become a self-reinforcing positive feedback loop. Therefore, CT is indeed very dangerous in countries where the portfolio of open exchange rate positions is high.

The purpose of this short paper is to provide an overview from the point of view of economic policy of the studies published in the topic. It is hoped that the paper will contribute to a deeper and more thorough understanding of the root causes and potential consequences of CT inflow. I attempted to make an estimate of the past extent of CT activity in the Hungarian forint market. In general, it can be concluded that foreigners failed to increase their HUF exposure over the years since 2000. In consequence, their CT activity could not cause a massive rise in the external debt of the Hungarian economy in the period. Nevertheless, the role of CT in exchange rate dynamics has grown during the past few years.

WHAT IS CARRY TRADE?

Some papers call almost all foreign investment CT, whereas the theoretical literature identifies CT as a clearly defined foreign currency market trading strategy.

Broad carry trade

In the broadest sense, CT is any kind of investment financed from a loan, i.e. a leveraged transaction. The investor buying a risky instrument financed with credit is confronted with the cash flows presented in Table 1. Upon concluding the deal (that is, at $t=0$) he takes out the loan necessary for buying the instrument, and then actually buys the instrument (at a price S_0). Upon maturity (at $t=1$) the carry trader receives the payoff on his investment (r_H) and pays back the loan. Thus, net cash flow at $t=1$ is $S_0(e^{r_H}-e^{r_L})$. Assuming that the investor's credit quality is high, and that the instrument to be purchased is risky, the pre-defined interest rate of the loan (r_L) shall be lower than the expected return on the investment $(E_0(r_H))$. This way, the strategy will be profitable over the long run. There may, however, be periods when the return on the investment ex-post falls short of the interest payable on the loan and the carry trader incurs a loss.

* The views expressed in this article are those of the author(s) and do not necessarily reflect the offical view ot the Magyar Nemzeti Bank.

Table 1

Cash flows of a carry trader

	t = 0	t = 1
Loan	$+S_0$	$-S_0e^{r_L}$
Investment	$-S_0$	$+S_0e^{r_H}$
Net cash flow	0	$S_0(e^{r_H} - e^{r_L})$

In this example, the investor will not tie up any of his own capital, and thus the potential profit realised upon maturity will be gained with zero investment costs. However, if the risky instrument pays a lower return ex-post than the interest payable on the loan used to purchase it, a payment obligation will be incurred automatically. Gearing enlarges the returns on the investment, but it proportionally enlarges its standard deviation as well.

Provided the investors' expected return on the investments $(E(r_H) - r_L)$ is growing or their risk aversion is declining, their demand for the risky instruments will increase. Such a situation may occur when financing costs are reduced (for instance, central banks in developed countries ease their monetary policy), or when the expected returns on the risky instruments grow (for instance, as the result of an economic boom).

The long-term profitability of this strategy is explained by the risk assumed. Large investors can access funding nearly at the risk-free interest rates. High risk instruments must ensure higher returns than that.

This definition of CT is very general. Almost all institutional investors (commercial, investment banks, hedge funds) finance their investments using loans, and thus they fit well into the broad definition of a carry trader. In addition, the risky instrument may be denominated in the same currency as the financing credit, therefore such transactions do not necessarily involve emerging markets.

Carry trade as a foreign exchange market trading strategy

CT in the narrower sense is the investment strategy in which the carry trader takes out a loan in low yielding currencies and invests it in high yielding currencies. Investors obtain their yield $(y–t)$ from two sources, the difference between the interest rates $(r_H–r_L)$ which is known ex-ante and the movement in the exchange rate during maturity which is not known beforehand. In formal terms, this is expressed as follows:

$$y=r_H-r_L-\Delta s \qquad (1)$$

where s stands for the logarithm of the exchange rate (the higher the value, the weaker the high interest rate currency). If both countries (i.e. the one with high short-term interest rates and the other one with low short-term interest rates) have similar sovereign rating, it will not be clear what risks are assumed by the investor.[1] Thus, it is not necessarily the case that this strategy is systematically profitable. If two instruments have the same risk, but their expected returns are different, all investors would sell the low return instrument and buy high return one instead, until the expected returns equalised. This mechanism ensures that no long-term arbitrage possibilities exist on the financial markets.

Hence, if the currencies are similarly risky, the expected return on CT shall be zero. Here, with the help of (1), the equation of uncovered interest rate parity (UIP) will be set up as follows:

$$E(\Delta s)=r_H-r_L \qquad (2)$$

In other words, a positive difference in interest rates must predict weakening of the high interest rate currency. Irrespective of the interest rate being higher in one of the countries, the exchange rate movement is expected to balance returns. This relationship was first tested by Fama (1984), estimating the following equation using the most developed G10 foreign currencies which have similarly low sovereign risk:[2]

$$\Delta(s) = \hat{\alpha} + \hat{\beta}\,(r_H - r_L) + \varepsilon. \qquad (3)$$

Should UIP apply, then $\alpha=0$, $\beta=1$. Fama – and everybody else estimating similar equations since – obtained a negative coefficient for $\hat{\beta}$. This means that high interest rate currencies usually appreciate against low interest rate currencies, and therefore CT is a profitable strategy over the long run. The negative coefficient means that the investor not only gains the interest rate differential, but also earns additional profits by the strengthening of the high yielding currency. Efforts to explain this phenomenon – called the UIP or CT puzzle in the theoretical literature – have spawned a large number of theories, which will be discussed in more detail in the following. In any case, foreign exchange market funds apply this investment strategy in practice, and their activities may be decisive in the exchange rate dynamics of the foreign currency in question.

[1] Exchange rate volatility in itself is not a sufficient reason to support a risk premium provided it does qualify as a non-systematic risk.

[2] It is assumed here that expectations are rational, i.e. ex-post exchange rates in average equal ex-ante expectations.

Table 2

Emerging market related OTC currency derivative stock

(USD billion)

	June 2001	June 2004	June 2007
Total FX	4,961	6,801	17,302
Forward and FX-swap	3,333	4,319	9,766
Currency swap	1,003	1,513	3,561
Options	560	951	3,902

Source: BIS.

Investors on the foreign exchange market attempt to take exchange rate positions in such a manner that they minimise both trading costs and counterparty risk.[3] For this purpose, derivative instruments are the most suitable candidates. CT is implemented most frequently with the use of a forward (or synthetic forward) transaction. The price of a foreign exchange forward contract (F_0) can best be determined as follows:

$$F_0 = S_0 e^{r_H - r_L}, \quad (4)$$

where S_0 is the spot price.[4] Upon maturity, the profit generated by the transaction $(F_0 - S_1)$ is the same as if the investor had purchased government bonds with maturity at t=1 denominated in the high interest rate currency using loans taken out in the low interest currency. The difference is that the derivatives market is much more liquid, and therefore if the investor intends to close his position before maturity, he can only do so on the government bond market at a much higher trading cost.

The bulk of derivative transactions does not appear in the balance of payments statistics. If a resident concludes a forward transaction on the exchange rate with a non resident, it will only be seen upon maturity, and only then to the extent of the final cash flow (provided the foreign party earns any profits on the transaction, as an outflow, or vice-versa).[5] Forward transactions do not represent financing either, thus the derivative portfolio of foreigners in the high yielding currency may increase, even if its economy experiences a period of net capital outflow.

Derivative markets on foreign currency are of significant sizes. Table 2 shows stocks of derivative contracts related to emerging market currencies taken from the BIS triennial survey.[6] The data reflect the face value of such derivative transactions where one of the foreign exchange counterparts is the currency of an emerging market. On average, this stock grew by 2 thousand billion USD annually between 2001 and 2007. This inflow can be compared in terms of size with the one realised by emerging market countries in the same period in terms of net capital inflow (including portfolio, foreign direct investment and loan type flows).[7] Unfortunately, no information is available on the direction of the position (i.e. whether long or short in the emerging currency), but there are good reasons to believe that the dynamic expansion is underpinned by speculation demand for the foreign currency of emerging market countries.

In the following, I analyse the narrower interpretation of CT. This activity is mostly restricted to the foreign exchange market.

Foreign exchange loans

Before embarking on a more in-depth discussion of CT transactions as an investment strategy on the foreign exchange markets, let us make a short detour with respect to foreign exchange lending. Taking out an uncovered foreign exchange loan can be regarded as a naive form of carry trade. The borrower of the foreign exchange loan pays lower instalments than agents taking out loans in the domestic (higher interest) currency, as long as the high interest domestic currency does not weaken to the extent corresponding to the UIP. However, the foreign investor extending the foreign exchange loan cannot be considered to be a carry trader at any rate, since his exposure will be generated in his own currency and thus he does not gain any

[3] According to Burnside et al. (2006), CT profits are very sensitive to trading costs.

[4] It can be seen from this formula that a CT position, which is hedged against FX risk always produces 0 gains. Assume that an investor takes 1 unit loan in the low yielding currency and invests it in the high yielding currency at a spot rate of S_0. Assume also that he sells a forward contract on the high yielding currency to hedge his FX exposure. At maturity he receives $S_0 e^{r_H}$ in high yielding currency, and converts this amount to low yielding currency at the predefined F_0 forward rate. Thus, he receives e^{r_L} in low yielding currency, which is just enough to pay back the loan.

[5] In the event that the two parties maintain a margin account, the mark-to-market gains shall also be presented in the statistics. However, a mark-to-market value will always be a far cry from the nominal value of the transaction in question.

[6] These are in fact those classified in the 'Other' category, which includes (apart from emerging market currencies) some of the developed countries' currencies, e.g. the Australian and New-Zealand dollar, the Danish and the Norwegian koruna.

[7] See BIS (2009).

interest differential just as much as he does not have to bear the risk of exchange rate fluctuations.

But borrowing in foreign exchange by households does not seem to be an effective 'investment' for a number of reasons. Such deals are differentiated from the strategy adopted by professional investors in respect of five factors:

1. *Long-term maturity.* Over a 10-year time span, the correctness of UIP cannot be empirically denied.[8] High interest rate differentials indicate a high level of differences in inflation rates or a high level of risk premium. Inflation differences appear in nominal weakening of exchange rates over such a long period of time. It is highly likely that the priced risk will be realised over a 10-15 year period.

2. *No diversification.* Professional investors hold a portfolio of high interest foreign currencies. Diversification can be used to reduce CT risks to a great extent. However, the amount of idiosyncratic risks is very large in a single currency pair. Darvas (2009) for instance studied 11 currencies and came to the conclusion that provided someone had taken out a carry position 30 years ago in any of the individual currency counterparts, at least once during this period of time he must have suffered such an amount of loss which would have wiped out all of the gains accumulated up to then. This analysis cannot be applied one-to-one with regard foreign exchange debtors, as Darvas assumed that the investor keeps the original gearing ratio, while the 'leverage' of households in retail markets will gradually diminish as the loan is amortised. Nevertheless, this example is a good illustration of the potential risks.

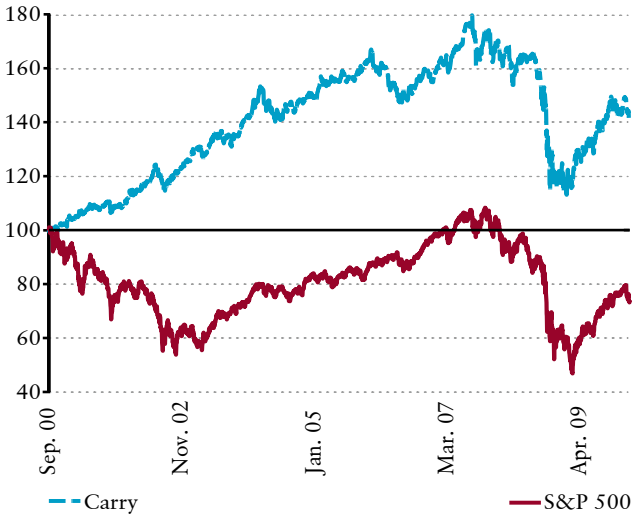
3. *Cognitive distortions in risk assessment.* One possible explanation for high carry yields is the peso problem. In other words, CT strategies are profitable for a long time, and losses are rare but large (see the above example from Darvas). It can be assumed that non professional investors overemphasise the recent performance of the strategy, instead of considering potential risks when judging the risks of a loan taken out in foreign currency.[9]

4. *Externalities.* Households are in a more favourable position than foreign carry traders from one point of view. At certain levels, they are protected against nominal exchange rate volatility. The inflation related to depreciation appreciates the nominal wealth of households, and thus the higher nominal monthly payment is partially offset by higher nominal salaries and higher collateral value. However, whereas nominal changes in the exchange rate appear instantly in the amortisation instalment payable, they are only slowly and partially incorporated into domestic price levels. Therefore, this kind of protection does not really function well in practical terms. Additionally, a nominal weakening of the exchange rate will have the effect of reinforcing the devaluation of the real exchange rate by the foreign exchange debtors themselves who generate real depreciation by refraining from consumption and liquidating their real estate collaterals. This way the other debtors' assets and revenues will be reduced further when compared to the amount of debt.[10]

5. *Moral hazard:* Upon deciding in favour of the foreign exchange denomination of a potential loan, debtors probably also consider that the government will assist them in the case of a substantial weakening of the exchange rate. This may be especially important when the portfolio of open positions is very large. In such cases, economic policy-makers are compelled to purchase insurance tools against large-scale weakening, for instance by accumulating large amounts of foreign exchange reserves, the costs of which is also paid by those who have no loans in foreign exchange.

Chart 1

Performance of the carry trade and the S&P 500



[8] See for instance Meredith & Chinn (1998) and Chinn (2006).
[9] For more on the typical psychological distortions seen in investor decisions, see Barberis & Thaler (2003).
[10] For externalities related to foreign exchange loans, see for instance Caballero & Krishnamurthy (2001), and Korinek (2008).

Chart 2

Distribution of monthly returns

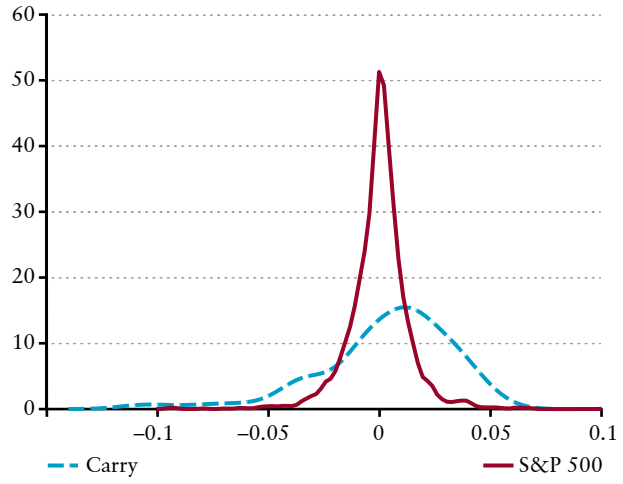
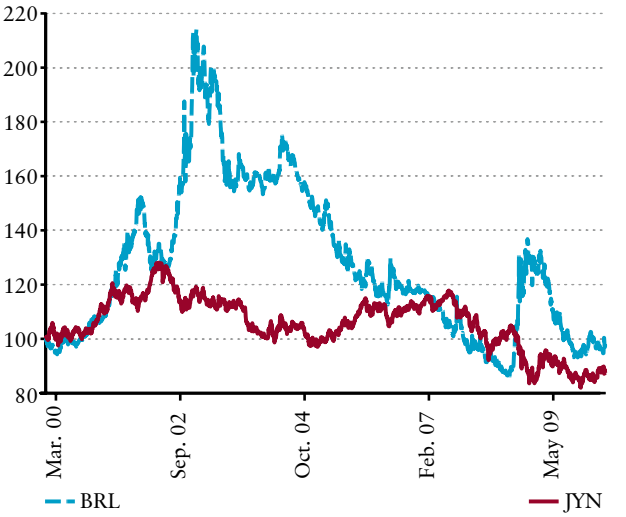


Chart 3

Exchange rate trends of the Japanese yen and the Brazilian real versus the US dollar



INTERNATIONAL EXPERIENCES

Diversified CT is very profitable over the long run. In order to illustrate this statement, I present the G10 Currency Harvest index by Deutsche Bank (Bloomberg code: DBHVG10U) and the cumulated performance of the S&P 500 American stock index in Chart 1. The carry index reflects the performance of an exchange traded fund (ETF), which declared that it held long positions in the three highest interest rate currencies and short positions in the three lowest interest rate currencies in the G10 universe. The fund operates with the highest attainable leverage meaning a 1/3-2/3 ratio in favour of debt financing. Surprisingly, CT outperformed the stock index substantially in this period, which can partly be attributed to the fact that the bear market at the beginning of the 2000s did not affect CT. Since there is only a very weak correlation between CT and stocks, it can prove to be a useful diversification tool.

The comparison above is doubtful not only because of the shortness of the period. The CT index operates with gearing which enlarges returns. These can be reduced to a common denominator when returns are standardised by volatility (Sharpe-ratio). In this index, CT appears to be just as good or perhaps slightly better than the stock market.[11] More complex strategies where the development of the portfolio is shaped by considerations other than the differentials between interest rates have outstanding performances.[12]

CT risks are manifested in the negative skew of the returns. Chart 2 shows the fitted historic monthly return distributions of the two indices. Due to the leverage structure in part, the extent of standard deviation associated with CT is larger, but a more striking feature is the long left tail of the distribution. This pattern is seen clearly in Chart 1 as well. Disregarding minor interruptions, CT was a profitable undertaking right from the beginning of the 2000s up to the crises in 2008, when a passive investor lost the cumulated profits of six years within a couple of weeks.

The distribution of high interest rate foreign currency returns is skewed towards the weakening direction. High interest rate currencies undergo slow appreciation periods, interrupted by sudden declines in the exchange rate. FX traders describe this feature as '*high interest rate currencies walk up by the stairs and come down by the elevator*'. When CT is unwound on a large scale, target currencies suddenly weaken and financing currencies gain strength. This causes negative skew with the former and positive in the latter. For similar reasons the financing and target currencies have a negative correlation. To illustrate this, I present the trends in the exchange rates of the Japanese yen and the Brazilian real in Chart 3. It is clear that when the real weakened to a great extent (2001, 2002 and 2008) the yen became stronger. The underlying mechanism is most probably explained by carry traders closing their long real/yen positions. Correlation between the two currencies on daily yields is –0.14.

High interest rate currencies depend very much on global liquidity conditions. Shock-like weakening usually occurs

[11] See Burnside et al. (2006), Burnside et al. (2007), Brunnermeier et al. (2008), and Hochradl & Wagner (2010).

[12] Jorda & Taylor (2009) for instance take into account the deviations of the real exchange rates by which Sharpe-ratios will double.

in situations when the financing conditions of carry traders suddenly weaken. These investors finance themselves using loans, and when they have to de-leverage they are forced to sell high interest foreign exchanges in return for low interest ones. Provided that many traders do this at the same time, it may become a self-reinforcing cycle. Investors in such situations are compelled to sell their high interest currencies even when they know that it will be strong again within a short period of time. The larger the stock of existing positions, the larger the extent of weakening can be.[13] Brunnermeier et al. (2008), Clarida et al. (2009) and Adrian et al. (2009) link the movements of high interest foreign currencies to the VIX index,[14] volatility of the target currency and the gearing ratio of US investment banks.

CT may weaken the exchange rate channel of the monetary transmission mechanism. In practical terms, the exchange rate of free floating currencies can be extremely volatile. This can be partially explained by speculation activities. The high degree of exchange rate volatility reduces the speed of pass-through of exchange rate changes in domestic prices. This reduces the ability of the central bank to influence inflation through the exchange rate. At the same time, volatile exchange rates deter domestic market players from being indebted in foreign exchange. This reinforces the interest channel of the transmission mechanism and is favourable from the point of view of financial stability.

CT may contribute to the overvaluation of real exchange rates which increases the risk of a balance of payments crisis. Emerging market crashes are almost always preceded by a long appreciation of the real exchange rate.[15] CT may contribute to this process by strengthening the nominal exchange rates.

A POTENTIAL EXPLANATION FOR THE CARRY TRADE PUZZLE

In relation to the stylised facts described above, the greatest puzzle is: Why is CT so profitable and why does a positive interest rate differential point towards appreciation? The Sharpe-ratio of CT is high and is only poorly correlated with traditional instruments. In other words, those investors who keep their money in the latter may benefit from allocating a part of their portfolio in high interest rate foreign currencies. Such increased demand would then depress CT yields and the puzzle would disappear. The question is: What is the risk which prevents investors from doing so?

If investors find high interest rate currencies more risky and their expectations are rational, the UIP equation will be modified as follows:

$$\rho_t = d_t - E_t(s_{t+1} - s_t), \tag{5}$$

where p is the risk premium and d is the interest differential. The equation above shows that a representative investor on average will earn the risk premium, the expected return by buying the high interest rate currency. According to this the investor will earn the same amount of profits by purchasing two similarly risky currencies even when their respective interest rates are very different. The central bank controls domestic short yields directly, but if the arbitrage condition described above is met, it will not be able to influence the expected returns of the foreign investors. This seemingly contradicts the very essence of CT, which tells us that we should invest in high interest rate foreign exchanges.

At the same time, the train of thought above does not mean that an unexpected increase in interest rates would not strengthen the exchange rate, but this effect will manifest itself in the spot price and not the subsequent trajectory thereof. The spot price of the currency is determined by the following equation:

$$s_t = \mathrm{E}_t \lim_{i\to\infty} s_{t+i} + \sum_{i=0}^{\infty} \mathrm{E}_t(\rho_i - d_i), \tag{6}$$

where $\mathrm{E}_t \lim_{i\to\infty} s_{t+i}$ is the long-term exchange rate expectation. If the interest rate differential increases unexpectedly, it causes an immediate strengthening of the exchange rate and a prolonged weakening thereafter. A negative premium shock has the same effect.

Volatile risk premium

The most evident explanation argues that the CT puzzle is not caused by the interest rate differential, but by the risk premium. When the central bank of the high interest rate currency reacts to risk premium shocks systematically, the increased interest rate differential will point towards appreciation, even though strengthening of the currency was not caused by the interest rate but by the shock experienced by the risk premium.[16] High interest rate

[13] See Brunnermeier et al. (2008) and Pojarliev & Levich (2010).

[14] The average implied volatility of option contracts on the American S&P 500 stock index is a frequently used proxy for the financing conditions of global financial institutions.

[15] See for instance Kose et al. (2009).

[16] See McCallum (1994).

currencies appreciate because their risk premia are higher.[17]

In emerging market countries, risk premia can be explained by the higher level of sovereign risk, and output is also more volatile than in developed countries.[18] Volatility of the sovereign risk premium may be caused by investors' incomplete or imperfect information on the probability of bankruptcy or devaluation. Investors' perception on the issue is updated upon the receipt of new information. Such new information may appear in economic or political news, or in the decisions made by other investors (whether instruments of the country in question are put or called). This phenomenon may lead to a herding effect. If a country turns out to be a fashionable investment target, such investors will also buy the instruments who otherwise would not do so based solely on their own information.[19]

In countries with similar levels of sovereign risk, the positive risk premium attached to the high interest rate currency (in the boom phase) may be caused by the different stage of the boom, as opposed to the one in the lower interest rate period (in recession). The risk aversion of economic agents which are being affected by the recession increases, and they are therefore willing to buy the instruments of the other economy only when the premium is higher.[20]

Liquidity constraints

Most probably, the risk aversion of representative agents in different countries is not sufficient to fully explain the CT puzzle. These models are not able to generate such an exchange rate risk premium which can be accommodated quantitatively with the data and could produce currency collapses endogenously.[21] Uncertainty concerning sovereign risks cannot always be justified either.

The persistent high returns on CT may be caused by the fact that too few agents invest in high interest rate currencies. Explanations built on financial market frictions assume that most investors do not actively trade in international instruments, and therefore such instruments are notoriously undervalued. According to this explanation, CT will approximate exchange rates to the fundamental value. Carry traders are nearly risk neutral institutional investors who take up the largest possible position in the underpriced instruments when they see an arbitrage opportunity. Due to the problem of asymmetric information, they can only take positions up to a limited extent, and therefore mispricing can persist longer.[22] According to this concept, the risk premium of equation (5) can be explained more by the financing constraints of the institutional investors active in the CT business, rather than by the risk aversion of final investors.

When carry traders are hit by a loss due to an adverse shock, the investors financing them may lose confidence in them, which results in capital withdrawal and forced selling. This is manifested in *stop-loss* limits in practice. For instance, if the exchange rate weakens as the consequence of a non-fundamental noise shock, an informed investor may want to increase his position taken in high interest rate currencies, since he reckons that the mispricing will be eliminated over time and an arbitrage profit may be made in addition to the usual yields. However, due to the initial losses, financing will be more difficult for him since his creditworthiness will be impaired with the loss of his assets' value.[23] Thus the investor soon finds himself in a situation where he is unable to increase his positions and even must cut them back, thus aggravating the initial shock. Thus, volatility of the risk premium is caused by these non-fundamental shocks and the mechanisms reinforcing them. This kind of liquidity risk is taken into account by professional investors in their decision making, which may be a partial explanation for the persistence of long-term high yields. According to calculations by Farhi et al. (2009), the risks associated with a sudden, severe fall may be an explanation for about one-fourth of all CT yields.

Distorted expectations

Irrational expectations can also explain the UIP anomaly and the profitability of CT. In practice, at least based on polls of market participants, market expectations cannot be regarded as undistorted estimates of actual exchange rate movements happening later on. An explanation for this may be that investors systematically underestimate the persistence of the monetary shock. Based on equation (6), if the interest

[17] To put it more accurately, the coefficient in equation (3) will take a negative value when the risk premium has a positive correlation with the interest margin and has a greater level of variance than that of the interest differential. These are the criteria formulated by Fama.

[18] For the role of the former played in exchange rate dynamics, see Kisgergely (2009), for the latter see Benczúr & Rátfai (2005).

[19] For the herding effect imposed on investors, see for instance Bacchetta & van Wincoop (1998) and Chari & Kehoe (2003).

[20] See for instance Verdelhan (2010).

[21] Backus (2001) demonstrated that affine yield curve models demanding a minimum level of restrictions cannot generate any appropriate level of risk premium either. Froot & Frankel (1989) denied compliance with the Fama criteria by the risk premium calculated from analysts' expectations.

[22] Provided lenders of a carry trader know that their client is investing in arbitrage transactions, they would provide financing to him without any collateral.

[23] For more on these liquidity spirals, see Brunnermeier & Pedersen (2007).

rate on a high interest foreign currency is raised unexpectedly, the exchange rate will strengthen, but the extent of this will depend on the persistence of the interest rate shock. Although it is very difficult to understand why investors never learn the real persistence of interest rate shocks, if expectations are indeed formed in this way, the exchange rate may strengthen for a prolonged period as a result of the interest shock.[24] This can be explained by the interest differential, which does not diminish as expected in the period after the shock and thus repeated positive interest shocks are exerted on market participants in each of the following periods.

A similar story is outlined by Benczúr (2003), focusing on interest rate based disinflation periods. In his model, the distorted expectations of exchange rates are formed through parameter learning caused by the altered monetary regime. In the event for instance that actual disinflation is slower than the original expectations of the investors, durable appreciation can be realised under rational expectations as well.

Exchange rate bubbles

The most common explanation for CT is that speculators push the high interest rate currency with their own purchases higher and higher, in other words CT causes a kind of exchange rate bubble. Since neither the fundamental real exchange rate nor the risk premium are variables which can be observed, the existence of such bubbles is difficult to prove ex-post as well. Theoretical economists were sceptical about bubbles for a long time, since it is very difficult to understand why investors – who are clearly aware of the existence of the bubble – do not eliminate the mispricing. Riding the bubble entails the danger of the bubble being popped by others and thus agents who have invested in the bubble will lose money. Asset prices usually approach the fundamental value. According to a famous saying by Milton Friedman, if speculators were to bet against fundamentals they would lose money on average.

There is a vast body of evidence, however, which indicates that professional investors buy overpriced instruments after all. It was Abreu & Brunnermeier (2003) who first built up a theoretically consistent bubble model, explaining the survival of the bubble by asymmetric information. Plantin & Shin (2008) explain the trends in high interest foreign currencies by the formation of the exchange rate bubble. In such a case, appreciation is caused by the exchange rate diverting from the fundamental level defined by equation (6) as a result of CT inflows. The bubble will burst at a point in time which cannot be foreseen and this will cause sudden episodes of weakening. Bubbles tend to burst when too many investors suddenly realise the mispricing. Such a coordination event can be for instance the disclosure of macro data pointing towards weakening of the high interest currency.

This explanation of the CT bubble is substantiated somewhat by the results of Jorda and Taylor (2009), who maintain that the profitability of CT is diminishing with the strengthening of the real exchange rate. This will suggest a story (although it cannot be regarded as positive proof) that an initially undervalued, high interest currency will attract speculators, who will strengthen the exchange rate by their buying pressure. The more overvalued a currency is, the greater the probability of a correction. Finally the bubble will burst, and the exchange rate becomes undervalued once again and the whole cycle begins again.

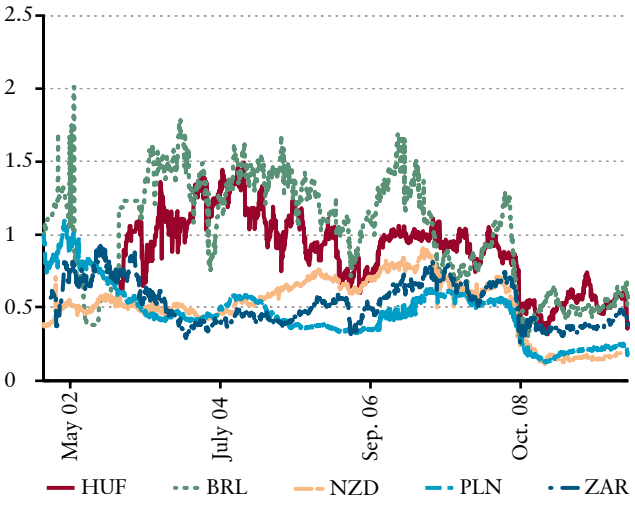
WAS CARRY TRADE A TYPICAL FEATURE IN HUNGARY?

In this section, I investigate whether the CT activity of foreign investors in the past may have been important in certain periods. Unfortunately, identification of CT positions is extremely difficult, and therefore speculative activity can only be estimated with approximation.

According to the calculations of Csávás (2008), the expected distribution of Hungarian forint exchange rates was continuously skewed toward weakening in the sample tested. This feature can be seen with all carry currencies. In

Chart 4

Interest differentials for a number of high yielding currencies standardised by their implied volatility

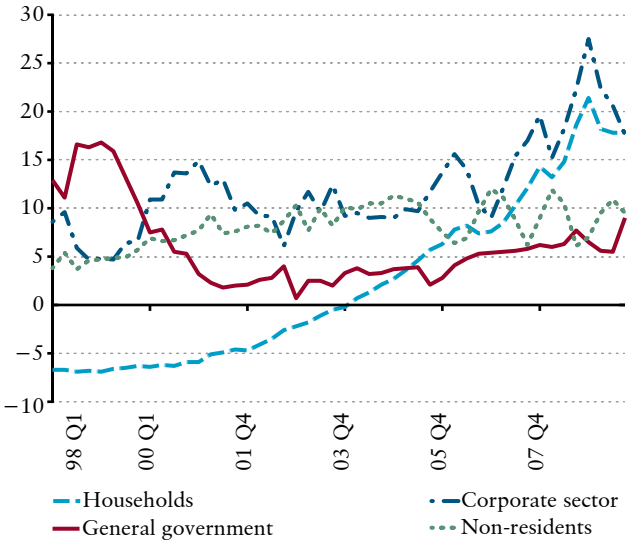


[24] For more details, see Gourinchas & Tornell (2004), and Bacchetta & van Wincoop (2006).

Chart 5

Hungarian forint positions of certain sectors

(as a percentage of GDP)



the case of HUF, however, another cause is also possible. High level of external liabilities may cause an exchange rate crisis without any CT, the risk of which is priced by the option markets. Furthermore, HUF was sometimes very close to the edge of the intervention band which limited additional strengthening.

By international standards, the interest rate differential of HUF was still very significant in the 2000s, although it had the declined greatly compared to the 1990s. Even if this measure is standardised with the implied volatility of the exchange rate, HUF still seems to be an attractive investment opportunity (Chart 4). Such differences in interest rates, however, can only be compared when it is assumed that the exchange rate expectations of the market is that exchange rates will not change in the upcoming period, which can usually be refused based on analyst polls.[25]

Exposure of foreigners to HUF

First, it is worthwhile to investigate the HUF exposure of individual sectors. Carry traders must assume an exchange rate risk: the risk premium cannot be earned with a covered position. Aggregate HUF positions are shown in Chart 5. Non-residents' exposure was remarkably stable over this period, and only a slight increase was seen up to 2004. Hungarian households were the only sector which increased its exposure to HUF. Upon the discontinuation of the HUF-denominated subsidised housing loan programme, the foreign currency loan portfolio experienced sudden explosive growth, and thus households accumulated a substantial amount of the HUF position. This trend was later joined by companies.

Despite the high interest differential, foreigners took positions against HUF en masse. Namely, the Hungarian banking system partly converted the HUF-denominated assets into foreign currency as well, in order to meet the demand of the retail sector for foreign currency debts. This conversion was mostly done on the FX-swap market.[26] Chart 6 presents the cumulative value of the daily changes in the non-resident FX-swap portfolio against HUF. It can be clearly seen that foreigners were in net positions against HUF on this market all along.[27] Such positions were partly used to cover exchange rate risks associated with their HUF instruments, and partly they did indeed take positions speculating on the weakening of the Hungarian forint. In both cases, interest differentials are paid for by the foreigners either because it makes sense to cover the exchange rate risk this way or because they expected a weakening exceeding the actual differences between the interest rates.

Since the foreign indebtedness observed during the 2000s was not associated with a similar increase of HUF exposure of foreigners, it means that the CT activities of foreigners played no role in this process. This does not mean that carry traders were not present on the foreign exchange markets. In past years, foreigners held HUF positions ranging up to 5-10 per cent of Hungarian GDP, part of which might have been held by CT funds. Most probably, these transactions were also concluded on the FX-swap market. Provided a non-resident investor takes up a carry position in favour of HUF, it will be seen in the reduction of their swap stock. In certain periods, it was observed that the swap stock did indeed diminish significantly. It is conceivable that Hungarian forint CT also played a role during these periods. This speculative activity may also have an impact on the exchange rate dynamics. Swap reduction (which may be caused by CT-inflow) implies usually stronger exchange rates, while an increase (which may be due to closing of CT positions) usually entails weakening of the Hungarian forint. Calculated on first differences thus filtering out the trend, the correlation coefficient between changes in HUF and the swap portfolio ranges up to nearly 0.6.

[25] According to the Reuters Polls for instance in the case of HUF, investors expected a relatively stable price throughout the last decade, but the tendency of appreciation of the Czech koruna was partly foreseen in the same period.

[26] On the role of domestic FX-swaps more in details see Mák & Páles (2009).

[27] In contrast with them, foreign exchange debtors took up positions in favour of HUF.

Chart 6

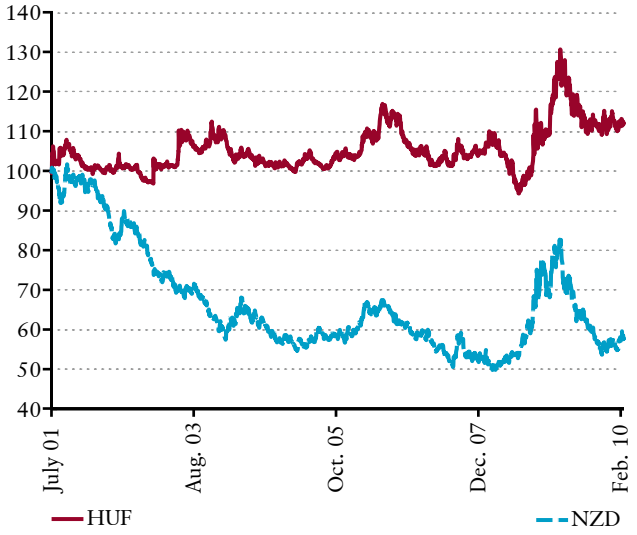
FX swap portfolio concluded by non-residents against HUF

(HUF billion)

Chart 7

Exchange rate dynamics of HUF and the New Zealand dollar

(June 2001 = 100)



Correlations

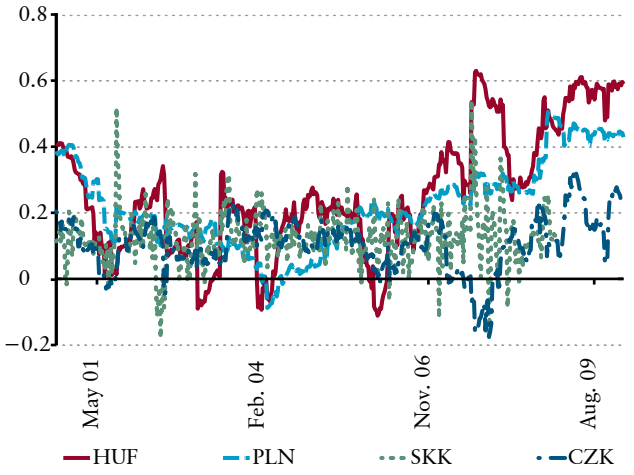
One sign of CT activity may be strengthening of the correlation between the exchange rates of the target currency and typical CT currencies. Chart 7 presents the exchange rates of HUF and the New Zealand dollar (kiwi). The latter can be regarded as one of the most typical carry currencies. It is remarkable that exchange rate volatility of the kiwi dollar is substantially higher than that of the Hungarian forint. As a result of continuous CT activity during the 2000s, the kiwi dollar appreciated by 50 per cent, and then fell 60 per cent in the crisis of the year 2008.[28] Any correlation in the two time series can be seen at first glance at around 2006 and in the crisis period.

For the purposes of a more formal investigation, conditional correlations for a number of other emerging market currencies and the CT-index were calculated.[29] In the case of the South African rand and the Brazilian real the counterpart was USD, for the rest it was EUR. Positive correlation between an exchange rate and a CT-index may mean that carry traders are relatively important players in the foreign exchange market. Instruments in the same investment category show usually strong correlation, which may be due to the funds trading in entire portfolios. For instance, they buy or sell high interest foreign currencies all at once.

The calculated correlations can be seen in Charts 8 and 9. Emerging currencies showed a positive correlation with CT for the entire period. In the first half of the period only the correlations of the real and the rand are outstanding. From 2006 on, the co-movement between the carry index and the local currencies increased everywhere, except for the Czech Republic and Slovakia. According to this, the massive withdrawal of CT may have played a role in the depreciation wave of 2008 and 2009 in the emerging markets too. Currently, CT activity may be at historical heights in the market of forint, zloty, real and rand. It is worth highlighting

Chart 8

Correlations between the carry factor and some emerging market currencies I

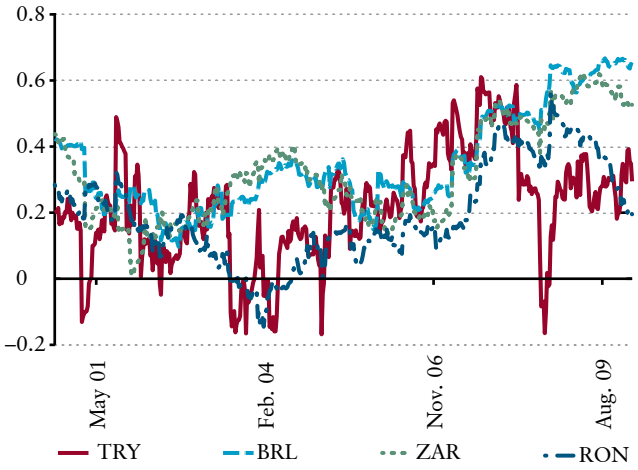


[28] It is worth noting that the kiwi dollar appreciated much more than HUF, despite its interest differential being substantially lower (see Chart 4).

[29] Such estimates were made using the DCC-GARCH model, which models the covariance matrix of – in this case – two variables so that variances are GARCH(1,1), while correlation follows a process similar to ARMA(1,1). Detailed description of this methodology can be found for instance in Silvennoinen & Teräsvirta (2007). In the estimation, I calculated using the negative of the log change in the exchange rate (in other words, a positive value means the strengthening of the currency).

Chart 9

Correlations between the carry factor and some emerging market currencies II



that according to our indicator CT activity on the Hungarian forint market increased to historical highs in the time when the economy ran a current account surplus This also underlines the fact that net capital inflow and CT activity are not the same phenomena.

No significant correlation was found between HUF correlation and the interest rate differential. Increase was partly caused by international factors (this tendency can be observed for several currencies). It is probable that the abolition of the intervention band in 2008 contributed to the increase in speculative activity. HUF volatility in the past was substantially lower than other typical CT currencies (see Chart 7). Provided CT activity on the domestic market is indeed so strong as indicated by the correlation level, it can be assumed that HUF will also face more extreme appreciation cycles.

CONCLUSIONS

CT is a leveraged investment style applied by specialised institutional investors. Foreign exchange market funds take up their positions predominantly through derivative instruments, and thus this kind of capital inflow does not entail financing for the receiving country. High interest currencies undergo prolonged appreciation cycles interrupted by sudden falls. Tendencies seen in the exchange rates of the high interest (CT receiving) currencies are shaped by the global liquidity conditions.

Foreigners' CT activity did not contribute to the indebtedness of the Hungarian economy. The exchange rate risk exposure associated with the increase of indebtedness was assumed entirely by resident agents – primarily households. At the same time, the increased correlation coefficient of HUF and the CT-index may suggest that the HUF exposure of foreigners may have shifted to CT funds in the past three years to a greater extent than before. Although this correlation coefficient is merely an imperfect indicator of actual CT activities, if speculation on HUF is indeed so strong, the evolution of more serious appreciation cycles can be anticipated in the future.

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