Do Japanese Retail Traders Destabilize Foreign Exchange Market?

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Abstract

In this chapter we explored behaviors of a new set of players, Japanese retail traders, in foreign exchange market and obtained implications for the price volatility.

One of our contributions is to present the first attempt to explore their trading behavior. We provide an evidence which implies that Japanese retail traders contribute to decrease excessive price movement. They behave as contrarian in response to price changes and thus contribute to dampen the volatility of the foreign exchange rate.

Considering returns of interest differential, they seem to act as momentum traders, but not all the time, contrary to general expectations. Although they are usually regarded as momentum traders in search for carry returns, we find that they are not momentum traders in every aspect. They buy past winners and also sell past winners and consequently gain profit by trading the most volatile currency in the preceding period. This implies that their search for yield activity does not always destabilize the exchange rate.

Keywords: Momentum, Contrarian, Portfolio performance measures, Foreign exchange rate
JEL classifications: F31, G11, G12

1 Introduction

Since the start of the global financial crisis with the downturn in equity markets and low interest rate, foreign exchange trading has gained popularity among retail investors around the world. The rise of retail traders is observed most remarkably in Japan and huge numbers of individual investors who entered the foreign exchange market in early 2000's became epitomized as "Mrs. Watanabe." It is the metaphoric Japanese housewife (Greenwich Associates (2010)). They are likely to be regarded as new players who induce excessive fluctuations in the market [1]. They are noted for taking advantage of carry trades [2], and searching for carry tends to promote deviation from fundamentals in the short run. Our motivation in this paper is to explore behaviors of this new set of players in foreign exchange trading and obtain implications for the market volatility [3].

Turning to theory associated with financial market volatility and trading behavior, Friedman (1953) argued that rational speculation must stabilize asset prices. He pointed out that irrational investors destabilize prices by buying assets when their prices rise and selling them when prices fall. They are consequently eliminated from the market in the face of profit losses. By contrast, rational speculators who buy when prices are low and sell when prices are high stabilize asset prices and promote them back to fundamentals.

Based on this argument, numerous studies examined whether investors behave as stabilizer or destabilizer in financial market. DeLong et al. (1990) exhibited that momentum traders (trend chasing or positive feedback traders) destabilize stock prices and thereby lead to threaten the efficiency of financial markets. They document that whether traders exacerbate fluctuations or dampen excessive fluctuations hinges on examination of identifying momentum (trend chasing) or contrarian (reverting) strategies. Various studies analyze specific players and explore what strategies they actually adopted. Grinblatt et al. (1995) found that mutual fund managers tend to pursue momentum investment strategies. Badrinath and Wahal (2002) exhibited that institutions act as momentum traders when they enter stock market but as contrarian traders when they exit or make adjustments to ongoing holdings.

[1] Greenwich Associates (2010) shows that 57% of retail aggregators in global forex market are located in Japan.

[2] Carry trades basically involves borrowing in low interest rate currencies, i.e., funding currencies, to invest in higher yielding target currencies.

[3] Although the presence of Japanese retail traders has become large in foreign exchange market, they are still price takers in vast global foreign exchange market. We hence do not consider endogeneity problem of price change and their trading behavior in our analysis.

Curcuru et al. (2011) dealt with US investors' foreign equity portfolio and found that their behavior was consistent with partial portfolio rebalancing (contrarian trading). Haan and Kakes (2011) focused on Dutch institutional investors and indicated that they are contrarians.

Those empirical studies mostly focused on institutional investors or stock market, and limited attempts have been made to explore foreign exchange market. While profitability of foreign exchange market is often analyzed, there are few studies that examine what trading behavior is adopted in the market. Further, no studies have ever tried to explore behavior of retail traders in the market, though it is worthwhile to examine the effect their emergence brings to the market. Against this backdrop, we in this chapter try to analyze whether Japanese retail traders in foreign exchange market stabilize or destabilize the exchange rate.

Our chapter presents three extensions to the existing literature. First, we focus on new players in the foreign exchange market, Japanese retail traders, and present the first attempt to explore their trading behavior. Grasping trading volume of foreign exchange market is usually difficult, and newly available data of Japanese retail traders' foreign exchange portfolio enable us to analyze their strategies with well-established techniques.

Second, we provide evidence which implies that Japanese retail traders contribute to decrease excessive price movement. They behave as contrarian in response to price changes and thus contribute to dampen the volatility of the foreign exchange rate. They behave consistently as contrarian in that they sell past winner portfolio and buy past loser portfolio.

Third, considering returns of interest differential, the retail traders seem to act as momentum traders, but not all the time, contrary to general expectations. In past studies carry trades and momentum trading are considered to be very close concepts, and Japanese retail traders are taken as typical players in search for carry return. However, we find that they are not momentum traders in every aspect. They buy past winners and also sell past winners and consequently gain profit by trading most volatile currency in the preceding period. This implies that their search for yield activities do not always destabilize the exchange rate.

Our analysis has some caveats and leave issues which should be explored in future researches [4].

[4]In addition, our approach ignores the foundation of utility maximization framework of individuals that the modern macro/micro economics requires. Our approach is based on the field of macro finance and here does not discuss individual portfolio allocation, but examination in the context of individual preference or heterogeneity can contribute to develop the study.

Our approach is based on technique many relevant studies have used in the past. It identifies trading strategies with a kind of simple calibration using actual price and portfolio data. We enjoys advantage of this intuitive method, but also shares limitation with past studies.

First, we here try to find trading strategies and derive indirect implications for volatility, as past studies do. We do not directly deal with links between volatility and trading behavior with this framework, though our interest lies in volatility. In studying drivers of market volatility, it is worthwhile to do a direct examination of volatility to achieve clear insights, but it is left for future research. Avramov et al. (2006) can be a good reference as they examined direct relationship between volatility and trading behavior and showed that contrarian trades (selling past winners and buying past losers) reduce volatility in daily volatility of individual stock returns [5].

Second, our focus is limited to backward looking behavior of individuals. We here aim to find how traders change their behaviors in reaction to past price changes so that we can obtain implication for the effect on price volatility. Our focus then is limited to past returns, but extending study to relationship with future returns give more insights for grasping traders' behavior. Curcuru et al. (2011) and others extended their focus on portfolio reallocations and future returns. They show an evidence that U.S. investors increase portfolio weights on a country's equity market just prior to its strong performance and concluded their trading expertise are informational advantage [6].

This chapter proceeds as follows. In the next section we present relevant literature from broader perspectives to clarify where our paper is located in the literature. In Section 3.3 we explain our data, analytical tool, and empirical results. Section 3.4 concludes the chapter. In the appendix, we show some additional exercises for checking profitability of trading strategies.

2 Relevant Literature

Other than prior studies referred in the above section, vast literatures attempted to explain development of exchange rate and its properties. The framework we based this chapter on has an assumption in which there exists abnormal returns in the financial market, though the basic theory presents

[5] This also provided evidence that herding trades increase volatility following stock price declines.

[6] Curcuru et al. (2011) carried out GMM estimation to handle expectation term of future returns.

no profitability in a complete financial market. We here review some studies relevant to the background of our analytical framework, so that we can make clear where our paper is located in previous studies.

Dating back to Fama (1970), efficient market hypothesis (hereafter EMH) is an essential framework in financial theory. It suggests that prices are theoretically unpredictable and there is no extra profit existing in the market. In other words, the price of financial assets correctly reflects all public information of fundamentals. Future price changes are thus unpredictable and there is no arbitrage opportunity. Investors with rational expectation use all available information efficiently and quickly respond to them, and the market price uniquely converges to the level which reflects economic fundamentals.

However, a substantial number of studies have cast doubt on the EMH. As for the foreign exchange markets a vast literature has documented abnormal returns. While the EMH suggests that the foreign exchange rate is assumed to be random walk and no technical trading rule makes profit, many studies have explored the performance of trading rules. General conclusion is that technical rules are able to earn significant excess returns that cannot be easily explained by bearing additional risk when using daily or weekly data [7].

Many papers attempted to explain this anomaly. The possible explanations are, for example, existence of noise traders, transaction cost, central bank intervention, and behavioral motivation.

Noise traders, who make their trading decisions based upon prior directional movement in the currency, give fluctuations in the market. Shleifer and Summers (1990) provided evidence that noise traders overreact to news in the foreign exchange market and hence generate deviations from fundamentals. Transaction costs make arbitrage less effective, too. Even though traders' speculative actions drive prices toward fundamental values, the correction will be costly due to the substantial transaction fees (Shleifer and Vishny (1997)). Another explanation is the central bank intervention. The objective for a central bank is not to earn trading profits, but instead to dampen foreign exchange volatility to ensure that currencies reflect politi-

[7] Sweeney (1986) documented the abnormal return when using filter rules in trading from a risk-free dollar asset to a risk-free Deutsche Marke assets. Okunev and White (2003) examined the profitability of momentum strategies in the foreign exchange market and found that its profitability holds for currencies throughout the 1990's. Taylor and Allen (1992) conducted a survey with London foreign exchange dealers and exhibited that they prefer to use technical rather than fundamental analysis to determine their short-term, intra-day to one week forecasting.

cally acceptable values. It generates non-random exchange rate movements which induce deviation from fundamentals and provide profitable opportunity for market participants (Sweeney (1997)). Behavioral theory of finance developed since DeBondt and Thaler (1985) also provides explanations. Hirshleifer (2001) showed that systemic mispricing causes market inefficiency and reasoned some rational traders can make profit by speculations.

Given market imperfections referred above, recent studies have attempted to relate abnormal returns and trading behaviors.

Another typical stylized fact in the foreign exchange market is a violation of uncovered interest parity (hereafter UIP). UIP implies there is a simple arbitrage between return gained from investing in foreign currency assets and return from holding home currency assets. However, it is widely known that actual observations support violation of UIP, which is often referred to as "forward premium puzzle (anomaly)." Forward premium anomaly is, in simple terms, the fact that currencies with high relative interest rates tend to appreciate with respect to low interest rate currencies [8].

Forward premium anomaly and trading behavior were considered to be closely related in recent academic discussions. The widespread use of carry trading implies that market participants are actively exploiting the forward premium anomaly. Thus, carry and momentum trading may be profitable in the short run, and as deviations from UIP grew larger, the more likely a subsequent reversion to UIP is observed. Hong and Stein (1999) showed that momentum trading amplifies the cycle of overshooting and reversions and causes deviations from fundamentals to persist for longer durations [9]. Brunnermeier et al. (2008) showed that carry trade returns exhibit severe conditional negative skewness and crash risk is the greatest when the carry trade appears most attractive. Baillie and Chang (2011) analysed in that a transition occurred from a regime where carry trading causes persistent deviations from UIP to one where subsequent reversion to UIP arises [10] [11].

[8] Harvey (1987) and Engel (1996) are nice survey articles for forward premium anomaly.

[9] They presented a model where slow diffusion of private information amplifies the cycle. After news watching traders causes an initial reaction to news, traders take a herding behavior to chase profit as the news is shared across traders and gets incorporated into prices.

[10] It is worth noting that yen carry trades against US dollar do not appear to exhibit reversion to UIP in their study. Yen carry trades have possibly persistent property, though the paper do not examine its background.

[11] Brunnermeier et al. (2008) and Baillie and Chang (2011) provided discussions to relate trading behavior to volatility. Under their framework, change of trading behavior is due to increase in volatility. The former study shows that increase in volatility decreases investor's risk appetite and lead to an unwinding of carry trades. The latter presents that

Our analysis follows past studies where we assume that market inefficiency or forward premium anomaly actually exists. We do not explore reasons why arbitrage opportunities exist in the market, and focus on trading behavior to exploit the opportunities and its implication for volatility.

3 Empirical Analysis

Empirical analysis is conducted by calculating momentum measures. We here describe data used in the analysis, methodology, and results.

3.1 Data

Our dataset consists of returns of foreign exchange transactions and currency portfolio of Japanese retail traders. We deal with daily exchange rate on nine major currencies (USD, EUR, GBP, CHF, AUD, CAD, SEK, NOK and NZD) measured against JPY [12]. We choose JPY as the numeraire currency because JPY is the generally funding currency for Japanese retail traders. The data are from database of Federal Reserve Bank of St. Louis. Computing carry component of returns was based on the money market rate from central banks [13].

Portfolio data are obtained from Tokyo Financial Exchange Incorporated. We calculate portfolio weights by subtracting long positions (buy and hold positions) from short positions (sell positions) for each currency pair. These data enable us to examine relationship between portfolio reallocations and past returns. The dataset covers the period from August 2006 to September 2011.

Table 1 reports summary statistics for base currency returns of each currency. Statistics are given for nine individual currencies and equally weighted portfolio (which we denote EWP) of these currencies. Shape ratios are simply calculated by dividing mean by standard deviations and describe returns that are not compensated for its risk. The table displays that mean and shape ratio of each currency in the sample period are almost zero, implying that no abnormal returns are observed as long as we average it

volatility promotes reversion to UIP and shrinks momentum trading behavior.

[12]Each abbreviation denotes US Dollar, Euro, British Pound, Swiss Franc, Australia Dollar, Canadian Dollar, Sweden Krona, Norwegian Kroner, and New Zealand Dollar, respectively. JPY is Japanese Yen.

[13]We use overnight deposit rate as interest rate. Calculating the compounded interest rate with daily return overestimates actual rate because the yield curve is very flat within 10 days. We thus use the average daily deposit rate for each horizon.

during the sample period. AUD and NZD are the most volatile currencies as they show the largest standard deviations and the difference between maximum and minimum values are larger than others. USD on the other hand is the most stable currency during this period.

Table 2 lists summary statistics for the interest-adjusted currency returns. AUD, NZD, and NOK exhibit positive shape ratio reflecting high interest rate. Volatility of each currency is relatively higher than base currency returns. CHF shows low mean and volatility reflecting its low and stable interest rate.

[Table 1: Descriptive Statistics (Base Currency Returns)]

[Table 2: Descriptive Statistics (Interest-Adjusted Currency Returns)]

3.2 Methodology

Computing momentum trading measure is a well-established technique to test for investors' strategies in the existing literature. We identify trading behavior in two categories, momentum and contrarian strategies. The advantage of this measure is that intuitions are straightforward and have implications for market volatility [14].

Following Grinblatt et al. (1995) and others, we measure the degree to which Japanese retail traders change their portfolio holding in the direction of previous returns using the equations below.

First, we give definitions of returns. Base currency returns R_t are defined as change in the exchange rate at time t, P_t, from $t-1$ and interest-adjusted currency returns are defined as $R_{I,t}$ [15].

$$R_t = \frac{P_t}{P_{t-1}} - 1,$$

[14] One potential caveat of this method is that classifying trading behaviors in two categories is too simple to grasp actual behaviors, as traders usually mix two strategies depending on market phases. Measurement thus needs to be taken as indicator to show mostly adopted strategy in each period.

[15] We here ignore transaction cost to swap currency pairs as it seems to be limited cost for traders.

$$
\begin{aligned}
R_{I,t} &= \frac{P_t}{F_{t-1}} - 1, \\
F_{t-1} &= P_{t-1} EXP[r_t^d - r_t^f],
\end{aligned}
$$

where F_{t-1} is the forward rate at $t-1$ and r_t^d and r_t^f denote the domestic and foreign interest rates, respectively. Approximately, interest-adjusted returns can be written as follows.

$$
R_{I,t} = (r_t^f - r_t^d) + \frac{P_t}{P_{t-1}} - 1.
$$

We next define $X_{i,t}$ as change in the weight of currency i portofolio at time t. We also adopt an alternative measure of weight change following relevant literatures. It, denoted by $X'_{i,t}$, is corrected for passive weight changes reflecting valuational change in asset price.

$$
\begin{aligned}
X_{i,t} &= W_{i,t} - W_{i,t-1} \\
X'_{i,t} &= W_{i,t} - W_{i,t-1} \frac{P_t}{P_{t-1}}
\end{aligned}
$$

Based on above calculations, we gain momentum trading measure with following equations. The intuition behind this indicator is straightforward. It relates net purchases to returns, which indicate to what extent investors tend to buy financial assets that have increased in values.

We can examine which strategies are generally adopted by testing the sign of momentum measure. Our null hypothesis is that traders do not behave as momentum trader nor contrarian traders. A significant and positive LM measure indicates that traders take a momentum trading strategy. A significantly negative value of LM is an evidence of contrarian trading, which is consistent with so-called portfolio rebalancing.

$$
\begin{aligned}
LM &= \frac{1}{T} \Sigma_{t=1}^{T} \Sigma_{k,t}^{K} X_{k,t} (R_{k,t-1} - R_{p,t-1}), \\
BM &= \frac{1}{T} \Sigma_{t=1}^{T} \Sigma_{k,t}^{K} X_{k,t} (R_{k,t-1} - R_{p,t-1}), \quad \text{if } X_{k,t} > 0, \\
SM &= \frac{1}{T} \Sigma_{t=1}^{T} \Sigma_{k,t}^{K} X_{k,t} (R_{k,t-1} - R_{p,t-1}), \quad \text{if } X_{k,t} < 0,
\end{aligned}
$$

where $R_{p,t-1} = \frac{1}{K} \Sigma_{k=1}^{K} R_{k,t}$ represents equally weighted portfolio of all nine currencies to evaluate relative performance. Indicators are described as the weighted average across K currency portfolios and throughout time T.

Our notations are similar to Curcuru et al (2011). LM is momentum trading measure and the other two additional momentum statistics identify trading strategies when investors increase weights (in other words, buy momentum, BM) from when they decrease weights (sell momentum, SM). BM and SM represent breakdowns of LM and their sum is equal to LM. These separate momentum measures for buying and selling enable us to check asymmetries.

We here present pictures to grasp time horizon and breakdown of momentum trading measures which are depicted in Figure 1 and 2.

[Figure 1: Time Horizon of Adopting Trading Strategies]

[Figure 2: Breakdowns of Momentum Trading Measure]

3.3 Results

Table 3 reports the result with base price returns. We carry out calculations for four time horizons; 1, 3, 7, and 10 days [16]. Results are shown for total sample periods and its subsample periods in order to check differences before and after the large financial shock in 2008.

As explained above, our test is whether the momentum measure has a mean value of zero [17].

[Table 3: Momentum Trading Measure (Base Currency Returns)]

[16] As past relevant studies used daily or weekly data, we chose arbitrary four types of horizons up to two weeks. In these calculations we follow the design of Jegadeesh and Titman (1993) and use overlapping data to increase the power of the tests.

[17] As for statistical significance we here provide t-tests to test null hypothesis. Considering the length of our time series and serially uncorrelated measure, central-limit theorem can be applied and asymptotic test statistics are virtually identical to the t-statistics used here.

[Table 4: Momentum Trading Measure (Base Currency Returns);
Corrected for Valuational Change]

When we focus on trading for one day, results show that momentum trading measure LM is not statistically significant. Statistical significance is shown partly in SM reflecting the result of former half of sample periods. Japanese retail traders on average decreased the weights on currency that performed poor yesterday.

Looking at the three days or longer horizon, it is evident that retail traders are contrarians. LM is negative and statistically significant throughout the sample periods. We also find both BM and SM are statistically significant implying that they behave as contrarian no matter which direction prices move into. In more simple terms, Japanese retail traders in general buy depreciated currency with expecting price reversal and sell currency appreciated in past days to assure profits. In the subsample period, results basically provide similar results and contrarian behavior seems more active in the latter half of periods.

One exception is that SM is not significant during 2006 and 2008. This reflects that traders possibly exhibit momentum behavior under severe financial turmoil. However, looking at Table 4 which shows the measures corrected for the valuational effect, they keep the negative sign and statistical significance. It turns out that exception observed above is due to the valuational effect of currency changes. The exchange rates experienced large volatility in the fourth quarter in 2008 and traders faced a decrease in values of their currency assets. When we neglect the effect of valuation, retail traders are always contrarians [18]. Our results in Table 4 are similar to Table 3 other than this case and this provides evidence for robustness.

We next repeat the same exercise for interest adjusted returns and the results are presented in Tables 5 and 6. The results provide a stark difference from the above results with base currency returns. LM is not statistically significant, while BM and SM exhibit positive and negative results with statistical significance, respectively. This means that Japanese retail traders do not follow specific trading strategy. Their behavior seems to have a contradiction at first glance, but hold rationality to gain their profit with their own way. They sell partial portfolio which performed well in prior periods to gain profits, while they also buy past winners expecting additional appreciation. They buy past winners and also sell past winners and gain

[18] We keep this result in total sample as valuational change does not largely affect most of sample periods.

profit by trading the most volatile currency in the preceding period, while they are likely to ignore other small rate changes [19]. This implies that their search for yield does not always destabilize the exchange rate.

[Table 5: Momentum Trading Measure (Interest-Adjusted Currency Returns)]

[Table 6: Momentum Trading Measure (Interest-Adjusted Currency Returns); Corrected for Valuational Change]

4 Concluding remarks

In this chapter we have explored behaviors of a new set of players, Japanese retail traders, in foreign exchange trading and obtained implications for the price volatility. One of our contributions is to present the first attempt to explore their trading behavior. Grasping trading volume of foreign exchange market is usually difficult, and newly available data of Japanese retail traders' foreign exchange portfolio enables us to analyze their strategies with well-established techniques.

We provide an evidence which implies that Japanese retail traders contribute to decrease excessive price movement. They behave as contrarian in response to price changes and thus contribute to dampen the volatility of the foreign exchange rate. They behave consistently as contrarian in that they sell past winner portfolio and buy past loser portfolio.

Considering returns of interest differential, they seem to act as momentum traders, but not all the time, contrary to general expectations. In past studies carry trades and momentum trading are considered to be very close concepts, and Japanese retail traders are taken as typical players in search for carry return. However, we find that they are not momentum traders in every aspect. They buy past winners and also sell past winners and consequently gain profit by trading the most volatile currency in the preceding period. This implies that their search for yield activities do not always destabilize the exchange rate.

[19] Their strategies in the face of depreciation are unclear and do not influence our result.

Appendix: Profitability of Trading Strategies

We here present a result on profitability of each trading strategy. Profitability is not directly related to our interest in this chapter, and thus we place this exercise in the appendix [20].

It turns out that the contrarian strategy keeps profitability in currency returns and momentum strategy does in interest adjusted returns, respectively. It is consistent that the traders act as contrarian in response to price changes and momentum trader to obtain carry returns. This implies that Japanese retail traders adopt profitable strategies [21]. In addition, we find that the momentum strategy still makes profit considering carry returns, but their profit faced downturn in recent years.

Methodology

We analyze profitability of the momentum and contrarian trading strategies to make sure whether Japanese retail traders adopt profitable strategies. Our exercises are limited just to check profitability as it is not our main focus in this chapter.

In the above section our calculation is based on actual observation of price changes and weight changes, and we here calculate profits based on hypothetical momentum or contrarian strategies.

We compute profits π_{t+1} for two trading strategies at each time period, t. Profits are product of prospective returns $R_{i,t+1}$and weight $W^l_{i,t}$put on each currency. Portfolio weights are formed to reflect typical momentum or contrarian behavior. In calculating the momentum weight, weights are placed on currency with relatively high performance in the past period $t-1$, and the contrarian weight is assumed to be a reverse function of the momentum weight.

Multiplying this hypothetical portfolio weight with actual return change produce profits of each strategy.

[20] Profitability of strategies is not the main focus of our anaysis, but profitability of trading strategies is another interest in the literature. Chou et al. (2007) demonstrated that contrarian strategies are profitable in Japanese stock market across all horizons. As for the foreign exchange market, Okunev and White (2003) demonstrated that momentum tracings in foreign exchange market is profitable using moving-average trading rules, and Harris and Yilmaz (2009) presented success of momentum trading strategies by extracting non-linear trend from currency returns. Zhang (2009), which we partly followed its specification, analyzed profitability wih recent data and examined sources of profits.

[21] Our finding is that Japanese retail traders are likely to choose relatively profitable strategies and it does not mean they always make profit. As a matter of fact, it is well known that they experienced large losses in the latter half of 2008.

Concrete calculations are specified as follows.

$$\begin{aligned} \pi^{l}_{t+1} &= \Sigma^{T}_{t=1} W^{l}_{i,t} R_{i,t+1}, \quad l = \{m,\ c\} \\ \text{where } W^{m}_{i,t} &= \frac{R_{k,t} - R_{p,t}}{\Sigma^{K}_{k}(R_{k,t} - R_{p,t})}, and \ \ W^{c}_{i,t} = (W^{m}_{i,t})^{(-1)}. \end{aligned}$$

W^m and W^c denote momentum weight and contrarian weight, respectively.

Results

Table 7 shows profits with base currency returns, and momentum profits are negative and contrarian profits are positve in most cases. Considering the result gained in this paper, retail traders adopt profitable contrarian strategies in response to price changes. Statistical significance is shown to test whether their profits are statistically apart from zero, and we find them partly.

Table 8 presents profit with interest adjusted currency returns. This reports profits of the momentum strategy are always positive and those of the contrarian strategy are negative. This is also consistent with traders choosing the momentum strategy when considering carry returns.

We here add a test to find out if profits in the former periods are different from the latter periods with statistical significance [22]. It turns out that base currency returns did not change between the two periods, but momentum profits decreased in recent years from the former sample periods.

[Table 7: Average Profits of Momentum and Contrarian Strategies (Base Currency Returns)]

[Table 8: Average Profits of Momentum and Contrarian Strategies (Interest-Adjusted Currency Returns)]

[22] We assume that Z-statistics here asymptotically follows normal distribution, because serial correlations are limited in our data, but our calculations with interest-adjusted returns show relatively high autocorrelations and thus we use Newey and West robust standard errors to identify significance.

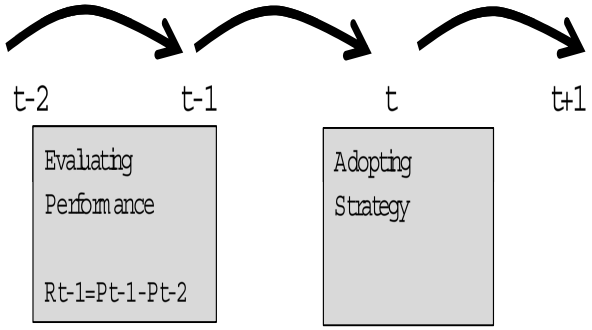

Figure 1. Time Horizon of Adopting Trading Strategies

		Increase in Return $R_{(t-1)}>0$	Decrease in Return $R_{(t-1)}<0$
Buy	$X_{it}>0$	Momentum Strategy	Contrarian Strategy
Sell	$X_{it}<0$	Contrarian Strategy	Momentum Strategy

Figure 2. Breakdowns of Momentum Trading Measure

Table 1: Descriptive Statistics (Base Currency Returns)

	CAD	USD	NK	SK	CH	AUD	EU	NZ	GBP	EWP
Mean	-0.02	-0.03	-0.02	-0.02	0.00	0.00	-0.02	-0.01	-0.04	-0.02
Median	0.01	-0.03	0.06	0.03	0.02	0.09	0.02	0.05	-0.02	0.01
Stdev.	1.16	0.73	1.20	1.22	0.84	1.46	0.94	1.42	1.07	0.95
Max	7.18	3.11	5.10	6.64	4.04	10.97	4.94	7.91	6.50	5.62
Min	-6.29	-5.08	-8.04	-6.71	-7.68	-12.10	-6.84	-10.77	-8.31	-7.30
Sharpe ratio	-0.02	-0.04	-0.02	-0.02	-0.01	0.00	-0.02	0.00	-0.04	-0.02

Table 2: Descriptive Statistics (Interest-Adjusted Currency Returns)

	CAD	USD	NK	SK	CH	AUD	EU	NZ	GBP	EWP
Mean	1.83	1.66	2.94	1.93	0.67	4.93	1.75	4.76	3.21	2.63
Median	1.58	0.78	2.81	2.05	0.74	5.06	1.60	4.22	2.76	2.34
Stdev.	1.93	2.13	1.76	1.79	1.13	1.85	1.72	2.75	2.22	1.76
Max	8.75	6.03	9.27	10.38	4.80	16.73	7.89	14.50	12.16	9.36
Min	-4.19	-4.34	-2.74	-4.49	-7.83	-6.60	-3.92	-4.18	-2.61	-3.35
Sharpe ratio	0.95	0.78	1.67	1.08	0.59	2.66	1.02	1.73	1.44	1.49

Table 3: Momentum Trading Measure (Base Currency Returns)

horizon	1day	1day	1day	3days	3days	3days	7days	7days	7days	10days	10days	10days
strategy	LM	BM	SM	LM	BM	SM	LM	BM	SM	LM	BM	SM
All period:	4.11	0.61	3.50 ††	-12.23 ††	-7.42 ††	-4.81 ††	-5.97 ††	-3.78 ††	-2.19 ††	-4.10 ††	-2.59 ††	-1.50 ††
	(1.64)	(0.39)	(2.09)	(-11.49)	(-13.10)	(-6.37)	(-13.28)	(-15.81)	(-6.82)	(-14.41)	(-16.04)	(-7.87)
Subperiod:												
2006-2008	3.45	-0.57	4.02 ††	-6.46 ††	-5.50 ††	-0.96	-2.62 ††	-2.60 ††	-0.02	-1.69 ††	-1.77 ††	0.08
	(1.52)	(-0.41)	(2.58)	(-5.04)	(-9.16)	(-0.99)	(-4.28)	(-10.95)	(-0.04)	(-4.58)	(-11.02)	(0.29)
2009-2011	4.68	1.63	3.05	-17.26 ††	-9.09 ††	-8.17 ††	-8.89 ††	-4.81 ††	-4.08 ††	-6.19 ††	-3.31 ††	-2.88 ††
	(1.10)	(0.61)	(1.08)	(-10.61)	(-9.90)	(-7.31)	(-14.08)	(-12.24)	(-9.91)	(-15.18)	(-12.46)	(-11.16)

Note: t-statistics are in parentheses.

††(†) denotes the rejection of the hypothesis at the1% (5%) level.

Table 4: Momentum Trading Measure (Base Currency Returns)
Corrected for Valuational Change

horizon	1day	1day	1day	3days	3days	3days	7days	7days	7days	10days	10days	10days
strategy	LM	BM	SM	LM	BM	SM	LM	BM	SM	LM	BM	SM
All period:	4.23	0.77	3.46 †	-13.83 ††	-7.90 ††	-5.93 ††	-5.06 ††	-2.59 ††	-2.47 ††	-3.56 ††	-2.12 ††	-1.44 ††
	(1.70)	(0.48)	(2.10)	(-13.38)	(-13.61)	(-8.31)	(-5.18)	(-4.44)	(-3.31)	(-4.73)	(-5.09)	(-2.38)
Subperiod:												
2006-2008	4.23	-0.14	4.37 ††	-7.92 ††	-5.91 ††	-2.01 ††	-4.11 ††	-2.07 ††	-2.05 ††	-2.70 ††	-1.18 ††	-1.52
	(1.88)	(-0.10)	(2.85)	(-6.91)	(-9.45)	(-2.54)	(-5.11)	(-4.46)	(-3.24)	(-2.59)	(-3.55)	(-1.56)
2009-2011	4.23	1.57	2.66	-18.99	-9.64 ††	-9.35 ††	-5.88 ††	-3.04 ††	-2.84 ††	-4.32 ††	-2.94 ††	-1.38
	(1.00)	(0.57)	(0.96)	(-11.61)	(-10.31)	(-8.29)	(-3.48)	(-3.00)	(-2.21)	(-4.01)	(-4.07)	(-1.83)

Note: t-statistics are in parentheses.
††(†) denotes the rejection of the hypothesis at the1% (5%) level.

Table 5: Momentum Trading Measure (Interest-Adjusted Currency Returns)

horizon	1day	1day	1day	3days	3days	3days	7days	7days	7days	10days	10days	10days
strategy	LM	BM	SM	LM	BM	SM	LM	BM	SM	LM	BM	SM
All period:	0.87	4.69 ††	-3.83 ††	-0.70	2.55 ††	-3.25 ††	-0.11	2.07 ††	-2.18 ††	-0.07	1.81 ††	-1.88 ††
	(0.83)	(6.94)	(-6.00)	(-1.22)	(6.92)	(-9.29)	(-0.30)	(9.80)	(-9.76)	(-0.24)	(10.79)	(-10.37)
Subperiod:												
2006-2008	0.74	4.30 ††	-3.56 ††	-0.26	2.92 ††	-3.18 ††	0.20	2.40 ††	-2.20 ††	0.21	2.01 ††	-1.79 ††
	(0.64)	(6.05)	(-4.48)	(-0.39)	(7.31)	(-7.38)	(0.46)	(9.39)	(-8.40)	(0.62)	(10.23)	(-8.46)
2009-2011	0.98	5.04 ††	-4.06 ††	-1.10	2.22 ††	-3.31 ††	-0.37	1.79 ††	-2.16 ††	-0.32	1.65 ††	-1.96 ††
	(0.59)	(4.56)	(-4.17)	(-1.19)	(3.74)	(-6.17)	(-0.68)	(5.47)	(-6.17)	(-0.71)	(6.23)	(-6.87)

Note: t-statistics are in parentheses.

††(†) denotes the rejection of the hypothesis at the1% (5%) level.

Table 6: Momentum Trading Measure (Interest-Adjusted Currency Returns)
Corrected for Valuational Change

horizon	1day	1day	1day	3days	3days	3days	7days	7days	7days	10days	10days	10days
strategy	LM	BM	SM	LM	BM	SM	LM	BM	SM	LM	BM	SM
All period:	0.99	5.28 ††	-4.29 ††	-9.89	18.85 ††	-28.75 ††	-4.02	9.79 ††	-13.81 ††	-1.91	7.07 ††	-8.98 ††
	(0.93)	(7.59)	(-6.58)	(-1.35)	(5.02)	(-4.61)	(-1.47)	(8.61)	(-5.65)	(-1.29)	(9.77)	(-7.22)
Subperiod:												
2006-2008	1.05	4.82 ††	-3.77 ††	-5.12	7.51 ††	-12.64 ††	-2.44	5.61 ††	-8.06 ††	-1.22	4.50 ††	-5.72 ††
	(0.90)	(6.67)	(-4.81)	(-1.48)	(8.47)	(-3.75)	(-0.97)	(6.40)	(-3.37)	(-0.82)	(7.52)	(-4.19)
2009-2011	0.94	5.69 ††	-4.74 ††	-14.05	28.73 ††	-42.78 ††	-5.40	13.44 ††	-18.84 ††	-2.52	9.32 ††	-11.84 ††
	(0.55)	(4.98)	(-4.69)	(-1.05)	(4.12)	(-3.80)	(-1.17)	(6.79)	(-4.63)	(-1.02)	(7.48)	(-5.92)

Note: t-statistics are in parentheses.
††(†) denotes the rejection of the hypothesis at the1% (5%) level.

Table 7: Profitability of Momentum and Contrarian Strategies
(Base Curency Returns)

		1day	3days	7days		10days	
Momentum trading	Full	-0.2	-0.4	-1.2	††	-0.7	††
		(-1.22)	(-1.19)	(-3.37)		(-2.07)	
	2006-2008	-0.4	-0.4	-1.2	†	-0.9	
		(-1.44)	(-1.19)	(-2.09)		(-1.55)	
	2009-2011	0.0	-0.4	-1.1	††	-0.5	
		(0.31)	(-1.90)	(-2.79)		(-1.39)	
	z-statistics	1.5	0.1	0.1		0.5	
Contrarian trading	Full	0.3	0.7	2.1	††	0.8	
		(1.35)	(1.95)	(2.66)		(1.70)	
	2006-2008	0.8	1.1	3.5	††	1.2	
		(1.63)	(1.48)	(2.19)		(1.36)	
	2009-2011	-0.1	0.4	0.8		0.4	
		(-0.82)	(1.80)	(1.87)		(1.09)	
	z-statistics	-1.8	-0.9	-1.6		-0.8	

Note: t-statistics are in parentheses.
††(†) denotes the rejection of the hypothesis at the1% (5%) level.

Table 8: Profitability of Momentum and Contrarian Strategies
(with Interst-Adjusted Currency Returns)

		1day		3days		7days		10days	
Momentum trading	Total Sample	0.3	††	0.2	††	0.2	††	0.2	††
		(16.32)		(13.07)		(5.28)		(4.67)	
	2006-2008	0.4	††	0.2	††	0.3	††	0.2	††
		(25.33)		(11.75)		(5.79)		(5.23)	
	2009-2011	0.2	††	0.1	††	0.2	††	0.2	††
		(36.35)		(21.34)		(5.40)		(4.45)	
	z-statistics	-30.7	††	-11.9	††	-9.0	††	-7.3	††
Contrarian trading	Total Sample	-0.3	††	-0.2	††	-0.2	††	-0.2	††
		(-12.58)		(-10.60)		(-2.69)		(-2.09)	
	2006-2008	-0.4	††	-0.2	††	-0.3	††	-0.2	††
		(-24.81)		(-9.13)		(-2.94)		(-3.84)	
	2009-2011	-0.2	††	-0.1	††	-0.2	††	-0.2	
		(-17.98)		(-21.44)		(-2.56)		(-1.35)	
	z-statistics	30.9	††	12.5	††	6.1	††	4.3	††

Note: t-statistics are in parentheses.
††(†) denotes the rejection of the hypothesis at the1% (5%) level.

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