Essays on Foreign Exchange Rate Predictability

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ABSTRACT

This dissertation consists of three interconnected essays on currency return predictability. The first essay investigates whether momentum or reversal is the dominant phenomenon in weekly currency returns. Using a broad basket of 63 emerging and developed market currencies in 16 short-term (1- to 4-week) look-back and holding period strategies, I find strong evidence in favour of cross-sectional momentum rather than reversal in weekly currency returns. Short-term momentum returns are statistically significant and are over 8% p.a. Moreover, the returns increase with an increase in the look-back period. I show these returns are higher in the earlier sub-period but they still exist in the most recent sub-period. Breakeven transaction costs range from 2 to 97 basis points. Furthermore, I find that short-term currency momentum returns are higher during business cycle expansions and during periods of depreciation of a basket of currencies versus the USD. Finally, robustness checks and regression analysis show that currency momentum returns are not linked to carry trade returns and are reduced by rising volatility in the foreign exchange market.

The second essay examines the profitability of the 52-Week high momentum strategy proposed by George and Hwang (2004) in the foreign exchange market. I show this strategy, which is more profitable than price momentum in stocks, is not profitable in the foreign exchange market using a large basket of 63 currencies. The related 52-week low and the 52-week high minus low strategies also fail to generate significantly positive returns. On further exploration of the causes of low returns to these strategies, I find the presence of non-independently floating currencies in long and short portfolios is a

contributing factor. Excluding these actively managed currencies helps in improving 52-week high strategy returns. Moreover, shortening the length of the strategy look-back period to 4- and 12-week also leads to minor improvement in returns, however, the improvement is not significant. Furthermore, I show that accounting for the timing of the 52-week high event also results in minor improvements in 52-week high strategy returns. Finally, I find that the 52-week high currency strategy does not generate positive returns in any phase of the business cycle and during UP or DOWN state of the FX market.

The third essay studies the profitability of currency value strategies by running a horse race of four measures of currency value including real exchange rate levels, 5-year change in the real exchange rate, the Purchasing Power Parity and the Big Mac Index. I find the real exchange rate level based strategies outperform all other strategies at shorter holding periods by generating annualized excess returns of up to 7% and the real exchange rate change strategies perform the best at longer (1- to 12-month) holding horizons. I show that a composite strategy which is based on all four value measures is highly profitable and yields average excess returns over all horizons up to 10% p.a. Furthermore, the returns to value strategies significantly improve when only non-independently floating currencies are used. I find that high yielding currency value strategies have considerably higher breakeven transaction costs starting from 58.5 basis points per one way trade due to low annual portfolio turnover. Moreover, the results indicate that real exchange rate levels and real exchange rate change strategies generate higher returns during expansionary phase of the US business cycle and during times of US dollar depreciation. Finally, detailed regression analysis shows that currency value returns exist independently of the currency carry trade returns and are not explained by a broad list of key macroeconomic variables.

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Read! In the Name of your Lord, Who has created (all that exists)

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I dedicate my thesis and my efforts to all the unprivileged people of this world who genuinely deserve and desire to learn and seek knowledge but they cannot do so because of the lack of opportunities and resources they face.

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LIST OF ABBREVIATIONS

OECD	Organisation for Economic Co-operation and Development
PPP	Purchasing Power Parity
NBER	National Bureau of Economic Research
GFD	Global Financial Data
CPI	Consumer Price Index
IP	Industrial Production
CIP	Covered Interest Rate Parity
RER	Real Exchange Rate
FX	Foreign Exchange
US	United States
USD	United States Dollar
MOM	Momentum
VOL	Volatility
HML	High minus Low
Fig	Figure
HAC	Heteroscedasticity and Autocorrelation Consistent
t-stat	t-statistics
DB	Deutsche Bank
Min	Minimum
Max	Maximum
S.D	Standard Deviation
p.a.	Per annum
Ln	Natural Logarithm
Log	Logarithm
NDF	Non Deliverable Forward

CHAPTER ONE

INTRODUCTION

This chapter outlines the motivation and need to explore the area of return predictability in the foreign exchange market and provides a brief introduction of the three essays contained in this thesis. The chapter concludes by outlining a structure for the remainder of the thesis.

1.1. Introduction

According to the Bank for International Settlement's (BIS) 2013 survey, the average daily turnover of the foreign exchange (FX) market is approximately $5.3 trillion. King, Osler, and Rime (2012) report the current foreign exchange market is about 16 times larger than the combined Gross Domestic Product of the 35 largest economies of the world and roughly 10 times the average daily turnover in the global equity markets. Some of the distinguishing characteristics of the foreign exchange market are 24-hour continuous trading, no short sales restrictions and relatively lower transaction costs as compared to the equity markets.

Unlike the availability of extensive strands of literature on stock return predictability, the academic literature on currency return predictability is relatively limited despite the massive size of the foreign exchange market. The relative lack of academic literature on currency return predictability, the enormous size and trading volumes, continuous operation, high liquidity, narrowing bid-ask spreads, absence of short sale constraints and my own interest in exchange rate determination theories is the main motivation behind the selection of this topic for my PhD thesis.

The majority of foreign exchange currency returns predictability literature focuses on return predictability from a Technical analysis or time series perspective. Technical analysis[1] employs filter rules, channel rules and moving average rules on the time series of individual currencies (Frankel and Froot, 1990; Neely, 1997; Sweeney, 1986). More recently, currency carry trade strategies have been studied. These involve buying high

[1]Menkhoff and Taylor (2007) and Park and Irwin (2007) provide a detailed review of available literature on technical analysis in the foreign exchange markets for interested readers.

interest rate currencies and selling short low interest rate currencies and are shown to result in very stable and significant excess returns (Jurek, 2014; Lustig, Roussanov, and Verdelhan, 2011). In the last few years, Menkhoff, Sarno, Schmeling, and Schrimpf (2012a) and others (Burnside, Eichenbaum, and Rebelo, 2011; Kroencke, Schindler, and Schrimpf, 2011; Asness, Moskowitz, and Pedersen, 2013) show that cross sectional momentum effect (Jegadeesh and Titman, 1993) also exists in the foreign exchange returns at various investment horizons.

This thesis comprises three interrelated essays on currency return predictability. The upcoming sections (1.2, 1.3 and 1.4) of this chapter provide an outline for each of the three essays and highlight the important contribution that each essay makes to the existing literature. Section 1.5 lists research outputs from this thesis. Finally, Section 1.6 summarizes the structure of the remainder of the thesis.

1.2. Essay One

The first essay considers whether there is momentum or reversal in foreign exchange markets at shorter (1-4 week) horizons using a broad basket of 63 emerging and developed market foreign currencies. Gutierrez and Kelley (2008) show evidence of reversal in 1- to 2-week equity returns before the long-lasting intermediate-term momentum in equity returns. Furthermore, recent foreign exchange literature such as Menkhoff, Sarno, Schmeling, and Schrimpf (2012a) find evidence of cross-sectional momentum in 1- to 12-month currency returns using a sample of 48 currencies. However, the presence of momentum or reversal phenomenon in short horizon (weekly) foreign exchange returns is not known. This essay contributes to the existing literature by answering this important

question. I implement 16 cross-sectional currency look-back and holding period strategies at short (1-4 week) horizons using spot and forward exchange rate data on a broad basket of 63 emerging and developed market currencies from Thomson Reuters Datastream. The first essay confirms the presence of momentum effect rather than reversal at short horizon (1- to 4-week) foreign exchange returns in a large cross-section of currencies. This finding is contrary to the short term reversal effect documented in equity markets by Gutierrez and Kelley (2008).

In addition to establishing the presence of momentum returns, numerous other questions are answered in this essay. For instance, the existence of cross-sectional momentum effect is examined over different sub-periods including the period of global financial crisis. My results indicate that the weekly currency momentum returns are higher during the earlier part of the sample but still exist in the most recent sample period and I document a lack of stable momentum returns during the recent Global Financial Crisis. By altering the look-back period and holding period of various strategies, I also show these momentum returns increase with the increase in the look-back period. Later in the essay, I also show the robustness of currency momentum returns to different portfolio compositions.

It is vital to establish whether the short horizon currency momentum returns are linked to currency carry trade returns. I investigate this possible relationship using different methodologies in this essay. My results indicate no relationship between carry trade and currency momentum returns. Furthermore, a breakeven transaction costs analysis depicts that short horizon currency momentum strategies are profitable with breakeven transaction costs ranging from 2 to 97 basis points. Unlike equity market studies, there is no prior study

which defines the UP and DOWN states of the foreign exchange market. I contribute to the existing currency literature by defining UP and DOWN states in the foreign exchange market following Cooper, Gutierrez, and Hameed (2004) and study the behavior of short horizon currency momentum returns during the UP and DOWN states of the foreign exchange market. My results confirm that weekly currency momentum is significantly higher during DOWN states (periods following depreciation of a basket of major currencies versus the USD) of the foreign exchange market and during expansionary phases of the US business cycle. In the later part of this essay, I show that rising volatility in the foreign exchange market negatively impacts weekly currency momentum returns.

1.3. Essay Two

The second essay examines the profitability of the 52-week high investment strategy (George and Hwang, 2004) in the foreign exchange market. George and Hwang (2004) find that the 52-week high momentum strategy is more profitable than Jegadeesh and Titman's (1993) price momentum strategy in equities. Recent literature confirms the profitability of the 52-week high momentum strategy in international stock markets (D. Du, 2008; Gupta, Locke, and Scrimgeour, 2010; Liu, Liu, and Ma, 2011) and in mutual funds (Sapp, 2011), however, Malin and Bornholt (2010) find that this strategy is not profitable in emerging stock markets and results in losses. According to my knowledge and a very recent survey of relevant literature, this essay is the first study to explore the profitability of the 52-week high strategy in the foreign exchange market. In contrast to the findings of George and Hwang (2004) in equity markets, this essay finds the 52-week high strategy does not generate positive excess returns in the foreign exchange market using a large basket of 63

emerging and developed market currencies. The 52-week high currency strategy returns are neither significant during the earlier nor in the later part of the sample period.

In addition to testing the profitability of the 52-week high strategy, a few closely related strategies such as the 52-week low and the 52-week high minus 52-week low strategies are also discussed in this essay. My results indicate these closely related strategies also fail to generate positive and statistically significant excess returns. In the second part of this essay, I investigate various possible explanations of the low returns to the 52-week high strategy and show the existence of non-independently floating currencies in the currency sample is a partial explanation for the poor performance of the aforementioned 52-week strategies. The 52-week strategy returns slightly improve when these currencies are excluded. My results further indicate that using shorter (4- and 12-week) look-back periods also leads to minor improvements in returns to the 52-week high strategy. Furthermore, I also find minor improvement in 52-week high returns when the timing of the 52-week high event is considered. Finally, contrary to my findings of stronger past return based FX momentum profits during expansionary phase of the US business cycle and during periods of appreciation of the US dollar in the first essay of this thesis, I find the 52-week price based momentum strategies do not generate meaningful returns in any phase of the US business cycle or during periods of appreciation or depreciation of the US dollar against a large basket of foreign currencies.

1.4. Essay Three

The third essay examines the profitability of value investing in the foreign exchange market. Value investing in equity markets involves buying (selling) stocks that are undervalued (overvalued) relative to earnings, dividends, book assets, or other measures of fundamental value. The profitability of value investing and its outperformance to growth investing in equity markets has gained considerable academic attention since the seminal findings of Fama and French (1992). The literature on the performance of value investing in the foreign exchange market is rather limited. This essay addresses this gap and presents a comparative analysis of four different currency value strategies using a broad cross-section of emerging and developed market currencies over weekly (1- to 3-week) and monthly (1- to 12-month) investment horizons. Currency value strategies, in this essay, are based on the trading signals generated by the underlying undervaluation (overvaluation) measures such as the levels and the changes of the real exchange rate, the purchasing power parity and the Big Mac Index.

In this essay I find the real exchange rate level based strategies perform the best over short (1- to 3-week) investment horizons and the 5-year real exchange rate change strategies outperform all other value strategies at 1- to 12-month investment horizons. My results indicate the Purchasing power Parity and the Big Mac Index approaches underperform at both short- and long-term investment horizons with returns typically not over 3% per annum. Furthermore, I find a composite strategy which combines overvaluation (undervaluation) signals from all four value measures generates a statistically significant excess return of about 15% per annum. My results further indicate that currency value returns improve when the currency sample is limited to independently floating

currencies only. Finally in this essay, I show that currency value returns are not driven by a large set of macroeconomic variables and currency risk factors and these returns are larger than reasonable estimates of transaction costs.

1.5. Theoretical Background of the Three Essays

The research questions explored in the three essays have a theoretical background which derives its motivation from the debate of Efficient Market Hypothesis proposed by Fama (1970) whereby prices incorporate all available information and hence neither technical nor fundamental analysis can be used to earn abnormal returns in equity markets. However, evidence challenging the Fama (1970) version of the Efficient Market Hypothesis such as intermediate term momentum (Jegadeesh and Titman, 1993), long term reversal (DeBondt and Thaler, 1985), value investing (Lakonishok, Shleifer, and Vishny, 1994) and the Other January effect (Rozeff and Kinney, 1976) is voluminous. Perhaps as a result of this, the Jensen (1978) version of the Efficient Market Hypothesis, which states prices may be "inefficient" up to the point where the benefits of acting on the inefficiency are offset by the costs of doing so. This has resulted in more focus on the costs of exploiting inefficiency and other limits to arbitrage. For instance, Lesmond, Schill, and Zhou (2004) and Korajczyk and Sadka (2004) show momentum profits in equity markets are reduced by transactions and short-selling costs. There is also increased awareness of the behavioral biases which can contribute to inefficiency such as slow information diffusion (Hong and Stein, 1999), investor under- and overreaction (Daniel, Hirshleifer and Subrahmanyam, 1998) and anchoring and adjustment bias (Kahneman and Tversky, 1974).

As the foreign exchange market is the largest financial market in the world with some unique characteristics such as high liquidity, no natural short selling constraints, lower transaction costs and a predominant majority of experienced institutional investors (King, Osler, and Rime, 2012), it is plausible to believe that new information is incorporated into prices more quickly and quantitative trading strategies are less profitable.

In this thesis I explore whether short-term price momentum, 52-week high momentum (George and Hwang, 2004) and value investing (Lakonishok, Shleifer, and Vishny, 1994) can predict excess returns in currencies. In general, I find each of these approaches generates lower returns in currency markets than other authors have reported for equity markets. This is consistent with predictions from existing literature and could be attributable to the lower limits to arbitrage and concentration of sophisticated institutional investors in the foreign exchange market who are less prone to individual behavioral biases. Furthermore, recent evidence suggests that the rise of high frequency and algorithmic trading is also resulting in reduced arbitrage opportunities, greater information efficiency in the FX market (Chaboud, Chiquoine, Hjalmarsson and Vega, 2014) and this phenomenon to some extent explains the declining profits to trading strategies and rules which performed better in the past.

1.6. Research Outputs from the Thesis

Essay One:

The first essay of this thesis has been published in the following journal:

Raza, A., Marshall, B. R., & Visaltanachoti, N. (2014). Is there momentum or reversal in weekly currency returns? *Journal of International Money and Finance, 45*, 38–60.

Moreover, this essay has been presented at the following forums:

Raza, A**.**, Marshall, B. R., & Visaltanachoti, N. (2013). Is there momentum or reversal in weekly currency returns? *26th Australasian Finance & Banking Conference*, Sydney, December 2013.

Raza, A., Marshall, B. R., & Visaltanachoti, N. (2013). Is there momentum or reversal in weekly currency returns? *Massey University Seminar Series*, Palmerston North, February 2013.

Essay Two:

This essay has been presented at the following forum:

Raza, A., Marshall, B. R., & Visaltanachoti, N. (2013). Is the 52-week high momentum strategy profitable in the foreign exchange market? *Massey University Seminar Series,* Palmerston North, February 2013.

1.7. Structure of the Thesis

The remainder of this thesis is structured as follows. The first essay which explores momentum or reversal effect in weekly currency returns is presented in Chapter 2. Chapter 3 presents the evidence on the profitability of the 52-week high momentum strategy in the foreign exchange market. Chapter 4 presents the third essay of this thesis in which various currency value strategies have been discussed. Chapter 5 outlines the main findings of the three Essays.[2]

[2] The essays presented in Chapters 2, 3, and 4 have been or will be submitted to journals as co-authored work with my two supervisors. The terms "we" and "our" rather than "I" and "my" are therefore used throughout these chapters.

CHAPTER TWO

ESSAY ONE

This chapter presents the first essay of this thesis which explores whether there is momentum or reversal in short horizon (1- to 4-week) currency returns. Spot and forward exchange rate data for a broad basket of 63 emerging and developed market currencies is used and 16 formation and holding period strategies are implemented. Dollar neutral, multicurrency cross-sectional portfolios are formed and held for different holding horizons. If the returns of the self-financing long – short portfolios are positive, we find evidence of momentum and reversal otherwise. The robustness of the results is checked by carrying out a sub-sample analysis including the global financial crisis sub-period. Furthermore, different portfolio compositions are tested for robustness of currency portfolio returns.

A brief introduction of the research question and the relevant literature is given in section 2.1 of the chapter. Data and portfolio construction methodology is described in Section 2.2. The empirical results of various long – short currency strategies are presented in Section 2.3. Section 2.4 illustrates the various robustness checks and performance of momentum strategies under different market circumstances. Section 2.5 contains a discussion of possible explanations for currency momentum. Section 2.6 concludes Chapter 2. An appendix to this chapter and the relevant reference list is provided at the end of this thesis. This entire chapter has been published in the *Journal of International Money and Finance* in 2014 as also mentioned with detail in section 1.5 of this thesis.

Is There Momentum or Reversal in Weekly Currency Returns?

Abstract

We investigate whether momentum or reversal is the dominant phenomenon in short horizon (one- to four-week) foreign exchange rate returns. We find, based on a broad sample of 63 emerging and developed market currencies, evidence of momentum rather than reversal. Momentum strategy returns are as large as 8% p.a. The short-term momentum effect appears to be robust. Returns are larger in the earlier sub-period but still exist in the more recent period. The strategies are also profitable when the USD is appreciating or depreciating but they perform better in business cycle expansions.

JEL Classification: F31, G15

Keywords: Currency, momentum, reversal

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2.1. Introduction

It is well established that there is medium-term (3-12 month) cross-sectional momentum in equity markets (e.g. Jegadeesh and Titman, 1993).[3] Gutierrez and Kelley (2008) show this long-lasting return continuation follows a cross-sectional reversal in short term (1-2 week) equity returns. More recently, Menkhoff, Sarno, Schmeling, and Schrimpf (2012a) find evidence of momentum in 1-12 month foreign exchange (FX) returns in 48 different currencies of up to 10% p.a., while Asness, Moskowitz and Pedersen (2013) find currency momentum profits of over 3% p.a. in 10 currencies. Okunev and White (2003), who form momentum winner and loser portfolios using moving averages, report momentum profits of up to 7% p.a. in eight currencies, while Chong and Ip (2009) report this approach generates net returns of approximately 20% p.a. in emerging market currencies. However, the literature leaves the following question unanswered - Is there cross-sectional momentum or reversal in weekly currency returns? We address this question by considering return dynamics over 1-4 week look-back and holding periods.[4] The momentum strategy we implement involves taking long (short) positions in currencies that have appreciated (depreciated) the most against the USD. The reversal strategy is the inverse of this. Long (short) positions are established in currencies that have depreciated (appreciated) the most. We rank the currencies every period on the basis of lagged excess

[3] Pan, Tang, and Xu (2013) show that equity momentum exists at weekly frequencies. Chan, Hameed, and Tong (2000) show that momentum effect is present in international equity markets. Griffin, Ji, and Martin (2003) find that momentum effect is stable around the world in both good and bad economic states.

[4] We use the term "cross-sectional momentum" to make it clear we refer to buying (selling) currencies based on their past returns relative to other currencies rather than the time-series momentum of Moskowitz, Ooi, and Pedersen (2012), which suggests buying and selling based on the past performance of the asset itself. Cross-sectional reversal is also measured relative to other currencies unlike the reversal of Jegadeesh (1990), Lehmann (1990) and Lo and MacKinlay (1990), which is based on the auto-covariance structure in the time series of individual asset returns. From this point on we use the terms "momentum" and "reversal" to refer to cross- sectional momentum and reversal respectively.

returns and form zero investment long-short portfolios from a momentum perspective. If the Winner-Loser (W-L) portfolio returns are positive (negative), there is evidence in favour of momentum (reversal). We consider look-back (*J*) and holding periods (*K*) of 1, 2, 3 and 4 weeks. Consequently, we implement a total of 16 strategies using weekly and monthly spot and forward data on 63 currencies. The period we focus on is November 1997 to July 2013. However, we also conduct a robustness check on fewer currencies for the January 1972 to October 1997 period.

We find large and statistically significant positive excess returns for almost all the holding and look-back periods we consider. There is strong evidence in favour of short-term momentum and against short-term reversal. For example, a three-week look-back and one-week holding period strategy yields 8.13% p.a. Similarly, a three-week look-back and two-week holding period strategy yields 7.70% p.a. We find a significant increase in momentum returns as we increase the look-back period. Momentum returns are larger in the earlier sub-period, not related to FX carry trade strategy returns, and are stronger during US expansions than recessions. We also observe momentum returns during both UP and DOWN states of the FX market. However, the returns are higher during the DOWN states (periods following a depreciation of a basket of major currencies versus the USD) of the FX market. Furthermore, momentum returns are lower when FX volatility is higher. Finally, breakeven transaction costs range from 2bps for the very short-term strategies which involve more frequent trading to 97bps for the monthly strategy.

While inconsistent with weak-form version of the efficient market hypothesis (e.g. Fama, 1970, 1991), the empirical evidence of under and overreaction does have theoretical foundations. Barberis, Shleifer, and Vishny (1998), Daniel, Hirshleifer, and Subrahmanyam

(1998) and Hong and Stein (1999) develop models based on behavioral biases, like investor under-reaction, overconfidence, conservatism and self-attribution bias which explain these phenomena.

The rest of this paper is organized as follows. We describe our data and portfolio construction methodology in Section 2.2. Section 2.3 details the empirical results of various long-short currency strategies. Section 2.4 illustrates the various robustness checks and performance of momentum strategies under different market circumstances. Section 2.5 contains a discussion of possible explanations for currency momentum. We conclude our discussion in Section 2.6.

2.2. Data and Methodology

2.2.1. Data

For our core analysis we use log spot and forward exchange rate (foreign currency units per USD) data on weekly and monthly frequencies for 63 emerging and developed market currencies from Thomson Reuters Datastream. These currencies are the same as those used by Burnside, Eichenbaum, and Rebelo (2007). This data series start in November 1997 and end in July 2013. We use mid exchange rates for all currencies and sample the data on every Wednesday. Our data set varies over the sample period due to the fact that the forward exchange rate data was not available for some currencies from the beginning of the sample. For instance, the Euro series starts in January 1999 and we include the Euro rather than the constituent currencies after its introduction. A detailed description of the currency symbols, start and end dates, regimes and other descriptive statistics are

given in Appendix A.1. Furthermore, we also make use of the carry trade (HML_{FX}) and the USD risk factor (RX) data made available by Lustig, Roussanov, and Verdelhan (2011) on their website[5] in our regression analysis, in order to investigate the possible relationship between currency momentum and carry trade returns. As a robustness test, we also generate results for the January 1972 to October 1997 period. This is based on data from Global Financial Data (GFD). Forward rate data for the frequencies we require are not available so we use spot exchange rate and interest rate data to calculate forward rates. The number of currencies included ranges from 29 to 52.

2.2.2. Currency Excess Returns

We calculate the excess currency returns to a US investor holding foreign currency *k* following Menkhoff, Sarno, Schmeling, and Schrimpf (2012a) as per equation 1:

$$rx_{t+1}^{k} \equiv \; i_t^k - i_t - \Delta s_{t+1} \approx \; f_t^k - s_{t+1}^k \;\; , \qquad (1)$$

where s is the (log) spot exchange rate and f is the forward exchange rate. Δs is the log spot rate change and i^k is the foreign interest rate. All exchange rates are quoted as foreign currency units per USD, where an increase in the value of s implies appreciation (depreciation) of the US (foreign) currency. As evident from equation (1), the return to currency investing has two components. One is the appreciation or depreciation component and the other is the interest earned on the foreign currency. However, Akram, Rime, and Sarno (2008) note these two return components can be approximated by taking the difference between, for example, the one week forward rate and the actual spot rate after a week due to the Covered Interest Rate Parity (CIP) relationship. We therefore follow

[5] http://web.mit.edu/adrienv/www/Data.html

Menkhoff, Sarno, Schmeling, and Schrimpf (2012a) and use equation (2) to calculate the returns to the currency investor.

$$rx_{t+1}^{k} = f_t^k - s_{t+1}^k \tag{2}$$

Equation (2) above is sufficient for calculating currency excess returns for one-week and one-month (4 weeks) holding period returns as we go long (short) a currency forward contract in currency *k* in week (month) *t* and unwind positions at week (month) *t+1* using data on 1-week (1-month) forward contracts. As the data on odd maturity forward contracts is not readily available, we compute two- and three-week holding period returns using equation (3) and (4) respectively for long positions.

$$rx_{t+2}^{k} = (\, f_t^k - s_{t+1}^k \,) + (\, f_{t+1}^k - s_{t+2}^k) \tag{3}$$

$$rx_{t+3}^{k} = (\, f_t^k - s_{t+1}^k \,) + (\, f_{t+1}^k - s_{t+2}^k) + (\, f_{t+2}^k - s_{t+3}^k \,) \tag{4}$$

The interpretation of equation (3) and (4) is simply that the investor rolls forward their long positions for two and three weeks respectively by buying a 1-week forward contract every week until the end of the relevant holding period. We use a similar approach for short positions and utilize mid foreign exchange rates throughout our empirical analysis. We calculate currency returns from Wednesday to Wednesday.

2.2.3. Portfolio Construction

The reversal strategy is the inverse of the momentum strategy. Whereas the momentum strategy involves taking long (short) positions in currencies that have appreciated (depreciated) the most versus the USD, the reversal strategy involves taking long (short) positions in currencies that have depreciated (appreciated) the most. We form portfolios from the momentum perspective. If these result in positive returns there is evidence in favour of momentum. However, if the returns are negative the evidence supports reversal.

Every Wednesday we calculate lagged excess returns for each *J*-week (1, 2, 3, and 4) look-back period. The 20% of currencies with the largest (smallest) lagged excess returns are classed as "winner" ("loser") currencies.[6] Winner and loser portfolio returns are then measured for *K*-week (1, 2, 3, and 4) holding periods. We report returns for the winner, loser, and zero investment winner minus loser (W-L) portfolios for each of the 16 portfolios. Furthermore, we annualize the weekly average excess returns by multiplying by 52. Similarly, we multiply the weekly standard deviation by $\sqrt{52}$ in order to obtain annualized volatility figures. Finally, the Sharpe ratio is the ratio of annualized mean to annualized volatility. The above procedure is similar to the one adopted by Lustig, Roussanov, and Verdelhan (2011).

[6] As a robustness check we classify winner (loser) currencies as those with in the group with the largest (smallest) 33% of returns.

2.3. Core Results

We begin our empirical analysis by reporting mean, minimum and maximum values of weekly excess returns and volatility statistics for all individual currencies of our sample in Table 2.1. We also report first order autocorrelation statistics for all currencies. We calculate individual currency excess returns in Table 2.1 by buying a one-week maturity forward contract and then selling the same in the spot market after one week. The Brazilian Real, Turkish Lira, and the Slovak Koruna have the highest, and the Greek Drachma, Japanese Yen, and the Taiwanese New Dollar have the lowest average weekly excess returns over the observed sample period. The Icelandic Krona, Indonesian Rupiah and South African Rand are the most volatile. A closer look at the maximum and minimum excess return figures shows the currencies of Indonesia and the Brazil have the largest extreme returns. The majority of these extreme returns occur during the global financial crisis. For example, the lowest Indonesian Rupiah return is in the second week of January 1998. Similarly, the Brazilian real generated the lowest excess returns during October 2008. The first order autocorrelation statistics are insignificant for 52 currencies out of the total sample of 63 currencies at the 5% level of significance over the full sample period.

Table 2.1: Average Weekly Excess Return Statistics for Individual Currencies

Currency	Mean	S.D	Max	Min	Autocorrelation
Argentine Peso	0.114	0.530	3.035	-2.527	0.086
Australian Dollar	0.070	1.779	6.686	-17.017	0.009
Austrian Schilling	0.011	1.112	3.491	-2.233	0.026
Belgian Franc	0.010	1.101	3.474	-2.215	0.030
Brazilian Real	0.233	2.160	10.848	-20.589	-0.050
British Pound	0.006	1.268	4.316	-7.118	-0.005
Bulgarian Lev	0.017	1.424	9.838	-5.028	0.010
Canadian Dollar	0.038	1.249	6.079	-6.029	-0.029
Chilean Peso	0.070	1.570	5.828	-10.403	0.059
Colombian Peso	0.133	1.629	6.586	-7.234	0.044
Croatian Kuna	0.046	1.511	9.626	-5.893	-0.006
Cyprus Pound	0.085	1.074	2.851	-3.388	-0.046
Czech Koruna	0.081	1.836	10.655	-9.900	0.016
Danish Krone	0.016	1.417	9.869	-5.107	0.011
Deutsche Mark	0.008	1.112	3.494	-2.230	0.027
Egyptian Pound	0.043	0.384	3.311	-3.463	0.403*
Estonian Kroon	0.027	1.459	9.906	-5.053	0.020
Euro	0.012	1.444	9.844	-5.093	0.010
Finnish Marrakka	-0.010	1.109	3.472	-2.228	0.038
French Franc	0.007	1.106	3.513	-2.240	0.021
Greek Drachma	-0.084	1.766	4.729	-10.542	-0.070
Hong Kong Dollar	-0.005	0.063	0.517	-0.306	0.198*
Hungarian Forint	0.111	2.074	9.348	-9.006	-0.034
Iceland Krona	0.020	2.628	23.251	-14.627	-0.140*
Indian Rupee	0.020	0.882	5.060	-3.645	0.070*
Indonesian Rupiah	-0.009	3.748	25.633	-44.169	0.007
Irish Punt	-0.013	1.261	3.554	-4.132	0.059
Israeli New Shekel	0.066	1.219	5.392	-5.264	-0.001
Italian Lira	0.029	1.091	3.504	-2.249	0.025
Japanese Yen	-0.026	1.473	9.595	-6.915	0.018
Kazakhstan Tenge	0.025	1.007	2.822	-20.001	-0.057
Kenyan Schilling	0.012	1.292	8.011	-8.638	-0.083
Kuwaiti Dinar	0.016	0.261	1.599	-2.230	0.106*
Latvian Lat	0.012	1.398	10.052	-5.144	0.020
Lithuanian Litas	0.022	1.425	9.852	-5.045	0.017
Maltese Lira	0.092	1.017	2.589	-2.848	-0.027
Mexican Peso	0.085	1.483	7.225	-17.286	-0.084*
Moroccan Dirham	0.068	1.163	8.097	-4.123	0.013

Netherland Guilder	-0.002	1.111	3.516	-2.227	0.037
New Zealand Dollar	0.082	1.851	8.547	-11.505	-0.034
Norwegian Krone	0.042	1.654	6.058	-11.843	-0.063
Pakistan Rupee	0.008	0.508	2.310	-3.660	0.252*
Philippine Peso	0.060	1.254	11.917	-11.853	-0.128*
Polish Zloty	0.106	2.066	6.094	-10.209	-0.041
Portuguese Escudo	0.021	1.098	3.563	-2.210	0.032
Qatar Rial	-0.001	0.029	0.115	-0.129	0.117*
Romanian Leu	0.113	1.810	7.149	-8.290	0.006
Russian Rouble	0.057	1.241	4.657	-6.525	-0.049
Saudi Rial	0.002	0.045	0.384	-0.761	0.019
Singapore Dollar	0.005	0.788	4.273	-4.168	0.053
Slovak Koruna	0.255	1.582	9.757	-5.385	0.039
Slovenian Tolar	0.048	1.136	2.788	-3.214	-0.040
South African Rand	0.047	2.358	17.341	-16.590	-0.044
South Korean Won	0.046	1.698	11.850	-16.214	-0.076
Spanish Peseta	0.016	1.089	3.416	-2.245	0.052
Swedish Krona	0.017	1.647	7.189	-8.222	-0.037
Swiss Franc	0.016	1.509	9.983	-8.621	0.051
Taiwan New Dollar	-0.015	0.682	3.360	-5.529	0.056
Thai Baht	0.080	1.227	14.340	-9.457	0.048
Tunisian Dinar	-0.005	1.029	6.862	-4.176	0.035
Turkish Lira	0.277	1.763	8.647	-14.155	0.037
Ukraine Hryvnia	0.020	2.196	19.269	-19.383	-0.144*
United Arab Emirates Dirham	-0.001	0.019	0.109	-0.208	0.715*

This table shows individual currency average excess returns which we calculate as $ER_{t+1}=\ln(f_t) - \ln(S_{t+1})$ by using data on spot exchange rates and 1-week currency forward contracts. All values are averaged over a week and are in percentages except the autocorrelation statistics. Data ranges from November 1997 to July 2013.***** indicates significance at 5% level.

Table 2.2 contains results for all sixteen short horizon long-short strategies over the full sample period from November 1997 to July 2013. We report average holding period returns for all strategies along with annualized excess returns and Sharpe ratios for a balanced comparison of strategy performance. The results indicate positive returns to the long (past winner) – short (past loser) portfolios which indicates a momentum rather than reversal effect. This result is based on winner and loser portfolios comprising the 20% of currencies with the largest (smallest) past returns. Appendix A.2 shows very similar results if portfolios are formed on the basis of top and bottom 33% currencies.

Table 2.2: Currency Look-back and Holding Period Returns

	Holding period				Holding period			
	1-Week	2-Week	3-Week	4-Week	1-Week	2-Week	3-Week	4-Week
Portfolio	**Panel A (1-Week Look-back)**				**Panel C (3-Week Look-back)**			
Winner – Loser (%)	0.035	0.124	0.214	0.288	0.156	0.296	0.395	0.470
Mean (%)	**1.837**	**3.221**	**3.716**	**3.450**	**8.125**	**7.697**	**6.852**	**5.637**
Max (%)	7.529	6.456	11.245	10.138	8.855	8.884	12.000	13.602
Min (%)	-5.450	-10.512	-9.245	-13.507	-5.798	-8.768	-10.301	-8.219
t-stat.	0.848	2.027	3.128	3.435	3.976	4.390	4.163	3.950
p-value	0.198	0.022	0.001	0.000	0.000	0.000	0.000	0.000
Volatility (%)	8.914	8.455	8.307	8.306	8.894	8.132	8.198	8.190
Sharpe Ratio	**0.206**	**0.381**	**0.439**	**0.415**	**0.913**	**0.947**	**0.820**	**0.688**
Winner (mean %)	0.084	0.179	0.280	0.359	0.147	0.274	0.380	0.475
Max (%)	7.502	6.919	9.774	10.538	5.688	6.357	8.321	8.034
Min (%)	-7.604	-10.956	-12.422	-19.777	-4.405	-5.893	-7.710	-11.933
Loser (mean %)	0.048	0.055	0.065	0.072	-0.009	-0.022	-0.015	0.005
Max (%)	4.874	11.280	9.915	8.361	5.739	9.347	11.305	9.108
Min (%)	-7.179	-6.770	-12.045	-11.340	-9.449	-10.467	-12.688	-13.923
	Panel B (2-Week Look-back)				**Panel D (4-Week Look-back)**			
Winner – Loser (%)	0.108	0.243	0.348	0.401	0.126	0.233	0.315	0.716
Mean (%)	**5.623**	**6.325**	**6.040**	**4.808**	**6.571**	**6.065**	**5.463**	**8.597**
Max (%)	6.951	7.322	8.685	13.854	8.761	8.437	12.207	17.491
Min (%)	-5.465	-7.110	-8.293	-8.955	-5.852	-11.205	-9.187	-8.786
t-stat.	2.589	3.693	4.231	3.630	3.226	3.342	3.260	5.675
p-value	0.005	0.000	0.000	0.000	0.001	0.000	0.001	0.000
Volatility (%)	8.834	8.034	7.913	8.213	8.792	8.274	8.246	8.291
Sharpe Ratio	**0.637**	**0.787**	**0.749**	**0.585**	**0.747**	**0.733**	**0.650**	**1.037**
Winner (mean %)	0.124	0.247	0.352	0.428	0.132	0.241	0.345	0.601
Max (%)	6.859	5.352	8.868	9.662	5.535	4.838	7.788	9.947
Min (%)	-7.465	-8.316	-11.088	-14.971	-4.770	-6.088	-7.020	-8.487
Loser (mean %)	0.016	0.003	0.004	0.028	0.006	0.007	0.030	-0.115
Max (%)	5.644	9.280	9.818	9.316	5.920	11.211	9.843	8.450
Min (%)	-7.507	-10.023	-10.929	-14.302	-9.449	-9.566	-12.688	-16.911

This table presents average excess returns of the Winner-Loser (long-short) portfolio using 63 currencies against the USD for 1-,2-,3- and 4-week formation and holding periods over the period November 1997-July 2013. Portfolios consist of 20% of available currencies. Positive returns indicate momentum whereas negative returns indicate reversal. The excess returns are calculated as ln(ft)-ln(St+1) and are in percent. The Mean and Volatility figures are annualized and are in percent. The Sharpe Ratio is calculated by dividing annualized excess returns by annualized volatility. The t-statistics are based on Newey-West standard errors.

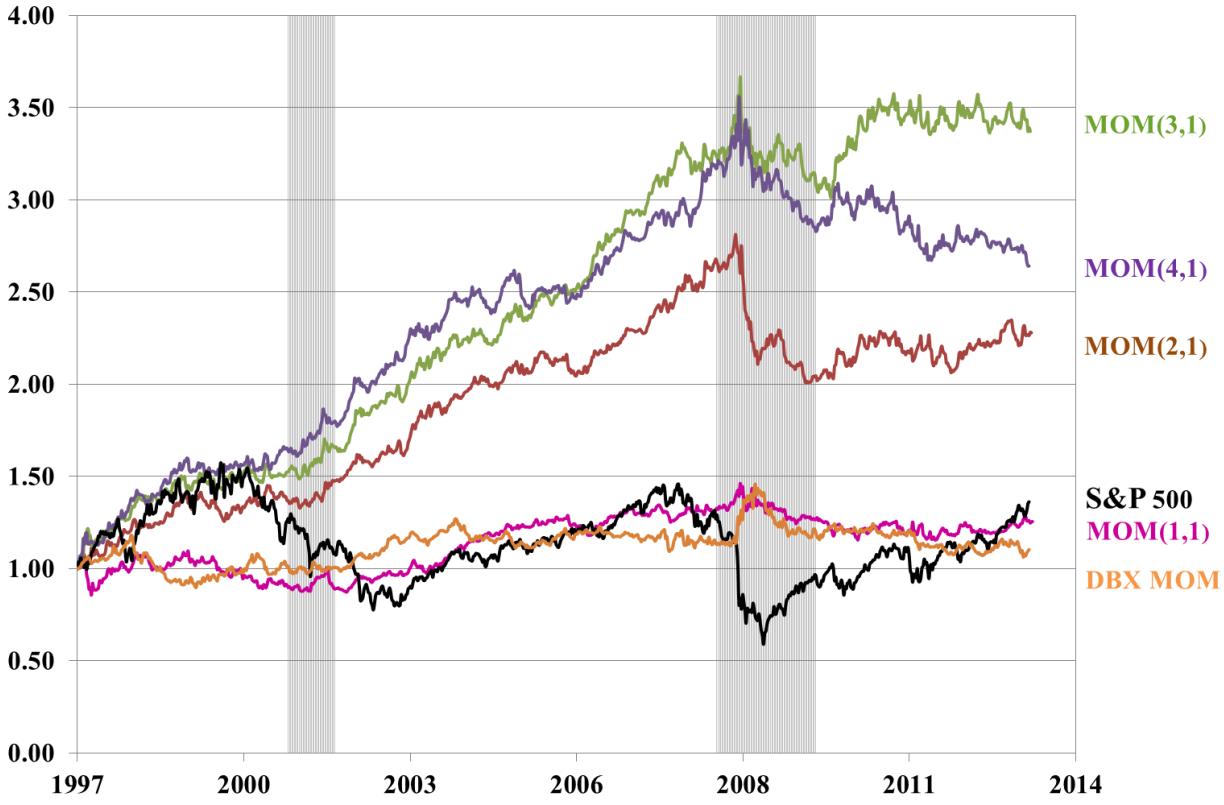
The Table 2.2 results provide strong evidence in favour of short-term momentum rather than reversal. Out of the sixteen look-back and holding period strategies we consider, not a single strategy provides negative mean returns. Therefore, we can reject the hypothesis of reversal in favour of momentum in weekly currency returns. The momentum returns range from 1.84% to 8.60% on an annualized basis and the returns to 15 of the 16 strategies are statistically significant. The one-week look back strategies generate the lowest returns, while the three- and four-week look-back strategies have the highest returns. Increasing the look-back period positively affects the short horizon momentum returns. For example, the annualized excess return for the MOM(1,1) strategy[7] is 1.84% with a Sharpe ratio of 0.21 and these returns increase to 5.62% and 8.13% for the 2-week (MOM(2,1)) and 3-week (MOM(3,1)) formation period momentum strategies respectively. Interestingly, our results in Table 2.2 differ from the findings of Mettler, Thöny, and Schmidt (2010), who conclude that trend strategies produce ambiguous and negative returns at weekly trading horizons. This contrast in findings could be due to the difference in time period and number of currencies under consideration as we use 63 currencies compared to the 12 currencies they use.

The main return contributor across the 16 strategies is the winner portfolio. On average, the winner portfolio for all strategies remains positive, which implies return continuation for the past winner currencies. The loser portfolio produces low and at times negative returns on average which also adds to the overall profitability of the winner-loser portfolio. Moreover, the reported momentum returns are also relatively stable in terms of

[7] We use the MOM(*J*,*K*) notation to represent look-back and holding period strategies throughout this paper. '*J*' refers to look-back period and '*K*' refers to holding period. Therefore, MOM(1,1) refers to a 1-week look-back and 1-week holding period strategy.

volatility. Our results in Table 2.2 show the annualized volatility figures for all strategies are fairly stable and range from 7.91% to 8.91%. Panel D of Table 2.2 shows that the strategy with a 4-week formation and holding period (MOM(4,4)) generates the maximum annualized excess return of 8.60% with a Sharpe ratio of 1.04. This result is consistent with that of Menkhoff, Sarno, Schmeling, and Schrimpf (2012a). Similarly, the strategy with a 3-week formation and 1-week holding period (MOM(3,1)) produces a statistically significant annualized excess return of 8.12% with a Sharpe ratio of 0.91.

Figure 2.1: Cumulative Excess Returns of One-Week Holding Period Currency Momentum Strategies

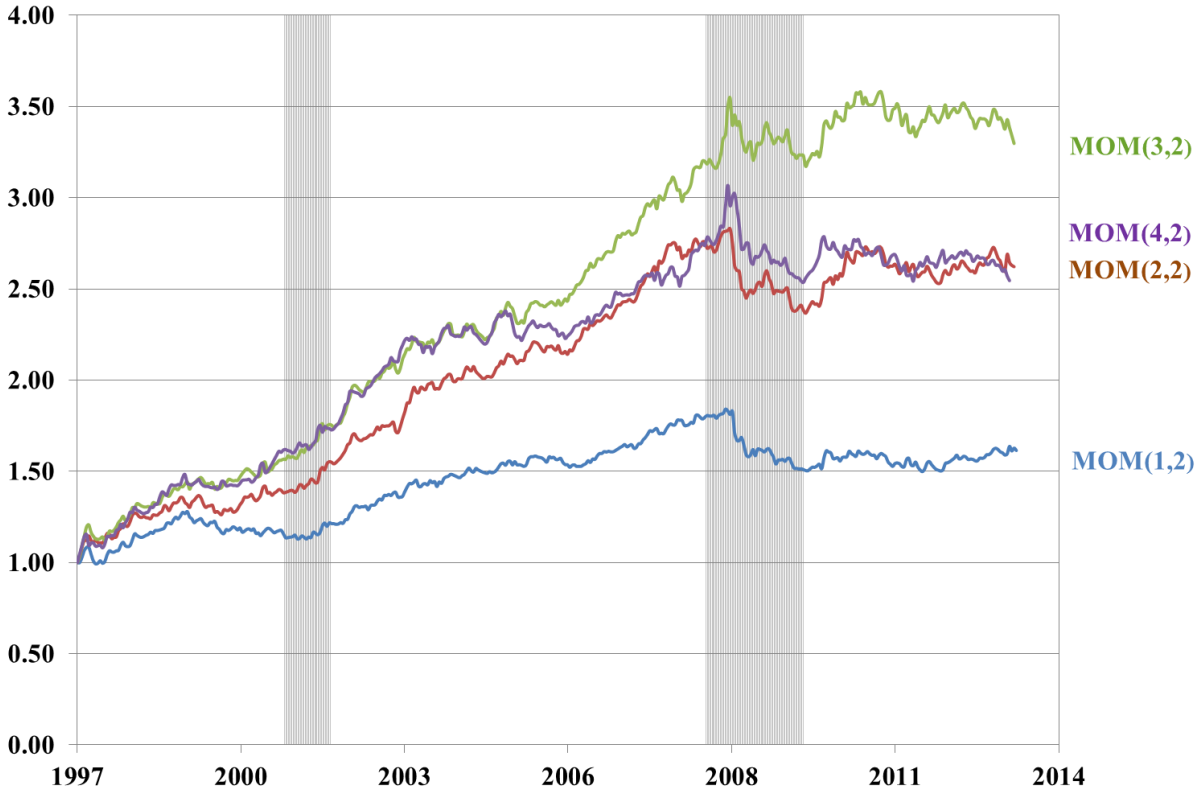


This figure shows cumulative excess returns to four currency momentum strategies along with the cumulative returns of the S&P500 and the Deutsche Bank's Currency momentum index (DBX MOM). All series are re-based to 1 USD in November 1997. The holding period for the four strategies shown here is 1-week whereas the look-back period is 1-,2-,3- and 4-weeks for MOM(1,1), MOM(2,1), MOM(3,1) and MOM(4,1) respectively. Shaded areas correspond to NBER recessions.

Figure 2.1 shows the cumulative returns of a subset of short-horizon currency momentum strategies (MOM(1,1), MOM(2,1), MOM(3,1) and MOM(4,1)) along with the cumulative returns of the S&P 500 and a benchmark currency momentum index maintained by the Deutsche Bank[8] over the full sample period from November 1997 to July 2013. For ease of exposition, we show the growth pattern of a USD invested in the start of the sample in all the figures. Shaded areas in Figure 2.1 correspond to NBER recessions. As apparent from Figure 2.1, our short horizon momentum strategies beat the equity as well as the FX momentum benchmark indices in most of the sample period we consider. Furthermore, Figures 2.2, 2.3 and 2.4 separately show the cumulative returns to the 2-, 3- and 4-week holding period strategies. As shown in Figures 2.1, 2.2, 2.3 and 2.4, 1 USD invested in the beginning of our sample grows to USD 1.25, 2.27, 3.37 and 2.64 at the end of our sample period on a cumulative basis for the MOM(1,1), MOM(2,1), MOM(3,1) and MOM(4,1) strategies respectively. Similarly, 1 USD grows to 1.61, 2.62, 3.30 and 2.54 at the end of July 2013 for the 1-, 2-, 3- and 4-week formation and 2-week holding period strategies. The fact that the strategy MOM(2,1) experiences the highest maximum drawdown of 28.57% and strategy MOM(1,4) experiences the lowest maximum drawdown of 6.12% is apparent from Figures 2.1 and 2.3 respectively.

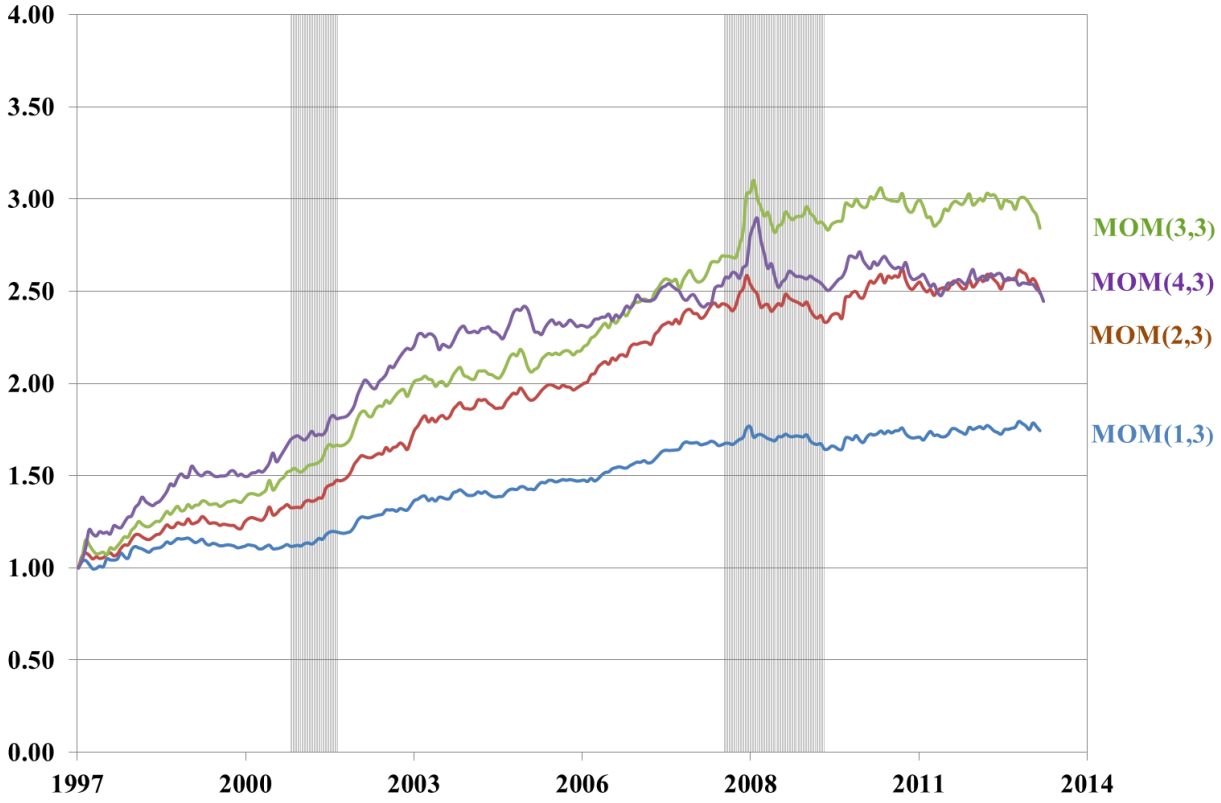
[8] Deutsche Bank offers a currency momentum index based on G10 currencies. This currency momentum ETF takes long position in three winner currencies and three loser currencies every month based on past spot rate changes from the basket of G10 currencies only. We use this index for comparison purposes as it closely resembles the methodology we follow in calculating momentum returns. More information on this index is available at https://index.db.com/index/FX_Momentum_USD.

Figure 2.2: Cumulative Excess Returns of Two-Week Holding Period Currency Momentum Strategies



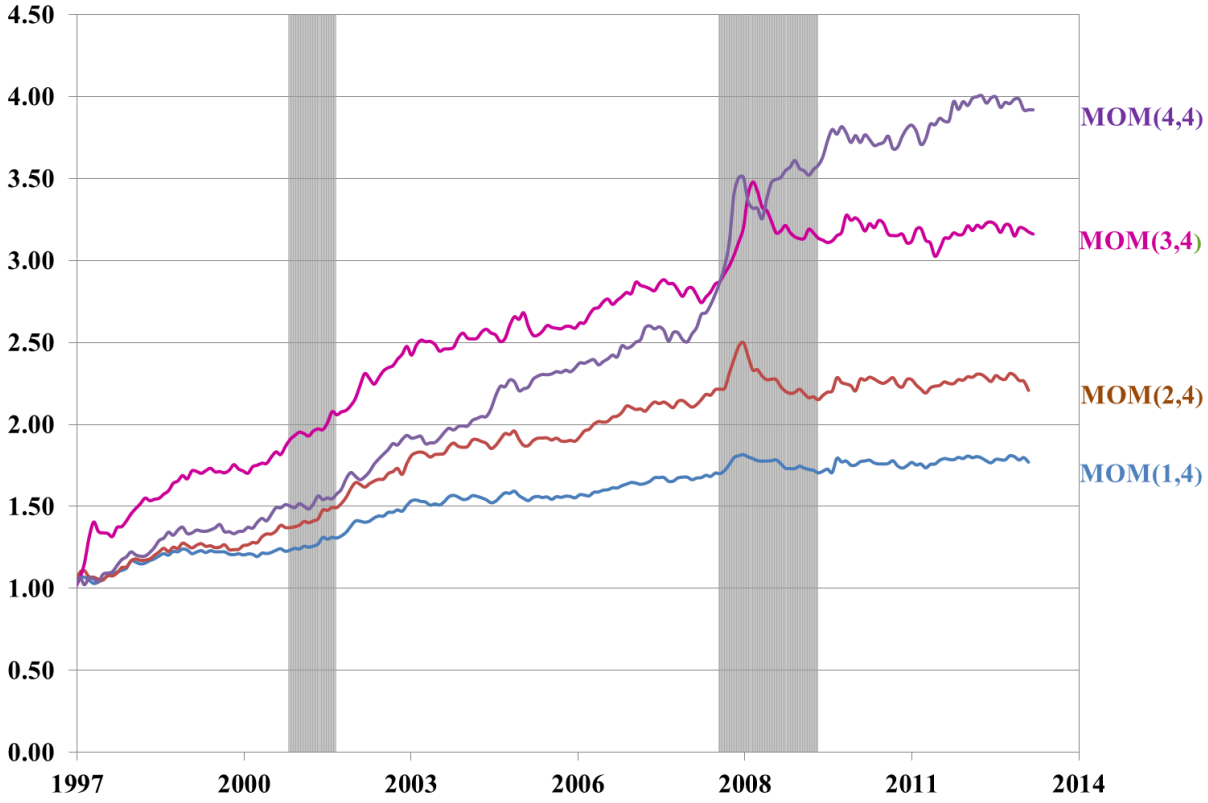
This figure shows cumulative excess returns to the four currency momentum strategies with a holding period of 2 weeks. All series are re-based to 1 USD in November 1997. The holding period for the four strategies shown here is two weeks whereas the look-back period is 1-,2-,3- and 4-weeks for MOM(1,2), MOM(2,2), MOM(3,2) and MOM(4,2) respectively. Shaded areas correspond to NBER recessions.

Figure 2.3: Cumulative Excess Returns of Three-Week Holding Period Currency Momentum Strategies



This figure shows cumulative excess returns to the four currency momentum strategies with a holding period of 3 weeks. All series are re-based to 1 USD in November 1997. The holding period for the four strategies shown here is 3-weeks whereas the look-back period is 1-,2-,3- and 4-weeks for MOM(1,3), MOM(2,3), MOM(3,3) and MOM(4,3) respectively. Shaded areas correspond to NBER recessions.

Figure 2.4: Cumulative Excess Returns of Four-Week Holding Period Currency Momentum Strategies



This figure shows cumulative excess returns to the four currency momentum strategies with a holding period of 4 weeks. All series are re-based to 1 USD in November 1997. The holding period for the four strategies shown here is 4-weeks whereas the look-back period is 1-,2-,3- and 4-weeks for MOM(1,4), MOM(2,4), MOM(3,4) and MOM(4,4) respectively. Shaded areas correspond to NBER recessions.

2.4. Robustness Checks

2.4.1. Sub-Period Analysis of Momentum Returns

Olson (2004) finds the returns to moving average trading rules in FX markets declined to close to zero in the 1990s from over 3% p.a. in the late 1970s as markets became more efficient. It is therefore possible the weekly momentum returns we document do not exist in the most recent period. We consider two sub-periods. The first starts in November 1997 and ends in December 2004. The second begins in January 2005 and ends in July 2013. We show the results of all sixteen short horizon momentum strategies for the first and the second subsample in Table 2.3 and Table 2.4 respectively.

Table 2.3: Currency Look-back and Holding Period Returns (Sub-period 1997-2004)

	Holding period				Holding period			
	1-Week	2-Week	3-Week	4-Week	1-Week	2-Week	3-Week	4-Week
Portfolio	**Panel A (1-Week Look-back)**				**Panel C (3-Week Look-back)**			
Winner – Loser (%)	0.065	0.242	0.310	0.510	0.243	0.470	0.644	0.866
Mean (%)	**3.378**	**6.303**	**5.372**	**6.121**	**12.661**	**12.220**	**11.164**	**10.392**
Max (%)	7.529	6.456	7.494	10.138	8.855	8.884	12.000	13.602
Min (%)	-5.450	-10.512	-8.492	-9.846	-4.294	-7.177	-10.301	-6.831
t-stat.	0.894	2.420	2.620	3.493	3.686	4.151	4.194	4.527
p-value	0.372	0.016	0.009	0.001	0.000	0.000	0.000	0.000
Volatility (%)	9.828	8.991	8.988	8.963	9.467	8.890	9.061	8.762
Sharpe Ratio	**0.344**	**0.701**	**0.598**	**0.683**	**1.337**	**1.375**	**1.232**	**1.186**
Winner (mean %)	0.130	0.296	0.403	0.554	0.215	0.407	0.582	0.794
Max (%)	6.927	6.919	9.774	10.538	3.137	5.469	8.321	8.034
Min (%)	-7.604	-5.426	-11.397	-12.147	-4.370	-4.689	-4.037	-5.258
Loser (mean %)	0.065	0.054	0.093	0.044	-0.029	-0.063	-0.062	-0.072
Max (%)	4.874	11.280	9.915	7.966	3.680	9.347	11.305	7.586
Min (%)	-4.495	-6.770	-9.620	-11.340	-9.449	-9.526	-12.688	-13.923
	Panel B (2-Week Look-back)				**Panel D (4-Week Look-back)**			
Winner – Loser (%)	0.207	0.411	0.564	0.740	0.265	0.477	0.677	0.960
Mean (%)	**10.773**	**10.697**	**9.769**	**8.877**	**13.789**	**12.409**	**11.731**	**11.519**
Max (%)	6.951	7.322	8.685	13.854	8.761	8.437	12.207	17.491
Min (%)	-4.212	-7.110	-8.293	-8.955	-4.887	-11.205	-9.187	-8.786
t-stat.	3.440	3.875	4.032	4.045	4.236	4.260	4.388	4.884
p-value	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Volatility (%)	9.303	8.840	8.932	9.068	9.289	9.047	9.215	8.923
Sharpe Ratio	**1.158**	**1.210**	**1.094**	**0.979**	**1.484**	**1.372**	**1.273**	**1.291**
Winner (mean %)	0.210	0.387	0.530	0.703	0.228	0.417	0.621	0.855
Max (%)	6.859	5.352	8.868	9.662	4.064	4.838	7.788	9.947
Min (%)	-7.297	-5.422	-11.088	-11.134	-2.940	-4.119	-4.475	-5.160
Loser (mean %)	0.002	-0.025	-0.034	-0.036	-0.037	-0.060	-0.056	-0.105
Max (%)	3.648	9.280	9.818	7.875	4.958	11.211	9.843	8.450
Min (%)	-5.755	-9.792	-9.732	-14.302	-9.449	-9.322	-12.688	-16.911

The structure of this table is similar to Table 2.2 except that we change the period of analysis. We present average excess returns of the Winner-Loser (long-short) using 63 currencies against the USD for 1-,2-,3- and 4-week formation and holding periods over the period November 1997-December 2004. Portfolios consist of 20% of available currencies. Positive returns indicate momentum whereas negative returns indicate reversal. The excess returns are calculated as ln(ft)-ln(St+1) and are in percent. The Mean and Volatility figures are annualized and are in percent. The Sharpe Ratio is calculated by dividing annualized excess returns by annualized volatility. The t-statistics are based on Newey-West standard errors.

Table 2.4: Currency Look-back and Holding Period Returns (Sub-period 2005-2013)

	Holding period				Holding period			
	1-Week	2-Week	3-Week	4-Week	1-Week	2-Week	3-Week	4-Week
Portfolio	**Panel A (1-Week Look-back)**				**Panel C (3-Week Look-back)**			
Winner – Loser (%)	0.011	0.026	0.135	0.104	0.084	0.153	0.191	0.145
Mean (%)	**0.557**	**0.669**	**2.348**	**1.250**	**4.378**	**3.973**	**3.310**	**1.742**
Max (%)	7.261	5.570	11.245	7.719	6.365	5.098	10.576	8.800
Min (%)	-4.685	-7.935	-9.245	-13.507	-5.798	-8.768	-6.804	-8.219
t-stat.	0.231	0.351	1.747	1.161	1.854	1.977	1.667	1.032
p-value	0.409	0.363	0.041	0.123	0.032	0.024	0.048	0.151
Volatility (%)	8.085	7.959	7.854	7.675	8.367	7.380	7.478	7.514
Sharpe Ratio	**0.069**	**0.084**	**0.299**	**0.163**	**0.523**	**0.538**	**0.443**	**0.232**
Winner (mean %)	0.045	0.082	0.178	0.199	0.091	0.164	0.214	0.213
Max (%)	7.502	5.946	6.058	9.575	5.688	6.357	5.345	6.189
Min (%)	-5.268	-10.956	-12.422	-19.777	-4.405	-5.893	-7.710	-11.933
Loser (mean %)	0.034	0.056	0.042	0.095	0.007	0.011	0.023	0.068
Max (%)	4.477	7.966	7.594	8.361	5.739	8.808	7.782	9.108
Min (%)	-7.179	-5.963	-12.045	-10.338	-7.552	-10.467	-12.217	-13.396
	Panel B (2-Week Look-back)				**Panel D (4-Week Look-back)**			
Winner – Loser (%)	0.026	0.104	0.171	0.122	0.012	0.033	0.019	0.517
Mean (%)	**1.358**	**2.715**	**2.968**	**1.466**	**0.626**	**0.855**	**0.329**	**6.209**
Max (%)	5.761	4.180	7.237	7.993	7.038	4.702	7.044	11.402
Min (%)	-5.465	-5.269	-5.653	-7.585	-5.852	-6.345	-7.888	-7.438
t-stat.	0.463	1.310	1.843	0.963	0.260	0.399	0.167	3.211
p-value	0.322	0.095	0.033	0.168	0.397	0.345	0.434	0.001
Volatility (%)	8.391	7.235	7.047	7.308	8.279	7.436	7.304	7.679
Sharpe Ratio	**0.162**	**0.375**	**0.421**	**0.201**	**0.076**	**0.115**	**0.045**	**0.809**
Winner (mean %)	0.054	0.131	0.206	0.203	0.053	0.095	0.119	0.394
Max (%)	4.718	5.130	6.376	5.850	5.535	4.097	5.685	5.911
Min (%)	-7.465	-8.316	-10.515	-14.971	-4.770	-6.088	-7.020	-8.487
Loser (mean %)	0.027	0.027	0.035	0.080	0.041	0.062	0.100	-0.123
Max (%)	5.644	7.017	5.868	9.316	5.920	7.612	7.743	7.171
Min (%)	-7.507	-10.023	-10.929	-11.503	-7.741	-9.566	-11.279	-16.879

The structure of this table is similar to Table 2.2 except that we change the period of analysis. We present average excess returns of the Winner-Loser (long-short) portfolio using 63 currencies against the USD for 1-,2-,3- and 4-week formation and holding periods over the period January 2005 to July 2013. Portfolios consist of 20% of available currencies. Positive returns indicate momentum whereas negative returns indicate reversal. The excess returns are calculated as ln(ft)-ln(St+1) and are in percent. The Mean and Volatility figures are annualized and are in percent. The Sharpe Ratio is calculated by dividing annualized excess returns by annualized volatility. The t-statistics are based on Newey-West standard errors.

The results indicate the momentum returns are higher in the earlier sub-period than the most recent sub-period, however, the returns do not disappear in the recent sub-period. For instance, the results of the 3-week formation period strategy are profitable and statistically significant for the 1-, 2-, 3-week holding period in both subsamples. Similarly, a MOM(4,4) strategy generates an annualized return of 6.21% in the most recent sub-period.

We also consider the performance of these strategies prior to November 1997.[9] We begin this extended period in January 1972 so the period follows the collapse of Bretton Woods and the fixed exchange rate regimes followed by many countries. We could not source forward rate data for the frequencies we require so we obtained spot currency and interest rate data from Global Financial Data (GFD) and calculated forward rates. This analysis finishes in October 1997 so we have a 26 year period. Data was available for 29 currencies at the start of the period and 52 currencies by the end of the period. The Table 2.5 results indicate our main conclusions hold in this earlier period. Firstly, there is strong evidence of momentum rather than reversal for look-back and holding periods ranging from one week to one month. Secondly, the returns are larger for longer look-back periods. Thirdly, these returns are larger (8.7% - 14.2%) than those in more recent years. This is not unexpected given the Table 2.3 and 2.4 evidence that that profitability of momentum strategies in currency markets is declining over time.

[9] We thank an anonymous referee for suggesting this analysis.

Table 2.5: Currency Look-back and Holding Period Returns (Period 1972-1997)

	Holding period				Holding period			
	1-Week	2-Week	3-Week	4-Week	1-Week	2-Week	3-Week	4-Week
Portfolio	**Panel A (1-Week Look-back)**				**Panel C (3-Week Look-back)**			
Winner – Loser (%)	0.168	0.414	0.660	0.904	0.236	0.547	0.812	1.105
Mean (%)	**8.738**	**10.760**	**11.438**	**10.853**	**12.273**	**14.231**	**14.082**	**13.263**
Max (%)	7.430	11.066	13.022	12.567	5.091	7.549	9.204	10.870
Min (%)	-6.332	-14.153	-14.501	-14.249	-8.083	-9.449	-11.044	-12.899
t-stat.	4.785	7.492	8.562	9.455	6.487	8.152	8.666	9.422
p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Volatility (%)	8.774	9.170	9.361	9.075	8.968	9.292	9.461	9.274
Sharpe Ratio	**0.996**	**1.173**	**1.222**	**1.196**	**1.369**	**1.532**	**1.488**	**1.430**
Winner (mean %)	0.165	0.343	0.551	0.783	0.200	0.431	0.640	0.907
Max (%)	6.079	7.867	9.982	11.895	6.181	6.166	9.659	10.081
Min (%)	-7.487	-13.715	-13.762	-13.643	-8.727	-9.728	-9.990	-12.819
Loser (mean %)	-0.003	-0.071	-0.109	-0.122	-0.036	-0.117	-0.172	-0.198
Max (%)	5.349	7.498	9.143	9.101	6.678	9.744	11.117	11.186
Min (%)	-6.908	-9.212	-9.575	-9.678	-4.573	-7.157	-8.936	-10.532
	Panel B (2-Week Look-back)				**Panel D (4-Week Look-back)**			
Winner – Loser (%)	0.210	0.512	0.771	1.055	0.250	0.538	0.805	1.102
Mean (%)	**10.940**	**13.299**	**13.369**	**12.661**	**12.993**	**13.980**	**13.959**	**13.225**
Max (%)	4.972	7.311	8.754	11.069	4.765	7.369	9.301	11.046
Min (%)	-6.085	-10.144	-12.410	-11.909	-7.537	-9.910	-11.569	-12.845
t-stat.	6.027	8.204	8.791	9.775	6.794	7.891	8.325	9.019
p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Volatility (%)	8.579	8.930	9.240	8.958	8.915	9.183	9.474	9.235
Sharpe Ratio	**1.275**	**1.489**	**1.447**	**1.413**	**1.457**	**1.522**	**1.473**	**1.432**
Winner (mean %)	0.181	0.414	0.623	0.864	0.207	0.426	0.644	0.915
Max (%)	4.785	5.875	8.452	9.020	5.653	6.729	8.668	9.289
Min (%)	-7.487	-9.720	-10.010	-12.115	-8.344	-9.486	-10.794	-12.529
Loser (mean %)	-0.030	-0.097	-0.148	-0.191	-0.042	-0.112	-0.162	-0.187
Max (%)	6.152	8.960	9.830	9.613	6.703	8.405	9.624	9.806
Min (%)	-4.694	-7.094	-7.988	-10.413	-4.418	-7.120	-8.938	-10.078

The structure of this table is similar to Table 2.2 except that we change the period of analysis. We present average excess returns of the Winner-Loser (long-short) portfolio using 29 to 52 currencies against the USD for 1-,2-,3- and 4-week formation and holding periods over the period January 1972 to October 1997. Portfolios consist of 20% of available currencies. Positive returns indicate momentum whereas negative returns indicate reversal. The excess returns are calculated as ln(ft)-ln(St+1) and are in percent. The Mean and Volatility figures are annualized and are in percent. The Sharpe Ratio is calculated by dividing annualized excess returns by annualized volatility. The t-statistics are based on Newey-West standard errors.

2.4.2. Breakeven Transaction Costs

In this section we calculate the level of transaction costs that would result in the trading strategy returns be reduced to breakeven.[10] At the end of each holding period we record the number of currencies that are removed from and added to the long and short portfolios as transaction costs are incurred when positions are opened and closed. Every time a currency moves from being long or short to neutral then one trade is recorded and another is recorded when currencies move from neutral to long or short. Moreover, if a currency moves from short to long or vice versa, two trades (one closing and one opening) are recorded. The proportion of trades to the total number of long / short currencies is then calculated each period and referred to as "turnover". The average turnover through time is then calculated and this number is annualized. The break even transaction cost is then calculated by dividing the annual momentum returns to each strategy by the annual turnover.

The Table 2.6 results show that average annual turnover ranges from 74% in the 4-week look-back strategies to 149% in the one-week look-back strategies. These turnovers imply breakeven transaction costs ranging from 2bps for the 1-week look-back and 1-week holding period strategy to 97bps for the four week look-back and 4-week holding period strategy. Mancini, Ranaldo, and Wrampelmeyer (2013) show spot market transaction costs for 9 major currency pairs, from 1 – 8 bps over the 2007 to 2009 period. These costs are similar to the 2 – 7 bps documented for G9 spot and forward currencies over the 2004 – 2008 period by Gilmore and Hayashi (2011). It is clear that the transaction costs for emerging market currencies are larger, with Gilmore and Hayashi (2011) finding average

[10] We thank an anonymous referee for suggesting this analysis.

costs of 11bps and 16bps for the spot and forward currencies respectively of 20 emerging countries.[11] However, while our results suggest that the short term strategies are unlikely to generate profits after transaction costs, they indicate the longer term strategies may.

Table 2.6: Strategy Returns and Break Even Transaction Costs

Strategy	Average Annual Turnover (%)	Break Even Transaction Cost (bps)
MOM(1,1)	149.350	2.37
MOM(1,2)	149.399	8.29
MOM(1,3)	149.399	14.35
MOM(1,4)	149.326	19.26
MOM(2,1)	104.891	10.31
MOM(2,2)	104.969	23.18
MOM(2,3)	104.986	33.19
MOM(2,4)	104.954	38.18
MOM(3,1)	85.316	18.31
MOM(3,2)	85.376	34.68
MOM(3,3)	85.283	46.35
MOM(3,4)	85.340	55.05
MOM(4,1)	74.015	17.07
MOM(4,2)	73.937	31.55
MOM(4,3)	73.927	42.63
MOM(4,4)	73.839	97.02

This table shows the break even transaction costs in basis points and annual turnover for all sixteen look-back and holding period strategies using 63 currencies over the period November 1997 to July 2013. The proportion of trades to the total number of long / short currencies is calculated each period. The average turnover through time is then calculated and this number is annualized. The break even transaction cost is then calculated by dividing the annual returns to each strategy by the annual turnover. MOM(1,1) refers to the 1-week look-back and 1-week holding period momentum strategy. Similarly, (1,2), (1,3) and (1,4) refer to the 1-week look-back and 2-,3- and 4-week holding period strategies respectively.

[11] These costs are consistent with those described by employee of a major international bank.

2.4.3. Are These Short Horizon Momentum Returns Linked to the Currency Carry Trade?

The carry trade strategy, which, as Burnside, Eichenbaum, and Rebelo (2011) note, involves buying high interest rate currencies and selling short low interest rate currencies, is a popular currency investment strategy. We investigate whether the carry trade phenomena is driving the weekly momentum returns.[12] Academic carry trade papers such as Menkoff, Sarno, Schmeling, and Schrimpf (2012b) tend to rank all currencies on a carry trade spectrum based on interest rate differentials or forward discounts rather than singling out certain currencies as "carry trade currencies." We therefore use the currencies that are eligible for inclusion in the Deutsche Bank Currency Carry ETF as carry trade currencies. These include both high interest rate (investment) and low interest rate (funding) currencies, including the Australian Dollar, Canadian Dollar, Swiss Franc, Euro, British Pound, Japanese Yen, Norwegian Krona, New Zealand Dollar, and the Swedish Krona.

We exclude these carry trade currencies and re-run our key Table 2.2 results and present these in Table 2.7. The main results hold. Firstly, there is strong evidence of momentum rather than reversal for look-back and holding periods ranging from one week to one month. Secondly, the returns are larger for longer look-back periods. Moreover, the returns are larger, on average, in Table 2.7 than in Table 2.2. For instance the four week look-back and holding period result increases from 8.60% to 12.64%. This is strong evidence that the momentum returns we document are not driven by the carry trade. This is confirmed by regression analysis in Appendix A.3 using the carry trade factor of Lustig, Roussanov, and Verdelhan (2011).

[12] We thank an anonymous referee for suggesting we consider the link to carry trade returns in manner we describe.

Table 2.7: Currency Momentum Returns Excluding Carry Trade Currencies

	Holding period				Holding period			
	1-Week	2-Week	3-Week	4-Week	1-Week	2-Week	3-Week	4-Week
Portfolio	**Panel A (1-Week Look-back)**				**Panel C (3-Week Look-back)**			
Winner – Loser (%)	0.089	0.237	0.371	0.482	0.239	0.449	0.600	0.732
Mean (%)	**4.646**	**6.166**	**6.431**	**5.781**	**12.446**	**11.679**	**10.405**	**8.784**
Max (%)	10.131	9.310	11.043	16.338	12.141	11.895	17.407	18.209
Min (%)	-8.358	-14.697	-11.954	-12.878	-6.286	-10.004	-15.315	-9.923
t-stat.	1.793	3.138	4.228	4.619	4.823	5.270	5.169	5.137
p-value	0.037	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Volatility (%)	10.473	9.985	9.862	9.731	10.706	10.107	10.203	9.910
Sharpe Ratio	**0.444**	**0.618**	**0.652**	**0.594**	**1.163**	**1.156**	**1.020**	**0.886**
Winner (mean %)	0.119	0.258	0.398	0.520	0.200	0.374	0.519	0.652
Max (%)	9.510	6.903	11.590	14.067	5.201	7.121	11.376	11.465
Min (%)	-9.569	-8.618	-15.309	-18.010	-5.415	-6.931	-8.411	-14.162
Loser (mean %)	0.029	0.021	0.026	0.038	-0.039	-0.075	-0.081	-0.080
Max (%)	6.663	15.494	13.568	10.671	6.008	13.023	15.457	9.925
Min (%)	-6.616	-10.069	-12.403	-17.464	-12.970	-12.793	-18.372	-18.504
	Panel B (2-Week Look-back)				**Panel D (4-Week Look-back)**			
Winner – Loser (%)	0.174	0.393	0.549	0.644	0.224	0.411	0.546	1.053
Mean (%)	**9.071**	**10.216**	**9.518**	**7.724**	**11.628**	**10.674**	**9.466**	**12.642**
Max (%)	9.654	10.473	12.682	17.516	12.010	12.093	17.698	18.676
Min (%)	-6.370	-10.070	-11.673	-12.251	-6.546	-15.113	-14.073	-11.238
t-stat.	3.696	4.869	5.339	4.915	4.699	4.959	4.718	7.111
p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Volatility (%)	10.533	9.861	9.899	10.076	10.461	9.919	9.983	9.841
Sharpe Ratio	**0.861**	**1.036**	**0.962**	**0.767**	**1.112**	**1.076**	**0.948**	**1.285**
Winner (mean %)	0.171	0.345	0.488	0.607	0.194	0.361	0.515	0.856
Max (%)	9.592	7.128	11.503	12.783	4.835	6.156	10.384	10.588
Min (%)	-9.965	-8.967	-15.338	-15.579	-5.234	-6.432	-6.891	-9.046
Loser (mean %)	-0.003	-0.047	-0.061	-0.037	-0.030	-0.050	-0.031	-0.197
Max (%)	6.387	13.023	13.789	9.840	6.808	15.470	13.916	10.727
Min (%)	-8.100	-12.735	-13.415	-18.046	-12.970	-12.793	-18.372	-18.504

The structure of this table is similar to Table 2.2 except that we exclude the Deutsche Bank's Currency Carry ETF currencies. We present average excess returns of the Winner-Loser (long-short) portfolio Portfolios consist of 20% of available currencies. Positive returns indicate momentum whereas negative returns indicate reversal. The excess returns are calculated as ln(ft)-ln(St+1) and are in percent. The Mean and Volatility figures are annualized and are in percent. The Sharpe Ratio is calculated by dividing annualized excess returns by annualized volatility. The t-statistics are based on Newey-West standard errors.

Our findings are consistent with those of Menkhoff, Sarno, Schmeling, and Schrimpf (2012a) as they also find that medium-term currency momentum and carry trades are different phenomenon. The short-term momentum returns compare favourably to carry trade returns on a risk-adjusted basis. Menkhoff, Sarno, Schmeling, and Schrimpf (2012b) document that a carry trade strategy provides an annualized Sharpe ratio of 0.82, whereas, our MOM(3,1), MOM(3,2), MOM(3,3), MOM(2,2), MOM(4,1), and MOM(4,4) momentum strategies produce annualized Sharpe ratios of 0.91, 0.94, 0.82, 0.79, 0.75 and 1.04 respectively as shown in Table 2.2.

2.4.4. Dynamics of Currency Momentum Returns Under Different Market Circumstances

In the following subsections, we present an empirical investigation of the behaviour of short-horizon momentum returns under different market circumstances. We study the returns over the different phases of the US business cycle, in UP and Down markets using the framework proposed by Cooper, Gutierrez, and Hameed (2004), and in periods of extreme market stress (down markets with high volatility) as per Daniel and Moskowitz (2012). We present the results in the following subsections.

2.4.4.1. Currency Momentum Returns and the State of the Business Cycle

In this subsection, we further explore the characteristics of currency momentum returns by investigating their dynamics over the different phases of the business cycle. For this purpose, we use expansion and recession dummy variables in the following regression specification.

$$MOM(J,K)_t = \beta_{exp} . D_{exp} + \beta_{rec} . D_{rec} + \in_{J,K,t} \quad (5)$$

Where $MOM(J,K)_t$ is the time series of the return to the short horizon momentum strategy (J and K alter from 1 to 4) at time t. D_{exp} is a dummy variable which is one if a return is in an expansionary phase and zero otherwise. D_{rec} is a dummy variable which is one if a return is in a recessionary phase and zero otherwise. We use Newey-West standard errors in the above estimation due to overlapping nature of momentum portfolios. The NBER, which provides US business cycle dates on its website, notes the first recession in our sample period starts in March 2001 and ends in November 2001, while the second recession starts from December 2007 and lasts till June 2009. The results of the above regression are given in Table 2.8.

Table 2.8: Momentum Returns and the US Business Cycle

Strategy	Mean Return	t-stat	Mean Return	t-stat	Mean Return	t-stat
	Expansion		Recession		Test of Equality (Expansion-Recession=0)	
MOM(1,1)	0.034	0.765	0.042	0.369	-0.008	-0.066
MOM(1,2)	0.177	2.775	-0.183	-1.046	0.361	2.213
MOM(1,3)	0.222	2.952	0.169	1.029	0.054	0.271
MOM(1,4)	0.282	3.040	0.317	1.726	-0.034	-0.145
MOM(2,1)	0.146	3.481	-0.108	-0.762	0.253	2.104
MOM(2,2)	0.292	4.164	-0.040	-0.221	0.332	2.144
MOM(2,3)	0.364	4.041	0.256	1.279	0.108	0.573
MOM(2,4)	0.400	3.451	0.407	1.223	-0.007	-0.030
MOM(3,1)	0.172	4.040	0.063	0.629	0.109	0.899
MOM(3,2)	0.295	4.045	0.302	1.735	-0.007	-0.041
MOM(3,3)	0.368	3.753	0.552	1.848	-0.184	-0.939
MOM(3,4)	0.423	3.455	0.737	1.955	-0.314	-1.349
MOM(4,1)	0.126	3.020	0.128	1.173	-0.002	-0.013
MOM(4,2)	0.237	3.281	0.210	0.961	0.027	0.172
MOM(4,3)	0.308	3.133	0.354	1.107	-0.045	-0.230
MOM(4,4)	0.616	5.126	1.290	2.693	-0.673	-2.868

MOM(1,1) refers to the 1-Week look-back and 1-Week holding period momentum strategy. Similarly, (1,2),(1,3) and (1,4) refer to the 1-Week look-back and 2-,3- and 4-week holding period strategies respectively. We use two dummy variables. The first is one if a return is in an expansionary phase and zero otherwise. The second is one if a return is in a recessionary phase and zero otherwise. We use US business cycle cut off dates directly from the NBER. The t-statistics are based on Newey-West standard errors.

We report individual significance statistics for each of our short horizon momentum strategies for recessionary as well as expansionary phases of the US business cycle along with a test of equality of means. It is evident from Table 2.8 that currency momentum returns have stronger statistical significance in expansionary phases of the business cycle. Only the MOM(1,1) strategy is not statistically significant in expansions. However, just five of the 16 strategies are statistically significant at the 10% level during recessions. There is not a consistent pattern of mean returns being statistically significantly larger in expansions or recessions However, based on the strength of the t-statistics of momentum returns during expansions, we can conclude that short horizon currency momentum strategies perform better in expansions.

2.4.4.2. Behaviour of Momentum Returns in UP and DOWN Currency Markets

Following Cooper, Gutierrez, and Hameed (2004), we investigate the performance of our short horizon momentum strategies in UP and DOWN currency markets. It is important to note here that we differentiate our analysis from the equity market literature by defining *UP* and *DOWN* states of the currency market. We use the RX (USD) currency slope factor[13] of Lustig, Roussanov, and Verdelhan (2011) as the currency benchmark. RX is the mean currency excess return to a US investor who goes long all the foreign currencies available in the forward FX market. We define an "UP" currency market whereby the cumulative return of the RX factor is positive over the past 36 months. Similarly, the currency market is in a "DOWN" state in a particular week if the cumulative return of the RX factor is negative or zero over the immediately preceding 36 months. Therefore, D_{up} is a dummy variable which is one when the past 36 month cumulative return

[13] The RX (dollar) factor data is available online at http://web.mit.edu/adrienv/www/Data.html.

of the USD (RX) factor of Lustig, Roussanov, and Verdelhan (2011) is positive and zero otherwise. D_{down} is a dummy variable which is one when the past 36 month cumulative return of the USD (RX) factor is negative and zero otherwise. Also, following the framework as in Cooper, Gutierrez, and Hameed (2004), we define mean returns as CERs (Cumulative Excess Returns) for any one of the sixteen momentum strategies we consider as:

$$CER_{t+K2} = \sum_{k=K1}^{K2} r_{k,t+k} \quad (6)$$

Where (K_1,K_2) are pairs of holding periods such as (week 1 and week 2), (week 1 and week 3) and (week1 and week 4). $r_{k,t+k}$ is the excess return to any MOM(J,K) strategy under focus. These CERs are overlapping, and hence we employ Newey-West standard errors in the estimation of the time series regressions of the similar form as equation (6) above. A period of economic expansion (recession) is distinct from an UP (DOWN) phase of the foreign exchange market. The correlation between the expansion (recession) and the UP (DOWN) market dummy variables is just 0.07, so it does not necessarily follow that the results in this section will be the same as those in the Section 4.3.1.

We report individual strategy statistics in both UP and DOWN states as well as a test of equality of means as in the previous section in Table 2.9 below. The findings of Table 2.9 indicate the momentum strategies are generally profitable in both UP and DOWN markets. However, returns tend to be larger and more statistically significant in the DOWN state of the currency market. The test of equality of means shows higher mean returns in the DOWN state as compared to the UP state of FX market. The relevant t-statistics are

negative for 15 out of 16 strategies and statistically significant at the 10% level for 13 strategies.

Table 2.9: Momentum returns in UP and DOWN FX Market States

Strategy	Mean Return	t-stat	Mean Return	t-stat	Mean Return	t-stat
	UP Markets		DOWN Markets		Test of Equality (Up-Down=0)	
MOM(1,1)	0.056	1.339	-0.005	-0.056	0.061	0.668
MOM(1,2)	0.060	0.919	0.250	1.989	-0.189	-1.544
MOM(1,3)	0.160	2.254	0.323	2.194	-0.164	-1.096
MOM(1,4)	0.173	2.042	0.516	2.843	-0.343	-1.933
MOM(2,1)	0.050	1.000	0.223	3.025	-0.172	-1.904
MOM(2,2)	0.141	1.902	0.447	3.553	-0.306	-2.633
MOM(2,3)	0.236	2.704	0.573	3.369	-0.337	-2.378
MOM(2,4)	0.249	2.149	0.704	3.036	-0.455	-2.591
MOM(3,1)	0.105	2.554	0.259	3.110	-0.154	-1.691
MOM(3,2)	0.180	2.568	0.527	3.747	-0.347	-2.945
MOM(3,3)	0.242	2.417	0.702	3.588	-0.460	-3.135
MOM(3,4)	0.234	1.891	0.942	3.834	-0.708	-4.065
MOM(4,1)	0.054	1.286	0.270	3.410	-0.216	-2.394
MOM(4,2)	0.096	1.286	0.508	3.620	-0.412	-3.440
MOM(4,3)	0.113	1.118	0.722	3.638	-0.609	-4.135
MOM(4,4)	0.586	4.269	0.978	3.869	-0. 392	-2.204

MOM(1,1) refers to the 1-week look-back and 1-week holding period momentum strategy. Similarly, (2,2),(2,3) and (2,4) refer to the 2-week look-back and 2-,3- and 4-week holding period strategies respectively. UP is a dummy variable which is one when the past 36 month cumulative return of the USD (RX) factor of Lustig, Roussanov, and Verdelhan (2011) is positive and zero otherwise. DOWN is a dummy variable which is one when the past 36 month cumulative return of the USD (RX) factor is negative and zero otherwise. The t-statistics are based on Newey-West standard errors.

2.4.4.3. Momentum Returns in Extreme Market Stress

In this section, we analyse the behaviour of short horizon currency momentum returns in periods of market stress. We define market stress as periods of high currency market volatility in DOWN states as defined in the previous section. Given we have data on UP and DOWN market states, here we only need to couple data on currency market volatility with DOWN market dummy. We construct a global foreign exchange volatility proxy by employing our own currency return dataset of 63 currencies using equation (7) below.

$$\sigma_{FXVOL,t} = \frac{\sum|r_t^k|}{K_t} \tag{7}$$

Where $\sigma_{FXVOL,t}$ in the above equation represents FX volatility in week *t*. K_t and $|r_t^k|$ denote the number of available currencies in week t and absolute weekly log return of currency *k* in week *t* respectively. We use the volatility innovation series in our regression framework detailed in equation (8) as measured by the first difference of the FX volatility time series ($\Delta\sigma_{FXVOL,t}$) . The spirit of our procedure for estimating FX volatility innovations is similar to the one recently suggested by Menkhoff, Sarno, Schmeling, and Schrimpf (2012b) except we use absolute weekly log returns in place of absolute daily log returns.

$$r_{MOM(J,K)_t} = \alpha_0 + \beta_{DOWN}.D_{DOWN} + \beta_{FXVOL}.\sigma^2_{FXVOL,t} + \beta_{int}.D_{DOWN}.\Delta\sigma^2_{FXVOL,t} + \in_t \tag{8}$$

$r_{MOM(J,K)_t}$ in the above specification is the excess return of the *MOM(J,K)* strategy in week *t*. $\sigma^2_{FXVOL,t}$ is the FX volatility innovation term we observe in the same week *t*.

β_{DOWN} is the coefficient on the DOWN dummy variable. The interaction term $D_{DOWN}.\Delta\sigma^2_{FXVOL,t}$ represents the *stress factor* in currency markets we are referring to in particular. We report the results of the above estimation in Table 2.10 below.

Table 2.10: Momentum Returns and Market Stress

Strategy	α	β(Down)	β(Volatility)	β(Down*Volatility)
MOM(1,1)	0.001	-0.001	0.260	-0.160
	1.347	-0.597	1.376	-0.584
MOM(1,2)	0.001	0.002	-0.706	0.023
	0.880	1.336	-5.834	0.081
MOM(1,3)	0.002	0.002	-0.655	-0.059
	2.272	0.958	-4.468	-0.218
MOM(1,4)	0.002	0.003	-1.024	-0.367
	2.052	1.680	-5.143	-1.094
MOM(2,1)	0.001	0.002	0.087	0.290
	0.999	1.934	0.512	1.211
MOM(2,2)	0.001	0.003	-0.131	0.141
	1.894	2.068	-1.141	0.536
MOM(2,3)	0.002	0.003	-0.321	0.103
	2.718	1.714	-1.759	0.377
MOM(2,4)	0.002	0.004	-0.619	0.402
	2.152	1.705	-3.625	1.182
MOM(3,1)	0.001	0.002	0.240	0.402
	2.565	1.651	1.226	1.107
MOM(3,2)	0.002	0.003	-0.184	0.194
	2.548	2.168	-1.442	0.792
MOM(3,3)	0.002	0.004	-0.326	0.287
	2.428	2.045	-1.571	0.889
MOM(3,4)	0.002	0.007	-0.474	0.138
	1.890	2.542	-2.627	0.454
MOM(4,1)	0.001	0.002	0.173	0.413
	1.287	2.425	0.908	1.159
MOM(4,2)	0.001	0.004	-0.336	0.264
	1.269	2.551	-2.871	1.055
MOM(4,3)	0.001	0.006	-0.345	0.275
	1.127	2.698	-1.856	0.924
MOM(4,4)	0.006	0.004	-0.228	-0.023
	4.255	1.332	-1.120	-0.062

Volatility refers to FX volatility innovations estimated using procedure in Menkhoff, Sarno, Schmeling, and Schrimpf (2012b). MOM (1,1) refers to the 1-week look-back and 1-week holding period momentum strategy. Similarly, (2,2), (2,3) and (2,4) refer to the 2-week look-back and 2-,3- and 4-week holding period strategies. DOWN is a dummy variable which is one when the past 36 month cumulative return of the USD (RX) factor of Lustig, Roussanov, and Verdelhan (2011) is zero or negative and zero otherwise.

It is evident from Table 2.10 that weekly FX momentum returns are negatively related to FX volatility. Out of the 16 different strategies we consider, slope factors of FX volatility load negatively for 12 strategies and the relevant Newey-West robust t-statistics are highly significant in most cases. Our finding that FX volatility innovations negatively impact short horizon momentum returns is consistent with the finding of Menkhoff, Sarno, Schmeling, and Schrimpf (2012a), who also state that FX volatility negatively impacts the returns to benchmark currency momentum strategies. The coefficients on the interaction term in our regression specification, which denote extreme market stress (DOWN markets coupled with FX volatility), are negative for the MOM(1,1), MOM(1,3), MOM(1,4), and MOM(4,4) momentum strategies. However, these are not statistically significant.

As a robustness check for this result, we also consider returns to all 16 momentum strategies over the recent Global Financial Crisis period, which we measure as of June 2007 to December 2009. The Appendix A.4 results show that the short horizon currency momentum returns are fairly low (negative in case of MOM(1,1), MOM(1,2), MOM(2,1) and MOM(2,2) strategies) and statistically insignificant for all look-back and holding horizons except the 4-week look-back and holding period strategy (MOM(4,4)).

2.5. Currency Momentum Explanations

There are both risk-based and behavioral explanations for the existence of momentum in stock markets. Papers who provide risk-based explanations include Harvey and Siddique (2000) who suggest momentum is related to systematic skewness, Chordia and Shivakumar (2002) who find momentum profits are related to macroeconomic

variables, and Pastor and Stambaugh (2003) who suggest that liquidity risk explains a portion of momentum profits.

Behavioral reasons include conservatism bias and the tendency of investors to underweight new information which Barberis, Shleifer, and Vishny (1998) suggest gives rise to underreaction and consequently momentum profits. Daniel, Hirshleifer, and Subrahmanyam (1998) propose that self-attribution bias leads to investors attributing successful investments to their skill and unsuccessful investments to bad luck, and this in turn results in overconfidence in their abilities resulting in the prices of winner stocks increasing beyond their fundamental levels. Finally, Hong and Stein (1999) suggest that not all investors are fully rational which leads to delays in information from informed traders being fully reflected in prices and this "gradual information diffusion" results in momentum.

Burnside, Eichenbaum, and Rebelo (2011) and Menkhoff, Sarno, Schmeling and Schrimpf (2012a) both find that risk-factors do not explain currency momentum. Moreover, Burnside, Han, Hirshleifer, and Wang (2011) suggest that behavioral biases that are evident in the stock market, such as overconfidence, can be used to explain currency phenomena such as the forward premium puzzle. This means that behavioral momentum explanations in the stock market may provide the best hope of understanding the reasons behind currency momentum. This is consistent with Menkhoff, Sarno, Schmeling and Schrimpf's (2012a, p. 661) comment "As in Jegadeesh and Titman (2001), we find some evidence of return continuation and subsequent reversals over long horizons of up to 36 months, which is consistent with behavioral biases, such as investor under- and overreaction, and suggests that momentum effects in different asset classes could share a common source."

2.6. Conclusion

We investigate whether momentum or reversal is the dominant phenomenon in weekly foreign exchange returns using a broad basket of 63 emerging and developed market currencies. By forming currency portfolios on the basis of past returns and employing various short horizon formation and holding period investment strategies, we find, in contrast to the short-term reversal documented in equity markets, strong evidence in favour of cross-sectional momentum. Annualized excess currency momentum returns reach up to 8% per year. These risk-adjusted returns are robust to different portfolio formations. Momentum returns increase with the increase in look-back period. Annualized excess returns increase from 1.84% for a 1-week look-back and holding period strategy to 8.12% for a 3-week look-back and 1-week holding period strategy. Breakeven transaction costs range from 2bps for the shorter term weekly strategies to 97bps for the monthly strategy. We also find that FX carry trade and momentum returns are unrelated.

Furthermore, we explore the behaviour of these short horizon momentum returns in expansionary and recessionary phases of the US business cycle, UP and DOWN states of the foreign exchange market and under extreme market stress. Our results confirm that weekly FX momentum is stronger in expansionary phases of the US business cycle and in DOWN states (periods following depreciation of a basket of major currencies versus the USD) of the foreign exchange market. Our results demonstrate that rising volatility in FX market negatively impacts short horizon currency momentum returns. We also find of a lack of consistent momentum returns during the recent Global Financial Crisis.

CHAPTER THREE

ESSAY TWO

This chapter presents the second essay of the thesis which explores the profitability of the 52-week high momentum strategy in the foreign exchange market. George and Hwang (2004) show a 52-week high momentum strategy, which involves buying (short-selling) stocks that are near to (far from) their 52-week high price generates higher returns than the price momentum strategy of Jegadeesh and Titman (1993) in stock markets. The same strategy has been found to be profitable in international stock markets (Du, 2008; Gupta, Locke, and Scrimgeour, 2010; Liu, Liu, and Ma, 2011), however, the profitability of this strategy in the foreign exchange market is undocumented. This chapter addresses this gap and tests the 52-week high and its closely related strategies in the foreign exchange market using a broad basket of 63 emerging and developed market currencies.

The chapter is structured as follows. The research question and relevant literature is discussed in Section 3.1. Section 3.2 explains the data, currency returns estimation and strategy formulation methodology. The returns to all 1-, 3- and 6-month holding period currency strategies are explained in Section 3.3. All the core results are analyzed in Section 3.4. Section 3.5 discusses the presence of the FX 52-week high returns under various market circumstances. This chapter concludes in Section 3.6. An appendix to this chapter and the relevant reference list is provided at the end of this thesis. This chapter is under review at the *International Review of Economics & Finance* Journal as of January 2015.

Is the 52-Week High Momentum Strategy Profitable in the Foreign Exchange Market?

Abstract

We find the 52-week high momentum strategy is not profitable in the foreign exchange market. This is puzzling as past price momentum strategies are profitable in currencies and the 52-week high strategy is more profitable than price momentum in equity markets. The underperformance of actively managed currencies is a contributing factor as these are typically close to their 52-week high price but they do not increase as much as freely floating currencies after long positions have been established. However, neither this nor the other possible explanations, such as faster mean reversion in currencies than equities fully explain the low returns.

JEL Classification: F31, G15

Keywords: Currency, momentum, 52-week high

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3.1. Introduction

George and Hwang (2004) show a 52-week high momentum strategy, which involves buying (short-selling) stocks that are near to (far from) their 52-week high price generates larger returns than the price momentum strategy of Jegadeesh and Titman (1993) in equity markets. Moreover, Menkhoff, Sarno, Schmeling, and Schrimpf (2012a) find price momentum generates returns of up to 10% per annum in the foreign exchange market. These findings give rise to the question of "what returns does the 52-week high momentum strategy generate in currencies?" We address this question in this paper.

Recent studies confirm the profitability of the 52-week high momentum strategy in major equity markets around the world (Du, 2008; Gupta, Locke, and Scrimgeour, 2010; Liu, Liu, and Ma, 2011) and in mutual funds (Sapp, 2011). However, there is also evidence of the 52-week high strategy not working in some settings. For instance, Malin and Bornholt (2010) find it is not profitable in emerging stock markets.

Lesmond, Schill, and Zhou (2004) and Korajczyk and Sadka (2004) find a large proportion of equity market momentum returns come from short selling small, illiquid stocks, which raises questions about the economic benefits to momentum investing. The foreign exchange market is therefore a natural setting to consider, as transaction costs are relatively low and short positions can be established as readily and at the same cost as long positions.[14] Quantitative investment strategies are very popular in the foreign exchange market with practitioners (e.g. Cheung and Chinn, 2001).

[14] Mancini, Ranaldo, and Wrampelmeyer (2013) document transaction costs of 1 – 8 bps for nine major currency pairs, while Gilmore and Hayashi (2011) find average costs of 11bps for 20 emerging countries.

We implement the 52-week high strategy in the foreign exchange market as follows: The currencies whose prices are nearest to the 52-week high price are bought and the ones whose prices are the farthest are sold short. As per Menkhoff, Sarno, Schmeling, and Schrimpf (2012a), these self-financing long – short portfolios are formed to allow the calculation of currency excess returns from a US investor's perspective. We also test a 52-week low strategy which involves going short (long) currencies closest to (farthest from) their 52-week low price, and the 52 week high minus 52-week low approach. Here, long portfolios are established from currencies closest to the 52-week high price and short portfolios are formed from currencies closest to the 52-week low price. We use 63 currencies studied by Raza, Marshall, and Visaltanachoti (2014). The estimation period for all strategies starts in January 1997 and ends in July 2013.

We find the 52-week high strategy generates negative returns over all holding horizons we consider. For instance, the 1-month holding period 52-week high strategy results in negative returns of about -2.98% p.a. and the losses increase to -5.68% for a 6-month investment horizon. The returns are less negative for the 52-week high minus low approach and the 52-week low strategy generates small positive returns. However, the overall result is clear. Neither the 52-week high strategy nor any of its derivations perform consistently well in currency markets.

In the second part of the paper, we investigate possible explanations for the poor performance of the 52-week price strategies. The impact of non-independently floating currencies is a partial explanation.[15] Given these currencies move in a relatively narrow band, they are consistently closer to either their 52-week high or low price than other

[15] We use the classification details provided in Raza, Marshall, and Visaltanachoti (2014) for pegged, currency board, managed float and independently floating currencies and use the term non-independently floating currencies to denote all pegged, currency board and managed float currencies.

currencies. They are therefore included in the long or short portfolio. However, they do not move much in the holding period which reduces the overall portfolio returns. Excluding these currencies from our analysis results in return improvements, but the gains are relatively minor. We also consider whether using the high or low price over the previous 52 weeks is too long a look back period. If currencies exhibit stronger mean reversion characteristics than stocks it might make more sense to use a four-week or a 12-week high strategy. Moreover, Menkhoff, Sarno, Schmeling, and Schrimpf (2012a) find price momentum is strongest in currencies when a four-week look back interval is used as compared to the longer intervals that are typically used in equity market momentum studies. However, our results suggest the length of the look back period only plays a minor role. Return improvements for shorter look back interval are not large. We also consider the timing of the 52-week high event as a possible explanation of poor 52-week high returns by following Bhootra and Hur (2013) who base their analysis on the behavioral hypothesis[16] that investors tend to put more weight on recent information and performance. We test a strategy which goes long (short) currencies which attain the 52-week high price in the recent (distant) past. We, however, find that timing of the 52-week high price is not a key factor in lowering 52-week high FX returns. We therefore conclude the underwhelming overall performance of 52-week high and 52-week low strategies in currencies is a puzzle.

As a final step, we consider whether the 52-week price momentum investing is only profitable in certain periods in currencies. Raza, Marshall, and Visaltanachoti (2014) find price based currency momentum is stronger during US business cycle expansions and in

[16] For instance, researchers such as Murdock Jr. (1962) show subjects are more likely to remember words from the end rather than beginning of a word list they are given and asked to memorize.

periods when the US dollar is appreciating. We therefore consider whether price strategies generate meaningful profits in these sub periods. We find this is not the case.

The remainder of this article is structured as follows. We explain our data, currency returns estimation and strategy formulation methodology in Section 3.2. We describe the returns to all 1-, 3- and 6-month holding period currency strategies in Section 3.3. We analyze our core results in Section 3.4. Section 3.5 discusses the presence of the FX 52-week high returns under various market circumstances. We conclude our discussion in Section 3.6.

3.2. Data and Methodology

3.2.1. Data

We obtain monthly (log) spot and forward foreign exchange rate data on 63 currencies over the period January 1997 to July 2013 from Thomson Reuters Datastream. These currencies are the same as those used by Burnside, Eichenbaum, and Rebelo (2007) and Raza, Marshall, and Visaltanachoti (2014). As some data series become available later in the sample and some currencies merged into the Euro, the number of currencies which constitute the currency portfolios varies over the sample period. Moreover, we obtain currency carry trade (HML_{FX}) and US Dollar risk (RX) factor data[17] for our regression analysis from Lustig, Roussanov, and Verdelhan (2011). We employ exchange rates as the US dollar (USD) price of one unit of foreign currency whereby an increase in the exchange rate implies appreciation of the foreign currency versus the US dollar.

[17] We thank the authors for making this data available on their website http://web.mit.edu/adrienv/www/Data.html

3.2.2. The 52-Week High Currency Strategy and its Variants

We follow George and Hwang (2004) and form self-financing long – short portfolios. The currencies are ranked in descending order at the end of every month *t* on the basis of the following ratio:

$$\frac{P_{i,t-1}}{High_{i,t-1}} \quad (1)$$

Where $P_{i,t-1}$ is the price of currency *i* at the end of month *t-1* and $High_{i,t-1}$ is the 52-week high price at the end of month *t-1* of the same currency over the immediately preceding 52 weeks. The currencies having the highest (lowest) ratio using expression (1) have their current price nearest (farthest from) to the 52-week high. We form five equal weighted portfolios at the end of every month *t* and go long the first 20% currencies (nearest to the 52-week high price) and sell short the last 20% (farthest from the 52-week high price) currencies. We discuss the procedure adopted for a timing based variant of the 52-week high strategy in sub-section 4.3.

The 52-week low strategy is very similar to the 52-week high strategy except that the 52-week high price is replaced by the 52-week low price as the buy/sell criterion. Expression (1) above is modified as follows for the 52-week low strategy:

$$\frac{P_{i,t-1}}{Low_{i,t-1}} \quad (2)$$

Where $Low_{i,t-1}$ is the lowest price of currency *i* at the end of month *t-1* over the immediately preceding 52 weeks. The currencies having the highest (lowest) ratio using the above expression will have their current prices farthest from (nearest to) the 52-week lowest price. We sort all available currencies in ascending order on the basis of expression

(2) above at the end of each month *t-1* and form self-financing portfolios by going long the bottom 20% currencies (farthest from 52-week low) and shorting the top 20% currencies (nearest to the 52-week low price) and hence implementing a momentum strategy.

The 52-week high – low strategy derives its returns from the above mentioned two strategies as in this strategy, at the end of each month, we go long the 20% currencies which are closest to their 52-week high price (*Long portfolio of the 52-week high strategy*) and short the currencies which are closest to their 52-week low price (*Short portfolio of the 52-week low strategy*).

3.2.3. Currency Excess Returns

We use spot and forward exchange rates and follow the methodology[18] as in Kroencke, Schindler, and Schrimpf (2014) in order to calculate currency excess returns as detailed in equation (3) below:

$$rx_{t+1}^{k} = s_{t+1}^{k} - f_{t}^{k} \ , \tag{3}$$

where *s* and *f* is the log spot and one-month forward exchange rate respectively. We simply use equation (4) for calculating portfolio excess returns to the US currency investor who is long a foreign currency. Similarly, for short positions we employ equation (5). We incorporate forex quotations as US dollar (USD) price of one unit of foreign currency[19] throughout this study.

$$rx_{t+1}^{k} = s_{t+1}^{k} - f_{t}^{k} \tag{4}$$

[18] We follow Kroencke, Schindler, and Schrimpf (2014) in terms of the currency quotation system they use however we employ log excess returns which is consistent with the procedure adopted in Menkhoff, Sarno, Schmeling, and Schrimpf (2012a) for calculating currency excess returns.

[19] Therefore an increase in the exchange rate implies appreciation of the foreign currency. For example, the movement of the NZ dollar exchange rate from 0.70 USD/NZD to 0.90 USD/NZD implies an increase in the price of the foreign currency, in this case the New Zealand dollar for a US currency investor.

$$rx_{t+1}^{k} = f_t^k - s_{t+1}^k \quad (5)$$

Due to the unavailability of longer maturity forward contract data in case of lengthier holding horizon strategies where long and short positions are held for three months and six months respectively, we roll the positions forward using 1-month maturity forward exchange rates to three and six months by extending equations (4) and (5) above. Furthermore, we denote the 12-month (52-week) look-back and 1-month holding period strategy as 52W(1). Similarly the 3-month and 6-month holding period strategies are denoted as 52W(3) and 52W(6) respectively throughout this study. The look-back period remains 52 weeks (12 months) by default for all strategies.

3.3. Core Findings

3.3.1. Entire Sample Period

In Table 3.1 we report the holding period mean, annualized mean, annualized volatility, Sharpe ratio and other descriptive statistics of the long, short and the long – short portfolio returns of our 52-week price strategies over the full sample period of January 1997 to July 2013.

As we show in Panel A, the 52-week high strategy performs poorly. The 1-month holding (52W(1)) self-financed long – short portfolio generates negative returns of -2.98% p.a. with a Sharpe ratio of -0.30 and with annualized volatility figures of 10.05%. The negative returns to the 52-week high strategy become more severe and statistically significant when the holding period is increased as the 52W(3) and 52W(6) strategy results show. The 52W(6) strategy generates returns of -5.68% p.a.

The 52-week low momentum strategy, which is based on the nearness of the current price to the 52-week lowest price, generates positive excess returns. However, these returns are relatively low. As we show in Panel B, the 1-month holding 52-week low strategy produces a return of about 4.32% p.a. and a Sharpe ratio of 0.46 on an annualized basis. Likewise, the 52-week low 52W(6) strategy generates a return of 4.69% p.a. with a Sharpe ratio of 0.45. The annualized volatility for this strategy reaches as high as 10.44%. The long portfolio of this strategy outperforms the short portfolio. The positive returns for all three holding periods for the 52-week low strategy are statistically significant at the 10% level.

Table 3.1: The 52-Week Price Currency Momentum Returns (All Currencies)

	Long – Short portfolio								Long Portfolio			Short Portfolio		
						Holding Period Return			Holding Period Return			Holding Period Return		
Holding Period	Mean (%)	Volatility (%)	Sharpe Ratio	*t*-stat	*p*-value	Mean (%)	Max (%)	Min (%)	Mean (%)	Max (%)	Min (%)	Mean (%)	Max (%)	Min (%)
Panel A. 52-Week High														
1-Month	-2.981	10.049	-0.297	-1.121	0.132	-0.248	9.552	-9.355	0.188	4.911	-3.039	0.436	10.049	-11.812
3-Months	-4.751	10.209	-0.465	-2.047	0.021	-1.188	18.654	-16.193	0.402	5.189	-10.424	1.590	19.818	-22.530
6-Months	-5.680	10.491	-0.541	-2.839	0.003	-2.840	17.830	-23.058	0.668	8.768	-19.518	3.508	23.601	-22.749
Panel B. 52-Week Low														
1-Month	4.323	9.395	0.460	1.782	0.038	0.360	7.419	-10.212	0.497	8.934	-11.106	0.137	5.230	-8.509
3-Months	4.111	9.874	0.416	1.821	0.035	1.028	14.358	-15.730	1.530	16.701	-23.972	0.502	11.605	-8.243
6-Months	4.689	10.445	0.449	2.307	0.011	2.344	21.808	-25.280	3.256	23.575	-31.740	0.912	13.788	-11.154
Panel C. 52-Week High – Low														
1-Month	0.609	4.632	0.132	0.516	0.303	0.051	5.906	-4.379	0.188	4.911	-3.039	0.137	5.230	-8.509
3-Months	-0.402	4.132	-0.097	-0.501	0.308	-0.100	6.616	-8.634	0.402	5.189	-10.424	0.502	11.605	-8.243
6-Months	-0.488	5.003	-0.098	-0.596	0.276	-0.244	9.339	-13.341	0.668	8.768	-19.518	0.912	13.788	-11.154

This table shows average excess returns of the Long, Short and the Long-Short portfolio of the 52-week high, low and high-low strategies using 63 currencies against the USD over the period January 1997-July 2013. The formation period is 52 weeks for all the 1-, 3- and 6-month holding period strategies. All figures except the holding period return figures are annualized. We calculate the Sharpe ratio by dividing annualized excess returns by annualized volatility. HAC robust (Newey-West) *t*-statistics are used in this estimation.

Panel C of Table 3.1 highlights the results of the 52-week high – low strategy for the full sample period for all three holding horizons. As we mentioned in the methodology section, this strategy is based on the long portfolio of the 52-week high strategy and the short portfolio of the 52-week low strategy. The 1-month holding (52W(1)) strategy in Panel C is the only strategy which generates positive returns on an annualized basis. However, the 0.61% annualized return it generates is economically small and statistically insignificant. Moreover, the returns for the 52-week high – low strategy become negative when we increase the holding horizon. For example the 52W(3) and 52W(6) strategies, as shown in Panel C, generate negative returns of about -0.40% p.a and -0.49% p.a with annualized volatility figures of 4.13% and 5.00% respectively. The long portfolio of the 1-month holding 52-week high – low strategy does outperform the short portfolio and hence we find some positive returns but these returns are negligible as mentioned earlier both economically and statistically. In summary, the Table 3.1 results indicate the 52-week high strategy and its closely related strategies underperform in foreign exchange markets, and in many cases, generate negative returns.

3.3.2. Sub-Period Analysis of the 52-Week High, Low and the High-Low Strategy Returns

In this sub-section we analyze the performance of the 52-week price strategies over two sub-periods. The first begins in January 1997 and ends in December 2005, while the second starts in January 2006 and ends in July 2013. We present a detailed sub-sample analysis of all holding period strategy returns in Tables 3.2 and 3.3.

Table 3.2: The 52-Week Price Currency Momentum Returns (sub-period 1997-2005)

	Long – Short portfolio								Long Portfolio			Short Portfolio		
						Holding Period Return			Holding Period Return			Holding Period Return		
Holding Period	Mean (%)	Volatility (%)	Sharpe Ratio	*t*-stat	*p*-value	Mean (%)	Max (%)	Min (%)	Mean (%)	Max (%)	Min (%)	Mean (%)	Max (%)	Min (%)
Panel A. 52-Week High														
1-Month	-3.322	9.720	-0.342	-0.931	0.177	-0.28	9.552	-9.355	0.246	4.911	-1.809	0.523	10.049	-10.422
3-Months	-5.803	11.065	-0.524	-1.628	0.053	-1.45	11.319	-16.193	0.556	5.189	-2.565	2.006	19.818	-10.317
6-Months	-6.588	12.330	-0.534	-1.888	0.031	-3.29	13.811	-23.058	1.015	6.308	-3.077	4.309	23.601	-15.003
Panel B. 52-Week Low														
1-Month	6.546	9.743	0.672	1.934	0.028	0.55	7.419	-9.410	0.694	8.934	-11.106	0.149	3.185	-2.973
3-Months	6.799	10.579	0.643	2.109	0.019	1.70	14.358	-11.929	2.078	16.701	-9.060	0.379	4.679	-7.566
6-Months	8.034	10.413	0.772	2.926	0.002	4.02	21.808	-19.412	4.593	23.575	-15.319	0.576	6.044	-11.154
Panel C. 52-Week High – Low														
1-Month	1.164	4.352	0.267	0.763	0.224	0.10	4.459	-3.938	0.246	4.911	-1.809	0.149	3.185	-2.973
3-Months	0.708	4.335	0.163	0.624	0.267	0.18	6.616	-4.434	0.556	5.189	-2.565	0.379	4.679	-7.566
6-Months	0.879	4.739	0.185	0.771	0.221	0.44	9.339	-6.476	1.015	6.308	-3.077	0.576	6.044	-11.154

The structure of this table is similar to Table 3.1, however, this table shows average excess returns of the Long, Short and the Long-Short portfolio of the 52-week high, low and high-low strategies using 63 currencies against the USD over the sub- period January 1997 to December 2005. The formation period is 52 weeks for all the 1-, 3- and 6-month holding period strategies. All figures except the holding period return figures are annualized. HAC robust (Newey-West) *t*-statistics are used in this estimation.

Table 3.3: The 52-Week Price Currency Momentum Returns (sub-period 2006-2013)

	Long – Short portfolio								Long Portfolio			Short Portfolio		
						Holding Period Return			Holding Period Return			Holding Period Return		
Holding Period	Mean (%)	Volatility (%)	Sharpe Ratio	*t*-stat	*p*-value	Mean (%)	Max (%)	Min (%)	Mean (%)	Max (%)	Min (%)	Mean (%)	Max (%)	Min (%)
Panel A. 52-Week High														
1-Month	-2.621	10.438	-0.251	-0.658	0.256	-0.22	9.209	-6.621	0.127	4.139	-3.039	0.345	7.535	-11.812
3-Months	-3.664	9.273	-0.395	-1.252	0.107	-0.92	18.654	-14.388	0.243	3.339	-10.424	1.159	17.358	-22.530
6-Months	-4.772	8.276	-0.577	-2.496	0.007	-2.39	17.830	-18.371	0.320	8.768	-19.518	2.706	20.906	-22.749
Panel B. 52-Week Low														
1-Month	1.977	9.018	0.219	0.585	0.280	0.165	5.286	-10.212	0.289	6.534	-10.066	0.125	5.230	-8.509
3-Months	1.334	8.935	0.149	0.442	0.330	0.333	8.673	-15.730	0.963	13.360	-23.972	0.630	11.605	-8.243
6-Months	1.344	9.982	0.135	0.485	0.314	0.672	12.900	-25.280	1.920	17.162	-31.740	1.248	13.788	-9.845
Panel C. 52-Week High – Low														
1-Month	0.024	4.928	0.005	0.013	0.495	0.002	5.906	-4.379	0.127	4.139	-3.039	0.125	5.230	-8.509
3-Months	-1.548	3.852	-0.402	-1.449	0.075	-0.387	5.815	-8.634	0.243	3.339	-10.424	0.630	11.605	-8.243
6-Months	-1.855	5.099	-0.364	-1.722	0.044	-0.928	7.892	-13.341	0.320	8.768	-19.518	1.248	13.788	-9.845

The structure of this table is similar to Table 3.1, however, this table shows average excess returns of the Long, Short and the Long-Short portfolio of the 52-week high, low and high-low strategies using 63 currencies against the USD over the sub- period January 2006 to July 2013. The formation period is 52 weeks for all the 1-, 3- and 6-month holding period strategies. All figures except the holding period return figures are annualized. HAC robust (Newey-West) *t*-statistics are used in this estimation.

As we show in Panel A of Tables 3.2 and 3.3, the 52-week high returns are negative for all 1-, 3- and 6-month holding period strategies for the earlier as well as the later sub-period. However, we note that the 52-week high strategy returns are lower in the earlier sub-period as compared to the most recent sub-period. In contrast, the 52-week low returns are larger in the earlier sub-period, where they range from 6-8% as compared to 1-2% in the later sub-period. We show in Panel C of Tables 2 and 3 that the returns to the 52-week high – low strategy further deteriorated in the recent sub-sample. For example, the annualized return of a 1-month holding horizon strategy dropped from 1.16% p.a. to 0.02% p.a. in the recent sub-sample and the returns to the 3- and 6-month holding period strategies turn negative in the recent sub-sample. In summary, while the 52-week low strategy generates meaningful positive returns in the early sub-period, neither this approach nor the 52-week high or high – low approaches achieve meaningful returns in the most recent sub-period.

3.4. Analysis of the Core Results

We now turn our attention to investigating why the returns documented in the previous section are so low compared to those found in most equity markets. Contrary to expectations, the Table 3.1 results show the mean returns to the long portfolio in the 52-week high strategy are closer to the mean short portfolio returns in the 52-week low strategy than the mean long portfolio returns. Similarly, mean returns to the short portfolio in the 52-week high strategy are closer to the mean long rather than short returns in the 52-week low strategy. We had expected a currency that is close to its 52-week high price (long portfolio in 52-week high strategy) to be far from its 52-week low price (short portfolio in

52-week low strategy), and a currency that is far from its 52-week high price (short portfolio in 52-week high strategy) to be close to its 52-week low price (short portfolio in the 52-week low strategy).

We explore this phenomenon as a potential cause of low returns by examining the currency composition of the long and short portfolios. As shown in Appendix B.1, there is a clear pattern of a strong presence of non-independently floating currencies, which move in a narrow range, in both the long and short portfolio of the 52-week high and 52-week low strategies. For example, as we show in Appendix B.1, the United Arab Emirates Dirham, the Saudi Riyal and the Hong Kong Dollar end up in the long portfolio of the 52-week high strategy 89.30%, 87.70%, and 78.07% of the times respectively over the full sample period. Noticeably, the same currencies appear in the short portfolio of the 52-week low strategy 93.58%, 91.44% and 86.10% of the times respectively throughout the sample period.

Table 3.4: Non-Independently Floating Currency Occurrence and Portfolio Composition Similarity

Panel A. Non-Independently Floating Currency Occurrence		
	52-Week High strategy	52-Week Low strategy
Long Portfolio	75.982%***	33.804%***
Short Portfolio	25.730%***	80.479%***
Panel B. Portfolio Composition Similarity		
	Short Portfolio-52-Week Low	Long Portfolio-52-Week Lo
Long Portfolio - 52-week high	42.877%***	
Short Portfolio - 52-week high		18.125%***

This table shows the presence of non-independently floating currencies (Panel A) and portfolio composition similarity (Panel B) in the long and short portfolios of the 52-week high and 52-week low strategies using a basket of 63 currencies against the USD over the period January 1997-July 2013. The percentage of the presence or occurrence of non-independently floating currencies and portfolio similarity is calculated every month on portfolio formation. Every month we calculate the ratio of non-independently floating currencies in a portfolio to the total number currencies in that particular portfolio. Similarly in Panel B, each month we calculate the percentage of currencies which are similar in the Long and Short portfolios of the above mentioned strategies. The above percentage figures are averaged over the entire strategy period. *** denotes significance at 1% level.

We summarize the finding of highly significant presence of non-independently floating currencies in the long (nearest to 52-week high) and short (nearest to 52-week low) portfolios in Panel A of Table 3.4 above. At the end of each month, we calculate the ratio of non-independently floating currencies in a portfolio to the total number currencies in that particular portfolio. It is apparent from the statistics provided in Panel A that the non-independently floating currencies end up in the near to 52-week high and near to 52-week low portfolios 75.98% and 80.48% of the times respectively throughout the estimation period and this phenomenon is also statistically highly significant at the 1% level. This finding partly explains the similar range of mean returns of the long and short portfolios of the 52-week high and low strategies, respectively.

We also compare and contrast the composition characteristics of the long (short) portfolio of the 52-week high strategy and the short (long) portfolio of the 52-week low strategy for any similarity in portfolio composition by calculating the percentage of matching currencies in these portfolios at the end of each month as shown in Panel B of Table 3.4. The long portfolio of 52-week high and the short portfolio of the 52-week low strategy have a significant number of identical currencies each month (42.88%) due to the high presence of non-independently floating currencies in both portfolios. We find less prevalence of identical currencies in the farthest (short portfolio of 52-week high and long portfolio of 52-week low) portfolios as depicted by the low similarity percentage of 18.12% in Panel B. However, our analysis[20] shows this does occur more frequently than in stock markets due to the lower number of currencies and the fact that non-independently floating currencies are frequently in the 52-week high long and 52 week low short portfolios.

[20] A detailed analysis of monthly portfolio compositions for all strategies and corresponding holding periods is available from the authors upon request.

3.4.1. Can the 52-Week High FX Returns be Improved by Controlling for Currency Regimes?

In this section we re-run our 52-week price strategy analysis by excluding all managed float, currency board and pegged currencies and keeping only the independently floating currencies in our currency portfolio[21]. We present this analysis over the full sample period in Table 3.5 below.

We base the analysis in this section on our findings in the previous section that the non-independently floating currencies have lower price variability and therefore generate lower and identical returns for the 52-week high and low strategies. Moreover, this argument is further strengthened by Menkhoff, Sarno, Schmeling, and Schrimpf's (2012a) suggestion that currencies which are pegged, or are highly managed and are not allowed to cross a particular price band may be less useful in setting up a FX momentum strategy given the prohibition of large price movements.

[21] In the remainder of this study and in all upcoming sections, we exclude all non-independently floating currencies from our analysis and only keep the independently floating currencies in an attempt to rectify the above mentioned narrow price range and non-independently floating currency issues.

Table 3.5: The 52-Week Price Currency Momentum Returns based on Independently Floating Currencies

	Long – Short portfolio								Long Portfolio			Short Portfolio		
						Holding Period Return			Holding Period Return			Holding Period Return		
Holding Period	Mean (%)	Volatility (%)	Sharpe Ratio	*t*-stat	*p*-value	Mean (%)	Max (%)	Min (%)	Mean (%)	Max (%)	Min (%)	Mean (%)	Max (%)	Min (%)
Panel A. 52-Week High														
1-Month	-1.843	9.739	-0.189	-0.801	0.358	-0.154	9.527	-8.096	0.259	6.328	-8.132	0.413	11.284	-14.093
3-Months	-3.723	8.967	-0.415	-2.047	0.021	-0.931	12.124	-12.762	0.596	11.939	-26.180	1.526	14.168	-33.277
6-Months	-4.357	9.175	-0.475	-2.630	0.005	-2.179	14.782	-25.387	1.155	17.706	-36.105	3.333	20.538	-38.080
Panel B. 52-Week Low														
1-Month	3.247	8.648	0.375	1.569	0.059	0.271	9.714	-9.402	0.408	6.929	-11.685	0.138	10.493	-12.911
3-Months	2.538	8.800	0.288	1.377	0.085	0.635	11.513	-11.807	1.309	13.692	-27.080	0.675	19.355	-29.137
6-Months	2.647	9.030	0.293	1.701	0.045	1.323	16.308	-15.753	2.878	19.034	-40.320	1.554	23.058	-36.469
Panel C. 52-Week High – Low														
1-Month	1.460	8.449	0.173	0.695	0.244	0.122	10.576	-7.957	0.259	6.328	-8.132	0.138	10.493	-12.911
3-Months	-0.317	8.083	-0.039	-0.237	0.407	-0.079	12.610	-12.860	0.596	11.939	-26.180	0.675	19.355	-29.137
6-Months	-0.799	8.169	-0.098	-0.758	0.225	-0.400	12.821	-18.555	1.155	17.706	-36.105	1.554	23.058	-36.469

This table shows average excess returns of the Long, Short and the Long-Short portfolio of the 52-week high, low and high-low strategies using a basket of independently floating currencies only from our overall sample of 63 currencies versus the USD over the period January 1997-July 2013. The formation period is 52 weeks for all the 1-, 3- and 6-month holding period strategies. All figures except the holding period return figures are annualized. We calculate the Sharpe ratio by dividing annualized excess returns by annualized volatility. HAC robust (Newey-West) *t*-statistics are used in this estimation.

We find some improvement in the 52-week high strategy results when we restrict our currency sample to independently floating currencies only. The 1-, 3- and 6-month holding horizon returns slightly improve by using independently floating currencies as compared to the results in the previous tables where we use all 63 currencies in strategy estimation. For instance, the 1-month holding horizon annualized returns are -1.84% when we exclude non-independently floating currencies and -2.98% p.a. when we include these currencies. Similar minor improvements are evident in the 3- and 6-month holding period 52-week high strategies. On the other hand, the returns to the 52-week low strategy are reduced after restricting the sample to independently floating currencies only. The return to the 1-month holding period 52-week low strategy is reduced to 3.25% p.a from 4.32% p.a when the currency basket included all 63 currencies. Similarly, the 3- and 6-month holding horizon 52-week low strategies also produce lower returns after introducing currency regime restrictions. Moreover, as we show in panel C, the 1-month holding 52-week high – low strategy returns improve after excluding non-independently floating currencies. However, the returns are still economically and statistically insignificant. The 3- and 6-month holding period strategies produce negative annualized returns of -0.32% and -0.80% respectively. Hence, we conclude that controlling for currency regime partially explains the suboptimal performance of the 52-week high strategy, however, the improvement is not consistent in case of 52-week low and high – low strategy.

3.4.2. Can Shorter Formation Periods Help in Improving 52-Week High FX Strategy Returns?

Menkhoff, Sarno, Schmeling, and Schrimpf (2012a) find that the most profitable momentum strategy is the short term (1-month) look back and holding horizon strategy. Similarly, Raza, Marshall, and Visaltanachoti (2014) find short term formation period (1- to 4-week) momentum strategies are profitable. Furthermore, exchange rates have been found to be mean reverting (Jorion and Sweeney, 1996). Taken together, this evidence implies that the exchange rates may start reverting towards the mean after increasing to near their 52-week high price. If reversion rather than continuation frequently occurs it would explain the weak performance of the strategies we test. Therefore, in this section we test whether a shorter formation period helps in improving the strategy returns. We reduce the look back period from 52-weeks to 4-weeks and 12-weeks and report the results in Table 3.6 and 3.7 respectively.

Table 3.6: The 4-Week High, Low and High – Low FX Strategy Returns

	Long – Short portfolio								Long Portfolio			Short Portfolio		
						Holding Period Return			Holding Period Return			Holding Period Return		
Holding Period	Mean (%)	Volatility (%)	Sharpe Ratio	*t*-stat	*p*-value	Mean (%)	Max (%)	Min (%)	Mean (%)	Max (%)	Min (%)	Mean (%)	Max (%)	Min (%)
Panel A. 4-Week High														
1-Month	0.813	8.677	0.094	0.363	0.358	0.068	9.719	-8.006	0.423	8.425	-6.677	0.355	9.700	-10.546
3-Months	-1.230	8.650	-0.142	-0.913	0.181	-0.308	13.283	-14.043	0.950	12.568	-21.105	1.258	16.075	-22.274
6-Months	-2.146	8.693	-0.247	-2.295	0.011	-1.073	20.132	-22.321	1.619	17.337	-23.606	2.692	22.983	-34.964
Panel B. 4-Week Low														
1-Month	2.460	8.024	0.307	1.444	0.075	0.205	8.141	-9.065	0.435	7.538	-10.317	0.230	10.493	-12.224
3-Months	1.768	8.995	0.197	1.509	0.066	0.442	17.198	-16.784	1.329	13.899	-29.991	0.887	14.814	-29.038
6-Months	0.941	8.688	0.108	0.871	0.193	0.471	20.507	-18.139	2.546	21.569	-31.164	2.076	18.265	-30.451
Panel C. 4-Week High-Low														
1-Month	2.317	7.410	0.313	1.147	0.127	0.193	8.065	-5.966	0.423	8.425	-6.677	0.230	10.493	-12.224
3-Months	0.252	8.355	0.030	0.195	0.423	0.063	17.161	-11.186	0.950	12.568	-21.105	0.887	14.814	-29.038
6-Months	-0.913	8.056	-0.113	-0.900	0.185	-0.457	18.562	-17.603	1.619	17.337	-23.606	2.076	18.265	-30.451

This table shows average excess returns of the Long, Short and the Long-Short portfolio of the 4-week high, low and high-low strategies using a basket of independently floating currencies only from our overall sample of 63 currencies versus the USD over the period January 1997-July 2013. The formation period is 4 weeks for all the 1-, 3- and 6-month holding period strategies. All figures except the holding period return figures are annualized. We calculate the Sharpe ratio by dividing annualized excess returns by annualized volatility. HAC robust (Newey-West) *t*-statistics are used in this estimation.

Table 3.7: The 12-Week High, Low and High – Low FX Strategy Returns

	Long – Short portfolio								Long Portfolio			Short Portfolio		
						Holding Period Return			Holding Period Return			Holding Period Return		
Holding Period	Mean (%)	Volatility (%)	Sharpe Ratio	*t*-stat	*p*-value	Mean (%)	Max (%)	Min (%)	Mean (%)	Max (%)	Min (%)	Mean (%)	Max (%)	Min (%)
Panel A. 12-Week High														
1-Month	0.777	8.761	0.089	0.353	0.362	0.065	10.628	-5.540	0.421	8.425	-7.409	0.356	8.103	-11.848
3-Months	-1.662	9.117	-0.182	-1.074	0.142	-0.415	14.369	-12.795	0.893	12.510	-25.724	1.308	17.155	-31.143
6-Months	-3.136	8.901	-0.352	-2.970	0.002	-1.568	17.175	-22.321	1.300	20.850	-30.457	2.868	25.203	-32.874
Panel B. 12-Week Low														
1-Month	2.367	8.095	0.292	1.443	0.075	0.197	8.794	-7.948	0.453	6.513	-10.687	0.256	10.493	-12.224
3-Months	1.052	8.475	0.124	0.787	0.216	0.263	10.465	-18.857	1.301	12.796	-31.750	1.038	19.355	-22.031
6-Months	0.139	8.122	0.017	0.127	0.449	0.070	14.150	-24.698	2.373	22.103	-37.404	2.303	23.058	-30.270
Panel C. 12-Week High-Low														
1-Month	1.973	7.558	0.261	0.949	0.172	0.164	8.551	-9.273	0.421	8.425	-7.409	0.256	10.493	-12.224
3-Months	-0.583	8.249	-0.071	-0.438	0.331	-0.146	14.167	-16.842	0.893	12.510	-25.724	1.038	19.355	-22.031
6-Months	-2.006	8.317	-0.241	-1.838	0.034	-1.003	12.896	-18.596	1.300	20.850	-30.457	2.303	23.058	-30.270

This table shows average excess returns of the Long, Short and the Long-Short portfolio of the 12-week high, low and high-low strategies using a basket of independently floating currencies only from our overall sample of 63 currencies versus the USD over the period January 1997-July 2013. The formation period is 12 weeks for all the 1-, 3- and 6-month holding period strategies. All figures except the holding period return figures are annualized. We calculate the Sharpe ratio by dividing annualized excess returns by annualized volatility. HAC robust (Newey-West) *t*-statistics are used in this estimation.

As we show in Panel A of Table 3.6, there is an improvement in strategy returns when we reduce the look back period to four weeks. For instance, the 1-month holding 4-week high strategy results in an insignificant but positive return of 0.81% p.a. Returns for the same strategy were -2.98% p.a. when the look back period was 52 weeks. Similarly, strategy returns are better for the 3- and 6-month holding periods for the 4-week high strategy as compared to the 52-week look back period strategy. As we show in Panel B, the 4-week low strategy does generate positive returns but these are economically trivial and statistically insignificant. We observe from Panel C that shortening the look back period to 4 weeks helps in improving high – low strategy returns. The results reported in Table 3.7, which relate to the 12-week look back period, also support the findings in Table 3.6 as we find signs of improvement in strategy returns after shortening the look back period. For example, as we report in Panel A of Table 3.7, the 12-week high 1-month holding period strategy generates 0.78% p.a. which is higher than the -2.98% p.a. return generated by the comparable 52-week high strategy. We find similar improvement in the case of 3- and 6-month holding periods. The 12-week low strategy, as reported in Panel B generates economically and statistically insignificant returns for all three holding horizons. The relevant Sharpe ratios are also lower. The 12-week high – low strategy returns as reported in Panel C again show some signs of improvement when we reduce the look back period from 52 weeks to 12 weeks. For example the 1-month holding period returns are 1.97% p.a. for the 12-week look back strategy compared to the 0.61% p.a. return when the look back period is 52 weeks. We conclude that shortening the look back period results in a small improvement in the profitability of the 52-week high and high – low strategies, but not the 52-week low strategy. Mean reversion of currencies over a 12-month period does not fully explain the under-performance of 52-week high momentum investing.

3.4.3. Can the Timing of the 52-Week High Event Improve FX Strategy Returns?

Recently, Bhootra and Hur (2013) find a new equity momentum strategy based on the timing of the 52-week high price significantly predicts future stock returns. They show that stocks that reach their 52-week high prices recently during the previous 52-weeks outperformed the stocks that attain their 52-week high price in the earlier part of the previous 52-weeks by 0.70% per month. Their hypothesis is based on the behavioral tendency of investors to put more weight on recent information rather than old information when making decisions. In this section, we implement an identical 52-week high strategy based on the timing (recency) of the 52-week high price of foreign currencies. We follow Bhootra and Hur (2013) and sort all currencies in our sample on the basis of the recency of the 52-week high price using the Recency Ratio (RR) measure as given in expression (6) below.

$$RR = 1 - \frac{Number\ of\ days\ since\ 52{-}Week\ high\ price}{364} \tag{6}$$

By construction, the Recency Ratio is higher for the currencies which attain their 52-week high price in the near past and lower for the currencies which attain their 52-week high price in the distant past. The maximum possible value for this ratio is 1, which is achieved if the ranking day price of a currency is its 52-week high price. Thus, after sorting currencies on the basis of the Recency Ratio at the end of each month, we form self-financing long – short portfolios by buying the top 20% currencies (recent 52-week high price achievers) and sell short the bottom 20% currencies (most distant 52-week high price achievers). We present the results of the timing based 52-week high strategy in Table 3.8 below. The structure of Table 3.8 is similar to the previous tables except we show a sub-sample analysis of this estimation in Panels B and C within the same table.

Table 3.8: The 52-Week High Momentum Strategy based on Recency Ratio

	Long – Short portfolio								Long Portfolio			Short Portfolio		
						Holding Period Return			Holding Period Return			Holding Period Return		
Holding Period	Mean (%)	Volatility (%)	Sharpe Ratio	*t*-stat	*p*-value	Mean (%)	Max (%)	Min (%)	Mean (%)	Max (%)	Min (%)	Mean (%)	Max (%)	Min (%)
Panel A. Full Sample														
1-Month	0.704	8.057	0.087	0.381	0.352	0.059	10.878	-7.421	0.280	6.911	-11.837	0.221	8.503	-12.634
3-Months	-0.416	8.083	-0.051	-0.256	0.399	-0.104	12.550	-9.525	0.771	13.640	-25.240	0.875	12.063	-31.017
6-Months	-0.860	8.131	-0.11	-0.587	0.279	-0.430	18.254	-16.438	1.601	19.022	-35.460	2.031	17.018	-35.904
Panel B. 1997-2005														
1-Month	1.730	7.994	0.216	0.647	0.260	0.144	8.920	-6.548	0.432	6.911	-3.565	0.288	6.877	-6.348
3-Months	0.186	9.357	0.020	0.107	0.458	0.046	12.550	-8.407	1.258	12.592	-5.531	1.212	12.063	-11.649
6-Months	-0.409	9.702	-0.042	-0.300	0.383	-0.204	18.254	-16.438	2.719	19.022	-12.246	2.923	16.189	-8.921
Panel C. 2006-2013														
1-Month	-0.379	8.155	-0.046	-0.105	0.458	-0.032	10.878	-7.421	0.119	5.145	-11.837	0.151	8.503	-12.634
3-Months	-1.038	6.550	-0.158	-0.429	0.335	-0.259	7.477	-9.525	0.268	13.640	-25.240	0.527	8.763	-31.017
6-Months	-1.311	6.216	-0.211	-0.681	0.249	-0.655	9.512	-9.216	0.484	16.904	-35.460	1.139	17.018	-35.904

This table presents average excess returns of the Long, Short and the Long-Short portfolio of a timing (Recency Ratio) based 52-week high strategy using independently floating currencies only versus the USD over the full sample period of January 1997-July 2013 as well as two sub-periods. The formation period is 52 weeks for all the 1-, 3-, 6-month holding period strategies. All figures except the holding period return figures are annualized. HAC robust (Newey-West) *t*-statistics are used in this estimation.

As evident from Panel A of Table 3.8, the 52-week high strategy returns for all holding periods slightly improve when the timing of the 52-week high event is considered. The 1-month holding timing based 52-week high strategy generates a positive return of 0.70% p.a. which is higher than the -2.98 % annualized return generated by the original 52-week high strategy as shown in Table 3.1 Panel A. Similarly, the 3-month holding period timing based 52-week high strategy generates -0.42% p.a. and a 6-month holding period strategy generates -0.86% p.a. The returns to the 3-month and 6-month holding 52-week high strategy were -4.75% and -5.68% p.a. respectively when the timing factor was not introduced. Therefore, we conclude that the 52-week high strategy returns in the FX market can be improved and are partially explained by considering the timing of the 52-week high event. This factor cannot, however, fully explain the low returns to the 52-week high strategy in the foreign exchange market.

3.5. The 52-Week High, Low and High – Low Strategy Returns Under Different Market Conditions

Raza, Marshall, and Visaltanachoti (2014) find currency momentum is stronger during US business cycle expansions and when the US dollar is appreciating against a basket of foreign currencies. In the forthcoming sub-sections we investigate whether 52-week high momentum profits exist under different phases of the business cycle, and when the US dollar is appreciating or depreciating against a basket of independently floating currencies.

3.5.1. The 52-Week High, Low and High-Low FX Returns During the Different Phases of the Business Cycle

We investigate whether the 52-week price strategy profits exist during the recessionary or expansionary phase of the US business cycle in this section. We employ the following dummy variable regression specification in order to separate the strategy returns under the expansionary and recessionary phases and use HAC robust Newey-West standard errors due to overlapping nature of our strategy returns.

$$52W(K)_t = \beta_{exp} \,.D_{exp} + \beta_{rec}.D_{rec} + \in_{K,t} \quad (7)$$

Where D_{exp} and D_{rec} in equation (7) are the dummy variables for the expansionary and the recessionary phase respectively and $52W(K)_t$ is the time series of the 52-week high, low and high-low FX returns for the 52W(1), 52W(3) and 52W(6) strategies. We obtain the business cycle expansion and recession dates directly from the NBER website. The results of this estimation are reported in Table 3.9 below.

Table 3.9: 52-Week Price FX Momentum Returns and the US Business Cycle

Strategy	Mean Return (%)	t-stat	Mean Return (%)	t-stat	Mean Return (%)	t-stat
	Expansion		Recession		Test of Equality (Expansion-Recession=0)	
Panel A. 52-Week High						
52W(1)	-3.186	-1.572	5.783	0.646	-8.969	-1.300
52W(3)	-4.298	-2.323	-0.498	-0.100	-3.800	-1.033
52W(6)	-4.829	-2.739	-1.763	-0.482	-3.066	-1.151
Panel B. 52-Week Low						
52W(1)	2.939	1.415	4.993	0.720	-2.053	-0.334
52W(3)	3.165	1.613	-0.974	-0.199	4.139	1.147
52W(6)	2.655	1.547	2.601	0.732	0.054	0.021
Panel C. 52-Week High – Low						
52W(1)	0.477	0.286	7.042	0.716	-6.565	-1.095
52W(3)	-0.039	-0.026	-1.872	-0.362	1.833	0.552
52W(6)	-1.100	-0.743	0.858	0.310	-1.959	-0.824

This table presents the performance of the 52-week high, low and high-low currency momentum strategies in the expansionary and recessionary phases of the US business cycle. 52W(1) refers to the one year (52-week) look back and one month holding period momentum strategy. Similarly, 52W(3) and 52W(6) refer to the 3 and 6 month holding period strategies. We use Recession and Expansion dummy variables in this estimation. Business cycle cut off dates are obtained directly from NBER. All figures are annualized and we employ independently floating currencies only in this estimation.

We note from the results presented in Panel A of Table 3.9 that the 52-week high strategy mean returns are higher but statistically insignificant during the recessionary phase of the US business cycle as compared to the expansionary phase. This effect is also evident from the test of equality of means we report in Table 3.9 for all strategies. For instance, the annualized mean return of the 1-month holding period 52-week high strategy during the recessionary phase is 5.78% and the relevant t-statistic is 0.65. The mean returns during the expansionary phase are negative for all 52-week high strategies in Panel A. For example, the annualized mean return of the 6-month holding period 52-week high strategy during the expansionary phase is -4.83% and the relevant t-statistic is -2.74. The 52-week low strategy returns are higher in the recessionary phase for the 1-month holding period and yet again statistically insignificant. Similarly, the 52- week high – low strategy returns are

insignificant economically and statistically in expansions and well as recessions. After considering the mean returns and the test of equality of means shown in Table 3.9 for all strategies, we conclude that the 52-week price strategy profits do not exist in either expansionary or recessionary phase of the US business cycle.

3.5.2. UP and DOWN States of The FX Market and the 52-Week Price Strategy Returns

Cooper, Gutierrez, and Hameed (2004) find that equity momentum profits critically depend on the state of the market and are higher during the UP state (periods following market gains). In this sub-section we explore whether the 52-week price FX strategies are profitable under any state (UP or DOWN) of the foreign exchange market. For this analysis we follow Cooper, Gutierrez, and Hameed (2004) who employ this analysis from an equity market perspective. We employ their methodology of defining an UP state and a DOWN state from a foreign exchange market perspective and make use of the RX currency market factor devised by Lustig, Roussanov, and Verdelhan (2011). The RX factor is a benchmark portfolio based on the average excess return to a US investor who buys all the available foreign currencies in the forward foreign exchange market. We therefore use the RX slope factor data in the below given regression framework and define an UP (DOWN) market state if the cumulative return of the RX factor over the previous 36 months is positive (zero or negative).

$$52W(K)_t = \beta_{UP} \,.D_{UP} + \beta_{Down}.D_{Down} + \in_{K,t} \quad (8)$$

The dummy variable D_{UP} in our regression specification in (8) above will assume the value of 1 if the cumulative return of RX factor over previous 36 months is positive.

Similarly, the D_{DOWN} dummy variable in the above given equation will assume the value of 1 if the RX factor's return is negative or zero over the preceding 36 months. $52W(K)_t$ is the time series of returns to our 52-week high, low and high-low FX strategies of 1-, 3- and 6-month holding periods.

We report the results of this analysis in panels A, B and C of Table 3.10 below. In addition to the mean strategy returns during UP and DOWN markets, we also include a test of equality of means and relevant *t*-statistics for all holding period strategies. It is obvious from Table 3.10 that all the strategies actually perform poorly and do not show any signs of significant profitability in both UP and DOWN market states. For instance, the UP market mean in Panel A for the 52W(1) strategy is 0.50% p.a. and for the same strategy it is -6.55% p.a. in DOWN market state. The UP market means are higher in the case of 52-week low strategy as shown in Panel B and the relevant *t*-statistics are significant in the case of 52W(3) and 52W(6). However, these profits are economically trivial and only marginally significant at the 10% level. For the 52-week high – low strategy as given in Panel C of Table 3.10, the UP market means are higher in the case of 52W(1) and 52W(3) but the relevant *t*-statistics are not significant. Overall, on the basis of the results presented in Table 3.10, we can conclude the 52-week price strategies do not generate profits and rather result in losses in both UP and DOWN state of the FX market.

Table 3.10: 52-Week Price FX Momentum returns in UP and DOWN FX Market States

Strategy	Mean Return (%)	t-stat	Mean Return (%)	t-stat	Mean Return (%)	t-stat
	Up state		Down state		Test of Equality (Up-Down =0)	
Panel A. 52-Week High						
52W(1)	0.496	0.192	-6.559	-1.569	7.055	1.349
52W(3)	-2.219	-1.363	-6.855	-1.577	4.635	1.654
52W(6)	-3.682	-2.717	-5.838	-1.386	2.156	1.040
Panel B. 52-Week Low						
52W(1)	3.680	1.531	2.372	0.620	1.308	0.280
52W(3)	3.562	1.739	0.407	0.106	3.155	1.142
52W(6)	2.946	1.732	1.991	0.634	0.956	0.467
Panel C. 52-Week High – Low						
52W(1)	3.228	1.472	-2.106	-0.496	5.334	1.174
52W(3)	0.377	0.273	-1.762	-0.464	2.139	0.842
52W(6)	-0.747	-0.578	-0.914	-0.283	0.168	0.090

This table illustrates the performance of the FX 52-week high, low and high-low strategy during the UP and DOWN states of the global FX markets. UP state and DOWN state are dummy variables. A particular month in the FX market is in UP(DOWN) state if the past 36 month cumulative return of the dollar (RX) factor of Lustig, Roussanov, and Verdelhan (2011) is positive (zero or negative). All the above mentioned strategies have one year look back horizon. We show annualized mean returns in the UP and DOWN states for all strategies along with a test of equality of means and employ independently floating currencies only in this estimation.

We also investigate whether the returns to the 52-week price strategies we consider are related to the FX carry trade strategy returns. We follow Raza, Marshall, and Visaltanachoti (2014) and run a time series regression of the carry trade returns on the 52-week high, low and high – low FX returns separately using carry trade (HML_{FX}) return data from Lustig, Roussanov, and Verdelhan (2011). We do not find any significant relationship overall between the carry trade returns and the returns to our 52-week price FX strategies as we show in Panels A, B and C of Appendix B.2.

3.6. Conclusion

We test the 52-week high equity momentum strategy proposed by George and Hwang (2004) and some closely related 52-week price strategies in the foreign exchange market over different investment horizons using a broad basket of 63 emerging and developed market currencies. We find the 52-high and its closely related derivative 52-week price strategies are not profitable in the FX market. For instance, the annualized returns from 52-week high strategy are -2.98% for a 1-month holding and -5.68% p.a. for a 6-month holding horizon. This finding is puzzling as 52-week high price based strategies generate larger returns than price based momentum strategies in equities and price based momentum strategies are profitable in FX markets.

Our analysis shows the existence of non-independently floating currencies in our sample is a partial explanation for the poor performance. These currencies remain near their 52-week high or low price and are frequently included in long and short portfolios, but their lack of subsequent movement results in reduced holding period returns. The 52-week strategy returns generally improve when these currencies are excluded but the returns remain negative or less than equity market equivalents. Stronger mean reversion in currencies than equities over a 52-week period is another possible explanation. However, using shorter (4- and 12-week) look back periods only leads to minor improvements. Furthermore, we explore whether strategies that focus on more recent 52-week high events result in higher returns. However, the return improvements are only minor here too.

Finally, contrary to the findings of stronger past return based FX momentum profits during expansionary phase of the US business cycle and during periods of appreciation of the US dollar, we find 52-week price based momentum strategies do not generate

meaningful returns in either expansionary or recessionary phases of the US business cycle nor during periods of appreciation or depreciation of the US dollar against a large basket of foreign currencies.

CHAPTER FOUR

ESSAY THREE

This chapter presents the third and the last essay of this thesis in which I present a detailed analysis of the performance of various currency value strategies. Value strategies have gained significant academic attention in equity markets, however, the literature on the performance of this strategy in the foreign exchange market is limited. I address this gap in this essay and present a comparative analysis of the performance of different short and long horizon currency value strategies based on four different measures of currency valuation. I run a horse race of four different currency value strategies using a large cross section of emerging and developed market currencies over the period January 1972 to July 2013. By using a multicurrency portfolio investment setup, this study also shows the differences in returns when the currency basket is limited to independently floating currencies only. Furthermore, it is explored whether the combination of these strategies generate higher returns as compared to when these are implemented in isolation. Furthermore, this chapter also includes a breakeven transaction costs analysis and a comparison of the performance of different value strategies under different states of the FX market and during the expansionary and recessionary phases of the US business cycle.

This chapter is organized as follows. The research question and relevant literature is introduced in Section 4.1. The data, currency returns estimation and strategy formulation methodology is described in Section 4.2. Section 4.3 provides the core results. Various robustness checks are shown in Section 4.4 and this chapter concludes in Section 4.5.

Currency Value Strategies

Abstract

We run a horse race of four currency value strategies. Tests conducted on 39 developed and emerging market currencies show real exchange rate level strategies generate the largest excess returns on intervals up to one 1 month, while real exchange rate changes produce the largest excess returns for intervals of 1-12 months. Purchasing power parity and Big-Mac index approaches underperform. However, a combination approach based on all four value techniques generates excess returns of over 10%. The returns are not explained by economic state variables or currency risk factors and are larger than estimated transaction costs.

JEL Classification: F31, G15

Keywords: Currency, valuation, real exchange rate

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4.1. Introduction

Value investing, which involves buying (selling) an asset that is undervalued (overvalued) relative to a measure of fundamental value, has been studied extensively in equity markets since the seminal findings of Fama and French (1992) and Lakonishok, Shleifer, and Vishny (1994).[22] However, value investing in the foreign exchange market has gained little academic attention as compared to other currency trading strategies.[23] We contribute to the literature by running a horse race of different currency value strategies based on four widely used measures of currency valuation using 39 developed and emerging market currencies. These measures include the levels of the real exchange rate, the 5-year cumulative return of the real exchange rate, Purchasing Power Parity and the Big Mac Index. We address the following questions: 1) Does the method of identifying undervalued (overvalued) currencies affect currency value strategy returns? 2) Does a composite strategy based on four different valuation methods yield larger returns than one method used in isolation? 3) Do currency value strategies generate positive returns at short (1- to 3-week) and long (1- to 12-month) investment horizons? 4) Are currency value strategy returns positive under different foreign exchange regimes, states of the foreign exchange market and the business cycle? 5) Can currency value returns survive transaction costs?

Our work builds on existing currency value work which mainly relies on a single measure of currency valuation. Asness, Moskowitz, and Pedersen (2013), who employ the

[22]See Chan and Lakonishok (2004), Fama and French (1998) and Fama and French (2012) for a detailed review of the literature.

[23]For a detailed discussion on currency carry trade techniques see Menkhoff, Sarno, Schmeling and Schrimpf (2012b); for currency momentum see Menkhoff, Sarno, Schmeling and Schrimpf (2012a) and Raza, Marshall, and Visaltanachoti (2014); for technical analysis in the foreign exchange market see Neely, Weller, and Dittmar (1997).

5-year change in purchasing power parity as a value measure, find returns of up to 3% p.a. in G-10 currencies. Similarly, Barroso and Santa-Clara (2014) find returns of about 3% p.a. in 27 OECD currencies using 5-year cumulative real currency depreciation as a measure of value. Moreover, Kroencke, Schindler, and Schrimpf (2014) employ a cumulative 5-year change of the real exchange rate approach and find currency value returns of up to 4% p.a. using a basket of 30 currencies. We use both these measures of value on our broad sample of developed and emerging market currencies. We also include the Purchasing Power Parity (PPP) and the Big Mac Index measures, which have been widely studied from a macroeconomics exchange rate forecasting perspective. For example, Cheung, Chinn, and Pascual (2005) find the PPP model best predicts exchange rates over longer horizons and Ong (1997) show the Big Mac Index is remarkably accurate in predicting exchange rates over the long run. PPP- based currency valuation strategies are popular amongst leading foreign exchange investment banks[24] like the Deutsche Bank and the Barclays. However, these currency value strategies have gained very limited academic attention.

Our paper addresses this gap and explores the PPP, Big Mac Index, 5-year real exchange rate changes (RERC) and real exchange rate levels (RERL) individually and as combined predictors of currency value returns at one place. We implement currency value strategies from a multicurrency portfolio perspective and form long (short) portfolios on the basis of currency undervaluation (overvaluation). We buy (go long) the currencies which are predicted to be the most undervalued and sell (short) the currencies which are predicted to be the most overvalued by four different measures. We hold the positions over different investment horizons ranging from 1-week to 12-months and calculate the excess returns of

[24] Pojarliev and Levich (2010) mention Deutsche Bank maintains a FX Value strategy index which relies on the OECD PPP rates and is limited to investment in G-10 currencies only.

a dollar neutral long minus short portfolio at the end of each holding period. Our approach of forming dollar neutral currency portfolios is similar to the one implemented by Menkhoff, Sarno, Schmeling and Schrimpf (2012a) in currency momentum strategies and by Lustig, Roussanov, and Verdelhan (2011) in carry trade strategies.

We find currency value strategies based on RERL and RERC consistently outperform other currency value strategies. Strategies based on RERL perform best for shorter holding periods, with returns of approximately 7% for one, two, and three week intervals, compared to 2% for real exchange rate change strategies. However, RERC strategies generate larger returns (approximately 7%) over one – twelve month intervals than the RERL strategies, which result in returns of approximately 5% over these intervals. PPP and Big Mac Index based strategies generate average returns of 2.3% and 1.9% respectively across all intervals. Our core sample includes currencies that are independently floating and those that are more actively managed. When the sample is restricted to independently floating currencies, the RERC strategy average return across periods of one month or more all increase from 7.3% to 9.7%. The returns to other strategies are less affected.

We show that combining valuation signals from all four measures of currency value can improve currency value returns than when any one value strategy is used in isolation. An equally weighted composite strategy which selects 20% most overvalued (undervalued) currencies concurrently identified by the underlying four value measures generates average returns to the composite strategy across all horizons of 10.8% compared to 5.4% and 5.9% for the RERC and RERL approaches respectively.

We find that high yielding currency value strategies have low annual portfolio turnover which results in significantly higher break-even transaction costs starting from 58.5 basis points per one way trade. Moreover, our results indicate that RERL and RERC strategies generate higher returns during expansionary phase of the US business cycle and during times of US dollar depreciation. Finally, our detailed regression analysis shows that currency value returns exist independent of the currency carry trade returns and are not driven by a broad list of major macroeconomic variables.

The remainder of this article is structured as follows. We explain our data, currency returns estimation and strategy formulation methodology in Section 4.2. We describe our core results in Section 4.3. We present our various robustness checks in Section 4.4 and we conclude our discussion in Section 4.5.

4.2. Data and Methodology

4.2.1. Data

We use weekly and monthly (log) spot and forward foreign exchange rate data on 39 currencies versus the US dollar over the period January 1972 to July 2013. Forward foreign exchange rates on weekly and monthly frequency are available for most currencies from Thomson Reuters Datastream over the period November 1997 to July 2013, however due to unavailability of quoted forward exchange rate data (particularly on weekly frequency) from Datastream for some currencies, we obtain exchange rate and interest rate data from the Global Financial Data (GFD) and manually calculate currency forward rates at weekly and monthly frequencies. Our dataset is similar to the one used by Raza,

Marshall, and Visaltanachoti (2014), however, our currency basket is limited to 39 currencies[25]. As some data series become available later in the sample and some currencies merged into the Euro, the number of currencies which constitute the currency portfolios differs over the sample period. For our PPP strategies we obtain annual OECD purchasing power parity for GDP figures directly from the OECD website quoted as national currency per US Dollar. CPI inflation data, rebased to unity in January 1970, for real exchange rate calculation and other macroeconomic data for regression analysis is obtained from the Global Financial Data. CPI data is mostly available on monthly frequency, however, in cases where CPI data is only available at quarterly frequency, we carry forward the value of the last available period to the next month following Barroso and Santa-Clara (2014). Big Mac Index data is available from *the Economist's* website starting in the year 2000. We source Big Mac Index data[26] from year 1986 to 2000 from Pakko and Pollard (2003). Moreover, we obtain currency carry trade (HML_{FX}) and US Dollar risk (RX) factor data[27] for our regression analysis from Lustig, Roussanov, and Verdelhan (2011). As we require past 5-year return for the RERC strategies, our first RERC strategy starts in January 1977. Similarly, the Big Mac data is only available starting from year 1986, therefore, our first Big Mac based strategy starts in 1986. All exchange rates are quoted as the US dollar (USD) price of one unit of foreign currency.

[25] Our currency basket is limited to 39 currencies as our PPP and Big Mac strategies utilize currency data directly from the OECD and *The Economist* and these sources do not provide required data on 63 currencies used by Raza, Marshall and Visaltanachoti (2014).
[26] We thank the authors for making this data available online.
[27] We are grateful to the authors for providing this useful data on their website.

4.2.2. Currency Valuation Methodologies

4.2.2.1. The Real Exchange Rate Levels Approach

Our first measure of currency value is based on the current levels of the real exchange rate. Following Kroencke, Schindler, and Schrimpf (2014) we define the real exchange rate $R_{j,t}$ as:

$$R_{j,t} = \frac{S_{j,t}P_{j,t}}{P*_t} \quad (1)$$

where $S_{j,t}$ is the nominal spot exchange rate at of currency *j* at time *t*. $P_{j,t}$ and $P*_t$ are the price levels of consumer goods in local currency for country *j* and price level of consumer goods in the US stated in United States Dollars, respectively. In order to identify overvalued (undervalued) currencies for the real exchange rate level (RERL) strategies, we calculate the ratio of the nominal spot exchange rate at time *t* to the corresponding real exchange rate at time *t*, both quoted as the foreign currency units per US Dollar. A ratio above unity indicates undervaluation and below unity indicates overvaluation.

4.2.2.2. The Real Exchange Rate Change Approach

Our second measure of currency valuation is real exchange rate change (RERC). In case of the RERC strategies, we follow Kroencke, Schindler, and Schrimpf (2014) and use a measure of currency value defined as the cumulative 5-year change of the real exchange rate as in equation (2) below:

$$FXV_{j,t} = \left(\frac{Q_{j,t-3}}{\bar{Q}_{j,t-60}} - 1\right) \times (-1) \quad (2)$$

where $\bar{Q}_{j,t-60}$ is the average real exchange rate measured over a period between 5.5 and 4.5 years in the past. $\bar{Q}_{j,t-3}$ is the real exchange rate three months ago. The real exchange rate return of the immediate past three months is skipped in order to avoid any overlap of momentum returns which are based on past 1- to 3-month currency returns. Similar approaches based on 5-year real exchange rate change have recently been utilized by Asness, Moskowitz, and Pedersen (2013) and Barroso and Santa-Clara (2014) whereby the currency with the highest (lowest) past 5-year return is considered most overvalued (undervalued).

4.2.2.3. The Purchasing Power Parity Approach

Our third approach of currency valuation is based on purchasing power parity figures obtained directly from the OECD. These PPP rates are calculated annually by OECD in order to make international GDP comparisons, rather than as a tool to forecast currencies. Therefore, it is more robust and comprehensive than other direct PPP measures. We define an overvalued (undervalued) currency on the basis of the following ratio for our PPP strategies:

$$\frac{AvgSpot_{i,t:t-3}}{PPP_{i,t}} \tag{3}$$

Where $AvgSpot_{i,t:t-3}$ is the average nominal spot exchange rate of currency *i* over the past three months (*t* to *t-3*) expressed as the US dollar (USD) price of one unit of foreign currency and $PPP_{i,t}$ is the annual purchasing power parity figure of the same currency published by the OECD in the same year *t* as $AvgSpot_i$. The currencies having the highest (lowest) ratio using expression (3) are the most overvalued undervalued). A similar PPP

based strategy is used by currency value PPP index of the Deutsche Bank, however, their rebalancing frequency, portfolio weights and holding horizon is different from ours along with limitations of investing only in G-10 currencies.

4.2.2.4. The Big Mac Index Approach

Our fourth and last measure of currency valuation is the Big Mac Index. Already calculated currency overvaluation and undervaluation figures according to the Big Mac Index are provided online at *the Economist'*s website. We use the same overvaluation (undervaluation) figures as provided by *the Economist* in our strategies. Big Mac Index is available in a raw version (original) and in an adjusted for GDP version. We employ the raw version in our strategy analysis.

4.2.3. Portfolio Formation and Excess Return Calculation

We form multicurrency portfolios by ranking all currencies on the basis of valuation figures estimated by above mentioned four measures from the most undervalued to most overvalued at the beginning of each month (week) *t* and form five equal weighted portfolios and go long the first 20% currencies (most undervalued) and sell short the last 20% (most overvalued) currencies. We hold the positions over a specified investment horizon and calculate currency excess returns in the same manner as Kroencke, Schindler, and Schrimpf (2014) as per equation (4) and (5) below for long and short positions respectively:

$$rx_{t+1}^{k} = s_{t+1}^{k} - f_{t}^{k} \qquad (4)$$

$$rx_{t+1}^{k} = f_t^k - s_{t+1}^k \quad (5)$$

where *s* in the above equation denotes (log) spot exchange rate and *f* represents the (log) forward exchange rate. We employ all exchange rates quoted as the US dollar (USD) price of one unit of foreign currency[28]. Hence, an increase in *s* indicates appreciation of the foreign currency or depreciation of the US dollar. Furthermore, where exact maturity forward contract data is not available, we follow Raza, Marshall, and Visaltanachoti (2014) and roll our positions till the end of the desired holding period employing 1-week and 1-month forward contract data using equation (6) and (7) for long positions and a similar procedure is adopted for short positions:

$$rx_{t+2}^{k} = (s_{t+1}^k - f_t^k) + (s_{t+2}^k - f_{t+1}^k) \quad (6)$$

$$rx_{t+3}^{k} = (s_{t+1}^k - f_t^k) + (s_{t+2}^k - f_{t+1}^k) + (s_{t+3}^k - f_{t+2}^k) \quad (7)$$

equations (6) and (7) imply that a long position is rolled over to the 2nd and 3rd month (week) by using a 1-month (1-week) forward contract. A similar procedure is adopted for short positions. Our currency returns are calculated from Wednesday to Wednesday using mid foreign exchange rates. Due to the overlapping nature of currency strategy returns, we use Newey-West HAC robust standard errors for our statistical and regression analysis throughout this paper.

[28] We use the same exchange rate quotation system as in Kroencke, Schindler, and Schrimpf (2014) however we use log excess returns following the procedure adopted in Menkhoff, Sarno, Schmeling, and Schrimpf (2012a) for calculating currency excess returns. We want to be clear here that we employ exchange rates as the US dollar (USD) price of one unit of foreign currency which implies an increase in the exchange rate means appreciation of the foreign currency. For example, the change of the NZ dollar exchange rate from 0.70 USD/NZD to 0.90 USD/NZD implies an increase in the price of the foreign currency, in this case the New Zealand dollar for a US currency investor.

4.3. Core Results

4.3.1. Entire Sample Results

We start our empirical analysis by presenting our full sample results of all RERC, RERL, PPP and the Big Mac Index strategies over horizons from one week to one year. Our full sample period starts in January 1972 and ends in July 2013. The long and short portfolios comprise of 20% most undervalued and overvalued currencies respectively in any week or month. We present the long – short (long minus short) portfolio statistics in order to conserve space[29].

It is apparent from Table 4.1 that the real exchange rate currency value strategies generate higher excess returns than the PPP and Big Mac Index based strategies. The RERC based strategies perform better at 1- to 12-month horizons whereas the RERL strategies perform well at short (1- to 3-week) investment horizons. For example the 9-month holding period RERC strategy produces a statistically and economically significant excess return of about 7.45% p.a. with a Sharpe Ratio of 0.62. Likewise, the 1-month holding horizon RERC strategy produces an annualized excess return of about 7.37% with a Sharpe Ratio of 0.76. The RERL strategies generate statistically and economically significant excess returns at weekly as well as monthly investment horizons, however, the monthly horizon returns are slightly less than the RERC strategies. For instance, the 1-week holding period RERL strategy generates an annualized excess return of about 6.90% with a Sharpe Ratio of 0.73 and the 9-month holding period RERL strategy generates an excess return of 5.34% p.a. Furthermore, it is apparent from Table 4.1, the RERL strategies generate higher excess returns at weekly holding periods as compared to all other strategies.

[29] Long and Short Portfolio results are available on request.

Table 4.1: Currency Value Returns Over All Currencies in Sample (full sample)

	Holding period							
Portfolio	1-Week	2-Week	3-Week	1-Month	3-Month	6-Month	9-Month	12-Month
Panel A. Real Exchange Rate Changes								
Long-short (%)	0.043	0.081	0.120	0.614	1.849	3.601	5.590	7.284
Annualized mean (%)	**2.260**	**2.106**	**2.086**	**7.371***	**7.398****	**7.201****	**7.451****	**7.284****
t-statistic	1.464	1.425	1.462	3.786	4.308	4.864	5.544	6.054
Sharpe ratio	0.266	0.242	0.233	0.762	0.674	0.637	0.624	0.600
Panel B. Real Exchange Rate Levels								
Long-short (%)	0.133	0.266	0.403	0.423	1.322	2.725	4.007	5.175
Annualized mean (%)	**6.903*****	**6.927*****	**6.992*****	**5.077**	**5.287**	**5.451**	**5.341**	**5.175**
t-statistic	4.169	4.351	4.541	2.542	2.820	3.284	3.573	3.702
Sharpe ratio	0.730	0.709	0.692	0.495	0.446	0.418	0.393	0.358
Panel C. Purchasing Power Parity								
Long-short (%)	0.045	0.091	0.138	0.139	0.455	1.161	1.922	2.650
Annualized mean (%)	**2.326**	**2.377**	**2.394**	**1.664**	**1.821**	**2.321**	**2.561**	**2.650**
t-statistic	2.058	2.188	2.274	1.245	1.518	2.192	2.700	3.055
Sharpe ratio	0.352	0.357	0.347	0.241	0.230	0.269	0.286	0.285
Panel D. Big Mac Index								
Long-short (%)	0.045	0.088	0.144	0.201	0.460	0.749	1.032	1.273
Annualized mean (%)	**2.352**	**2.283**	**2.496**	**2.407**	**1.841**	**1.498**	**1.376**	**1.273**
t-statistic	1.553	1.604	1.796	1.330	1.323	1.366	1.462	1.504
Sharpe ratio	0.301	0.297	0.315	0.292	0.216	0.194	0.184	0.166

This table presents full sample excess return statistics of all four currency value strategies over weekly and monthly horizons using 39 currencies. Long (short) portfolios comprise of 20% of most undervalued (overvalued) currencies available in a particular month (week). Excess return for long positions is calculated as $\ln(f_t) - \ln(S_{t+1})$. Sharpe ratio is calculated by dividing annualized excess returns by annualized volatility. The portfolio return *t*-statistics are based on Newey-West standard errors. One asterisk (*) denotes the statistical significance of the difference of the mean return of the highest yielding strategy to one other competing strategy. Similarly, we add two (three) asterisks (*) if the annualized mean of a strategy is higher and statistically significant than two (three) other competing strategies.

The PPP and the Big Mac Index strategies, as we show in Panel C and D, do not perform well either at weekly or monthly investment horizons. For instance, the PPP based on a 3-week holding period strategy produces an annualized excess return of about 2.39% with a low Sharpe Ratio of 0.35. Similarly, a 12-month holding period PPP strategy generates an excess return of 2.65% p.a. with a Sharpe Ratio of 0.29. The Big Mac Index strategies generate the lowest excess returns and Sharpe Ratios with insignificant *t*-statistics over the entire sample period. For example, the highest annualized excess return of 2.50% is generated by a 3-week holding period Big Mac Index strategy. Likewise, the 6-month holding period Big Mac Index based strategy produces an excess return of 1.50% p.a. which is not statistically significant.

We test the robustness of our results in Table 4.1 by measuring the statistical significance of the differences of the returns between different strategies. For this purpose, we calculate the difference in returns of the highest yielding strategy and the lowest yielding strategies within the same investment horizon and measure the simple OLS *t*-statistics. In Table 4.1, we attach one asterisk[30] (*) to the annualized mean return of the highest yielding strategy if it is significantly higher than one other strategy at 10% level. Similarly, we add two asterisks (*) if the annualized mean is higher and statistically significant than two other competing strategies and so on. On the basis of individual returns and the difference of return *t*-statistics shown in Table 4.1, we conclude that the RERL strategies perform better as compared to all other strategies at weekly horizons and RERC strategies perform best at 1- to 12-month investment horizons. The RERL strategies consistently outperform all other currency value strategies at weekly investment horizons

[30] We do the same robustness check in the upcoming Table 4.2.

and generate annualized excess returns as high as 7%. The PPP and the Big Mac Index strategies generate low and statistically insignificant excess returns.

4.3.2. Foreign Exchange Regimes and Currency Value Returns

Menkhoff, Sarno, Schmeling and Schrimpf (2012a) control for currency regimes while calculating currency momentum returns on the assumption that currencies which are highly managed may not be very useful in momentum strategies due to prohibition of large price swings in such currencies. In this section we control for currency regimes on the basis of similar assumptions that highly managed may not depreciate or appreciate to a large extent and hence might not be very useful in currency value strategies. Therefore, in this section we explore the effect of foreign exchange regimes on currency value strategy returns. We utilize the foreign exchange regime classification provided in Raza, Marshall, and Visaltanachoti (2014) and exclude all non-independently floating currencies from our sample and re-run all RERC, RERL, PPP and the Big Mac Index based strategies for all weekly and monthly horizons and present our findings in Table 4.2 below.

Table 4.2: Currency Value Returns When Actively Managed Currencies are Excluded

	Holding period							
Portfolio	1-Week	2-Week	3-Week	1-Month	3-Month	6-Month	9-Month	12-Month
Panel A. Real Exchange Rate Changes								
Long-short (%)	0.061	0.119	0.179	0.797	2.486	4.816	7.369	9.597
Annualized mean (%)	**3.156**	**3.094**	**3.103**	**9.570****	**9.945*****	**9.631*****	**9.822*****	**9.597*****
t-statistic	2.046	2.107	2.200	4.689	5.433	6.110	6.978	7.820
Sharpe ratio	0.368	0.355	0.346	1.006	0.884	0.804	0.786	0.779
Panel B. Real Exchange Rate Levels								
Long-short (%)	0.133	0.270	0.407	0.377	1.202	2.551	3.965	5.280
Annualized mean (%)	**6.912*****	**7.017*****	**7.049*****	**4.519**	**4.806**	**5.103**	**5.286**	**5.280**
t-statistic	3.971	4.182	4.337	2.057	2.342	2.789	3.209	3.491
Sharpe ratio	0.725	0.706	0.675	0.417	0.373	0.355	0.354	0.339
Panel C. Purchasing Power Parity								
Long-short (%)	0.077	0.154	0.231	0.146	0.487	1.116	1.798	2.361
Annualized mean (%)	**3.996**	**4.017**	**4.004**	**1.757**	**1.949**	**2.233**	**2.397**	**2.361**
t-statistic	3.188	3.343	3.456	1.126	1.326	1.659	2.012	2.245
Sharpe ratio	0.537	0.538	0.517	0.221	0.200	0.202	0.214	0.211
Panel D. Big Mac Index								
Long-short (%)	0.008	0.017	0.028	0.023	0.078	0.003	-0.158	-0.283
Annualized mean (%)	**0.415**	**0.441**	**0.479**	**0.271**	**0.310**	**0.006**	**-0.210**	**-0.283**
t-statistic	0.282	0.318	0.362	0.186	0.239	0.005	-0.236	-0.350
Sharpe ratio	0.054	0.059	0.063	0.037	0.041	0.001	-0.030	-0.039

The structure of this table is similar to Table 4.1 except that we restrict our currency basket to independently floating currencies only. Long (short) portfolios comprise of 20% of most undervalued (overvalued) currencies available in a particular week (month). Excess return for long positions is calculated as $\ln(f_t) - \ln(S_{t+1})$. Sharpe ratio is calculated by dividing annualized excess returns by annualized volatility. The *t*-statistics are based on Newey-West standard errors. One asterisk (*) denotes the statistical significance of the difference of the mean return of the highest yielding strategy to one other competing strategy. Similarly, we add two (three) asterisks (*) if the annualized mean of a strategy is higher and statistically significant than two (three) other competing strategies.

The Table 4.2 results show there is a material increase in returns to the RERC strategy when actively managed currencies are excluded. The average return across all horizons increases from 5.4% to 7.2%. There is not much change in the average RERL returns, but PPP strategy returns increase from an average of 2.3% to 2.8%. Big Mac strategy returns decline from 1.9% to 0.2%. However, despite the increase in RERC average returns and lack of material change in RERL returns, the key conclusion from Table 4.1 remains unchanged. The RERL strategy dominates for holding periods of up to one month, while the RERC approach generates larger returns for periods of 1-12 months. The superior performance at these respective intervals is both statistically and economically significant.

4.3.3. Currency Value Returns based on a Composite Strategy

In this section we present the results of a composite strategy based on a combination of the RERC, RERL, PPP and Big Mac Index strategies. Rather than forming a long (short) portfolio based on the 20% of currencies that are most undervalued (overvalued) by one of the four measures we select the 5% of overvalued and 5% of undervalued currencies from each of the fours strategies.

Table 4.3: Currency Value Returns to a Composite Strategy

	Holding period							
Portfolio	1-Week	2-Week	3-Week	1-Month	3-Month	6-Month	9-Month	12-Month
Long-short (%)	0.246	0.575	0.758	0.668	2.062	4.434	7.373	10.226
Annualized mean (%)	**12.775**	**14.948**	**13.136**	**8.021**	**8.249**	**8.868**	**9.829**	**10.226**
Max (%)	15.373	20.298	24.401	28.959	73.939	108.491	120.509	134.404
Min (%)	-16.216	-16.929	-17.937	-22.251	-48.914	-67.607	-58.184	-35.409
t-statistic	4.987	5.017	5.410	2.115	2.348	2.852	3.496	4.031
p-value	0.000	0.000	0.000	0.017	0.010	0.002	0.000	0.000
Volatility (%)	11.962	14.837	14.132	15.191	20.605	24.075	25.705	26.298
Sharpe ratio	1.068	1.007	0.930	0.528	0.400	0.368	0.382	0.389
Long (mean %)	0.238	0.558	0.726	0.764	2.322	4.746	7.476	10.006
Max (%)	9.628	21.045	23.846	28.251	69.154	96.098	114.059	119.122
Min (%)	-17.821	-18.619	-18.679	-17.954	-41.971	-68.587	-63.838	-36.851
Short (mean %)	-0.008	-0.017	-0.032	0.095	0.259	0.312	0.103	-0.220
Max (%)	8.300	8.970	9.262	8.458	20.261	20.994	19.489	24.821
Min (%)	-14.832	-16.048	-16.872	-10.107	-13.930	-21.465	-26.873	-32.806
Composite – RERC	**3.581**	**3.890**	**4.026**	0.852	1.227	**2.214**	**3.217**	**4.121**
Composite – RERL	**2.914**	**3.380**	**3.243**	1.531	**1.984**	**2.776**	**4.174**	**5.310**
Composite – PPP	**4.924**	**5.192**	**5.806**	**3.111**	**4.263**	**5.241**	**6.623**	**7.579**
Composite – Big Mac Index	**3.308**	**3.563**	**3.684**	**1.671**	**2.516**	**3.770**	**5.213**	**6.486**

This table shows excess return statistics of a composite strategy which is based on four primary measures of currency valuation. Upper panel shows returns of an equally weighted composite strategy which is based on 20% of available currencies in long and short portfolios of the four constituent value strategies. We employ all 39 currencies in this estimation. Excess return for long positions is calculated as $\ln(f_t) - \ln(S_{t+1})$. Sharpe ratio is calculated by dividing annualized excess returns by annualized volatility. The portfolio return *t*-statistics are based on Newey-West standard errors. The lower panel shows the statistical significance (*t*-statistics) of the difference of returns between the composite and the individual strategies. RERC, RERL and PPP represent Real exchange rate change, real exchange rate level and the purchasing power parity strategies.

The Table 4.3 results indicate the composite strategy consistently generates larger returns than those from any of the four value techniques used in isolation. The larger returns are both economically and statistically significant. The average return across all horizons is 10.8% compared to 5.4% and 5.9% for RERC and RERL respectively. Moreover, several of the interval returns are even more materially larger than the equivalent returns to a standalone value metric. For instance, a 2-week holding period composite strategy generates an annualized excess return of about 15% with a Sharpe Ratio of 1.01. Similarly, a 3-week holding period composite strategy generates a statistically significant excess return of 13.14% p.a. with a Sharpe Ratio of 0.93.

4.3.4. Can Macroeconomic Variables Explain Differences in Currency Value Returns?

In this section we explore the impact of a variety of macroeconomic state variables and currency return specific risk factors on the return differences between the four currency value approaches. We run numerous univariate time-series regressions following Menkhoff, Sarno, Schmeling and Schrimpf (2012a) in their momentum study. However, the Table 4.4 results are based on the differences of individual strategy returns[31] such that we subtract the returns of the least profitable strategy from the most profitable strategy for each holding period and then regress on a list of macroeconomic and currency risk variables.

"Cons" refers to growth in US real personal consumption expenditures. "Empl" stands for US total nonfarm employment growth, "MI" denotes US ISM Manufacturing PMI Composite Index, "IP" represents growth in US industrial production. "M2" stands for

[31] We also run univariate regressions on the levels of independent strategy returns rather than the differences of alternative strategy returns on the same basket of macroeconomic variables and present the results in Appendix C.1.

growth in real money balances. "DPI" denotes growth in real disposable personal income. "TED" spread is the difference between 3-month interbank and T-bill rates whereas "Term" spread represents the difference between 20-year maturity and 3-month maturity T-bill rate. "HML_{FX}" and "VOL_{FX}" represent the returns to carry trade and global foreign exchange volatility respectively. "VOL_{FX}" is estimated using a similar procedure as in Raza, Marshall, and Visaltanachoti (2014). Due to a large number of regression variables, relevant alphas and *t*-statistics, we only report slope coefficients and represent these in bold font if they are significant at 10% level.

Our results show very low R^2s in majority of the cases. These range from 0.5% to about 18%. We further note from Table 4.4 that the slope coefficients in majority of the cases are not significant at the 10% level, indicating the state variables and risk factors do not consistently explain the larger returns generated by the RERL strategy at shorter intervals nor the RERC strategy at longer intervals. Increases in employment growth, the ISM Manufacturing PMI Composite Index, and industrial production contribute to the out-performance of the RERL approach over shorter intervals in approximately half the tests we run. However, there is no consistent pattern of a variable explaining the superior performance of the RERC approach over intervals of one month or longer. The Appendix C.1 results are similar in that they show no variable consistently being linked to the returns generated by any of the value strategies.

Table 4.4: Macroeconomic Variables, Risk Factors and Currency Value Returns

Strategy	Cons	Empl	MI	IP	M2	DPI	TED	Term	HML_{FX}	VOL_{FX}
Panel A. 1-Week – 1-Week										
RERL – RERC	0.028	0.953	0.007	0.454	-0.797	-0.086	**0.724**	-0.366	-0.050	-0.036
RERL – PPP	0.092	**1.747**	**0.052**	**0.542**	**-0.652**	-0.088	**-0.308**	-0.042	0.026	0.026
RERL – Big Mac Index	**0.286**	2.141	0.015	0.120	-0.242	0.003	0.335	**-0.294**	0.013	0.075
Panel B. 2-Week – 2-Week										
RERL – RERC	0.041	**2.232**	**0.100**	**0.901**	-0.693	-0.030	-0.424	0.006	0.030	0.157
RERL – Big Mac Index	**0.233**	2.253	0.018	0.279	-0.300	0.111	0.316	**-0.292**	0.016	0.057
RERL – PPP	0.077	**1.787**	**0.047**	**0.601**	**-0.560**	-0.026	**-0.278**	-0.033	0.055	0.010
Panel C. 3-Week – 3-Week										
RERL – RERC	0.043	**2.649**	**0.087**	**0.806**	-0.654	0.046	-0.290	0.011	0.044	0.162
RERL – PPP	0.110	**2.096**	**0.042**	**0.553**	**-0.508**	0.020	**-0.229**	-0.021	0.067	0.031
RERL – Big Mac Index	0.171	**2.321**	0.017	0.208	-0.413	0.117	0.499	-0.265	-0.017	0.119
Panel D. 1-Month – 1-Month										
RERC – PPP	**0.533**	0.291	-0.004	0.090	0.525	0.009	-0.179	-0.026	-0.129	0.003
RERC – Big Mac Index	0.442	-1.114	-0.024	-0.356	-0.492	-0.099	-0.831	-0.114	-0.199	-0.002
RERC – RERL	0.166	-1.311	**-0.061**	-0.333	0.288	0.134	0.123	0.043	**-0.346**	0.131
Panel E. 3-Month – 3-Month										
RERC – PPP	**0.344**	0.767	0.000	0.293	0.192	0.096	-0.085	0.064	0.050	-0.016
RERC – Big Mac Index	**0.292**	-0.345	-0.016	-0.061	-0.529	-0.089	-0.883	-0.059	0.008	0.020
RERC – RERL	0.096	-1.280	-0.051	-0.178	0.408	0.153	0.050	0.101	-0.004	-0.028
Panel F. 6-Month – 6-Month										
RERC – Big Mac Index	-0.143	0.891	0.032	0.184	-0.237	0.074	-0.400	-0.035	0.041	0.006
RERC – PPP	-0.032	1.007	0.028	0.223	-0.197	0.156	0.200	0.073	0.024	-0.016
RERC – RERL	-0.040	-0.797	-0.023	-0.027	0.182	0.157	0.231	0.070	0.001	-0.016
Panel G. 9-Month – 9-Month										
RERC – Big Mac Index	-0.060	1.076	0.031	0.184	-0.170	0.053	-0.146	-0.065	-0.040	0.023
RERC – PPP	0.000	0.978	0.019	0.160	0.216	**0.176**	**0.230**	**0.106**	-0.018	-0.011
RERC – RERL	-0.023	-0.577	-0.018	-0.034	0.423	0.123	0.316	0.073	-0.011	0.010
Panel H. 12-Month – 12-Month										
RERC – Big Mac Index	-0.052	**1.270**	0.028	0.144	0.061	0.105	0.046	-0.089	0.015	0.010
RERC – PPP	0.022	**1.159**	0.024	0.159	0.217	**0.160**	**0.269**	**0.102**	0.007	0.016

RERC – RERL	-0.041	-0.345	-0.009	-0.020	**0.498**	0.114	**0.336**	0.088	0.001	0.009

This table presents the slope coefficients from the regression of the difference of individual currency value returns on a variety of macroeconomic variables and currency risk factors. RERL – RERC means the difference of returns between the real exchange rate levels and the real exchange rate change strategy. “Cons” in this table refers to growth in US real personal consumption expenditures. “Empl” stands for US total nonfarm employment growth, “MI” denotes US ISM Manufacturing PMI Composite Index, “IP" represents growth in US industrial production. “M2” stands for growth in real money balances. “DPI” denotes growth in real disposable personal income. “TED” spread is the difference between 3-month interbank and T-bill rates whereas “Term” spread represents the difference between 20-year maturity and 3-month maturity T-bill rate. “HML_{FX}” and “VOL_{FX}” represent the returns to carry trade and foreign exchange volatility respectively. Slope coefficients which are significant at 10% level are in bold font. We used Newey-West standard errors in this regression estimation. “MI” values are in percent.

4.3.5. Portfolio Turnover and Break-even Transaction Costs

Lesmond, Schill, and Zhou (2004) find that equity momentum profits are greatly reduced when transaction costs are taken into account. However, currency momentum profits have been shown to survive transaction costs (Menkhoff, Sarno, Schmeling and Schrimpf , 2012a), largely due to rapidly declining bid-ask spreads and greater liquidity in the foreign exchange markets. In this section we follow Raza, Marshall, and Visaltanachoti (2014) and conduct a break-even transaction costs analysis as we do not have quoted bid-ask spread data for most of the included currencies and especially for the earlier part of our sample. Hence, a break-even transaction cost analysis is expected to provide a reasonable assessment of the apparent profitability of our weekly and monthly currency value strategies.

Therefore, following Raza, Marshall, and Visaltanachoti (2014), we note the number of currencies and their movement from long portfolio to middle or short portfolio and vice versa at the start and end of each holding period. Transaction costs are incurred when a currency is added to or dropped from the long (short) portfolio. We record one trade when a currency moves from long (short) portfolio to the middle or neutral portfolio and vice-versa. We record two trades if a currency moves from long (short) portfolio to short (long) portfolio. Turnover is calculated as the ratio of total trades incurred to the total number of eligible (sum of total long and short) currencies in a holding period. We then calculate average turnover over the whole trading period for a particular strategy and report the annualized turnover figures for all strategies in Table 4.5. Finally, we calculate break-even transaction (in percent per trade) costs by dividing each strategy's annualized return by its respective "annual turnover".

The Table 4.5 results indicate currency value investing is attractive from a transaction cost perspective. For example, the break-even transaction cost (per one way trade) for the 1-week holding period RERC strategy is over 59 bps and the other breakeven transaction costs are even larger. The break-even transactions costs benefit from the fact that currencies in these strategies do not switch positions (portfolios) very often compared to those in currency momentum portfolios where currencies switch portfolios frequently. It therefore appears that currency value strategy returns are larger than reasonable estimates of transaction costs which range from 1 – 8 bps for major currency pairs (Mancini, Ranaldo, and Wrampelmeyer, 2013) and 11 – 16 bps for emerging market currencies (Gilmore and Hayashi, 2011).

Table 4.5: Portfolio Turnover and Break-even Transaction Costs

Strategy	Annualized Return (%)	Average Annual Turnover (times)	Break-even Transaction Cost (%)
Panel A. Real Exchange Rate Changes			
1-Week	2.260	3.862	0.585
2-Week	2.106	1.931	1.091
3-Week	2.086	1.287	1.621
1-Month	7.371	2.162	3.409
3-Month	7.398	0.721	10.265
6-Month	7.201	0.360	19.985
9-Month	7.451	0.240	31.024
12-Month	7.284	0.180	40.427
Panel B. Real Exchange Rate Levels			
1-Week	6.903	0.352	19.62
2-Week	6.927	0.176	39.38
3-Week	6.992	0.117	59.65
1-Month	5.077	0.351	14.47
3-Month	5.287	0.117	45.20
6-Month	5.451	0.058	93.21
9-Month	5.341	0.039	137.03
12-Month	5.175	0.029	176.98
Panel C. Purchasing Power Parity			
1-Week	2.326	0.547	4.249
2-Week	2.377	0.274	8.683
3-Week	2.394	0.182	13.121
1-Month	1.664	0.435	3.825
3-Month	1.821	0.145	12.560
6-Month	2.321	0.072	32.017
9-Month	2.561	0.048	53.014
12-Month	2.650	0.036	73.102
Panel D. Big Mac Index			
1-Week	2.352	0.476	4.945
2-Week	2.283	0.238	9.599
3-Week	2.496	0.159	15.748
1-Month	2.407	0.484	4.972
3-Month	1.841	0.161	11.410
6-Month	1.498	0.081	18.570
9-Month	1.376	0.054	25.589
12-Month	1.273	0.040	31.572

This table presents break-even transactions cost analysis of all currency value strategies. Turnover is calculated as the ratio of total trades to the sum of total long and short currencies in a holding period and is annualized. Break-even transaction costs are calculated by dividing annualized return by respective annual turnover for a strategy. We show turnover in times and break-even costs in percent. For example, the very first row refers to an annual turnover of 3.86 times and a break-even transaction cost of 0.585% (58.5 basis points) per one way trade.

4.4. Robustness Checks

4.4.1. Currency Value Returns and the US Business Cycle

In this sub-section we explore the performance of currency value strategies during the expansionary and recessionary phases of the US business cycle. We follow Raza, Marshall, and Visaltanachoti (2014) and estimate a dummy variable regression as in equation (8) to separate the currency value returns during expansionary and recessionary phases. However, rather than the absolute performance of one of the four strategies, we focus on differences between the best performing strategy over a particular interval and the other three approaches.

$$\Delta FXV_t = \beta_{exp} \, . D_{exp} + \beta_{rec} . D_{rec} + \in_{K,t} \quad (8)$$

where ΔFXV_t in equation (8) refers to the difference between the returns of the more and the lesser profitable value strategy at time *t* (for example the 1-week holding RERL minus 1-week holding RERC strategy at time *t*) and D_{exp} and D_{rec} represent the dummy variables for the expansionary and the recessionary phase, respectively. We source business cycle dates directly from the NBER and use Newey-West standard errors in this estimation due to overlapping nature of strategy returns. We present mean returns during different phases as well as a test of equality of means along with relevant *t*-statistics in Table 4.6 below.

Table 4.6: Currency Value Returns Under Different Phases of the US Business Cycle

	Expansion		Recession		Test of Equality (Expansion-Recession=0)	
Strategy	Mean (%)	*t*-stat	Mean (%)	*t*-stat	Mean (%)	*t*-stat
Panel A. 1-Week – 1-Week						
RERL – RERC	-0.187	-0.533	-0.093	-0.104	-0.094	-0.119
RERL – PPP	0.600	4.290	-0.701	-2.186	1.301	4.036
RERL – Big Mac Index	0.808	3.662	0.255	0.466	0.553	1.019
Panel B. 2-Week – 2-Week						
RERL – RERC	0.757	2.223	-0.844	-1.664	1.600	2.591
RERL – Big Mac Index	0.829	3.831	0.202	0.352	0.627	1.204
RERL – PPP	0.586	4.234	-0.644	-1.940	1.231	4.060
Panel C. 3-Week – 3-Week						
RERL – RERC	0.776	2.301	-0.773	-1.563	1.549	2.547
RERL – PPP	0.596	4.350	-0.593	-1.808	1.190	4.037
RERL – Big Mac Index	0.848	3.779	0.169	0.316	0.679	1.291
Panel D. 1-Month – 1-Month						
RERC – PPP	0.532	3.145	-0.316	-0.504	0.848	1.849
RERC – Big Mac Index	0.319	1.470	-0.005	-0.005	0.323	0.526
RERC – RERL	0.039	0.164	0.343	0.373	-0.305	-0.530
Panel E. 3-Month – 3-Month						
RERC – PPP	0.505	3.376	-0.213	-0.396	0.719	2.513
RERC – Big Mac Index	0.371	2.068	-0.124	-0.154	0.494	1.199
RERC – RERL	0.019	0.087	0.414	0.507	-0.395	-1.035
Panel F. 6-Month – 6-Month						
RERC – Big Mac Index	0.367	2.450	-0.258	-0.448	0.625	2.390
RERC – PPP	0.365	2.692	0.206	0.456	0.158	0.773
RERC – RERL	-0.044	-0.236	0.547	0.876	-0.591	-2.149
Panel G. 9-Month – 9-Month						
RERC – Big Mac Index	0.379	2.788	-0.297	-0.690	0.676	3.181
RERC – PPP	0.371	2.853	0.167	0.468	0.204	1.154
RERC – RERL	-0.022	-0.130	0.589	1.167	-0.610	-2.654
Panel H. 12-Month – 12-Month						
RERC – Big Mac Index	0.354	3.019	-0.199	-0.514	0.552	2.973
RERC – PPP	0.343	2.717	0.204	0.695	0.139	0.837
RERC – RERL	-0.015	-0.097	0.523	1.252	-0.538	-2.615

This table shows the performance of currency value strategies under expansionary and recessionary phases of the US business cycle. RERL – RERC means the difference of returns between the real exchange rate levels and the real exchange rate change strategy. We first calculate the difference between the highest and the lowest return generating strategies over a holding period and then calculate mean returns during expansionary and recessionary phases. We use all 39 currencies over the period January 1972 to July 2013 in this table. We obtain US business cycle cut off dates directly from the NBER. The *t*-statistics are based on Newey-West standard errors.

It is apparent from the results in Table 4.6 that the difference in returns of the more and the lesser profitable strategies is typically higher and statistically significant during the expansionary phase of the US business cycle. The mean returns are mostly negative and insignificant during the recessionary phases of the US business cycle. For example, as we show in Panel B, the difference between the highest return generating strategy (RERL) and the lowest return generating strategy (RERC) for the 2-week holding period is 0.76%. Similarly, as we show in Panel D, the returns to the RERC strategy are 0.53% higher than the PPP strategy during the expansionary phase in case of 1-month holding period. The differences in the returns for the same strategies are negative and insignificant during the recessionary phase. This result is also apparent from the test of equality of means reported in the same table. We conclude from the higher mean returns and significant *t*-statistics in Table 4.6 during the expansionary phase that high yielding currency value strategies generate higher excess returns during the expansionary phase of the US business cycle.

4.4.2. States of the Foreign Exchange Market and Currency Value Returns

Cooper, Gutierrez, and Hameed (2004) find equity momentum profits are state dependent and are higher (lower) following positive (negative) market returns. Raza, Marshall, and Visaltanachoti (2014) show currency momentum profits are larger and more statistically significant following periods of negative returns in the foreign exchange market. We run a similar dummy variable regression framework in this section as in Raza, Marshall, and Visaltanachoti (2014) in order to explore the performance of currency value strategies during UP and DOWN states of the foreign exchange market. We define UP (DOWN) state of the foreign exchange market when the past 36-month cumulative return of the US dollar (RX) risk factor of Lustig, Roussanov, and Verdelhan (2011) is positive

(zero or negative) or a period of good performance of the foreign exchange market. We separate the difference in strategy returns during UP and DOWN states using equation (9) below.

$$\Delta FXV_t = \beta_{UP} . D_{UP} + \beta_{DOWN} . D_{DOWN} + \in_{K,t} \quad (9)$$

The interpretation of equation (9) is similar to the one employed in section 4.1 above except that the dummy variables D_{UP} and D_{DOWN} represent UP state and DOWN state dummy variables, respectively. ΔFXV_t denotes the difference between the higher return generating strategy and the lower return generating strategy for a particular holding period at time *t*. We show the mean of differences of alternative (highest minus lowest) strategy returns during UP and DOWN state and a test of equality of means along with relevant *t*-statistics in Table 4.7.

The mean returns and the tests of equality of means in Table 4.7 indicate the relative difference of currency value returns are higher during the UP state rather than the DOWN state for most of the strategies. The RERC strategies generate higher excess returns in UP market states as compared to all other strategies at 1-month and longer investment horizons. For example, the (mean) difference between the 1-month holding period RERC strategy and the PPP strategy is higher during UP market state than the DOWN market state. This is apparent from the test of equality of means that the RERC strategy performs better during UP state of the currency market. Overall we conclude that the relative difference in currency value strategies is positively associated with the performance of the overall currency market.

Table 4.7: States of the Foreign Exchange Market and Currency Value Returns

	UP State		DOWN State		Test of Equality (UP - DOWN=0)	
Strategy	Mean (%)	*t*-stat	Mean (%)	*t*-stat	Mean (%)	*t*-stat
Panel A. 1-Week – 1-Week						
RERL – RERC	-0.655	-1.515	1.791	3.111	-2.446	-0.227
RERL – PPP	0.544	2.981	0.783	2.433	-0.239	3.107
RERL – Big Mac Index	0.667	2.634	1.005	2.800	-0.338	1.033
Panel B. 2-Week – 2-Week						
RERL – RERC	0.983	2.234	0.821	1.354	0.162	1.339
RERL – Big Mac Index	0.684	2.742	1.036	2.855	-0.352	1.233
RERL – PPP	0.538	2.971	0.756	2.206	-0.219	3.134
Panel C. 3-Week – 3-Week						
RERL – RERC	0.999	2.276	0.844	1.396	0.155	1.452
RERL – PPP	0.567	3.203	0.765	2.080	-0.198	3.209
RERL – Big Mac Index	0.726	2.930	0.961	2.366	-0.235	1.335
Panel D. 1-Month – 1-Month						
RERC – PPP	0.213	0.986	-0.049	-0.116	0.261	1.705
RERC – Big Mac Index	0.409	1.716	-0.188	-0.366	0.597	0.497
RERC – RERL	-0.188	-0.587	-0.705	-1.382	0.517	0.369
Panel E. 3-Month – 3-Month						
RERC – PPP	0.201	1.072	-0.038	-0.107	0.239	2.339
RERC – Big Mac Index	0.355	1.777	0.149	0.332	0.206	1.168
RERC – RERL	-0.232	-0.811	-0.680	-1.533	0.449	0.059
Panel F. 6-Month – 6-Month						
RERC – Big Mac Index	0.420	2.771	-0.117	-0.330	0.537	2.377
RERC – PPP	0.185	1.362	-0.394	-1.117	0.579	2.336
RERC – RERL	-0.219	-0.960	-0.881	-2.467	0.662	0.104
Panel G. 9-Month – 9-Month						
RERC – Big Mac Index	0.440	3.176	-0.140	-0.497	0.579	3.181
RERC – PPP	0.204	1.649	-0.466	-1.449	0.671	3.091
RERC – RERL	-0.177	-0.913	-0.906	-3.094	0.730	0.375
Panel H. 12-Month – 12-Month						
RERC – Big Mac Index	0.389	3.205	-0.029	-0.117	0.419	2.973
RERC – PPP	0.197	1.545	-0.440	-1.497	0.637	2.467
RERC – RERL	-0.188	-1.047	-0.768	-2.876	0.580	0.064

This table shows the performance of currency value strategies during UP and DOWN states of the foreign exchange market. RERL – RERC means the difference of returns between the real exchange rate levels and the real exchange rate change strategy. We first calculate the difference between the highest and the lowest return generating strategies over a holding period and then calculate mean returns during UP and DOWN states of the foreign exchange market. UP is a dummy variable which is 1 (0) when the past 36 month cumulative return of the dollar (RX) risk factor of Lustig, Roussanov, and Verdelhan (2011) is positive (zero or negative). The *t*-statistics are based on Newey-West standard errors.

4.5. Conclusion

Currency value strategies have gained relatively little academic attention as compared to equity market value strategies and other currency trading strategies like momentum and carry trade approaches. Recent literature such as Asness, Moskowitz, and Pedersen (2013), Barroso and Santa-Clara (2014) and Kroencke, Schindler, and Schrimpf (2014) discuss a long-term measure of currency value such as the 5-year change of the real exchange rate and find value strategy generates positive excess returns.

We build on this literature by running a horse race of four currency value strategies based on the levels of the real exchange rate, 5-year change of the real exchange rate, the purchasing power parity approach and the closely related Big Mac Index approach using 39 emerging and developed market currencies. We find real exchange rate based strategies consistently outperform other competing strategies throughout the entire sample period. Currency value strategies based on the levels of the real exchange rate are the best performers for horizons up to one month, generating average excess returns of 7% p.a. In contrast, real exchange rate change strategies generate the largest excess returns (7% p.a. on average) for 1-12 month intervals. Purchasing power parity and Big Mac approaches underperform with returns typically less than 3% p.a. A composite strategy which combines overvaluation (undervaluation) signals from all four above mentioned measures yields highly significant returns. These average 10% p.a. over all holding periods and are as high as 15% p.a. for a two-week holding period. Limiting the sample by removing actively managed currencies results in larger returns on average.

Neither the relatively larger returns to the real exchange rate level and change approaches over shorter and longer holding periods respectively, nor the absolute returns to any of the four value approaches appear to be explained by economic state variables or currency risk factors. Moreover the returns that are generated appear to be larger than estimates of transaction costs.

CHAPTER FIVE

CONCLUSION

This chapter concludes the thesis by presenting a brief summary of the main findings from all the three essays in sections 5.1.1, 5.1.2 and 5.1.3 respectively.

5.1. Major Findings

5.1.1. Essay One

The first essay of this thesis explores whether momentum or reversal is the dominant phenomenon in weekly foreign exchange returns using a broad basket of 63 emerging and developed market currencies. Forward and spot exchange rate data on weekly and monthly frequency is obtained from Thomson Reuters Datastream. The main period of estimation starts in November 1997 and ends in July 2013, however, a robustness check is carried over the period January 1972 to October 1997 period. The results of the earlier as well as the recent sub-period confirm that there is strong evidence of momentum in 1- to 4-week currency returns contrary to the evidence in equity markets where reversal is the dominant phenomenon (Gutierrez and Kelley, 2008).

I find large and statistically significant annualized excess returns over 8% p.a. using 16 look-back and holding period currency investment strategies. The short-term currency momentum returns are robust to different portfolio and strategy formations. Returns increase with the increase in the look back period. Furthermore, the breakeven transaction costs range from 2 bps to 97 bps which imply that short term momentum profits can exist even after reasonable transaction costs for most of the strategies. Moreover, this essay contributes to the literature by showing the performance of the short horizon momentum strategies during UP and DOWN states of the foreign exchange market and during expansionary and recessionary phases of the US business cycle. The results illustrate that weekly currency momentum is higher during expansionary phases of the US business cycle and during DOWN (periods following depreciation of a basket of major currencies versus

the USD) state of the foreign exchange market. Finally, I show that rising FX volatility negatively impacts the short horizon momentum returns and there is evidence of inconsistent momentum returns during the recent global financial crisis period.

5.1.2. Essay Two

The second essay investigates whether the 52-week high momentum strategy (George and Hwang, 2004) is profitable in the foreign exchange market using a large basket of 63 emerging and developed market currencies. George and Hwang (2004) show a 52-week high momentum strategy, which involves buying (short-selling) stocks that are near to (far from) their 52-week high price yields higher returns than the price momentum strategy of Jegadeesh and Titman (1993) in equity markets. Essay two aims to explore the profitability of this strategy in the foreign exchange market. The 52-week high strategy is implemented such as the currencies whose prices are nearest to the 52-week high price are bought and the ones whose prices are the farthest are sold short and self-financing long – short portfolios are formed to calculate currency excess returns from a US investor's perspective. This essay also discusses the profitability of the closely related 52-week low and the 52-week high minus 52-week low strategies in currency markets.

The results suggest that the 52-week high strategy is not profitable in the foreign exchange market and generates negative returns over all holding horizons considered. For example, a 1-month holding period 52-week high strategy yields negative returns of about -2.98% p.a. and the losses increase to -5.68% for a 6-month investment horizon. The results show that the returns are less negative for the 52-week high minus low approach and the 52-week low strategy generates small positive returns. However, the overall

finding is evident. Neither the 52- week high strategy nor any of its derivations perform well in the foreign exchange market.

In the second part of the essay, possible explanations for the poor performance of the 52-week price strategies are considered. A partial explanation is the effect of non-independently floating currencies as these currencies move in a comparatively narrow band, they are consistently closer to either their 52-week high or low price than other freely floating currencies. These currencies are frequently included in the long or short portfolio but their prices do not change much in the holding period which decreases the overall portfolio returns. A slight improvement is noticed if these currencies are excluded from the sample. Another possible explanation of the negative returns to the aforementioned strategies is the length of the look-back period. Menkhoff, Sarno, Schmeling, and Schrimpf (2012a) show price momentum is strongest in currencies when a one month (4-week) look-back interval is used as compared to the longer intervals that are typically used in equity market momentum studies. However, the results recommend the length of the look-back period only plays a minor role in improving returns. Moreover, I also consider the timing of the 52-week high event as a possible explanation of poor 52-week high returns by following Bhootra and Hur (2013) who base their analysis on the behavioral hypothesis that investors tend to put more weight on recent information and performance. The results show that timing of the 52-week high price is not an important factor in lowering 52- week high FX returns. Finally, I consider whether the 52-week price momentum investing is only profitable in certain periods in currencies as Raza, Marshall, and Visaltanachoti (2014) show past return based FX momentum returns are stronger during US business cycle expansions and in periods when the US dollar is appreciating. My results in this

essay illustrate that 52-week high and its closely related strategies do not generate meaningful profits in these sub periods as well.

5.1.3. Essay Three

In the third essay of my thesis, I compare and contrast the profitability of various currency value strategies. Currency value strategies have not gained significant academic attention as compared to equity market value strategies and other currency trading strategies like momentum and carry trade. Furthermore, recent literature such as Asness, Moskowitz, and Pedersen (2013), Barroso and Santa-Clara (2014) and Kroencke, Schindler, and Schrimpf (2014) only discuss an identical long term measure of currency value based on the 5-year change of the real exchange rate. I build on the existing strand of currency value literature and assess, compare and contrast the suitability of other available measures of currency value in predicting currency excess returns from a multicurrency portfolio investment perspective in this essay.

In summary, I run a horse race of four currency value strategies based on the levels of the real exchange rate, 5-year change of the real exchange rate, the purchasing power parity approach and the closely related Big Mac Index approach using 39 emerging and developed market currencies. My results show that the real exchange rate based strategies consistently perform better than other competing strategies throughout the entire sample period which starts in January 1972 and ends in July 2013. Currency value strategies based on the levels of the real exchange rate outperform all other strategies at weekly investment horizons and yield excess returns up to 7% p.a. Strategies based on the 5-year change of the real exchange rate perform better at longer term (1- to 12-month) horizons and generate

excess returns over 7% p.a. I show a composite strategy which combines overvaluation (undervaluation) signals from all four above mentioned measures yields highly significant excess returns of up to 15% per year. Furthermore, I find currency value strategy returns improve when the currency basket is limited to independently floating currencies only.

My results show that real exchange rate based strategies are profitable as currencies used in these strategies do not switch portfolios frequently and therefore have a very low annual turnover and significantly higher breakeven transaction costs starting from 58 basis points. I find no linkage between the carry trade returns and currency value strategy returns. Therefore, currency value returns seem to exist independently of carry trade returns. My detailed regression analysis in this essay also confirms that FX value returns are not explained by a broad list of macroeconomic variables. Finally, the robustness checks included in this essay show real exchange rate based strategies yield higher excess returns during expansionary phases of the business cycle and in periods following positive market returns in the foreign exchange market.

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APPENDIX A

FOR ESSAY ONE

Appendix A.1
Individual Currency Characteristics

Currency	Symbol	Data Start	DF/NDF	Regime*	BIS Trading Volume (Rank)**
Argentine Peso	ARS	Mar-04		Pegged	35
Australian Dollar	AUD	Nov-97		Independently Floating	5
Austrian Schilling	ATS	Nov-97		Independently Floating	
Belgian Franc	BEF	Nov-97		Independently Floating	
Brazilian Real	BRL	Mar-04	NDF	Independently Floating	21
British Pound	GBP	Nov-97		Independently Floating	4
Bulgarian Lev	BGN	Mar-04		Currency Board	
Canadian Dollar	CAD	Nov-97		Independently Floating	7
Chilean Peso	CLP	Mar-04		Independently Floating	29
Colombian Peso	COP	Mar-04		Managed Float	32
Croatian Kuna	HRK	Mar-04		Pegged	
Cyprus Pound	CYP	Mar-04		Independently Floating	
Czech Koruna	CZK	Nov-97		Independently Floating	27
Danish Krone	DKK	Nov-97		Pegged	22
Deutsche Mark	DEM	Nov-97		Independently Floating	
Egyptian Pound	EGP	Mar-04	NDF	Managed Float	
Estonian Kroon	EEK	Mar-04		Currency Board	
Euro	EUR	Jan-99		Independently Floating	2
Finnish Markka	FIM	Nov-97		Independently Floating	
French Franc	FRF	Nov-97		Independently Floating	
Greek Drachma	GRD	Nov-97		Independently Floating	
Hong Kong Dollar	HKD	Nov-97		Currency Board	8
Hungarian Forint	HUF	Nov-97		Independently Floating	24
Iceland Krona	ISK	Mar-04		Independently Floating	
Indian Rupee	INR	Nov-97	NDF	Managed Float	15
Indonesian Rupiah	IDR	Nov-97	NDF	Managed Float	30
Irish Punt	IEP	Nov-97		Independently Floating	
Israeli New Shekel	ILS	Mar-04		Independently Floating	31
Italian Lira	ITL	Nov-97		Independently Floating	
Japanese Yen	YEN	Nov-97		Independently Floating	3
Kazakhstan Tenge	KZT	Mar-04	NDF	Pegged	
Kenyan Schilling	KES	Mar-04		Managed Float	
Kuwaiti Dinar	KWD	Nov-97		Pegged	

Latvian Lat	LVL	Mar-04		Pegged	
Lithuanian Litas	LTL	Mar-04		Currency Board	37
Maltese Lira	MTL	Mar-04		Independently Floating	
Mexican Peso	MXN	Nov-97		Independently Floating	14
Moroccan Dirham	MAD	Mar-04		Pegged	
Netherland Guilder	NLG	Nov-97		Pegged	
New Zealand Dollar	NZD	Nov-97		Independently Floating	10
Norwegian Krone	NOK	Nov-97		Independently Floating	13
Pakistan Rupee	PKR	Mar-04		Managed Float	
Philippine Peso	PHP	Nov-97	NDF	Independently Floating	28
Polish Zloty	PLN	Feb-02		Independently Floating	18
Portuguese Escudo	PTE	Nov-97		Independently Floating	
Qatar Rial	QAR	Mar-04		Pegged	
Romanian Leu	RON	Mar-04		Managed Float	33
Russian Rouble	RUB	Mar-04	^NDF/DF	Pegged	16
Saudi Rial	SAR	Nov-97		Pegged	34
Singapore Dollar	SGD	Nov-97		Managed Float	12
Slovak Koruna	SKK	Feb-02		Pegged	
Slovenian Tolar	SIT	Mar-04		Independently Floating	
South African Rand	ZAR	Nov-97		Independently Floating	20
South Korean Won	KRW	Feb-02	NDF	Independently Floating	11
Spanish Peseta	ESP	Nov-97		Independently Floating	
Swedish Krona	SEK	Nov-97		Independently Floating	9
Swiss Franc	CHF	Nov-97		Independently Floating	6
Taiwan New Dollar	TWD	Nov-97	NDF	Pegged	23
Thai Baht	THB	Nov-97		Managed Float	26
Tunisian Dinar	TND	Mar-04		Pegged	
Turkish Lira	TRY	Nov-97		Independently Floating	19
Ukraine Hryvnia	UAH	Mar-04	NDF	Managed Float	
United Arab Emirates Dirham	AED	Nov-97		Pegged	
US Dollar	USD	Nov-97		Independently Floating	1

*****Source: IMF's De Facto classification of exchange rate regimes and monetary policy frameworks available online at https://www.imf.org/external/np/mfd/er/2008/eng/0408.htm

******Source: Bank for International Settlements Triennial Central Bank Survey. Report on Global Foreign Exchange Market Activity in 2010. ISBN 92-9197-854-X. Page 12 Table B.4

DF: Deliverable forward

NDF: Non-Deliverable Forward

^Russian Rouble is traded in both NDF and DF markets in large volumes.

All data series end in July 2013 except the Euro constituent currencies.

Appendix A.2

Currency Look-back and Holding Period Returns (3 Portfolios)

	Holding period				Holding period			
	1-Week	2-Week	3-Week	4-Week	1-Week	2-Week	3-Week	4-Week
Portfolio	**Panel A**	**(1-Week Look-back)**			**Panel C**	**(3-Week Look-back)**		
Winner – Loser (%)	0.039	0.116	0.208	0.269	0.127	0.242	0.308	0.365
Mean (%)	**2.033**	**3.008**	**3.610**	**3.233**	**6.598**	**6.297**	**5.345**	**4.386**
Max (%)	6.430	4.906	9.342	7.070	5.754	5.749	8.444	7.754
Min (%)	-3.966	-7.028	-8.251	-12.815	-3.014	-6.502	-6.347	-7.322
t-stat.	1.181	2.373	3.657	3.927	4.013	4.430	4.049	3.919
p-value	0.119	0.009	0.000	0.000	0.000	0.000	0.000	0.000
Volatility (%)	7.214	6.991	6.958	6.911	7.167	6.769	6.828	6.705
Sharpe Ratio	**0.282**	**0.430**	**0.519**	**0.468**	**0.921**	**0.930**	**0.783**	**0.654**
Winner (mean %)	0.073	0.157	0.256	0.338	0.119	0.232	0.318	0.402
Max (%)	7.128	5.119	6.803	10.204	6.400	8.570	7.015	6.773
Min (%)	-4.618	-9.445	-10.576	-17.229	-3.747	-6.008	-6.863	-12.120
Loser (mean %)	0.034	0.041	0.047	0.069	-0.008	-0.010	0.010	0.037
Max (%)	4.147	6.600	6.714	7.583	3.267	6.668	7.042	8.400
Min (%)	-5.697	-6.182	-11.471	-8.322	-7.478	-9.572	-13.245	-13.412
	Panel B	**(2-Week Look-back)**			**Panel D**	**(4-Week Look-back)**		
Winner – Loser (%)	0.081	0.182	0.252	0.291	0.110	0.198	0.277	0.537
Mean (%)	**4.188**	**4.721**	**4.370**	**3.494**	**5.705**	**5.137**	**4.805**	**6.441**
Max (%)	4.468	4.466	6.947	8.633	5.412	5.568	9.326	10.526
Min (%)	-4.846	-4.810	-4.582	-7.470	-3.716	-6.505	-6.616	-6.147
t-stat.	2.404	3.490	3.799	3.439	3.385	3.374	3.420	5.281
p-value	0.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Volatility (%)	7.124	6.542	6.561	6.567	7.029	6.760	6.840	6.654
Sharpe Ratio	**0.588**	**0.722**	**0.666**	**0.532**	**0.812**	**0.760**	**0.703**	**0.968**
Winner (mean %)	0.100	0.200	0.286	0.362	0.108	0.202	0.298	0.486
Max (%)	6.537	6.719	7.911	7.019	7.034	4.998	6.268	8.481
Min (%)	-6.446	-8.387	-9.269	-15.093	-3.881	-5.535	-7.491	-8.093
Loser (mean %)	0.020	0.018	0.034	0.070	-0.002	0.004	0.021	-0.051
Max (%)	3.691	5.819	5.890	7.785	4.083	6.721	7.031	7.639
Min (%)	-6.528	-6.684	-10.349	-9.899	-6.695	-9.724	-13.871	-15.493

This table presents average excess returns of the Winner-Loser (long-short) portfolio using 63 currencies against the USD for 1-,2-,3- and 4-week formation and holding periods over the period November 1997-July 2013. Portfolios consist of 33% of available currencies. Positive returns indicate momentum whereas negative returns indicate reversal. The excess returns are calculated as ln(ft)-ln(St+1) and are in percent. The Mean and Volatility figures are annualized and are in percent. The Sharpe Ratio is calculated by dividing annualized excess returns by annualized volatility. The t-statistics are based on Newey-West standard errors.

Appendix A.3

Currency Momentum and Carry Trade (HML_{FX})

Strategy	α	β	R^2
MOM(1,1)	0.003	-0.088	0.011
	(1.994)	(-1.571)	
MOM(1,2)	0.002	0.052	0.005
	(1.575)	(0.727)	
MOM(1,3)	0.003	-0.020	0.001
	(3.373)	(-0.487)	
MOM(1,4)	0.003	0.005	0.000
	(3.350)	(0.161)	
MOM(2,1)	0.005	-0.002	0.000
	(2.142)	(-0.021)	
MOM(2,2)	0.005	0.040	0.003
	(3.006)	(0.514)	
MOM(2,3)	0.005	-0.003	0.000
	(4.289)	(-0.076)	
MOM(2,4)	0.004	0.031	0.003
	(3.266)	(0.809)	
MOM(3,1)	0.006	0.017	0.000
	(4.183)	(0.250)	
MOM(3,2)	0.006	0.037	0.002
	(4.187)	(0.562)	
MOM(3,3)	0.005	0.012	0.000
	(4.038)	(0.254)	
MOM(3,4)	0.004	0.056	0.007
	(3.365)	(1.142)	
MOM(4,1)	0.005	0.005	0.000
	(3.163)	(0.085)	
MOM(4,2)	0.004	0.065	0.006
	(2.699)	(1.090)	
MOM(4,3)	0.004	0.078	0.012
	(2.710)	(1.617)	
MOM(4,4)	0.006	0.113	0.025
	(4.344)	(1.770)	

This table shows the regression of carry trade returns on the weekly FX momentum returns. All (Momentum and carry trade) return series are on a monthly basis in this regression specification as the HML_{FX} data was only available on a monthly frequency. HML_{FX} is the return to the carry trade long-short portfolio (Lustig, Roussanov, and Verdelhan, 2011). Insignificant betas imply that momentum returns are different from the returns of the carry trade strategy. The t-statistics are based on Newey-West standard errors.

Appendix A.4

Currency Look-back and Holding Period Returns during the Global Financial Crisis

	Holding period				Holding period			
	1-Week	2-Week	3-Week	4-Week	1-Week	2-Week	3-Week	4-Week
Portfolio	**Panel A**	**(1-Week Look-back)**			**Panel C**	**(3-Week Look-back)**		
Winner – Loser (%)	-0.033	-0.157	0.058	0.094	0.021	0.155	0.283	0.272
Mean (%)	**-1.710**	**-4.082**	**1.009**	**1.122**	**1.068**	**4.028**	**4.897**	**3.263**
Max (%)	7.261	5.570	11.245	7.719	6.365	5.098	10.576	8.800
Min (%)	-4.685	-7.935	-9.245	-13.507	-5.798	-8.768	-6.804	-8.219
t-stat.	-0.331	-0.963	0.372	0.520	0.214	0.913	1.033	0.776
p-value	0.371	0.169	0.355	0.302	0.415	0.182	0.152	0.219
Volatility (%)	10.367	10.089	9.497	9.609	11.189	9.149	9.572	9.980
Sharpe Ratio	**-0.165**	**-0.405**	**0.106**	**0.117**	**0.095**	**0.440**	**0.512**	**0.327**
Winner (mean %)	0.020	-0.078	0.072	0.127	0.051	0.144	0.231	0.280
Max (%)	7.502	5.946	5.805	9.575	5.688	6.357	5.345	5.380
Min (%)	-5.268	-10.956	-12.422	-19.777	-4.405	-5.733	-7.710	-11.933
Loser (mean %)	0.053	0.079	0.014	0.034	0.030	-0.011	-0.052	0.008
Max (%)	4.252	7.966	7.594	7.969	5.739	8.808	7.782	9.108
Min (%)	-7.179	-5.963	-12.045	-10.338	-7.552	-10.467	-12.217	-13.396
	Panel B	**(2-Week Look-back)**			**Panel D**	**(4-Week Look-back)**		
Winner – Loser (%)	-0.112	-0.079	0.058	0.058	0.005	0.016	0.012	0.947
Mean (%)	**-5.809**	**-2.053**	**1.000**	**0.699**	**0.254**	**0.423**	**0.205**	**11.368**
Max (%)	5.761	3.206	7.237	7.993	7.038	4.702	7.044	11.402
Min (%)	-5.465	-5.269	-5.653	-7.585	-5.852	-6.345	-7.888	-7.438
t-stat.	-0.834	-0.443	0.311	0.192	0.050	0.084	0.042	2.155
p-value	0.203	0.329	0.378	0.424	0.480	0.467	0.483	0.016
Volatility (%)	10.727	8.383	7.924	9.326	11.144	9.593	9.639	10.608
Sharpe Ratio	**-0.542**	**-0.245**	**0.126**	**0.075**	**0.023**	**0.044**	**0.021**	**1.072**
Winner (mean %)	-0.039	0.010	0.119	0.175	0.080	0.114	0.135	0.682
Max (%)	4.718	5.130	6.376	5.850	5.535	4.097	5.685	5.865
Min (%)	-7.465	-8.316	-10.515	-14.971	-4.770	-5.983	-7.020	-8.487
Loser (mean %)	0.073	0.089	0.061	0.117	0.075	0.098	0.123	-0.265
Max (%)	5.644	7.017	5.284	9.316	5.920	7.612	7.743	7.044
Min (%)	-7.507	-10.023	-10.929	-11.503	-7.741	-9.566	-11.279	-16.879

This table presents average excess returns of the Winner-Loser (long-short) portfolio using 63 currencies against the USD for 1-,2-,3- and 4-week formation and holding periods over the global financial crisis period of June 2007 to December 2009. Portfolios consist of 20% of available currencies. Positive returns indicate momentum whereas negative returns indicate reversal. The excess returns are calculated as ln(ft)-ln(St+1) and are in percent. The Mean and Volatility figures are annualized and are in percent. The Sharpe Ratio is calculated by dividing annualized excess returns by annualized volatility. The t-statistics are based on Newey-West standard errors.

APPENDIX B

FOR ESSAY TWO

Appendix B.1
Currency Portfolio Composition Analysis

Currency	52-Week High			52-Week Low			Mean Range (%)
	Long (%)	Middle (%)	Short (%)	Long (%)	Middle (%)	Short (%)	
United Arab Emirates Dirham	89.305	10.695	0.000	0.000	6.417	93.583	0.081
Qatar Rial	85.714	14.286	0.000	0.000	4.464	95.536	0.191
Saudi Rial	87.701	12.299	0.000	0.000	8.556	91.444	0.209
Hong Kong Dollar	78.075	21.925	0.000	0.000	13.904	86.096	0.448
Kuwaiti Dinar	65.241	33.690	1.070	0.535	59.358	40.107	2.987
Egyptian Pound	51.786	34.821	13.393	2.679	29.464	67.857	6.783
Taiwan New Dollar	28.877	59.893	11.230	4.278	78.610	17.112	7.825
Pakistan Rupee	8.036	71.429	20.536	0.893	20.536	78.571	8.369
Singapore Dollar	26.203	72.727	1.070	3.743	91.444	4.813	8.561
Kazakhstan Tenge	35.714	44.643	19.643	3.571	54.464	41.964	9.596
Indian Rupee	12.299	72.727	14.973	2.139	73.797	24.064	10.205
Ukraine Hryvnia	33.929	52.679	13.393	9.821	47.321	42.857	10.569
Lithuanian Litas	1.786	81.250	16.964	4.464	94.643	0.893	11.191
Latvian Lat	5.357	81.250	13.393	3.571	94.643	1.786	11.219
Israeli New Shekel	17.857	75.893	6.250	12.500	75.893	11.607	11.407
Tunisian Dinar	1.786	86.607	11.607	0.000	86.607	13.393	11.684
British Pound	9.091	83.422	7.487	9.626	82.888	7.487	12.553
Moroccan Dirham	5.357	94.643	0.000	0.893	98.214	0.893	12.659
Philippine Peso	19.786	57.219	22.995	17.647	63.102	19.251	12.866
Kenyan Schilling	14.286	64.286	21.429	16.071	67.857	16.071	12.983
Canadian Dollar	14.439	73.797	11.765	19.251	73.262	7.487	13.000
Maltese Lira	0.000	100.000	0.000	0.000	97.778	2.222	13.223
Mexican Peso	12.299	56.150	31.551	22.460	64.171	13.369	14.016
Argentine Peso	5.357	58.036	36.607	0.000	1.786	98.214	14.565
Bulgarian Lev	8.036	75.893	16.071	3.571	94.643	1.786	14.988
Cyprus Pound	8.889	84.444	6.667	6.667	93.333	0.000	15.276
Japanese Yen	14.973	57.219	27.807	24.599	69.519	5.882	15.326
Croatian Kuna	11.607	73.214	15.179	11.607	87.500	0.893	15.569
Estonian Kroon	7.407	71.605	20.988	1.235	98.765	0.000	15.694
Slovenian Tolar	0.000	90.909	9.091	0.000	100.000	0.000	16.015
Irish Punt	0.000	100.000	0.000	0.000	83.333	16.667	16.025

Thai Baht	19.251	62.567	18.182	19.251	74.332	6.417	16.098
Danish Krone	6.952	74.866	18.182	9.626	86.096	4.278	16.133
Italian Lira	8.333	91.667	0.000	0.000	100.000	0.000	16.133
Finnish Marrakka	8.333	91.667	0.000	0.000	91.667	8.333	16.157
Euro	6.135	83.436	10.429	11.656	85.276	3.067	16.174
French Franc	8.333	91.667	0.000	33.333	66.667	0.000	16.188
Deutsche Mark	8.333	91.667	0.000	0.000	100.000	0.000	16.189
Austrian Schilling	33.333	66.667	0.000	0.000	100.000	0.000	16.192
Belgian Franc	33.333	66.667	0.000	16.667	83.333	0.000	16.198
Spanish Peseta	0.000	100.000	0.000	0.000	100.000	0.000	16.199
Netherland Guilder	0.000	100.000	0.000	0.000	100.000	0.000	16.206
Portuguese Escudo	0.000	100.000	0.000	0.000	100.000	0.000	16.216
Swiss Franc	8.021	68.984	22.995	26.203	70.588	3.209	16.224
Greek Drachma	2.778	58.333	38.889	22.222	61.111	16.667	16.424
Chilean Peso	10.714	65.179	24.107	36.607	59.821	3.571	16.803
Slovak Koruna	13.415	74.390	12.195	68.293	30.488	1.220	17.283
Norwegian Krone	6.952	83.957	9.091	24.064	73.797	2.139	17.717
Swedish Krona	4.813	75.401	19.786	32.086	64.171	3.743	17.860
Colombian Peso	17.857	58.036	24.107	50.893	44.643	4.464	18.991
Russian Rouble	13.393	74.107	12.500	8.036	85.714	6.250	19.162
South Korean Won	14.599	72.263	13.139	26.277	65.693	8.029	20.656
Australian Dollar	9.626	69.519	20.856	45.455	50.802	3.743	20.668
Iceland Krona	6.250	43.750	50.000	37.500	56.250	6.250	20.965
Czech Koruna	10.695	59.358	29.947	54.545	43.316	2.139	21.007
Hungarian Forint	8.021	48.663	43.316	46.524	43.850	9.626	21.010
Polish Zloty	5.109	55.474	39.416	56.934	40.146	2.920	21.213
New Zealand Dollar	9.091	59.358	31.551	48.663	47.594	3.743	21.386
Romanian Leu	2.679	50.000	47.321	44.643	51.786	3.571	21.831
Brazilian Real	16.071	51.786	32.143	53.571	42.857	3.571	25.674
Indonesian Rupiah	9.091	45.989	44.920	37.968	45.989	16.043	27.358
South African Rand	4.278	39.037	56.684	43.850	49.198	6.952	28.017
Turkish Lira	4.571	37.143	58.286	27.429	50.857	21.714	31.502

In this table, we report the inclusion of a particular currency in Long, Middle and Short portfolio of the 52-week high and 52-week low FX momentum strategy in percentage terms. For instance, the United Arab Emirates Dirham has been a constituent of the Long portfolio of the 52-week high strategy (near to the 52-week high price) 89.30% of the times. Similarly, the Thai Baht has been a part of the Short portfolio of the 52-week low strategy (near to the 52-week low price) 6.42% of the times during the overall strategy estimation period of January 1997 to July 2013. The mean range is calculated as the average of the absolute percentage (log) difference between the highest and lowest price of a currency in a particular year averaged over the entire estimation period. We present currencies based on the ascending mean range numbers. All non-independently floating currencies are in bold font.

Appendix B.2
52-Week Price FX Momentum Returns and the Carry Trade (HML_{FX})

Strategy	A	β	R^2
Panel A. 52-Week High			
52W(1)	0.001	-0.358	0.098
t-stat	(0.564)	(-3.711)	
52W(3)	-0.008	-0.248	0.018
t-stat	(-1.867)	(-1.577)	
52W(6)	-0.019	-0.350	0.017
t-stat	(-2.721)	(-1.401)	
Panel B. 52-Week Low			
52W(1)	0.003	0.018	0.000
t-stat	(1.219)	(0.188)	
52W(3)	0.005	0.182	0.010
t-stat	(1.139)	(1.338)	
52W(6)	0.013	-0.010	0.000
t-stat	(1.829)	(-0.043)	
Panel C. 52-Week High – Low			
52W(1)	0.002	-0.152	0.024
t-stat	(1.208)	(-2.003)	
52W(3)	-0.001	0.060	0.001
t-stat	(-0.332)	(0.431)	
52W(6)	-0.003	-0.135	0.003
t-stat	(-0.485)	(-0.639)	

This table shows the results of a time series regression of the 52-week high, low and high-low returns on the carry trade portfolio returns. Carry trade return series is obtained from Lustig, Roussanov, and Verdelhan (2011). 52W(1) refers to the one year (52-week) look back and one month holding period strategy. Similarly, 52W(3) and 52W(6) refer to the 3 and 6 month holding period strategies. Insignificant betas imply that the 52-week high, low and high-low momentum returns are different from the returns of the carry trade strategy. HAC robust (Newey-West) based *t*-statistics are in parentheses. We employ independently floating currencies only in this estimation.

APPENDIX C

FOR ESSAY THREE

Appendix C.1
Macroeconomic Variables, Currency Risk Factors and Value Returns

Strategy	Cons	Empl	MI	IP	M2	DPI	TED	Term	HML_{FX}	VOL_{FX}
Panel A. Real Exchange Rate Changes										
1-Week	-0.006	-0.083	**0.000**	**-0.073**	**0.111**	0.008	0.027	-0.020	-0.002	-0.024
2-Week	-0.008	-0.214	**0.000**	**-0.151**	**0.209**	0.018	0.058	-0.032	-0.003	-0.034
3-Week	-0.007	-0.324	**0.000**	**-0.208**	0.282	-0.018	0.068	-0.039	-0.005	-0.028
1-Month	**0.410**	0.036	0.000	-0.060	0.157	0.051	-0.124	-0.038	-0.044	-0.055
3-Month	**0.684**	0.765	-0.001	0.061	0.499	0.220	-0.301	0.103	0.178	-0.010
6-Month	-0.088	1.797	0.000	0.212	0.163	0.274	0.471	0.246	0.079	-0.075
9-Month	0.153	3.402	-0.001	0.254	2.467	0.636	0.909	0.425	-0.072	0.012
12-Month	0.321	**8.597**	0.001	1.122	**3.085**	0.889	1.555	0.520	0.255	0.122
Panel B. Real Exchange Rate Levels										
1-Week	0.020	**0.333**	0.000	**0.103**	-0.109	-0.003	**-0.076**	-0.007	0.004	0.018
2-Week	0.020	**0.692**	0.000	**0.233**	-0.178	-0.001	**-0.142**	-0.007	0.010	0.033
3-Week	0.027	**1.218**	0.000	**0.297**	-0.275	-0.002	**-0.177**	-0.004	0.025	0.073
1-Month	0.165	**1.125**	0.000	0.242	-0.226	-0.135	**-0.247**	-0.047	**0.302**	**-0.156**
3-Month	0.331	**4.008**	0.001	0.620	-0.946	-0.264	-0.577	-0.117	0.191	0.081
6-Month	0.075	5.213	0.001	0.395	-1.777	**-0.879**	**-1.123**	-0.118	0.070	0.024
9-Month	0.302	6.564	0.001	0.655	**-2.738**	-0.852	**-1.858**	-0.126	0.030	-0.079
12-Month	0.669	9.170	0.001	1.354	-4.626	-1.013	-2.308	-0.379	0.246	-0.014
Panel C. Purchasing Power Parity										
1-Week	0.000	-0.064	0.000	-0.021	0.043	0.018	-0.004	0.003	-0.002	0.012
2-Week	-0.013	-0.119	0.000	-0.041	0.083	0.011	-0.013	0.008	-0.015	0.028
3-Week	-0.046	-0.216	0.000	-0.083	0.081	-0.017	-0.018	0.011	-0.021	**0.052**
1-Month	**-0.162**	-0.307	0.000	-0.129	-0.387	-0.011	-0.003	-0.005	0.085	-0.053
3-Month	**-0.359**	-1.361	**-0.001**	**-0.640**	-0.282	-0.098	-0.195	-0.049	0.027	0.039
6-Month	0.081	**-3.454**	**-0.002**	**-0.856**	0.668	**-0.674**	**-0.840**	-0.091	-0.065	0.011
9-Month	0.165	**-4.122**	**-0.002**	-0.856	-0.346	**-0.970**	**-1.236**	-0.360	0.091	0.086
12-Month	0.099	-4.133	**-0.002**	-0.571	-0.784	**-1.046**	**-1.652**	-0.516	0.167	-0.068

Panel D. Big Mac Index										
1-Week	**-0.039**	0.112	0.000	0.065	**0.100**	**0.049**	**0.075**	0.003	0.000	-0.005
2-Week	**-0.074**	0.203	0.000	0.102	**0.261**	0.060	**0.167**	0.010	-0.002	0.006
3-Week	**-0.090**	0.298	0.000	0.154	**0.443**	0.079	0.218	0.009	0.020	-0.004
1-Month	-0.034	0.439	0.000	0.124	0.257	0.119	**0.516**	-0.031	**0.194**	-0.062
3-Month	-0.181	-0.108	0.000	-0.136	0.978	0.362	**1.085**	0.075	0.183	-0.094
6-Month	**0.700**	-2.835	-0.001	-0.301	0.216	-0.136	0.926	0.197	-0.099	-0.126
9-Month	**0.692**	-4.196	-0.001	-0.016	0.882	0.020	0.720	0.473	**0.539**	-0.083
12-Month	**0.919**	-4.612	0.001	0.104	-1.541	-0.237	0.555	**1.063**	0.294	-0.027

The structure and information provided in this table is similar to Table 4.4 in the main text, however, here we regress individual strategy returns on macroeconomic variables rather than the differences of strategy returns as we did in Table 4.4. “Cons” in this table refers to growth in US real personal consumption expenditures. “Empl” stands for US total nonfarm employment growth, “MI” denotes US ISM Manufacturing PMI Composite Index, “IP" represents growth in US industrial production. “M2” stands for growth in real money balances. “DPI” denotes growth in real disposable personal income. “TED” spread is the difference between 3-month interbank and T-bill rates whereas “Term” spread represents the difference between 20-year maturity and 3-month maturity T-bill rate. “HMLFX” and “VOLFX” represent the returns to carry trade and foreign exchange volatility respectively. Slope coefficients which are significant at 10% level are in bold font. We used Newey-West standard errors in this regression estimation.