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FINANCIAL DETERMINANTS OF CARRY TRADE ACTIVITY

Katarzyna Czech, Adam Waszkowski
Warsaw University of Life Sciences – SGGW

Abstract. Recently, the yen carry trade is perceived to be one of the most widely used currency speculation strategy. The aim of the paper is to examine the relationship between the yen carry trade activity and the related variables. The study is focused on the Japanese and U.S. financial variables. It is assumed that carry trade activity is affected by the interest rate differential between U.S. and Japan, JPY/USD exchange rate and the S&P 500 option implied volatility index (VIX). The paper investigates above relationship by the structural vector autoregression (SVAR) model. The results suggest that JPY/USD exchange rate is the only variable which has a significant impact on carry trade activity. It is shown that the depreciation of Japanese yen against U.S. dollar leads to the increase in yen carry trade activity.

Key words: carry trade strategy, JPY/USD exchange rate, SVAR, Granger causality

INTRODUCTION

Market evidence suggests that carry trades are the most widely used currency speculation strategy [Galati and Melvin 2004]. The strategy is based on borrowing in currency with a relatively low interest rate and using the funds to invest in high interest rate currencies [Fong 2010]. Carry trades are profitable if the interest rate differential is not completely offset by the change in the value of exchange rate. Thus, the profitability of carry trade directly violates the uncovered interest rate parity (UIP) condition. Moreover, an increase in carry trade activity tends to weaken the low interest-yielding currency and strengthen the high interest rate currencies, which is also contrary to the UIP predictions.

Corresponding authors – Adres do korespondencji: Katarzyna Czech, Adam Waszkowski, Warsaw University of Life Sciences – SGGW, Faculty of Economic Sciences, 166 Nowoursynowska St., 02-787 Warsaw, Poland, e-mail: katarzyna_czech@sggw.pl, adam_waszkowski@sggw.pl.

The paper investigates the relationship between carry trade activity and the related financial variables. The study is focused on the Japanese and U.S. financial variables. It needs to be stressed that Japanese yen is one of the most popular funding currency in carry trades because of prolonged low interest rate policy of the Bank of Japan [Gagnon and Chaboud 2007]. The yen carry trade activity is measured by net open positions of non-commercial traders in the Japanese currency FX futures. Non-commercial traders are classified by Commodity Futures Trading Commission as those who use futures not for hedging but for speculative purposes. It is worth to emphasize that there is some imperfect classification of commercial and non-commercial traders. Besides, there is possibility that some commercial traders also take speculative positions or non-commercial traders, identified as speculative, may not result from carry trade. Moreover, much of the liquidity in the currency market is in the over-the-counter forward market. Subject to these caveats, however, these data are the best publicly available data which reflect the carry trade activity [McGuire and Upper 2007].

In the paper we assume that carry trade activity is affected by the interest rate differential between U.S. and Japan, JPY/USD exchange rate and the S&P 500 option implied volatility index (VIX). With regard to the relationship between the interest rate differential and carry trade activity, a larger differential seems to be associated with the increase of carry trade activity. It concerns mainly the level of interest rates in Japan. Tightening monetary policy by the Bank of Japan may imply that the investors will borrow less money in Japan and invest less elsewhere. The second factor that can have an impact on the carry trade activity is the level of exchange rate. It is commonly believed that the Japanese yen depreciation brings about the growth in carry trade activity. Therefore, we can expect that the higher the JPY/USD exchange rate, the higher the yen carry trade activity is supposed to be. As far as the VIX is concerned, we can assume that the higher the level of the S&P 500 option implied volatility index the lower the carry trade activity. VIX is perceived as the popular measure of investors' attitude towards risk [Coudert and Gex 2008]. The greater the value of VIX, the higher the risk aversion among the market participants. The increase in VIX tends to be associated with appreciation of the low yielding currency and a lower carry trade returns [Clarida, Davis and Pedersen 2009]. In turn, the lower the carry trade returns, the lower the carry trade activity. It altogether implies the negative relationship between the S&P 500 option implied volatility index and the carry trade activity.

The aim of the paper is to examine the relationship between the yen carry trade activity and the related financial variables. The remainder of the paper is organized as follows. Section 2 reviews the relevant literature. The subsequent one presents the structural vector autoregression methodology and data. The empirical results are described in section 4. The last section provides concluding remarks drawn from the empirical research.

LITERATURE REVIEW

Although the activity of carry trades has been examined in a number of papers recently, we focus mainly on three works that more directly matter to our aims. Similar researches have been conducted by Klitgaard and Weir [2004], Nishigaki [2007] and Mutafoglu [2011]. Klitgaard and Weir [2004] examine the relationship between weekly

net position data on futures traded on Chicago Mercantile Exchange and the level of exchange rates. They have found strong and stable contemporaneous connection between changes in speculators' positions and exchange rate movements of the major currency pairs over a ten-year period. It implies that there may be strong and significant link between carry trade activity and the value of chosen currency.

Both Nishigaki [2007] and Mutafoglu [2011] investigate the relationship between carry trade activity and related financial variables. They both use the net positions of non-commercial traders in the Japanese currency futures as a measure of carry trade activity. Their researches are focused on the U.S. and Japanese financial markets and cover the period from January 1993 to January 2007. Although, Nishigaki and Mutafoglu conduct similar researches, they obtain different results. Nishigaki [2007] observes that the interest rate differential between the U.S. and Japan insignificantly affects the yen carry trade activity. Moreover, he discovers that U.S. stock prices have a positive impact on the movement of the yen carry trade. And last but not least, he finds that the carry trade activity significantly affects the nominal JPY/USD exchange rate. Mutafoglu [2011], in turn, observes the significant impact of the JPY/USD exchange rate on the yen carry trade activity. He finds that when the Japanese yen depreciates against U.S. dollar, the yen carry trade increases.

According to Mutafoglu, the results obtained by Nishigaki are not robust. Nishigaki uses monthly positioning data of non-commercial traders in currency futures. Mutafoglu, however, applies weekly positioning data to the same methodology and sample period and he has obtained completely different results. Mutafoglu claims that aggregating data from higher to lower frequencies may imply some risk and cause the lack of robustness. Temporal aggregation loses information about the underlying data processes [Marcellion 1999]. Therefore, the application of weekly positioning data to the study of relationship between carry trade activity and related financial variables, seems to be more appropriate.

DATA AND METHODOLOGY

The paper examines the relationship between carry trade activity and the related financial variables. We have chosen three variables which are related to yen carry trade. There are interest rate differential (IRD), JPY/USD exchange rate and the S&P 500 option implied volatility index (VIX). The interest rate differential (IRD) reflects the difference between U.S. and Japan 3-month LIBOR interest rates. As a proxy for carry trade activity (CTA) we apply data on the net positions of non-commercial traders on the Japanese yen futures market traded on the Chicago Mercantile Exchange. The data are published in the weekly Commitments of Traders Report released by the U.S. Commodity Futures Trading Commission. The net yen position is measured as a ratio of short to long yen positions. The higher the ratio, the higher the yen carry trade activity. The analysis is carried out on the basis of weekly data from January 1997 to December 2010, with a total of 725 observations. The data are obtained from Reuters Datastream, except CTA which is calculated from the Commitments of Traders reports. All variables apart from IRD are entered into natural logarithms.

The relationship between carry trade activity and the chosen financial variables is examined by a structural vector autoregression (SVAR) model. The assumptions can be summarized in the following equations that link the reduced-form errors to the structural shocks:

$$\begin{bmatrix} e_{IRD} \\ e_{VIX} \\ e_{USD/JPY} \\ e_{CTA} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ g(VIX, IRD) & 1 & 0 & 0 \\ g(JPY/USD, IRD) & g(JPY/USD, VIX) & 1 & 0 \\ g(CTA, IRD) & g(CTA, VIX) & g(CTA, USD/JPY) & 1 \end{bmatrix} \begin{bmatrix} u_{IRD} \\ u_{VIX} \\ u_{USD/JPY} \\ u_{CTA} \end{bmatrix}$$

where e_j are the structural disturbances, u_j represent the residuals in the reduced-form VAR equations, IRD is the interest rate differential between U.S. and Japan and CTA is the carry trade activity ratio.

The IRD is treated as the exogenous to the other variables. Further, the volatility index VIX is assumed to be affected only by shocks to IRD. As far as the JPY/USD is concerned, we assume that the exchange rate depends on both IRD and VIX. The last equation depicts the carry trade activity. CTA is expected to be influenced by shocks to all other variables. The theoretical reasoning of this relationship is included in the introduction part of the paper.

SVAR MODEL – EMPIRICAL RESULTS

The first step before conducting the SVAR analysis is to test the stationarity of each time series. The results of the Augmented Dickey-Fuller (ADF) test are reported in the Table 1.

Table 1. Augmented Dickey-Fuller test
Tabela 1. Rozszerzony test Dickey-Fullera

	Intercept		Intercept and Trend	
	Level	**First Difference**	**Level**	**First Difference**
IRD	–0.67	–13.60***	–1.31	–13.60***
VIX	–3.43**	–33.76***	–3.47**	–33.74***
USDJPY	–0.79	–26.66***	–2.21	–26.68***
CTA	–6.42***	–18.27***	–6.42***	–18.26***

Note: *** H_0 of a unit root is rejected at the 1%, **5%, and *10% significance level.

Source: Own calculations.
Źródło: Opracowanie własne.

The Augmented Dickey-Fuller test is applied to the level and first difference. The ADF tests indicate that the hypothesis of a non-stationary level cannot be rejected at the 1% significance level for any of the series except CTA. The results for the first difference, however, show that the null hypothesis of a unit root is rejected. Consequently, all variables apart from CTA, are integrated of order one.

The optimal lag length of the VAR estimation is determined on the basis of the Akaike information criterion (AIC) and Schwarz criterion (SC) and the residuals are tested for autocorrelation. Both tests suggest a lag of the second order. The Lagrange multiplier test suggests that the residuals are not serially correlated. The LM statistics for 2 lags is equal 16.47 and the corresponding *p*-value equals 0.42. Therefore, on the basis of the following results we cannot reject the null hypothesis that there is no serial correlation in the residuals. Moreover, the estimated model is stable. It results from the AR Roots graph (Fig. 1). All of the roots have modulus less than one and lie inside the unit circle.

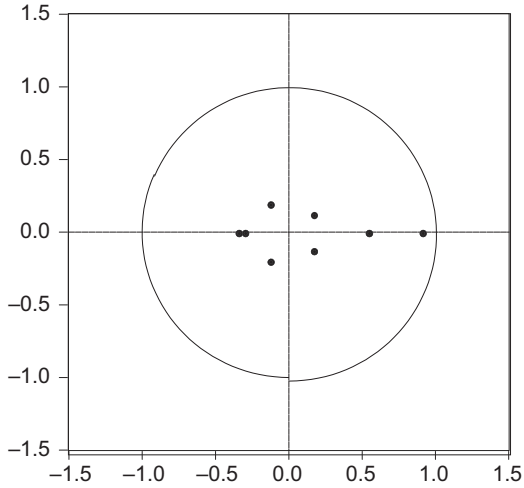

Fig. 1. Stability of the model – graphical representation of root
Rys. 1. Stabilność modelu – pierwiastki równania charakterystycznego

Source: Own calculations.
Źródło: Opracowanie własne.

The study of the relationship between carry trade activity and related financial variables is based on the impulse response functions, variance decompositions and VAR Granger causality test. An impulse response function traces the effect of shock to one endogenous variable on the other variables in SVAR model. The shocks underlying the impulse responses are based on a Choleski decomposition with the ordering IRD, VIX, USDJPY and CTA. The impulse response functions play the central role in assessing how and to what extent structural shocks influence carry trade activity (CTA). Figure 2 displays the estimated responses of CTA to particular structural shock on all analysis variables over a 20-weeks period range and contains ±2 standard error bands. The results suggest that a one-standard deviation shock to the JPY/USD exchange rate is associated with the increase in yen carry trade activity (CTA). It means that when the Japanese yen depreciates against U.S. dollar then the CTA increases. Therefore, we can expect that the higher the JPY/USD exchange rate, the higher the yen carry trade activity is supposed to be. None of the other variables have a significant impact on the level of speculative yen carry trade activity.

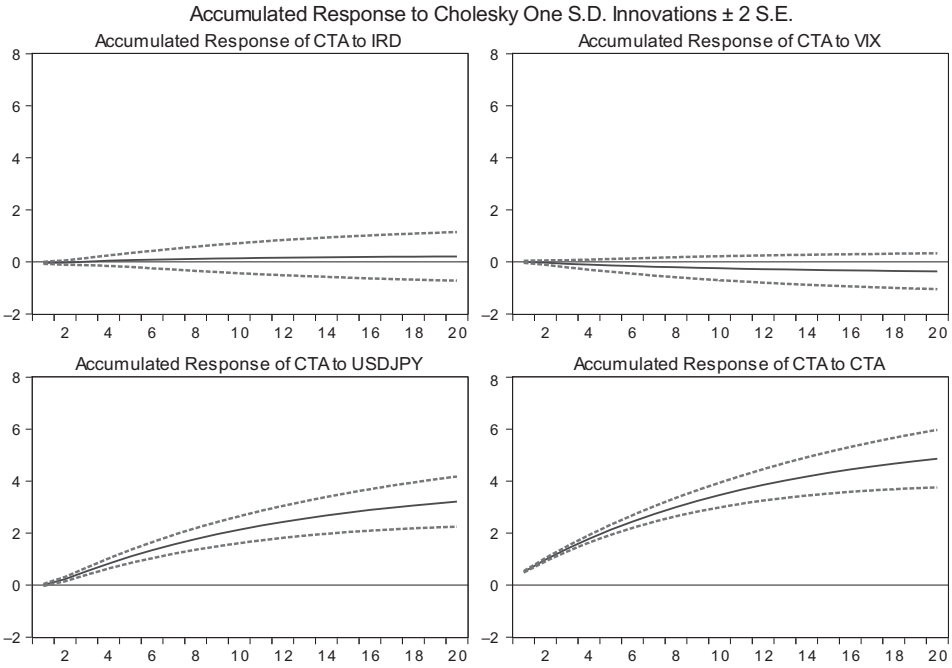

Fig. 2. Impulse responses of CTA to a shock on IRD, VIX and USDJPY variables
Rys. 2. Wykres funkcji reakcji na impuls dla CTA na szok IRD, VIX i USDJPY

Source: Own calculations.
Źródło: Opracowanie własne.

As far as the variance decomposition analysis is concerned it provides the information about the relative importance of each random shock to one endogenous variable in affecting the other variable. Table 2 reports the estimated variance decompositions of carry trade activity variable (CTA).

The variance decomposition of CTA suggests that shocks in JPY/USD exchange rate explain about 26.09% of the variance in CTA six weeks after a shock. Moreover, the explanatory power of shocks to JPY/USD increases to almost 30% after twenty weeks. The outcomes of variance decompositions analysis are consistent with the results from impulse responses functions analysis.

Table 2. Variance decompositions of CTA
Tabela 2. Dekompozycja wariancji zmiennej CTA

Period	S.E.	IRD	VIX	JPY/USD	CTA
1	0.51	0.58	0.00	0.00	99.42
6	1.18	0.38	0.41	26.09	73.12
12	1.39	0.32	0.41	29.17	70.10
20	1.47	0.30	0.41	29.96	69.33

Note: S.E. is the estimated standard error.

Source: Own calculations.
Źródło: Opracowanie własne.

Finally, we perform the Granger causality test, which indicates whether the lagged independent variables affect a particular dependent variable. In our analysis the dependent variable is the carry trade activity (CTA). We arrange the data in the order IRD, VIX, JPY/USD and CTA. The results of the test are provided in Table 3.

Table 3. VAR Granger causality test (*p*-values)
Tabela 3. Test przyczynowości w sensie Grangera (wartości *p*-value)

Independent variable	Chi-square test statistic	df	*p*-value
IRD	0.75	2	0.69
VIX	0.65	2	0.72
JPY/USD	166.88	2	0.00

Note: Carry trade activity (CTA) – dependent variable.

Source: Own calculations.
Źródło: Opracowanie własne.

According to the results of Granger causality test the changes in JPY/USD exchange rate significantly Granger-causes the speculative carry trade activity. None of the other variables have any causal effect on the yen carry trade. Therefore, the carry trade activity is affected mainly by the changes in dollar against yen exchange rate. The obtained results are in line with the outcomes of impulse response functions and variance decompositions analysis.

CONCLUSIONS

The aim of the paper is to examine the relationship between the yen carry trade activity and the related financial variables. The study is focused on the Japanese and U.S. financial markets. The paper assumes that carry trade activity is affected by the interest rate differential between U.S. and Japan, JPY/USD exchange rate and the S&P 500 option implied volatility index (VIX). The results of SVAR analysis suggest that JPY/USD exchange rate is the only variable which has a significant impact on carry trade activity. It is shown that the depreciation of Japanese yen against U.S. dollar leads to the increase in yen carry trade activity. The outcomes of impulse response functions analysis, variance decompositions analysis and Granger causality test confirm the findings. Above conclusions are in line with the results obtained by Mutafoglu [2011].

The most surprising research result is that the interest rate differential between U.S. and Japan does not significantly affect the yen carry trade activity. It implies that interest rate differential does not play a crucial role in assessing the attractiveness of carry trade strategy. Investors are likely to pay more attention to the level of exchange rates than to interest rate differentials. It needs to be emphasized, however, that the outcomes concern the interest rate differential and exchange rate of U.S. and Japan. There is high possibility that the results will differ dramatically when we take into account country with higher interest rates than the U.S. Hence, an interesting issue for future research would be to replicate the SVAR analysis based on the JPY/AUD, JPY/NZD or JPY/TRY exchange rates and the corresponding interest rate differential. Australian dollar, New Zealand dollar and

Turkish lira are becoming more and more popular as a targeting currency in carry trade strategy. The role of U.S. dollar as a targeting currency, however, has been reduced after the financial crisis of 21st century.

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FINANSOWE DETERMINANTY POZIOMU ZAANGAŻOWANIA INWESTORÓW W STRATEGIĘ SPEKULACYJNĄ „CARRY TRADE"

Streszczenie. W ostatnich latach zauważalny jest znaczny wzrost zainteresowania walutową strategią spekulacyjną „carry trade". Celem artykułu jest identyfikacja zależności między poziomem zaangażowania inwestorów w strategię „carry trade" a wybranymi zmiennymi finansowymi. Badania oparto na analizie zmiennych powiązanych z gospodarką Japonii i Stanów Zjednoczonych Ameryki Północnej. W artykule założono, że atrakcyjność strategii „carry trade" zależna jest od różnicy w poziomie stóp procentowych w USA i Japonii, poziomu kursu walutowego JPY/USD i wskaźnika implikowanej zmienność opcji na indeks S&P 500 (VIX). Powyższa relacja została zbadana na podstawie strukturalnego modelu wektorowej autoregresji. W artykule wykazano, że jedyną zmienną mającą istotny wpływ na poziom zaangażowania inwestorów w strategię „carry trade" jest kurs walutowy JPY/USD. Deprecjacja jena japońskiego względem dolara amerykańskiego przyczynia się bowiem do wzrostu zainteresowania spekulacyjną strategią walutową „carry trade".

Słowa kluczowe: strategia spekulacyjna „carry trade", kurs walutowy JPY/USD, SVAR, przyczynowość Grangera

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