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To my family

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ABSTRACT

This thesis consists of three chapters and focuses on the relationship between foreign exchange rates and other areas of Finance. The first chapter is sole-authored and is titled 'Foreign Exchange Rate Exposure and Corporate Policies.' The second chapter is coauthored work with Professor Emeritus Paul Weller, Assistant Vice President Chris Neely and Professor David Rapach and is titled 'Can Risk Explain the Profitability of Technical Trading in Currency Markets.' The third chapter is titled 'Foreign Exchange Movements and Cross-country Fund Allocation Decisions.'

In the first chapter, I examine the relationship between foreign exchange rate exposure and corporate policies. Despite the fact that empirical tests estimate foreign exchange rate exposure net of corporate hedging, there are still firms that exhibit significant residual exposures. It is believed that when faced with higher foreign exchange rate exposure, companies are more likely to run into an underinvestment problem. Therefore, in the current study I explore whether foreign exchange rate exposure is reflected in corporate policies beyond hedging. I establish that companies with higher foreign exchange rate exposure tend to hold more cash, have a higher likelihood of accessing capital markets and are less likely to issue dividends. Further, the relationship between foreign exchange rate exposure and these corporate policies is more pronounced for firms for which the underinvestment problem is likely to be more severe, namely firms with higher growth opportunities and firms operating in more competitive industries. Additionally, I find that half of the significant foreign exchange rate exposures in my sample come from firms with only domestic sales. Thus, I conclude that foreign exchange rate exposure is relevant not only to the decisions of multinational corporations

with international involvement, but also for domestic corporations and deserves additional investigation.

The second chapter examines the robust finding that technical trading rules applied to foreign exchange markets have earned substantial excess returns over long periods of time. However, the approach to risk adjustment has typically been rather cursory, and has tended to focus on the CAPM. We examine the returns to a set of dynamic trading rules and look at the explanatory power of a wide range of models: CAPM, quadratic CAPM, C-CAPM, Carhart's 4-factor model, an extended C-CAPM with durable consumption, Lustig-Verdelhan (LV) factors, volatility and skewness. Although skewness has some modest explanatory power for the observed excess returns, no model can plausibly account for the very strong evidence in favor of the profitability of technical analysis in the foreign exchange market. We conclude that these findings strengthen the case for considering models incorporating cognitive bias and the processes of learning and adaptation, as exemplified in the Adaptive Markets Hypothesis.

The third chapter is motivated by the fact that investment success in international equity markets is a function of the stock picking ability of the manager within the particular foreign market as well as the (un)favorable foreign exchange rate movements against the domestic currency. Therefore, the objective of this paper is to study in more detail the relationship between currency returns and the cross country equity flows of U.S. international equity mutual funds. We are interested in the question of whether mutual funds are able to take advantage of beneficial currency movements, and more importantly whether they destroy value through inappropriate currency positions. We establish that funds are better at managing contemporaneous changes in currency movements rather than at predicting future changes. We find that 80% of the funds increase their portfolio exposure to a particular currency (by increasing the relevant country allocation) when it has positive returns and decrease the exposure to that currency when it has negative returns. Further, the average fund does not create or destroy significant value through its country allocation decisions. Moreover, mutual fund managers do not have an advantage in predicting certain currencies over others. Most importantly however, it has to be noted that international mutual funds are not eroding value through their currency management, even in the case of the most active funds.

PUBLIC ABSTRACT

In this dissertation I explore the connections between foreign exchange markets and risk and other areas of finance. This is an area that has not been explored a lot and can provide interesting insights for academics and practitioners alike.

In the first chapter, I study how companies can manage currency risk beyond the usual hedging. The main finding is that in order to buffer this risk, companies that are highly exposed to foreign exchange movements hold more cash, access external capital markets more often, and issue fewer dividends. Additionally, it is stressed that currency risk is relevant not just for companies with direct international exposure, but also for domestic firms.

In the second chapter, we address the question of what risk factors can explain the high returns earned by technical trading in currency markets. We find that models that are known in the literature to explain the profitability of other currency strategies have little bearing on technical trading, which makes this puzzle even more mysterious.

In the last chapter, we explore whether international equity mutual fund managers are able to take advantage of beneficial currency movements and more importantly whether they destroy value through inappropriate currency positions. We find that managers are better at detecting and responding to contemporaneous currency changes rather than at predicting future currency movements. Most importantly however, we stress that international mutual funds are not eroding value through their currency management even in the case of the most active funds.

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1. CHAPTER
FOREIGN EXCHANGE RATE EXPOSURE AND CORPORATE POLICIES

1.1 Introduction

The interest in the link between foreign exchange rates and firm value dates back to the fall of the Bretton Woods system in the beginning of the 1970's. It is generally believed that exchange rate fluctuations are an important source of macroeconomic uncertainty that should have significant impact on firm value[1]. The theoretical exchange rate exposure literature[2] claims that in the presence of exchange rate changes, the cash flow volatility of the firm increases. Therefore, firms are more likely to face an underinvestment problem and run out of funds to take on positive NPV projects; which in turn affects the value of the firm. However, empirical tests of the sensitivity of firm value to exchange rate movements[3] have produced mixed results with some authors finding no significant exposure[4] and others finding better proof for its existence[5]. This mixed evidence is known as the foreign exchange rate exposure puzzle.

One of the possible explanations for the puzzle is that firms can hedge their exposure to foreign exchange rate fluctuations either through financial instruments; operational hedging or pass-through[6] and the estimated empirical exposures are actually residual exposures net of hedging(Bartram & Bodnar, 2005).[7] At the same time, markets are not frictionless and hedging is costly. Even if employed, hedging might not be effective due to the difficulty to measure the indirect economic component of foreign exchange rate exposure and the need to roll over contracts[8]. Therefore, certain firms can still have high residual foreign exchange rate exposures and face an underinvestment problem due to increased cash flow volatility.

This is where the current study initiates its analysis and seeks to explore whether higher firm exposure to foreign exchange rate fluctuations is associated with changes in corporate policies beyond hedging. It is hypothesized that firm foreign exchange rate exposure is related to corporate policies that secure funds in the case of possible underinvestment. For example, firms might need to access capital markets more often, stockpile cash in case of shortages or even change their dividend payout policy. Thus, this paper attempts to bridge the gap between the

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[1] Shapiro, 1975; Levi, 1994; Marston, 2001
[2] Shapiro & Titman, 1985; Lessard, 1990; Stulz, 1990; Froot, Scharfstein, & Stein, 1993
[3] Referred to as foreign exchange rate exposure (Jorion, 1990) and measured as the coefficient from regressions of stock returns on exchange rate changes.
[4] Jorion, 1990; Gentry & Bodnar, 1993; Amihud, 1994; Miller & Reuer, 1998; Hsin, Shiah-Hou, & Chang, 2007; Choi & Jiang, 2009
[5] He & Ng, 1998; Doukas, Hall, & Lang, 2003; Kiymaz, 2003; Huffman, Makar, & Beyer, 2010
[6] Hsin, Shiah-Hou, & Chang, 2007; Choi & Jiang, 2009
[7] Some alternative motivations for why firms engage in hedging activities are convexity of tax schedule, transactional costs of bankruptcy and managerial risk aversion and compensation structure (Smith & Stulz, 1985).
[8] Stulz & Williamson, 2000; Di Iorio & Faff, 2000; Williamson, 2001

exchange rate exposure literature and the studies on corporate policies (cash holdings, dividend payout and capital issuance) and determine whether there are actions beyond hedging that could counteract the negative effects of firm sensitivity to exchange rate changes.

Foreign exchange rate (FX) exposure is applicable to cash decisions within the context of the precautionary motive, which states that firms will use cash as a buffer against adverse cash flow shocks[9], especially if they have greater investment opportunities[10]. As movements in exchange rates lead to instability of firm cash flows, either directly through translation of its earnings or indirectly through changes in the competitive environment, it is expected that firms with higher FX exposure will hold higher levels of cash to prevent possible underinvestment.

Further, if a company with high FX exposure cannot secure funding necessary for its projects internally, it can access external financial markets which will increase the likelihood of capital issuance. This idea is partially related to the pecking order theory, according to which, the decision to issue capital depends primarily on the firm's availability of internal funds and the possible investment opportunities that the company faces[11]. Therefore, factors like foreign exchange rate exposure that affect the cash flow stability of the firm are also believed to be related to its financing decision, especially for firms that can run into an underinvestment problem.

Lastly, as an alternative to holding more cash, firms with higher exposure to exchange rate changes can alter their dividend payout to secure funds for their projects. This idea is related to two themes in the dividend payout literature: the life-cycle motive, according to which firms choose their optimal payout in response to the evolution of their opportunity set[12], and the discussion of cash-flow instability as one of the influential factors on dividend payouts[13].

Additionally, one could expect that the relationship between corporate policies and FX exposure will be stronger in cases when the possible underinvestment is more severe: a) when a firm has more investment opportunities or b) when it is part of a competitive industry with large degree of shared investment opportunities.

It has to be emphasized that the span of firms that could be affected by exchange rate fluctuations today is different from what it was several decades ago. It is likely that twenty or thirty years ago when markets were relatively closed, for political or economic reasons, fluctuations in exchange rates were more relevant to multinational corporations which were doing business directly in foreign countries. However, as economic markets have become more

[9] Campell, Almeida, & Acharya, 2007; Bates, Kahle, & Stulz, 2009
[10] Williamson, Stulz, Pinkowitz, & Opler, 1999
[11] Myers & Shyam-Sunder, 1999; Rangan & Flannery, 2006; Dasgupta & Chang, 2009; Goyal & Frank, 2003
[12] DeAngelo & DeAngelo, 2006; DeAngelo, DeAngelo, & Stulz, 2006; Denis & Osobov, 2008
[13] Lintner, 1956; Brav, Graham, Harvey, & Michaely, 2005; Chay & Suh, 2009

integrated over the last couple of decades, this view has changed. Thus, today not only MNC's but also domestic companies are likely to be affected by currency movements either through their supply chain, their customers or through the decisions of their competitors. As markets become more globalized, exchange rate sensitivity becomes more relevant to the average firm[14].

The empirical analysis conducted confirms the initial expectations about the relationship between exchange rate exposure and corporate policies. The main findings can be summarized as follows:

The mean estimated foreign exchange rate exposure in the sample is - 0.57 [15] indicating that the average firm has adverse stock price reactions to U.S. dollar appreciation and benefits from its depreciation. This means that 1% depreciation of the U.S. dollar against other currencies is accompanied by 0.57% increase in firm value. Furthermore, almost half of the firm exchange rate exposures (49%) are statistically significant at the 10% level[16], suggesting that a major part of the firms experience significant changes in their value responding to fluctuations in exchange rates. The current results are believed to complement and expand on the findings of Huffman et al (2010)[17] because the present sample is considerably larger (1231 firms) and is not constrained to MNC's that have foreign sales. Specifically, 52% of the significant FX exposures come from firms that are not internationally involved. This indicates that even firms that are domestic are affected by exchange rate changes confirming that today exchange rate exposure is relevant to the average firm and not just to MNC's. Further, it is established that firms that are smaller, are more internationally involved, are less diversified and are in less competitive industries tend to have higher exchange rate exposures.

Next, the relationship between cash holdings and foreign exchange exposure is explored. I find a positive and significant association between firm cash ratio and FX exposure (β_{FX})[18]. This indicates that firms that are more sensitive to exchange rate fluctuations also tend to have larger cash holdings as a proportion of assets, which is consistent with the precautionary motive for cash demand. Everything else equal, an increase in β_{FX} from the 25th to the 75th percentile leads to an 8.6% *relative* increase in cash holdings, based on comparison to the sample median of 4.42%. In addition, it is shown that the coefficient on β_{FX} increases monotonically with the increase of company investment opportunities and is significant only for firms with high

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14 Therefore, unlike previous studies, the current analysis does not pose restrictions on specific industries or the international involvement of the companies in the sample. The main sample covers the period between 1992 and 2008 and includes companies with full stock price information (initially 1231).

15 Static approach of estimation

16 And 40% of the exposures are significant at the 5% level

17 They also use the FF three-factor model for their estimation and find that 38.5% of 171 US MNC's have significant exposure at the 5% level for the period 1997 to 2004

18 β_{FX} is the absolute value of estimated foreign exchange rate exposure coefficient from the augmented three factor FF model.

investment opportunities for which the underinvestment problem is likely to be more costly. For these firms, the inter-quartile change in exchange rate exposure is associated with a 27.8% *relative* increase in the cash ratio. Similarly, it is established that the positive relationship between FX exposure and cash holdings is driven by firms in highly competitive industries for which an underinvestment problem could be more costly. Therefore, the increase in cash holdings associated with higher sensitivity to foreign exchange rate movements is not only statistically significant but also economically meaningful.

Similarly, a positive and significant relationship between capital issuance and foreign exchange rate exposure is established. The results indicate that firms with higher sensitivity to exchange rate fluctuations are more likely to issue external capital. The inter-quartile increase in β_{FX} leads to a *relative increase* in the probability of capital issuance of 5.2%, compared to a predicted initial probability of 45.6%. One can also notice a monotonic increase in the likelihood of issuing capital for companies with higher FX exposure as the set of investment opportunities increases. In this case, the inter-quartile increase in foreign exchange rate exposure is accompanied by a 12% *relative* increase in the probability to issue capital. Similarly, the significant relationship between FX exposure and capital issuance is driven by firms which face higher competition. This confirms that companies whose underinvestment problem could be more severe are also more likely to issue capital when they are faced with higher foreign exchange rate exposure.

Furthermore, a negative and significant relationship between foreign exchange rate exposure and dividend issuance is documented. Firms with larger sensitivity to exchange rates, which are likely to have unstable cash flows, also have a lower propensity to issue dividends. For dividend non-payers, the inter-quartile increase in β_{FX} leads to a *relative* drop of 25% in the propensity to pay dividends, compared to a predicted initial probability of 8%. Additionally, the general negative relationship that is seen between FX exposure and dividend decisions is driven by companies facing higher competition for investment opportunities. Thus, companies that have higher foreign exchange exposure tend to have a lower propensity to pay dividends, especially in cases when the underinvestment problem can be more severe like for dividend non-payers and firms in more competitive industries.

To my knowledge, this study makes the first attempt to explore how firm exposure to exchange rate fluctuations relates to corporate policies beyond financial hedging. It is shown that firms with higher foreign exchange rate exposure hold more cash, have a higher likelihood of accessing capital markets, and have a lower likelihood of issuing dividends. Moreover, the relationship is stronger in cases when the possible underinvestment problem is more severe, namely when companies are subject to more competition and when they have more investment opportunities.

This study confirms that even domestic companies have significant exposure to exchange rate fluctuations. Markets have become more globalized and firms are affected by international trade either directly through their supply chain and their customers or indirectly through the competitive strategies of their industry rivals. Thus, FX exposure is applicable not only to the decisions made by multinational corporations but also firms that are predominantly domestic. Therefore, it is believed that sensitivity to exchange rate fluctuations is a relevant factor that should be taken into consideration when corporate policies are determined and it is especially important for firms that are likely to have a more severe underinvestment problem. Thus, consideration of exchange rates is not only applicable to hedging decisions, but also other policies on the corporate level like the demand for cash, payout policy and capital issuance.

The rest of the paper is organized as follows: Section II. Literature background and Motivation; Section III. Hypothesis; Section IV. Data; Section V. Measuring foreign exchange exposure; Section VI. Cash holdings and foreign exchange exposure; Section VII. Capital issuance and foreign exchange exposure; Section VIII. Dividend payout and foreign exchange exposure; Section IX. Additional considerations; and Section X Conclusion.

1.2 Literature background and motivation

The interest in the link between foreign exchange rates and firm value was born after the fall of the Bretton Woods system in the beginning of the 1970's. From a theoretical point of view it is generally believed that exchange rate fluctuations are an important source of macroeconomic uncertainty that should have significant impact on firm value[19].

With continual international market integration, there has been an increasing focus on empirically testing the sensitivity of firm value to exchange rate movements (Koutmos & Martin, 2003). However, this endeavor has had mixed success which gave rise to the foreign exchange rate exposure puzzle[20]. Some authors document a weak contemporaneous relationship between exchange rates and firm value[21]. For example, Jorion (1990) finds that only but a few of 287 U.S. MNC's exhibit significant exposure and Miller & Reuer (1998) show that out of 404 U.S. manufacturing firms 13%-17% have significant foreign exchange rate exposures. However, more

[19] Shapiro, 1975; Levi, 1994; Marston, 2001
[20] It has to be noted that the estimation methodologies differ across studies, which could make the direct comparison of results inappropriate.
[21] Jorion, 1990; Gentry & Bodnar, 1993; Amihud, 1994; Miller & Reuer, 1998

recent studies show better evidence of the presence of significant relationship between firm value and exchange rate fluctuations[22]. For example, Huffman et al (2010) and Kiymaz (2003) find that 38.4% of U.S. MNC's and 50% of Turkish firms have significant exposures. Yet a couple of points have to be made about previous studies.

Firstly, the majority focus on very narrow samples such as multinational corporations, exporting companies, and particular industries (banking, oil, mines) or foreign countries. However, exchange rates can affect firm value not only directly through transactional and translational exposures but also indirectly by affecting the competitive environment of the firm[23]. Therefore, I believe that the study of foreign exchange rate exposure should not be limited only to the context of companies that have international involvement. It is likely that twenty or thirty years ago when markets were relatively closed, due to extreme political regimes and lower economic development, fluctuations in exchange rates were more relevant to multinational corporations (MNC's) like Coca Cola and Nestle. However, after the fall of the USSR, the expansion of the European free trade zone, the opening of the Chinese economy and international outsourcing, markets have become more globalized. Thus, today companies that are both domestic and international are likely to be affected by currency risk either through the global reach of their supply chain, their customers or through the decisions of their competitors.

Second, it has to be noted that estimated exposures are actually residual exposures net of hedging. Thus, some authors try to explain the foreign exchange rate exposure puzzle with the ability of companies to decrease their FX exposure through financial hedging, operational hedging and cost pass-through[24]. However, even if companies engage in hedging, it is not necessarily effective. The indirect (competitive/economic) exposure to exchange rate fluctuations is hard to estimate as it depends not only on the actions of the firm but also on the responses of its rivals. Therefore, it is hard to hedge it efficiently which may still leave firms exposed to exchange rate fluctuations.

Therefore, unlike the majority of the literature that tries to solve the foreign exchange rate exposure puzzle or improve the procedures for estimation of currency exposure, this study takes a new approach. It explores whether foreign exchange rate exposure is reflected in the actions taken by managers on the firm level beyond hedging and whether it has any relation to corporate policies like cash holdings, dividend payout and capital issuance.

The literature on cash holdings provides four different motivations for why companies might want to hold cash reserves. Foreign exchange exposure is believed to be applicable to cash

[22] Doukas, Hall, & Lang, 2003; Huffman, Makar, & Beyer, 2010; Kiymaz, 2003; He & Ng, 1998
[23] Stulz & Williamson, 2000; Di Iorio & Faff, 2000; Williamson, 2001
[24] Hsin, Shiah-Hou, & Chang, 2007; Choi & Jiang, 2009

decisions within the context of the precautionary motive, which states that firms will use cash as a buffer against adverse cash flow shocks[25], especially if they have greater investment opportunities[26]. As movements in exchange rates lead to instability of firm cash flows, it is expected that firms with higher foreign exchange rate exposure will hold higher levels of cash to prevent possible underinvestment.

As an alternative to holding more cash, firms with higher exposure to exchange rate changes can alter their dividend payout to secure funds for their projects. This idea is related to two directions in the dividend payout literature. Firstly, in the life-cycle explanation of dividend decisions, firms choose their optimal payout in response to the evolution of their opportunity set. So in times when a company has more opportunities and less funds available it will prefer to pay lower or no dividends[27]. Secondly, other authors discuss that cash flow instability is one of the most influential factors on dividend payouts[28].

Lastly if a company with high exchange exposure cannot secure funding necessary for its projects internally, it can also access the external financial markets, which will increase the likelihood of capital issuance. This idea is related to the pecking order theory, according to which, the decision to issue capital depends primarily on the firm's availability of funds connected to its profitability and the possible investment opportunities that the company faces[29]. Therefore, factors that affect the cash flow stability of the firm are also believed to impact its financing decision, especially for firms that can run into an underinvestment problem.

1.3 Hypotheses

As markets become more globalized, exchange rate sensitivity becomes more relevant to the average firm. Thus, this paper seeks to explore for the first time the connection between foreign exchange rate exposure and major corporate policies. The firm decisions covered more in detail are cash holdings, dividend payout and capital issuance.

It is generally believed that exchange rate fluctuations are an important source of macroeconomic uncertainty that should have significant impact on firm value[30]. The theoretical exchange rate exposure literature[31] claims that in the presence of exchange rate changes, the cash flow volatility of the firm increases. Therefore, firms are more likely to face an underinvestment

[25] Campell, Almeida, & Acharya, 2007; Bates, Kahle, & Stulz, 2009
[26] Williamson, Stulz, Pinkowitz, & Opler, 1999
[27] DeAngelo & DeAngelo, 2006; DeAngelo, DeAngelo, & Stulz, 2006; Denis & Osobov, 2008
[28] Lintner, 1956; Brav, Graham, Harvey, & Michaely, 2005; Chay & Suh, 2009
[29] Myers & Shyam-Sunder, 1999; Rangan & Flannery, 2006; Dasgupta & Chang, 2009; Goyal & Frank, 2003
[30] Shapiro, 1975; Levi, 1994; Marston, 2001
[31] Shapiro & Titman, 1985; Lessard, 1990; Stulz, 1990; Froot, Scharfstein, & Stein, 1993

problem and run out of funds to take on positive NPV projects; which in turn affects the value of the firm. Hence, it is hypothesized that firm foreign exchange rate exposure is related to corporate policies that secure funds in the case of possible underinvestment. For example, firms might need to access capital markets more often, stockpile cash in case of shortages or even change their dividend payout policy. This leads to several testable implications:

H1: Firms with higher foreign exchange rate exposure will hold more cash.

H2: Firms with higher foreign exchange rate exposure will be more likely to access external capital markets.

H3: Firms with higher foreign exchange rate exposure will be less likely to pay dividends.

As the motivation for the relationship between corporate policies and foreign exchange rate exposure is based on the underinvestment problem, one could assume that the above predictions will also be stronger in cases when the possible underinvestment is more severe. The first occasion is when a firm has more investment opportunities. If a firm faces better growth opportunities the possible loss to its value is more severe and it will be more motivated to avoid the underinvestment problem.

H4: The relationship between foreign exchange rate exposure and corporate policies will be stronger when companies have more investment opportunities.

Secondly, an increasing part of the literature discusses the underinvestment risk which results in loss of market share to competitive rivals[32]. The sensitivity of firms to exchange rate fluctuations is believed to be complicated by the firm's competitive position and indirectly influence its future development possibilities. Thus, the economic environment of the firm is function not only of its own decisions but also the strategic reaction of the competing firms[33]. Therefore, it is believed that in industries that are subject to high competition and substitutability of products, there is a larger degree of shared investment opportunities. Thus, in more competitive industries the cost of underinvestment could be more severe, which in its turn will impact the relationship between foreign exchange exposure and corporate policies.

H5: The relationship between foreign exchange rate exposure and corporate policies will be stronger when companies are part of industries with higher level of competition.

[32] Haushalter, Klasa, & Maxwell, 2007
[33] Muller & Verschoor, 2006

1.4 Data

The main period for the sample is 1992 to 2008 and the initial number of companies is 1,231 with full monthly stock price information over the sample period. The number of companies and time periods will vary in different sections of the analysis due to the availability of accounting and industry competition data.

The data used in this paper come from several different sources. Stock return information is provided from The Center for Research in Security Prices (CRSP). Information about the Fama- French three factors (SMB, HML, Rm-RF) is sourced from Kenneth French's website. Exchange rate information in the form of the Trade-Weighted U.S. Dollar Index is provided by the Federal Reserve Board's H.10 Report. Firm accounting data comes from COMPUSTAT. Industry concentration ratios are available through the United States Census Bureau for the period from 1993 to 2007. As variables used vary for the computation of foreign exchange exposure and analysis of corporate policies, more detailed description of the calculation of relevant variables will be provided in the respective sections VI (cash holdings), VII (capital issuance), VIII (dividend payout).

Table I presents summary statistics for the change in the exchange rate index and key variables for companies that have estimated foreign exchange rate exposure[34] and have available accounting information on book assets covering the period from 1992 to 2008. On average the US dollar appreciated by 0.82% per year for that period. At the same time, the range of exchange rate changes is quite wide with the 25^{th} and 75^{th} percentile of annual changes equal to - 4.8% and 6.34% respectively. In addition, Figure I depicts the time trend in the exchange rate changes on a monthly and annual basis.

The mean and median foreign exchange exposures (FX exposure) are 0.9 and 0.67 respectively. For additional information, Figure II presents the time trend in the average cross-sectional foreign exchange rate exposure, indicating that foreign exchange rate exposure might change over time.

Median and mean assets are $968 million and $12.1B respectively. The mean foreign sales ratio is 0.16 and at least half of the companies have no foreign sales indicating that the sample has good representation of companies that trade only domestically. Additionally, half of the firms with available segmentation data are diversified by having at least 2 business segments and half are focused on a single area. The mean and median cash holdings as percent of assets are 8.2% and 4.2% respectively. On average firms have 17% leverage ratio. About two-thirds of the

[34] Estimated through the 60-month moving window procedure.

firms issue dividends and about half of them issue external capital equal to or greater than 1% of their assets.

1.5 Measuring foreign exchange rate exposure

In 1975 Shapiro made the first attempt to formally model the relationship between firm value and exchange rates. To measure it empirically, Jorion (1990) defined firm exchange rate exposure as the sensitivity of firm value to exchange rate variability. Thus, foreign exchange rate exposure assesses the percentage change in firm value against a 1% change in the exchange rate. The proxy used for firm value is its stock return. Thus, foreign exchange rate exposure is measured as the coefficient from regressions of stock returns on exchange rate changes.

Before the firm exposure can be measured, one has to choose the relevant exchange rate factor. As this paper is interested in exploring the general relationship between exchange rate exposure and corporate policies rather than disentangling whether certain currencies have bigger influence, an exchange rate index is chosen rather than bilateral currency exchange rates. The preference for an index is consistent with many other authors (Jorion, 1990; Bodnar & Gentry, 1993; Huffman, Makar, & Beyer, 2010; Ng & He, 1998). It is acknowledged that the use of weighted index models may underestimate firm exposure (Muller & Verschoor, 2006), but it is not believed to be a problem in this case as it will bias against finding significant exposures.

The Trade Weighted U.S. Dollar Index is used as a proxy for the exchange rate risk factor. It is a weighted average of the foreign exchange value of the U.S. dollar against a subset of currencies that circulate widely outside the country of issue, including the Euro Area, Canada, Japan, United Kingdom, Switzerland, Australia, and Sweden. The index is provided by the Federal Reserve Board’s H.10 Report. It is stated as units of foreign currency per U.S. dollar. R_{FX} measures the percentage change in the index. An appreciation of the US dollar is equivalent to an increase in the index and $R_{FX} > 0$.

The model used for estimation of firm exposure follows two recent developments in the literature. Usually, the exchange rate exposure is measured in a FX-market model, which includes regressions of firm returns on the market return and changes in an exchange rate factor. However, Huffman et al. (2010) introduce the Fama – French three factor model to the exchange rate exposure literature and conclude that it produces more significant exchange rate exposure coefficients than the traditional FX- market model. Additionally, Vásquez & Sandoval (2009), He et al (1996), Kiymaz (2003) stress the problem of possible multi-collinearity between the market and exchange rate factors and suggest orthogonalization as a possible solution. Therefore, the model used to measure foreign exchange rate exposure is as follows:

$$R_{it} - R_{ft} = \alpha + \beta_m \left(R_m - R_f \right)_t + \beta_s \, SMB_t + \beta_h \, HML_t + \beta^*{}_{FX} \, R_{FX\,t} + \varepsilon_t \qquad (1)$$

where

R_{ft} is the return on the 30-day Treasury bill in month t;

SMB_t is the return on the "small minus big" benchmark portfolio for month t;

HML_t is the return on the "high minus low" benchmark portfolio for month t;

$\left(R_m - R_f \right)_t$ is the market excess return orthogonolized on the change in the Trade-Weighted U.S. dollar index;

$R_{FX\,t}$is the percentage change in the Trade-Weighted U.S. dollar index. $R_{FX} > 0$ signifies U.S. dollar appreciation and $R_{FX} < 0$ signifies U.S. dollar depreciation;

$\beta^*{}_{FX}$ is the foreign exchange rate exposure, which assesses the percentage change in firm value against a 1% change in the exchange rate. A firm with negative exchange rate exposure or $\beta^*{}_{FX} < 0$ will have adverse stock price effects as a result of U.S. dollar appreciation and benefit from its depreciation. A firm with positive exchange rate exposure or $\beta^*{}_{FX} > 0$ will have adverse stock price effects as a result of U.S. dollar depreciation and benefit from its appreciation.

Initially, foreign exchange rate exposure is assumed to be constant. The sample explored covers the period from 1992 to 2008 and includes companies with full monthly stock price information from CRSP totaling 1,231 firms. The first step is to estimate firm level exchange rate exposures and check their significance.

Table II presents an overview of the firm level foreign exchange rate exposure summarized by industry.[35] The mean exposure in the sample is - 0.57 indicating that the average firm has adverse stock price reactions to U.S. dollar appreciation and benefits from its depreciation, consistent with He et al (1998). This indicates that 1% depreciation of the US dollar against other currencies (1% drop in the Trade-Weighted U.S. dollar index) is accompanied by 0.57% increase in firm value. This, compared to the average monthly U.S. depreciation over the sample period of 1.43%, leads to an average firm value increase of 0.82%.

Furthermore, 88% or 1,081 of the firms in the sample have negative exposures. The top industries that are the most sensitive to exchange rate fluctuations are Oil and Petroleum Products and Mining and Mineral, which is expected as commodity prices are usually determined by

[35] Industries are classified according to the Fama French 17 industry definitions.

international supply and demand. The industries that exhibit the least exposure to exchange rates are Drugs, Soaps, Perfumes, Tobacco and Retail Stores.

Moreover, almost half of the firm exposures (49%) are statistically significant at the 10% level and 40% are significant at the 5% level, suggesting that a major part of the firms experience significant changes in their value responding to fluctuations in exchange rates. Other studies that document higher percentages of significant exchange rate exposures are He et al. (1998) and Doukas et al (2003) who show that 25% of Japanese MNC's (multinational corporations) and Japanese firms respectively have significant exposures and Kiymaz (2003) who shows that 50% of Turkish firms have significant sensitivity to exchange rates.

The current findings are believed to be related more closely to the findings of Huffman et al (2010), who also use the Fama-French three-factor model for their estimation. They find that 38.5% of their sample, compromised of 171 U.S. MNC's, has significant exposure at the 5% level for the period 1997 to 2004. However, the current findings are believed to expand on Huffman et al because the present sample is considerably larger (1,231 firms) and is not constrained to firms that have foreign sales. Additionally, it should be noted that 52% of the significant exchange rate exposures come from firms with no foreign sales. This indicates that even firms that are domestic and are not necessarily internationally involved are affected by exchange rate changes. More importantly, this finding confirms that today exchange rate exposure is relevant to the average firm and not just to MNC's.

Breaking down the results by industry, it can be seen that most of the industries exhibit similar high proportion of significant exposures: 14 out of the 17 industries have at least 40% of their firms exhibiting significant sensitivity to exchange rates (at the 10% level). The two industries with the smallest proportion of significant exposures are also the industries with the lowest average exposure (Drugs and Retail).

In summary, the majority of the firms benefit from U.S dollar depreciation and nearly half of them have statistically significant exposures.

The implicit assumption made previously was that firm's exchange rate exposure remains constant over time. However, it is likely that as the economic environment, competition, firm operational structure and hedging behavior change over time, firm exchange exposure will also change. Other studies indicate that exchange rate coefficients fluctuate from period to period[36] although no clear patterns have been detected. Therefore, to allow for potential temporal instability of firm exchange rate exposure, the coefficients are re-estimated using 60 month moving-window regressions with 1 year lag every time. Five year moving windows are used to

[36] Jorion, 1990; He & Ng, 1998; Doukas, Hall, & Lang, 2003; Glaum, 2000

mitigate the effects of outliers as advised by Du & Hu (2012). This procedure results in 17 estimates of foreign exchange exposure per firm for the sample period. Figure II presents the time trend in the mean cross-sectional foreign exchange rate exposure, which also indicates that foreign exchange rate exposure is not stable over time.

Additionally, as the main focus of this study is to determine how firm sensitivity to exchange rates relates to corporate policies, the magnitude of the exposure is more relevant than its sign, so from now on foreign exchange rate exposure β_{FX} will signify the absolute value of the ${\beta^*}_{FX}$ coefficient estimated from the augmented Fama-French three factor model (equation (1)).

Table III summarizes the characteristics of firms that tend to have higher foreign exchange rate exposures. The variables used are as follows: size is the log of firm book assets; foreign sales ratio is the proportion of sales outside the United States to total sales for the given year; export sales ratio is the proportion of sales of domestically produced goods/services overseas to total firm sales for a given year; number of segments is the number of business segments of the firm; CR is industry concentration ratio measured by the percentage of industry sales represented by the largest four companies. The dependent variable is the absolute value of the estimated foreign exchange rate exposure β_{FX} [37]. The samples in the three columns differ due to the availability of information on business segments and competition measures.

The results in Table III column 1 show that firm size is negatively related to exchange rate exposure with a coefficient of -0.063, significant at the 1% level. Thus, larger firms exhibit smaller sensitivity to currency movements. The coefficient sign is consistent with size acting as a proxy for economies of scale in transaction costs (financial hedging) or for larger probability of operating in several locations which could act as a natural operational hedge, both of which would reduce the foreign exchange rate exposure.

Foreign and export sales proxy for international involvement of the company. The coefficients on both variables are positive (0.2 and 0.7 respectively) and statistically significant (at least 5% level, Column 1), which indicates that firms that are more involved in international trade also tend to have higher sensitivity to exchange rate fluctuations. These results are similar to the conclusions reached by Huffman et al (2010), Hsin et al (2007) and Doukas et al (2003).

Column 2 explores firms that have available data for their business segments. The number of segments proxies for business diversification. The coefficient on the variable is negative at -0.015 and significant at the 5% level. Therefore, firms that are more diversified also have lower exchange rate exposure, with cash flow variations from different segments potentially cancelling each other.

[37] Moving window regression procedure

Column 3 presents the results for firms with available industry concentration ratios for the period 1993 to 2007. The coefficient on CR is positive at 0.005 and significant at the 1% level. Lower concentration indicates higher competition. Therefore, firms that are subject to more competition tend to have lower exchange rate exposures. One potential explanation for this relationship could be that the higher competition increases the need of firms to hedge to keep their competitive position.

In general, firms that are smaller, are more internationally involved, are less diversified and are in less competitive industries tend to have higher exchange rate exposures.

The following sections will discuss in detail the relationship between foreign exchange rate exposure and separate corporate policies (cash holdings, capital issuance, and dividend payout).

1.6 Cash holdings and foreign exchange rate exposure

The finance literature provides four different reasons why companies might decide to hold cash: transaction motive (Orr & Miller, 1966), tax motive (Foley, Hartzell, Titman, & Twite, 2007), agency motive (Dittmar & Jan, 2007) and precautionary motive (Campell, Almeida, & Acharya, 2007) . Bates et al (2009) explore the four different explanations in the context of the recent tendency for firms to hold more cash than they used to several decades ago. They suggest that the precautionary demand for holding cash is an important determinant of recent trends and find support for it in the empirical data. According to this theory, firms will use cash as a buffer against adverse cash flow shocks. It is also believed that fluctuations in foreign exchange rates can lead to negative effects on firm cash flows not only through its transactional exposure but also through its competitive component. Additionally, firms that have better investment opportunities will have a higher cost of underinvestment and tend to hold more cash as a precaution. Opler et al (1999) provide evidence consistent with this theory by showing that firms with riskier cash flows stockpile cash and Bates et al (2009) suggest that the increase in cash ratios is predominant in industries with high cash flow volatility.

In the context of exchange rates, it is assumed that fluctuations in foreign currencies affect the volatility of firm's cash flows through the notional translation of its sales and the changes in the competitive landscape. Therefore in the framework of the precautionary motive, it is expected that firms with higher exchange rate exposure will hold more cash relative to firms with lower exposure to buffer against adverse shocks. This hypothesis is explored by extending the set of cash holding explanatory variables accepted in the literature[38] with the foreign exchange rate exposure variable estimated previously.

Control variables

Cash ratio: it is measured as firm's cash holdings scaled by book value of assets.

Market-to-book ratio: proxies for investment opportunities. It is measured as the book value of asset minus the book value of equity plus the market value of equity scaled by the book value of assets. It is expected that firms that have better investment opportunities will hold more cash as a precaution against adverse shocks.

Size: it is measured as log of book assets. It is expected that there are certain economies of scale to holding cash.

Cash flow to assets: the variable is measured as earnings before interest and tax (EBIT) minus interest expense, minus taxes, minus common dividends scaled by the book value of assets. Previous research indicates that the expected coefficient is ambiguous depending on the relationship between profitability and investment opportunities.

Net working capital to assets: the variable is calculated as the difference between current assets and current liabilities minus cash holdings, scaled by the book value of assets. NWC is considered an alternative to cash.

Capital expenditure to assets (capex): the variable is measured as capital expenditure divided by the book value of assets. The expected coefficient on capex is ambiguous as it can proxy for investment opportunities yielding a positive sign or if it is considered as an asset enhancement used as a collateral for debt issuance it could lead to a negative sign.

Leverage: the variable is measured as long term debt divided by book assets. The expected sign on the variable is ambiguous. On one hand, if the cost on debt is high enough firms will prefer to hold more cash. Yet if firms hold large amounts of debt, they can also stockpile cash as hedge (Achariya et al (2007).

Dividend dummy: the variable has a value of one when the company pays common dividends and is zero otherwise. If a firm pays dividends it is likely that it does not have valuable investment opportunities and does not need to hold cash as a buffer.

R&D to assets: the variable is calculated as research and development expense scaled by book assets. The expected sign on the variable is ambiguous as the expense itself could be a use of cash but at the same time it could be a proxy for investment opportunities.

[38] Bates, Kahle, & Stulz, 2009

Acquisitions to assets: the variable is measured as cash outflows from acquisitions divided by the book value of assets. The expected coefficient might vary similar to the rationale provided for capex.

Return on assets: it is measured as net income divided by net assets and is intended to proxy for firm profitability. Expected sign is ambiguous similar to cash flow to assets.

Industry dummies: a dummy equal to one if a firm belongs to a particular industry according to the Fama-French 17 industry classification.

Due to availability of the abovementioned accounting data the sample reduces to 13,673 firm-year observations covering 880 unique firms and the period 1992-2008.

Results

Table IV, Panel A Column 1 presents the results for regressions of cash ratios on foreign exchange rate exposure and control variables. All standard errors are double clustered by firm and year. All control variables are significant at the 1 percent level with signs and magnitudes similar to the result presented by Bates et al (2009). In general, firms with higher market-to-book ratios, higher R&D ratios and higher return on assets hold higher cash levels as percent of assets. Similarly, firms with higher cash flow ratios, higher net working capital ratio, higher capital expenditures, higher acquisition expenditures, higher leverage and dividend payers tend to have lower cash ratios.

The variable of interest in this analysis is the foreign exchange rate exposure of the firm. Its coefficient is positive at 0.004 and highly statistically significant (1% level). This indicates that firms that are more sensitive to exchange rate fluctuations also tend to have larger cash holdings as percent of assets, which is consistent with the precautionary motive for cash demand.

To provide an economic context to the estimated coefficient, one can explore the change in the cash ratio due to a change of the foreign exchange rate exposure from its 25th percentile to the 75th percentile. All else equal, the shift in the exchange exposure translates into a change in the cash ratio of 0.38%[39], meaning that firms in the 75th percentile of exchange exposure hold 0.38% more cash as percent of their assets compared to firms in the 25th percentile. One can also compare this increase to the median cash ratio in the sample of 4.42%, indicating an 8.6% *relative* increase. Therefore, the increase in cash holdings as percent of assets associated with higher sensitivity to foreign exchange rate changes is not only statistically significant but also economically meaningful.

The channel through which the connection between FX exposure and cash holdings is currently motivated is the possible firm value loss due to unrealized investment projects which

[39] The foreign exchange exposure changes from 0.31 to 1.18.

leads to firms holding more cash for a precautionary reason. In this context, one can expect that the relationship will be stronger for firms whose underinvestment problem could be more costly. The first example of which is companies that face more investment opportunities. Market-to-book ratio is used as a proxy for investment opportunities. Next, dummies indicating companies with varying degree of investment opportunities are created. MB_{low} indicates companies with low level of investment opportunities and is equal to one if the company's MB ratio is lower than the 25th percentile, and zero otherwise. MB_{high} indicates companies with high level of investment opportunities and is equal to one if the company's MB ratio is higher than the 75th percentile, zero otherwise. MB_{med} encompasses all remaining companies.

Table IV, Column 2 presents the augmented regression results where the foreign exchange rate exposure variable is interacted with the three MB dummy variables. One can notice that the coefficient on β_{FX} increases monotonically with the increase of company's investment opportunities and is significant (1% level) only for firms with high investment opportunities for which the underinvestment problem is likely to be more costly. Additionally, the magnitude of the coefficient increases substantially from 0.004 in the base case from Column 1 to 0.014 for companies with high investment opportunities in Column 2. In economic terms this signifies that everything else equal, for companies with high investment opportunities the change of the exchange exposure from the 25th to the 75th percentile is accompanied by a 1.23% positive change in the cash ratio. Comparing this to the sample median, results in a 27.8% *relative* increase. This indicates that the results are driven by companies that have more severe underinvestment problem, which is associated with holding more cash as a precaution against adverse cash flow shocks.

Secondly, the underinvestment problem is believed to be more costly for industries where firm's investment opportunities can by realized by different rivals, so there is a larger competition for every project. Therefore, the next step is to explore the role of competition on the relationship between exchange rate exposure and cash holdings. As a measure of industry competition industry concentration ratios are used.

Concentration Ratio (CR) indicates the percentage of industry sales (market share) concentrated in the top four companies with largest sales. The industry classification is performed by four digit North American Industry Classification System (NAICS) codes. The data is provided by the US Economic Census Bureau for the period 1993 to 2007. [40]

Three dummy variables are constructed based on the CR concentration measure. CR_{low} is a dummy variable equal to one if a firm belongs to an industry with a CR between 0% and 50%,

[40] There are no data provided for Mining (NAICS 21), Construction (23), Management of Companies and Enterprises (55).

corresponding to low concentration industry or high competition. CR_{high} is a dummy variable equal to one if a firm belongs to an industry with a CR between 80% and 100%, corresponding to high concentration industry or low competition. CR_{med} encompasses all other firms. To explore how the coefficient on FX exposure changes with the degree of competition, the three concentration dummy variables are interacted with fxbeta.

Table V, Column 1 repeats the results from the base regression from Table IV, Column 1 for comparison purposes. Table V, Column 2 adds the industry concentration measure CR to the regression and the interactions between FX exposure and the dummy variables based on industry concentration. The sample period in this case runs from 1993 to 2007. [41] Due to the availability of industry concentration data the sample size shrinks to 10,447 firm-year observations covering 782 unique firms.

The coefficients on the control variables in Column 2 do not change qualitatively and their statistical significance remains the same compared to the base regression. Additionally, one can notice that the concentration measure CR by itself does not have a significant association with cash holdings with a p-value of 0.32. However, the level of industry competition impacts the coefficient of exchange rate exposure. The coefficients of β_{FX} for industries with high and medium concentration are not significant. However, for industries with low concentration, or in other words high competition for investment opportunities, the relationship between FX exposure and cash holding is positive at 0.006 and significant at the 1% level. This indicates that firms with higher exchange rate exposure tend to hold more cash as a percent of assets only in the cases where their underinvestment problem could be more severe, namely in highly competitive industries. In economic terms, a change from the 25th to the 75th percentile of foreign exchange rate exposure is accompanied by a 0.52% increase in cash holdings. If it is compared to the median cash ratio, this indicates a 12.4% *relative* increase.

An additional factor that has been explored previously as a determinant of cash holdings is the cash-flow volatility of the firm. Bates et al (2009) use industry sigma as a proxy for cash flow risk. It is measured as the standard deviation of industry cash flow to assets: for each-firm year the standard deviation of cash flow to assets is calculated for the previous 10 years and these estimates are averaged for each year across two-digit SIC codes. The correlation between foreign exchange rate exposure and industry sigma is 0.03. Table IV (Panel B) adds industry sigma to the base regression from Table IV Panel A. The coefficient on industry sigma is positive and significant, confirming that companies with higher cash flow volatility tend to hold more cash.

[41] Year 1992 census data is based on SIC classification instead of the NAICS used in later years; hence it is dropped for this analysis. No updated data is released after 2007; hence year 2008 is dropped from the analysis.

However, it has to be noted that the coefficient on foreign exchange rate exposure remains positive and significant, even in the presence of the industry sigma. An inter-quartile change in industry sigma leads to an increase of cash holdings of 0.14%, which indicates a 3.33% relative increase compared to the sample median of 4.2%. At the same time, an inter-quartile change in β_{FX} is associated with a 0.39% increase in cash holdings, or 9.3% relative increase. Therefore, the impact of foreign exchange rate exposure is also significant in economic terms when compared to industry sigma.

In summary, the results in this section indicate that companies with higher foreign exchange rate exposure tend to hold more cash as percent of assets. The results are statistically and economically significant and are driven by companies for which the underinvestment problem could be more severe, which is consistent with the precautionary demand for cash.

1.7 Capital issuance and foreign exchange rate exposure

The extensive financial literature on capital structure provides three possible hypotheses (trade-off theory, pecking order, market timing theory) to explain the main drivers that cause companies to adjust their leverage and issue capital. Yet there is still no consensus reached about the merits of one hypothesis over the others[42].

According to the pecking order theory, the decision to issue capital depends primarily on the firm's availability of internal funds and the possible investment opportunities that the company faces. Therefore, factors that affect the cash flow stability of the company are likely to impact its financing decision, especially for firms that can run into an underinvestment problem.

It is believed that firm exposure to foreign exchange fluctuations can affect firm's cash flow stability and its profitability not only through direct translational and transactional exposure but also through the change in the firm's competitive scene. While this study does not intend to differentiate between different types of external capital, it seeks to explore whether larger exchange rate exposure, which increases the instability of company's cash flows, is also likely to be associated with higher probability of firms tapping into capital markets to finance its projects and avoid a possible underinvestment problem. To check this hypothesis, the set of capital structure determinants used previously in the literature is extended with the foreign exchange rate sensitivity of a firm.

[42] Myers & Shyam-Sunder, 1999; Rangan & Flannery, 2006; Dasgupta & Chang, 2009; Goyal & Frank, 2003

Control variables

Net debt issuance: it is calculated as short term debt for the current year plus long term debt for the current year minus short term debt for the previous year minus long term debt for the previous year, scaled by last year's book assets.

Net equity issuance: the variable equals the difference between sale of common and preferred stocks and the purchases of common and preferred stock for the current year, scaled by last year's book assets.

Capital Issuance Dummy: it is an indicator variable which is equal to one if net debt issuance is greater than 1% or if net equity issuance is greater than 1%, and zero otherwise.

EBIT to assets (EBIT/ TA): the variable is measured as earnings before interest and tax divided by total book assets. It is expected that companies that are more profitable will have lower need to access capital markets.

Market-to-book ratio: proxies for investment opportunities. It is measured as the book value of asset minus the book value of equity plus the market value of equity scaled by the book value of assets. It is expected that companies with higher growth opportunities might also need more funds to finance them, leading to a positive relationship with capital issuance.

Depreciation to assets: measured as depreciation expense divided by book value of assets. Depreciation expense is considered an additional way for companies to save taxes, which makes interest deductions less needed, decreasing the demand for debt issuance.

Size: it is measured as log of book assets. Larger companies are believed to possess economies of scale, making it easier and cheaper for them to access capital markets.

Fixed assets to total assets: it is measured as fixed assets divided by total assets. Firms can use their tangible assets as collateral increasing their debt capacity.

R&D to total assets: measured as research and development expense scaled by total book assets. The variable has been used in previous studies as a proxy for intangible assets indicating firm preference for equity financing or as an investment proxy, indicating higher need for capital.

Due to the availability of the abovementioned accounting data the sample is comprised of 17,758 firm-year observations covering 1,095 unique firms.

Results

Table VI, Column 1 and 2 present the results for the logit regressions of capital issuance on foreign exchange rate exposure and control variables. Column 2 does not include industry dummies, while Column 1 does. All standard errors are double clustered by firm and year. All control variables are significant at the 1 percent level with the exception of R&D to assets. Results are consistent with previous studies (Rangan & Flannery, 2006; Roberts & Leary, 2010).

In general firms that are more profitable and use higher depreciation tend to have a lower likelihood of accessing capital markets. At the same time, companies that have higher growth opportunities, are larger in size and have more tangible assets tend to have a higher likelihood of issuing external capital.

Further, the coefficient on the variable of interest, foreign exchange rate exposure, is positive at 0.114 and is significant at the 1% level. The results indicate that firms with higher sensitivity to exchange rate fluctuations also tend to have a higher likelihood of issuing external capital in the form of debt or equity. It is believed that the higher exchange exposure is accompanied by instability in firm cash flows, which means that companies have to access capital markets more often to gain funding for their projects.

To provide economic context to the regression results, one can explore the change in the likelihood to issue capital based on a change of exchange exposure from its 25^{th} to its 75^{th} percentile. The estimates are provided based on the regression from Column 2, for which no industry assumptions have to be made and all control variables are represented at their mean values. The inter-quartile increase in β_{FX} leads to an increase of the probability to issue capital of 2.4%. Compared to a predicted initial probability of 45.6%, this constitutes a sizable *relative* increase of 5.2% in the propensity to issue capital.

Additionally, one can conjecture that if the need for additional funding is necessary to avoid a possible underinvestment problem then the relationship with foreign exchange rate exposure will be magnified for companies that have more growth opportunities. Therefore, in Column 3 and 4 of Table VI, β_{FX} is interacted with three dummy variables for differing investment opportunities. One can notice a monotonic increase in the likelihood to issue capital for companies with higher exposure as the set of investment opportunities increases. The coefficient on β_{FX} more than doubles from 0.114 in the base case in Column 1 to 0.256 in Column 3 for companies with high investment opportunities. This confirms that companies whose underinvestment problem could be more severe are also more likely to issue capital when they are faced with higher FX exposure. To access the economic significance of the β_{FX} coefficient I provide estimates based on Column 4 for which no industry assumptions have to be made. In this case a change in FX exposure from its 25^{th} to its 75^{th} percentile is accompanied by 5.4% increase in the probability to issue capital. This compared to an initial estimated probability of 46% constitutes a significant relative increase of 12%. This confirms that the relationship between foreign exchange rate exposure and capital issuance is not only statistically significant but also economically meaningful.

Next, Table VII explores how the relationship between foreign exchange rate exposure and capital issuance changes with the level of competition in the industry, providing another context in which the cost of the underinvestment problem could differ among firms. Similarly, Roberts & Leary (2010) find that firms make financial decision by responding to the financing decisions of their peers. Column 1 of Table VII repeats the base regression from the same column in Table VI for comparison. Column 2 adds the variable for industry competition CR and interacts the β_{FX} variable with three dummies for different levels of industry concentration. Due to competition data limitations, the sample in this panel runs from 1993 to 2007 and has 13,857 firm-year observations, covering 985 unique firms.

The coefficients of the control variables in Column 2 have the same signs and significance as in Column 1. The variables of industry concentration does not affect the capital issuance decision directly as the coefficient on the variable is not statistically significant, p-value of 0.42. However, when one explores the coefficients on FX exposure for different levels of competition, one can notice that the β_{FX} coefficient is significant only when firms are part of industries subject to high competition. Therefore, it can be concluded that the findings about the significant relationship between foreign exchange rate exposure and capital issuance are driven by firms which are faced with higher competition for their investment opportunities making a possible underinvestment problem more costly for them.

In summary, foreign exchange rate exposure and capital decisions demonstrate a significant positive relationship with firms with higher sensitivity to exchange fluctuations also being more likely to access capital markets and issue debt or equity. This behavior is demonstrated by companies that are likely to have a more severe underinvestment problem. Thus, the results are driven by companies in more competitive industries and the relationship is stronger for firms that have higher investment opportunities.

1.8 Propensity to pay dividends and foreign exchange rate exposure

Numerous papers have discussed the determinants of dividend payout policy. In 2001 Fama and French explore the disappearing dividend puzzle and determine that three fundamentals seem to determine the decision to pay dividends including profitability, firm size and investment opportunities, which is later confirmed for different samples and countries by DeAngelo et al (2006) and Denis et al (2008). Further, DeAngelo and DeAngelo (2006) propose a life-cycle explanation of dividend policy according to which firms choose their optimal dividends through time in response to the evolution of their opportunity set. Thus, when investment opportunities surpass internally generated capital, firms prefer not to pay or to pay low dividends and when there are no more value generating opportunities for the company, cash is paid out in the form of dividends to avoid misuse. In 2006, DeAngelo et al confirms the life cycle theory by finding that the propensity to pay dividends is positively related to the earned/contributed capital mix of the company.

A recent renewal in the dividend literature also brings back the relevance of cash flow uncertainty to payout policy (Chay & Suh, 2009). In practice, corporate managers point out that earnings and future cash flow stability is one of the influential factors on dividend payouts (Lintner, 1956;Brav, Graham, Harvey, & Michaely, 2005). In the context of cash flow uncertainty and investment opportunities being determinants of dividend policy, one can expect that firm foreign exchange rate exposure will also be related to the dividend policy decision especially in cases when possible underinvestment is more costly. To check this hypothesis, one can extend the set of dividend determinants circulated in the literature with the foreign exchange rate sensitivity of a firm.

Control variables

Dividend: dummy variable, which is equal to one if the firm pays common dividend during a given year, zero otherwise.

Lag Dividend: the variable is the same as the dummy variable dividend, but lagged one year. The expected coefficient is positive, indicating that managers are reluctant to stop paying dividends once they begin.

Retained Earnings to Total Equity (RE/ TE): the variable is calculated as retained earnings scaled by total equity and measures the ratio of internally generated to total (including earned and contributed) common equity. The variable is intended to proxy for the life cycle stage of the company expecting positive relationship to the dividend decision. This will indicate that mature companies that have less a surplus of internal funds compared to possible investment opportunities are more likely to redistribute their spare funds as dividends.

Total Equity to Total Assets (TE / TA): the variable is measured as total common equity to total book assets. It is included as a control to distinguish between the effect of total equity financing and the effects of the composition of equity financing.

Return on Assets (ROA): calculated as net income over total book assets. The variable proxies for profitability and is expected to have a positive relationship to dividend payout.

Market to Book ratio: proxies for investment opportunities. It is measure as the book value of asset minus the book value of equity plus the market value of equity scaled by the book value of assets. According to the life cycle theory, a negative coefficient is expected as firms that have more investment opportunities are likely to use their funds for firm value creation rather than pay it out as dividends.

Size: the variable is measured as the log of book value of assets. A positive relationship to dividend policy is expected if size is also intended as a proxy of the maturity of the firm.

Cash ratio: is measured as firm's cash holdings scaled by book value of assets. The expected sign is ambiguous as larger cash holdings can either be motivated by stockpiling as a buffer for possible investments or as merely as build-up of excess cash.

Due to availability of the abovementioned accounting data the sample is comprised of 17,984 firm-year observations covering 1,100 unique firms for the period 1992-2008.

Results

Table VIII, Colmn 1 and 2 present the results for the logit regressions of dividend payout decision on foreign exchange rate exposure and control variables. Column 2 does not include industry dummies, while Column 1 does. All standard errors are double clustered by firm and year. All control variables are significant at least at the 10 percent level with the exception of total equity to total assets (TE/ TA). The signs of the coefficients are consistent with results presented in the literature, for example DeAngelo et al (2006). The positive and significant coefficient on Retained earnings to total equity confirms the life cycle motivation for dividend policy. Therefore, companies that are less mature, have lower earned to contributed capital and have larger investment opportunities also tend to have lower dividend propensity. Furthermore, companies that are more profitable and larger in size are more likely to pay dividends while companies that have larger cash holding tend to have lower dividend propensity. Additionally, the coefficient on the lag dividend variable, indicating that the firm was a dividend payer the previous year, is positive and significant, which is confirms Lintner's (1956) finding that companies are unwilling to stop paying dividends once they have been initiated.

As a next step, this study wants to explore whether firm sensitivity to exchange rates is also related to the payout decision. The variable of interest, foreign exchange rate exposure, has a negative (-0.3) and significant coefficient (1% level) even after controlling for the variables that are considered main determinants of dividends in the previous literature. This indicates that firms with larger sensitivity to exchange rates, which are likely to have unstable cash flows, also have a lower propensity to issue dividends. This finding is complementary to the literature that discusses the relationship between cash flow uncertainty and dividend policy. For example, Chay et al (2009) concludes cash flow uncertainty has a negative impact on the amount of dividends as well as the probability of paying dividends.

For an economic interpretation of the marginal drop in the likelihood to pay dividends due to a change in β_{FX} from its 25th to its 75th percentile, one can use sample averages for the control variables. Results provided are based on the regression from Column 2, for which no assumptions about the industry of the firm have to be made. For dividend non-payers (lag dividend set to 0), the inter-quartile increase in β_{FX} leads to a drop of the probability to pay dividends of 2%. Compared to a predicted initial probability of 8%, this constitutes a substantial *relative* drop of 25% in the propensity to pay dividends. For dividend payers (lag dividend set to 1), the inter-quartile increase in β_{FX} leads to a drop of the probability to pay dividends of 0.5%. Compared to a predicted initial probability of 98.2%, this constitutes a *relative* drop of 0.5% in the propensity to pay dividends.

This finding shows that the sensitivity of firms to exchange rates is negatively associated with dividend policy; however the relationship is stronger for dividend non-payers. Dividends are known to be sticky, so the fact that dividend payers will not be willing to drop their dividends even if they have higher foreign exchange rate exposure is understandable. In the context of the life cycle theory, dividend non- payers are also companies that are more likely to need their funds for investment opportunities. Therefore, this confirms that the impact of foreign exchange rate exposure is intensified in cases in which firms' underinvestment problem could be more severe.

Column 3 of Table VIII interacts β_{FX} with three dummy variables proxying for different opportunity sets. The coefficient on β_{FX} for firms with high investment opportunities is negative and significant at the 2% level indicating that firms for which the underinvestment problem could be larger also tend to have lower propensity to pay dividends. In this context, the larger β_{FX} coefficient on companies with smaller investment opportunities can seem puzzling. However, one can explain this with added flexibility to make dividend payout decisions when funds are not tied to investment projects. If a firm has lots of investment opportunities it will dedicate its funds to them and pay lower dividends, allowing for less flexibility to the dividend payout decision should additional factors arise, like higher FX exposure. In the case of firms with low investment opportunities, there is more flexibility to the payout decision because dividends are not tied to investment decisions and if the company (with high FX exposure) wants to buffer against uncertainty of its cash flows by holding more cash it will have a larger flexibility to divert funds from its dividends.

Next, Table IX explores how the relationship between exchange exposure and dividend policy changes with the level of competition in the industry. Column 1 repeats the regression from the same column in Table VIII for comparison. Column 2 adds the variable for industry competition CR and interacts the β_{FX} variable with three dummies for different levels of industry concentration. Due to competition data limitations, the sample in this panel runs from 1993 to 2007 and has 14,062 firm-year observations, covering 989 unique firms.

Competition by itself does not seem to affect the dividend payout decision as the coefficient on CR is insignificant with a p-value of 0.26. However, it affects dividend policy indirectly through the foreign exchange rate exposure of the firm. Holding exposure constant, one can notice a decrease in the likelihood to pay dividends by moving from firms that are subject to low competition to firms subject to high competition. The general negative relationship that is observed between foreign exchange rate exposure and dividend decisions (presented in Column 1) is driven by the cases in which companies face higher competition for investment opportunities.

In general companies with higher foreign exchange rate exposure tend to have a lower propensity to pay dividends, especially in cases when the underinvestment problem can be more severe like for dividend non-payers, firms with higher investment opportunities and in more competition industries. The relative drop in the likelihood to pay dividends is also economically meaningful especially for dividend non-payers.

1.9 Conclusion

As economic markets have become more integrated over the last couple of decades, foreign exchange rate sensitivity becomes more relevant to the average firm and not just multinational corporations. I show that nearly half of the measured foreign exchange rate exposures in my sample are statistically significant; indicating that for a major part of companies, firm value is affected by fluctuations in exchange rates. Furthermore, I find that foreign currency exposure matters not only for internationally involved firms as 52% of the significant FX exposures come from firms with no foreign sales.

Unlike the majority of the literature that tries to solve the foreign exchange rate exposure puzzle or improve the procedures for estimation of currency exposure, this study takes a new approach and tries to explore whether FX exposure is reflected in the actions taken by managers on the corporate level beyond hedging. The empirical results confirm the initial hypotheses showing that firm foreign exchange rate exposure is significantly related to corporate policies connected to securing funds in the case of possible underinvestment.

The analysis shows that firms with higher foreign exchange rate exposure hold more cash, which is consistent with the precautionary motive for cash demand. They also have a higher likelihood of accessing capital markets by issuing debt or equity, which fits into the pecking order motivation for using external capital when there are value creating projects available and not enough internally generated funds. Additionally, firms with higher exchange rate exposure have a lower likelihood of issuing dividends, consistent with the life-cycle theory of dividend payout and the concern of cash flow instability.

Moreover, it is shown that the relationship between foreign exchange rate exposure and corporate policies is stronger in cases when the possible underinvestment is more severe, namely when companies are subject to more competition and when they have more investment opportunities.

Further, the relationship between foreign exchange rate exposure and corporate policies is not only statistically significant but also economically meaningful. Thus, everything else equal, an increase of FX exposure from its 25^{th} to its 75^{th} percentile is accompanied by: up to a 27.8% *relative* increase in cash holdings based on a comparison to the sample median of 4.2%[43]; up to 12% *relative* increase in the probability to issue capital based on a comparison to the estimated initial probability of 46%[44]; up to 25% *relative* drop in the propensity to pay dividends based on a comparison to initial estimated probability of 8% [45]

In summary, the sensitivity to exchange rate fluctuations is extremely relevant to corporate policies and is especially important for firms that are likely to have a more severe underinvestment problem. Thus, consideration of exchange rates is not only applicable to hedging decisions, but also other policies on the corporate level like the demand for cash, payout policy and capital issuance. Therefore, it is believed that corporate managers even at purely domestic firms should pay a closer attention to the impact exchange rates have on their firm value and potentially incorporate foreign exchange rate exposure into their corporate policy analysis.

[43] Based on calculation for firms with high investment opportunities
[44] Based on calculation for firms with high investment opportunities
[45] For previous year dividend non-payers, who are also likely to have higher investment opportunities according to the life-cycle theory

Table 1.1 Selected summary statistics

Summary statistics are presented for companies that have estimated foreign exchange rate exposure (moving window procedure) and have available accounting information on book assets covering the period from 1992 to 2008. Obs refers to the firm-year observations with available information for the respective variable. R_{FX} is the % change in the U.S. Trade-Weighted Index. β^*_{FX} is the estimated coefficient in equation (1) from regressing firm returns on the augmented Fama-French model. FX exposure is foreign exchange rate exposure β_{FX} defined as the absolute value of β^*_{FX} and capturing the sensitivity of firm value to changes in exchange rates. For detailed description of other variables refer to the Appendix.

Panel A

Variable	Obs	Mean	Std. Dev	Percentiles 25th	50th	75th
R_{FX} (monthly) %	204	0.06	1.65	-0.91	0.21	1.19
R_{FX} (annual) %	17	0.82	7.24	-4.80	2.28	6.34
β^*_{FX}	18,712	-0.60	1.09	-1.11	-0.53	-0.03
FX exposure=β_{FX}= $\lvert\beta^*_{FX}\rvert$	18,712	0.90	0.85	0.32	0.67	1.22
Size	18,712	6.79	2.33	5.21	6.88	8.48
Foreign sales ratio	18,649	0.16	0.29	0.00	0.00	0.28
Export sales ratio	18,649	0.03	0.09	0.00	0.00	0.00
# Segments	15,919	2.49	1.75	1.00	2.00	4.00
Cash ratio	18,148	0.08	0.12	0.01	0.04	0.11
Leverage	18,712	0.17	0.17	0.02	0.13	0.27

Panel B

Variable	Obs	Mean	Std. Dev	YES	NO
Dividend payout	20,553	0.69	0.46	14,192	6,361
Capital issuance	18,624	0.48	0.50	8,997	9,627

Table 1.2 Foreign exchange rate exposure on the firm level

The table presents an overview of the estimated firm level foreign exchange rate exposures summarized by industry. Foreign exchange rate exposure β^*_{FX} is estimated from the augmented Fama-French model in equation (1) for the period 1992 to 2008. Note that here foreign exchange rate exposure is explored with its sign. It assesses the percentage change in firm value against a 1% change in the exchange rate. A firm with negative exchange rate exposure or $\beta^*_{FX} < 0$ will have adverse stock price effects as result of U.S. dollar appreciation and benefit from its depreciation. A firm with positive exchange exposure or $\beta^*_{FX} > 0$ will have adverse stock price effects as result of U.S. dollar depreciation and benefit from its appreciation. The foreign exchange rate factor is proxied by the Trade-Weighted U.S. dollar index. The sample covers 1231 firms with full monthly stock price information for the sample period. Industries are classified according to the Fama-French 17 industry definition. N indicates the number of firms in the respective sample.

Industry	Total N	Significant at 10%	Significant at 5%	Significant at 1%	Negative N	Positive N	Avg FX Exposure	St Dev FX Exposure
All	1231	602	492	314	1081	150	-0.57	0.55
		49%	*40%*	*26%*	*88%*	*12%*		
Oil and Petroleum Products	54	63%	61%	50%	53	1	-1.14	0.53
Mining and Minerals	21	57%	57%	48%	20	1	-1.10	0.71
Fabricated Products	16	63%	56%	38%	15	1	-0.77	0.54
Steel Works etc	12	58%	58%	50%	12	0	-0.77	0.33
Chemicals	24	58%	54%	46%	22	2	-0.71	0.60
Machinery and Business Equipment	166	46%	37%	24%	153	13	-0.70	0.56
Consumer Durables	29	55%	34%	14%	28	1	-0.64	0.38
Transportation	42	48%	43%	24%	38	4	-0.62	0.48
Other	230	40%	31%	14%	202	28	-0.60	0.58
Food	42	57%	45%	24%	37	5	-0.57	0.49
Textiles,Apparel, Footware	24	42%	25%	13%	18	6	-0.55	0.59
Automobiles	21	33%	19%	10%	20	1	-0.49	0.44
Banks, Insurance and Other Financials	331	53%	44%	32%	286	45	-0.46	0.49
Construction and Construction Materials	42	43%	36%	21%	29	13	-0.46	0.61
Utilities	78	68%	50%	31%	73	5	-0.41	0.26
Drugs, Soaps, Perfumes, Tobacco	44	23%	18%	14%	38	6	-0.37	0.48
Retail Stores	54	28%	20%	4%	37	17	-0.28	0.61

Table 1.3 Characteristics of firms with higher foreign exchange rate exposure

The table summarizes what kind of firms tend to have higher foreign exchange rate exposures. The dependent variable is foreign exchange rate exposure β_{FX} measured as the absolute value of the coefficient β_{FX}^{*} estimated from the augmented Fama-French model in equation (1). The augment FF model is applied to 60-month moving- window regressions with lag of one year every time to allow for potential temporal instability in firm exposure. Thus, the samples in column 1 and 2 cover the period from 1992 to 2008. Size is measured as the natural log of book assets for a given year. Foreign sales ratio is the proportion of sales outside the United States to total sales for the given year; export sales ratio is the proportion of sales of domestically produced goods/services overseas to total firm sales for a given year; number of segments is the number of business segments of the firm; CR is industry concentration ratio measured by the percentage of industry sales represented by the largest four companies, data on CR is available for the years 1993 to 2007. All standard errors are double clustered by firm and year. Significance level: *** 1%, ** 5%,* 10%.

	Foreign exchange rate exposure = β_{FX}					
	[1]		[2]		[3]	
	Coefficient	P-Value	Coefficient	P-Value	Coefficient	P-Value
Size	-0.063 ***	0.00	-0.068 ***	0.00	-0.067 ***	0.00
Foreign Sales Ratio	0.199 **	0.02	0.201 **	0.02	0.158 **	0.05
Export Sales Ratio	0.710 ***	0.00	0.680 ***	0.00	0.690 ***	0.00
# Segments			-0.015 **	0.04		
CR					0.005 ***	0.00
Industry dummies	Yes		Yes		Yes	
Double clustered error	Yes		Yes		Yes	
Obs	18648		15865		14529	
N firms	1112		1013		1005	
T	17		17		15	
R^2	0.08		0.08		0.09	

Table 1.4 Cash holdings and foreign exchange rate exposure varying investment opportunities

The table explores the relationship between foreign exchange rate exposures and cash holdings. The dependent variable is the firm cash ratio, measured as firm's cash holdings scaled by book value of assets. Foreign exchange rate exposure β_{FX} measured as the absolute value of the coefficient β^{*}_{FX} estimated from the augmented Fama-French model in equation (1). The augment FF model is applied to 60-month moving- window regressions with lag of one year every time to allow for potential temporal instability in firm exposure. Thus, the samples in columns 1 and 2 cover the period from 1992 to 2008. For detailed description of other variables refer to the Appendix. All standard errors are double clustered by firm and year. Significance level: *** 1%, ** 5%,* 10%.

Panel A

	Cash Ratio					
	[1]			[2]		
	Coefficient		P-Value	Coefficient		P-Value
β_{FX}	0.004	***	0.01			
β_{FX} x MB_{low}				-0.002		0.34
β_{FX} x MB_{med}				0.001		0.62
β_{FX} x MB_{high}				0.014	***	0.00
MB	0.008	***	0.00	0.007	***	0.00
Size	-0.006	***	0.00	-0.007	***	0.00
CF/TA	-0.134	***	0.00	-0.149	***	0.00
NWC / TA	-0.106	***	0.00	-0.115	***	0.00
Capex	-0.328	***	0.00	-0.360	***	0.00
Leverage	-0.168	***	0.00	-0.180	***	0.00
R&D / TA	0.218	***	0.00	0.220	***	0.00
Dividend dummy	-0.042	***	0.00	-0.045	***	0.00
Acquisitions/ TA	-0.149	***	0.00	-0.164	***	0.00
ROA	0.090	***	0.00	0.098	***	0.00
Cash holdings Δ						
Absolute Δ	0.38%			1.23%		
Relative Δ	8.60%			27.80%		
Industry dummies	Yes			Yes		
Double clustered error	Yes			Yes		
Obs	13673			13673		
N firms	880			880		
T	17			17		
R^2	0.37			0.38		

Table 1.4 - continued

Industry sigma is measured as the standard deviation of industry cash flow to assets: for each-firm year the standard deviation of cash flow to assets is calculated for the previous 10 years and these estimates are averaged for each year across two-digit SIC codes. The samples in columns 1 and 2 cover the period from 1992 to 2008. For detailed description of other variables refer to the Appendix. All standard errors are double clustered by firm and year. Significance level: *** 1%, ** 5%,* 10%.

Panel B

	Cash Ratio					
	[1]			[2]		
	Coefficient		P-Value	Coefficient		P-Value
β_{FX}	0.004	***	0.01	0.004	***	0.01
Industry σ				0.003	***	0.01
MB	0.008	***	0.00	0.008	***	0.00
Size	-0.006	***	0.00	-0.007	***	0.00
CF/TA	-0.134	***	0.00	-0.130	***	0.00
NWC / TA	-0.106	***	0.00	-0.105	***	0.00
Capex	-0.328	***	0.00	-0.323	***	0.00
Leverage	-0.168	***	0.00	-0.168	***	0.00
R&D / TA	0.218	***	0.00	0.212	***	0.00
Dividend dummy	-0.042	***	0.00	-0.041	***	0.00
Acquisitions/ TA	-0.149	***	0.00	-0.149	***	0.00
ROA	0.090	***	0.00	0.086	***	0.00
Industry dummies	Yes			Yes		
Double clustered error	Yes			Yes		
Obs	13673			13673		
N firms	880			880		
T	17			17		
R^2	0.37			0.37		

Table 1.5 Cash holdings and foreign exchange rate exposure – varying industry competition

The table explores the relationship between exchange rate exposures and cash holdings. The dependent variable is the firm cash ratio, measured as firm's cash holdings scaled by book value of assets. Foreign exchange rate exposure β_{FX} measured as the absolute value of the coefficient β^*_{FX} estimated from the augmented Fama-French model in equation (1). The augment FF model is applied to 60-month moving- window regressions with lag of one year every time to allow for potential temporal instability in firm exposure. Thus, the sample in column [1] covers the period from 1992 to 2008. Concentration Ratio CR indicates the percentage of industry sales (market share) concentrated in the top four companies with largest sales, data available for the year 1993- 2007 (column [2]). For detailed description of other variables refer to the Appendix. All standard errors are double clustered by firm and year. Significance level: *** 1%, ** 5%,* 10%.

	Cash Ratio					
	[1]			[2]		
	Coefficient		P-Value	Coefficient		P-Value
β_{FX}	0.004	***	0.01			
β_{FX} x CR_{low}				0.006	***	0.00
β_{FX} x CR_{med}				-0.003		0.53
β_{FX} x CR_{high}				0.018		0.18
CR				0.000		0.32
MB	0.008	***	0.00	0.008	***	0.00
Size	-0.006	***	0.00	-0.006	***	0.00
CF/TA	-0.134	***	0.00	-0.112	***	0.00
NWC / TA	-0.106	***	0.00	-0.126	***	0.00
Capex	-0.328	***	0.00	-0.431	***	0.00
Leverage	-0.168	***	0.00	-0.191	***	0.00
R&D / TA	0.218	***	0.00	0.232	***	0.00
Dividend dummy	-0.042	***	0.00	-0.042	***	0.00
Acquisitions/ TA	-0.149	***	0.00	-0.175	***	0.00
ROA	0.090	***	0.00	0.082	***	0.01
Cash holdings Δ						
Absolute Δ	0.38%			0.52%		
Relative Δ	8.60%			12.40%		
Industry dummies	Yes			Yes		
Double clustered error	Yes			Yes		
Obs	13673			10447		
N firms	880			782		
T	17			15		
R^2	0.37			0.37		

Table 1.6 Capital issuance and foreign exchange rate exposure- varying investment opportunity sets

The table presents the results for the logit regressions of capital issuance on foreign exchange rate exposure and control variables. The dependent variable is Capital Issuance Dummy: an indicator variable equal to one if net debt issuance is greater than 1% or if net equity issuance greater than 1%, and zero otherwise. Foreign exchange rate exposure β_{FX} measured as the absolute value of the coefficient β^{*}_{FX} estimated from the augmented Fama-French model in equation (1). The augment FF model is applied to 60-month moving- window regressions with lag of one year every time to allow for potential temporal instability in firm exposure. Thus, the samples in columns [1] to [4] cover the period from 1992 to 2008. For detailed description of other variables refer to the Appendix. All standard errors are double clustered by firm and year. Significance level: *** 1%, ** 5%,* 10%

	Capital Issuance (Logit)							
	[1]		[2]		[3]		[4]	
	Coefficient	P-Value	Coefficient	P-Value	Coefficient	P-Value	Coefficient	P-Value
β_{FX}	0.114 ***	0.00	0.109 ***	0.00				
β_{FX} x MB_{low}					-0.063	0.18	-0.069	0.15
β_{FX} x MB_{med}					0.152 ***	0.00	0.147 ***	0.00
β_{FX} x MB_{high}					0.256 ***	0.00	0.247 ***	0.00
EBIT / TA	-2.065 ***	0.00	-2.055 ***	0.00	-2.200 ***	0.00	-2.208 ***	0.00
MB	0.088 ***	0.00	0.084 ***	0.00	0.060 ***	0.00	0.056 ***	0.01
Depreciation / TA	-6.636 ***	0.00	-7.381 ***	0.00	-6.703 ***	0.00	-7.602 ***	0.00
Size	0.077 ***	0.00	0.078 ***	0.00	0.075 ***	0.00	0.076 ***	0.00
FA / TA	1.186 ***	0.00	1.273 ***	0.00	1.180 ***	0.00	1.239 ***	0.00
R&D / TA	-0.099	0.88	0.437	0.54	-0.416	0.55	0.061	0.93
Probability to issue capital - Δ								
Absolute Δ			2.4%				5.4%	
Relative Δ			5.2%				12.0%	
Initial Probability			45.6%				46.0%	
Industry dummies	Yes		No		Yes		No	
Double clustered error	Yes		Yes		Yes		Yes	
Obs	17758		17758		17758		17758	
N firms	1095		1095		1095		1095	
T	17		17		17		17	
Pseudo R^2	0.03		0.03		0.04		0.03	

Table 1.7 Capital issuance and foreign exchange rate exposure - varying industry competition

The table presents the results for the logit regressions of capital issuance on foreign exchange rate exposure and control variables. The dependent variable is Capital Issuance Dummy: an indicator variable equal to one if net debt issuance is greater than 1% or if net equity issuance greater than 1%, and zero otherwise. Foreign exchange rate exposure β_{FX} measured as the absolute value of the coefficient β^{*}_{FX} estimated from the augmented Fama-French model in equation (1). The augment FF model is applied to 60-month moving- window regressions with lag of one year every time to allow for potential temporal instability in firm exposure. Thus, the sample in columns [1] covers the period from 1992 to 2008. Concentration Ratio CR indicates the percentage of industry sales (market share) concentrated in the top four companies with largest sales, data is available for the years 1993- 2007 (column [2]). For detailed description of other variables refer to the Appendix. All standard errors are double clustered by firm and year. Significance level: *** 1%, ** 5%,* 10%

	Capital Issuance (Logit)					
	[1]			[2]		
	Coefficient		P-Value	Coefficient		P-Value
β_{FX}	0.114	***	0.00			
β_{FX} x CR_{low}				0.124	***	0.00
β_{FX} x CR_{med}				0.012		0.85
β_{FX} x CR_{high}				-0.029		0.77
CR				0.002		0.42
EBIT / TA	-2.065	***	0.00	-2.122	***	0.00
MB	0.088	***	0.00	0.088	***	0.00
Depreciation / TA	-6.636	***	0.00	-8.487	***	0.00
Size	0.077	***	0.00	0.079	***	0.00
FA / TA	1.186	***	0.00	1.297	***	0.00
R&D / TA	-0.099		0.88	0.120		0.84
Industry dummies	Yes			Yes		
Double clustered error	Yes			Yes		
Obs	17758			13857		
N firms	1095			985		
T	17			15		
Pseudo R^2	0.03			0.03		

Table 1.8 Dividend payout and foreign exchange rate exposure - varying investment opportunity sets

The table presents the results for the logit regressions of dividend payout on foreign exchange exposure and control variables. The dependent variable is Dividend dummy, which is equal to one if the firm pays common dividend during a given year, zero otherwise. Foreign exchange rate exposure β_{FX} measured as the absolute value of the coefficient β^*_{FX} estimated from the augmented Fama-French model in equation (1). The augment FF model is applied to 60-month moving- window regressions with lag of one year every time to allow for potential temporal instability in firm exposure. Thus, the samples in columns [1] to [3] cover the period from 1992 to 2008. For detailed description of other variables refer to the Appendix. All standard errors are double clustered by firm and year. Significance level: *** 1%, ** 5%,* 10%

	Dividend Payout (Logit)					
	[1]		[2]		[3]	
	Coefficient	P-Value	Coefficient	P-Value	Coefficient	P-Value
β_{FX}	-0.295 ***	0.00	-0.348 ***	0.00		
β_{FX} x MB_{low}					-0.523 ***	0.00
β_{FX} x MB_{med}					-0.125	0.15
β_{FX} x MB_{high}					-0.276 **	0.02
RE / TE	0.007 ***	0.00	0.007 ***	0.00	0.007 ***	0.00
TE / TA	0.488	0.14	0.027	0.90	0.518	0.13
ROA	6.914 ***	0.00	7.245 ***	0.00	6.709 ***	0.00
MB	-0.087 *	0.09	-0.129 **	0.02	-0.094 *	0.05
Size	0.243 ***	0.00	0.245 ***	0.00	0.234 ***	0.00
Cash ratio	-1.032 **	0.02	-1.208 ***	0.00	-1.019 **	0.03
Lag Dividend	6.635 ***	0.00	6.740 ***	0.00	6.662 ***	0.00
Probability to pay dividends - Δ			Past Non-payers	Past Payers		
Absolute Δ			2.0%	0.5%		
Relative Δ			25.0%	0.5%		
Initial Probability			8.0%	98.2%		
Industry dummies	Yes		No		Yes	
Double clustered error	Yes		Yes		Yes	
Obs	17984		17984		17984	
N firms	1100		1100		1100	
T	17		17		17	
Pseudo R^2	0.83		0.83		0.83	

Table 1.9 Dividend payout and foreign exchange rate exposure - varying industry competition

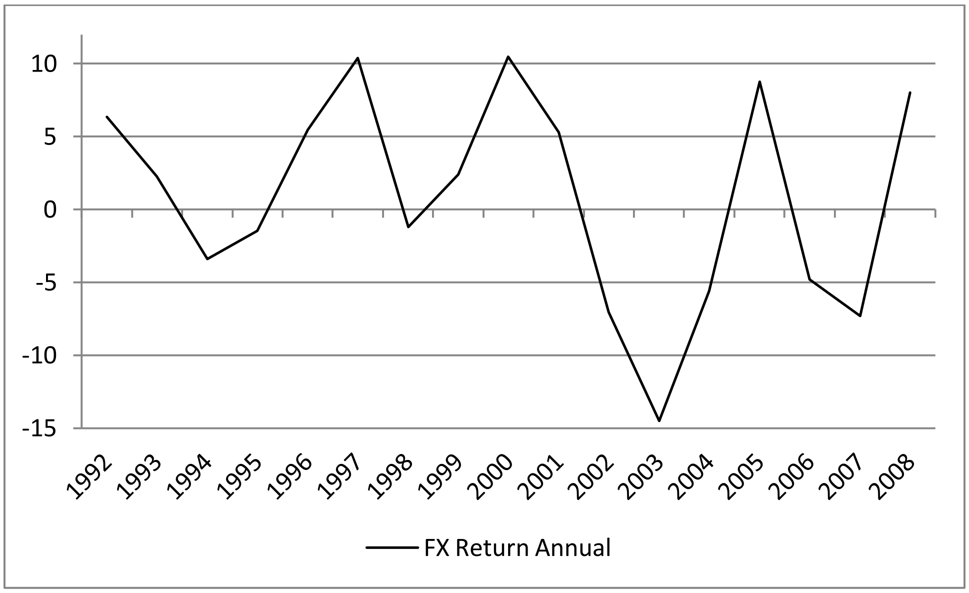
The table presents the results for the logit regressions of dividend payout on foreign exchange exposure and control variables. The dependent variable is Dividend dummy, which is equal to one if the firm pays common dividend during a given year, zero otherwise. Foreign exchange rate exposure β_{FX} measured as the absolute value of the coefficient β^{*}_{FX} estimated from the augmented Fama-French model in equation (1). The augment FF model is applied to 60-month moving-window regressions with lag of one year every time to allow for potential temporal instability in firm exposure. Thus, the sample in column [1] covers the period from 1992 to 2008. Concentration Ratio CR indicates the percentage of industry sales (market share) concentrated in the top four companies with largest sales, data is available for the years 1993- 2007 (column [2]). For detailed description of other variables refer to the Appendix. All standard errors are double clustered by firm and year. Significance level: *** 1%, ** 5%,* 10%

	Dividend Payout (Logit)			
	[1]		[2]	
	Coefficient	P-Value	Coefficient	P-Value
β_{FX}	-0.295 ***	0.00		
β_{FX} x CR_{low}			-0.331 ***	0.00
β_{FX} x CR_{med}			-0.452	0.15
β_{FX} x CR_{high}			1.424 **	0.04
CR			-0.007	0.26
RE / TE	0.007 ***	0.00	0.000	0.93
TE / TA	0.488	0.14	0.778 ***	0.00
ROA	6.914 ***	0.00	7.512 ***	0.00
MB	-0.087 *	0.09	-0.122 ***	0.01
Size	0.243 ***	0.00	0.243 ***	0.00
Cash ratio	-1.032 **	0.02	-1.406 **	0.01
Lag Dividend	6.635 ***	0.00	6.577 ***	0.00
Industry dummies	Yes		Yes	
Double clustered error	Yes		Yes	
Obs	17984		14062	
N firms	1100		989	
T	17		15	
Pseudo R2	0.83		0.83	

Figure 1.1 Changes (%) in the Trade Weighted U.S. Dollar Index 1992-2008

The figure represents the percentage changes in the Trade Weighted U.S. Dollar Index, which is the weighted average of the foreign exchange value of the U.S. dollar against a subset of currencies that circulate widely outside the country of issue, including the Euro Area, Canada, Japan, United Kingdom, Switzerland, Australia, and Sweden. It is stated as units of foreign currency per U.S. dollar. An appreciation of the US dollar is equivalent to an increase in the index and $R_{FX} > 0$.

Panel A: FX Return Annual



Panel B: FX Return Monthly

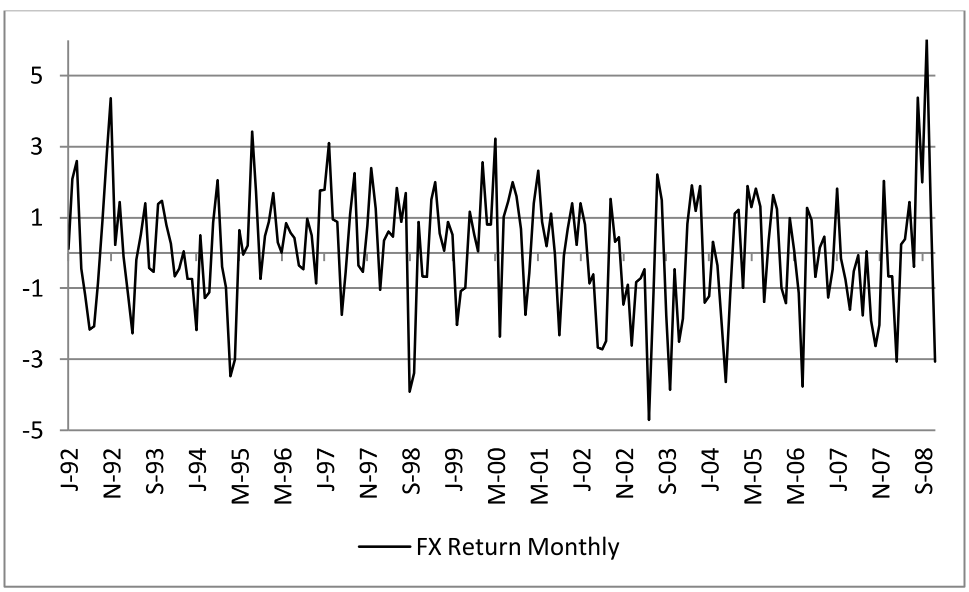
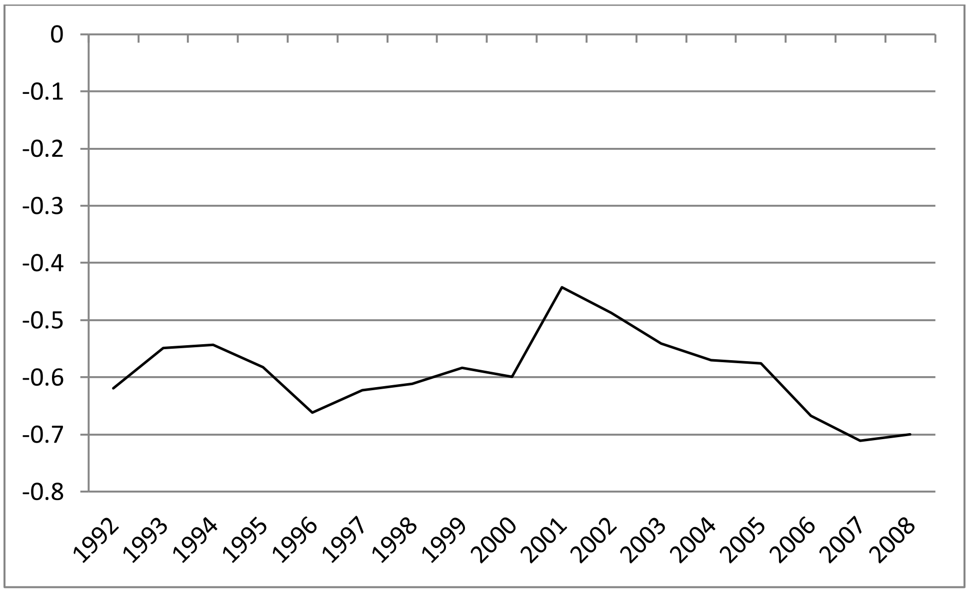


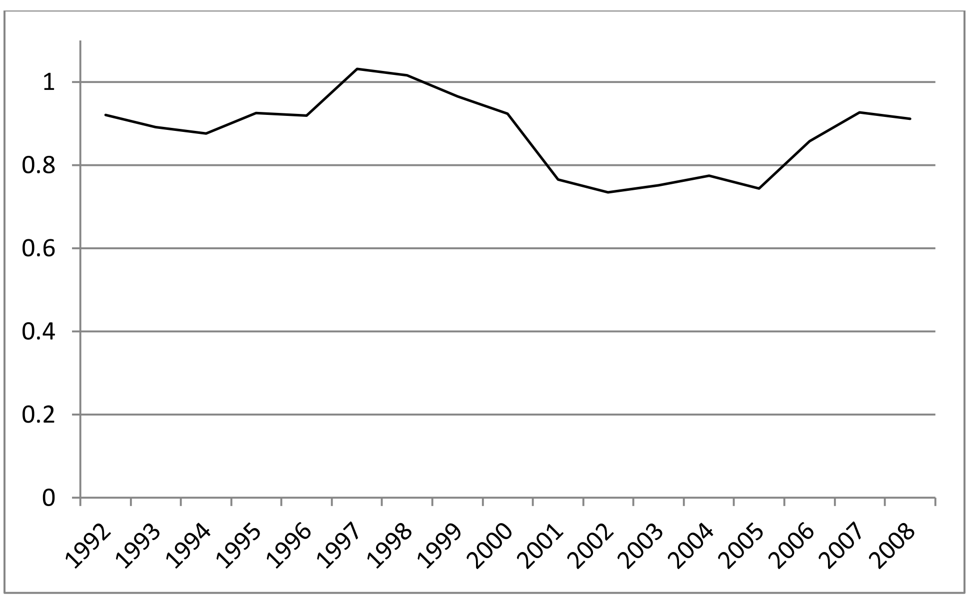
Figure 1.2 Average cross-sectional foreign exchange rate exposure 1992-2008

The figure depicts the average cross sectional foreign exchange rate exposure. β^{*}_{FX} is the estimated coefficient in equation (1) from regressing firm returns on changes in exchange rates and the three FF factors. FX exposure β_{FX} is foreign exchange exposure defined as the absolute value of β^{*}_{FX} and capturing the sensitivity of firm value to changes in exchange rates.

Panel A: Mean Cross-Sectional β^{*}_{FX}



Panel B: Mean Cross-Sectional FX Exposure β_{FX}



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2 CHAPTER
CAN RISK EXPLAIN THE PROFITABILITY OF TECHNICAL TRADING IN CURRENCY MARKETS?

2.1 Introduction

It is a stylized fact that excess returns for currency-related trading strategies, especially the carry trade, are weakly correlated with traditional risk factors, such as the CAPM's equity market factor. To better measure abnormal returns in currency markets and assess market efficiency, recent studies propose a variety of risk factors for carry trade portfolios. These risk factors include consumption growth (Lustig and Verdelhan, 2007), crash risk (Brunnermeier, Nagel, and Pedersen, 2008), a forward premium slope factor (Lustig, Roussanov, and Verdelhan, 2011), economic size (Hasan, 2013), global exchange rate volatility (Menkhoff, Sarno, Schmeling, and Schrimpf, 2012), and liquidity (Mancini, Ranaldo, and Wrampelmeyer, 2013).

These recently proposed currency risk factors usefully explain the returns to a cross-section of carry trade portfolios. Nevertheless, the economic case for these factors would be more compelling if they could also explain excess returns for investment strategies beyond the carry trade (Burnside, 2011). Such explanatory ability would allay data-mining concerns and better establish the economic relevance of the newly proposed currency risk factors. In this spirit, the present paper investigates the ability of recently proposed currency risk factors to account for the excess returns of technical trading strategies. Technical trading has received less attention than the carry trade despite being as successful, well-documented and mysterious. Technical analysis (or trend following) is very popular among currency market participants (Menkhoff and Taylor, 2007), and a sizable literature indicates that traditional risk factors fail to explain the profitability of a variety of technical strategies. From this standpoint, the ability of newly proposed currency risk factors to account for the profitability of technical strategies provides an informative test of the relevance of these factors. If new risk factors cannot adequately account for the behavior of technical strategies, then these factors are less appealing economically and the search for more robust currency risk factors should continue.

We investigate the ability of a broad array of currency risk factors to explain excess returns for a group of technical portfolios developed in Neely and Weller (2013). These portfolios are based on a variety of popular technical indicators and provide a realistic picture of returns for trend-following practitioners. We consider the following models: CAPM, quadratic CAPM, C-CAPM, Carhart's 4-factor model, an extended C-CAPM with durable consumption, Lustig-

Verdelhen (LV) factors, volatility and skewness. In a nutshell, our results show that recently proposed currency risk factors have very little explanatory power for technical portfolio returns. The risk factors identified in the recent literature thus do not appear relevant for an important class of portfolios in the currency space. We highlight the dimensions along which the new risk factors fail to account for the behavior of technical portfolios. The inadequacies of extant currency risk factors highlight the challenges in explaining technical portfolio returns.

The rest of the paper is organized as follows. We first describe the construction of currency portfolios. We then describe the different currency risk factors that we consider and econometric methodology. Our empirical results follow.

2.2 Trading rules and data

The goal of our paper is to examine whether recent advances in risk-adjustment can explain the seemingly very strong performance of traditional technical trading rules in foreign exchange markets. To do so, we must construct such returns in a manner consistent with the literature that has established their profitability. We would like our trading rules to represent those that the academic literature has investigated but also to be chosen dynamically, to exploit changing patterns in adaptive markets. In order to do so, we basically follow Neely and Weller (2013) who dynamically constructed portfolio strategies from an underlying pool of frequently studied rules— 7 filter rules, 3 moving average rules, 3 momentum rules, and 3 channel rules— on 19 dollar and 21 cross exchange rates.[46] There is one notable difference between the rules used in this paper and those in Neely and Weller (2013): to isolate the determinants of technical trading rules, the present paper does not include carry trade returns among the rules.

Menkhoff et al. (2012b) have previously studied the risk-adjustment of certain types of currency momentum strategies. One might be concerned that the rules studied here—technical rules—would be very similar to the momentum rules studied by Menkhoff et al. (2012b). But Menkhoff et al. (2012b) evaluate this concern and argue that technical rules and momentum rules are quite different.

All of the bilateral rules borrow in one currency and lend in the other. Thus they all produce excess returns. We will first describe the types of trading rules before detailing the dynamic rebalancing procedure for currency trading strategies.

[46] Dooley and Shafer (1984) and Sweeney (1986) look at filter rules; Levich and Thomas (1993) look at filter and moving average rules; Jegadeesh and Titman (1993) consider momentum rules in equities, citing Bernard (1984) on the topic; and Taylor (1994) tests channel rules, for example.

A filter rule generates a buy signal for a foreign currency when the exchange rate S_t (domestic price of foreign currency) has risen by more than y percent above its most recent low. It generates a sell signal when the exchange rate has fallen by more than the same percentage from its most recent high.

Thus,

$$z_t = \begin{cases} 1 & \text{if} \quad S_t \geq n_t(1+y) \\ -1 & \text{if} \quad S_t \leq x_t(1-y), \\ z_{t-1} & \text{otherwise,} \end{cases} \tag{1}$$

where z_t is an indicator variable that takes the value +1 for a long position in foreign currency and –1 for a short position. nt is the most recent local minimum of S_t and xt the most recent local maximum. The seven filter rules have filter sizes (y) of 0.005, 0.01, 0.02, 0.03, 0.04, 0.05, and 0.1.

A moving average rule generates a buy signal when a short-horizon moving average of past exchange rates crosses a long-horizon moving average from below. It generates a sell signal when the short moving average crosses the long moving average from above. We denote these rules by MA(S, L), where S and L are the number of days in the short and long moving averages, respectively. The moving average rules are MA(1, 5), MA(5, 20), and MA(1, 200). Thus, MA(1, 5) compares the current exchange rate with its 5-day moving average and records a buy (sell) signal if the exchange rate is currently above (below) its 5-day moving average.

Our momentum rules take a long (short) position in an exchange rate when the n-day cumulative return is positive (negative). We consider windows of 5, 20 and 60 days for the momentum rules.

A channel rule takes a long (short) position if the exchange rate exceeds (is less than) the maximum (minimum) over the previous n days plus (minus) the band of inaction (x).

Thus,

$$z_t = \begin{cases} 1 & \text{if} \quad S_t \geq \max\left(S_{t-1}, S_{t-2}, \ldots S_{t-n}\right)(1+x) \\ -1 & \text{if} \quad S_t \leq \min\left(S_{t-1}, S_{t-2}, \ldots S_{t-n}\right)(1-x) \\ z_{t-1} & \text{otherwise} \end{cases} \tag{2}$$

We set n to be 5, 10, and 20, and x to be 0.001 for all rules.

We apply these 16 bilateral rules —7 filter rules, 3 moving average rules, 3 momentum rules, and 3 channel rules— to 19 dollar and 21 cross exchange rates, listed in Table 1. The series for the DEM was spliced with that for the EUR after January 1, 1999. For simplicity we refer to this series throughout as the EUR. Not all exchange rates are tradable throughout the sample. Table 1 details the dates on which we permit trading in each exchange rate.

In any study of trading performance—especially when using exotic currencies—it is important to pay close attention to transaction costs. Rules and strategies that may appear to be profitable when such costs are ignored turn out not to be once the appropriate adjustments have been made. We follow the methods in Neely and Weller (2013) and calculate transactions costs using historical estimates for such costs in the distant past and fractions of Bloomberg spreads after those were available. Neely and Weller (2013) detail these calculations.

2.3 Dynamic trading strategies

We would like to construct dynamic strategies to mimic the actions of foreign exchange traders who backtest potential rules on historical data to determine trading strategies. Accurately modeling potential trading returns provides the most realistic environment for assessing whether risk adjustment explains such returns.

Therefore, we construct dynamic trading strategies as follows:

We apply the 16 bilateral rules to all available exchange rates at each point in the sample, calculating the historical return statistics for each exchange rate-rule pair at each point. There is a maximum of (16*40=) 640 exchange rate-rules on any given day, but missing data for some exchange rates often leave fewer than half that number of currency-rule pairs.

Starting 500 days into the sample, we evaluate the Sharpe ratios of all exchange rate-rule pairs with at least 250 days of data since the beginning of the respective samples. We then sort the rate-rule pairs by their ex post Sharpe ratios, ranking the rate-rule pairs by Sharpe ratio from 1 to 640. We then measure the performance of the strategies over the next 20 days.

Every 20 business days, we evaluate, sort and rank all available rate-rule pairs using the complete sample of data available to that point. Thus, the returns on the top-ranked strategy pair will be generated by a given trading rule applied to a particular exchange rate for a minimum of 20 days, at which point it may (or may not) be replaced by another rule applied to the same or a different currency.

Although we select the rate-rule pairs for the dynamic strategies based upon historical performance, as described above, we evaluate the strategies' performance after they are selected. That is, all return performance statistics in this paper are for strategies that were chosen ex ante and are thus implementable.

2.4 Currency portfolios

As is customary in related literature, we examine the risk-adjustment of technical trading rules in the following way: Using strategies 1 to 300 to use as test assets, we form 12 equally weighted portfolios of 25 strategies per portfolio. Thus portfolio p1 at time t consists of the 25 currency-rule pairs with Sharpe ratios ranked 1 to 25. Portfolio p2 consists of the 25 currency-rule pairs with Sharpe ratios ranked 26 to 50, and so on. The makeup of the portfolios of currency-rule pairs may change from period to period with ex post Sharpe ratio rankings.[47]

Figure 1 shows the spread in excess return, standard deviation and Sharpe ratios over the 12 portfolios. The top panel shows that all 12 portfolios have positive excess returns, generally declining as one goes from p1 (4.61% per annum) to p12 (1.08% per annum). The middle panel shows that the high ranked portfolios also tend to have more volatile returns, though the relation is not as steep as for returns. The third panel confirms this: ex post Sharpe ratios are higher for the portfolios with higher ex ante rankings, ranging from 0.92 for p1 to 0.29 for p12.

2.5 Theoretical framework

To provide a general framework within which to measure risk exposure we need to characterize equilibrium in the foreign exchange market. We assume the existence of a representative investor based in the US, and introduce a stochastic discount factor (SDF), M_{t+1} that prices payoffs in dollars.[48] It represents a marginal rate of substitution between present and future consumption in different states of the world. The first order conditions for utility maximization subject to an intertemporal budget constraint imply that any asset return R_{t+1} must satisfy

$$E(M_{t+1}R_{t+1}|I_t) = 1 \quad (3)$$

where I_t denotes the information available to the investor at time t. Varying assumptions about the content of I_t produce the different categories of market efficiency advanced by Fama. Since we are modeling the risk exposure of technical trading rules we will be exclusively concerned with weak-form efficiency in which the information set I_t contains only past prices.

[47] Alternatively, one could examine risk-adjusted returns to a portfolio of the top N strategies. Although we omit the full results for brevity, we also risk-adjust the return to four such portfolios, using equal and ex ante, mean-variance optimal weights and N = 10, 50. We will note results from these exercises where appropriate.

[48] Although we motivate the SDF framework with a representative investor, much weaker assumptions are sufficient. In particular, absence of arbitrage implies the existence of a SDF framework, as in equation (3).

Equation (3) implies that the risk-free asset return R_t^f is given by

$$R_t^f = \frac{1}{E(M_{t+1}|I_t)} \tag{4}$$

Using (3), (4) and the definition of covariance, it follows that

$$E(R_{t+1}|I_t) = R_t^f - \frac{cov(M_{t+1}, R_{t+1}|I_t)}{E(M_{t+1}|I_t)}. \tag{5}$$

That is, the excess return to any asset, and by extension any trading strategy, will be proportional to the covariance of the asset return with the SDF.

The implication for technical trading strategies that take positions in foreign currencies based on past prices is then straightforward. If we find a strategy that earns a positive excess return, that fact is consistent with market efficiency only if we simultaneously observe a negative covariance between excess return and the SDF. This then raises the question of how to model the SDF and how to test whether equation (5) or some variant explains returns.

There are potentially several ways in which one could test the extent to which the SDF framework can explain excess returns to the trading rules. The most direct would be to model the SDF, M_{t+1}, in (3) with a specific utility function and calibrated parameters and test whether the errors from (3) are mean zero. Alternatively, one could estimate the parameters of M_{t+1} with some nonlinear optimization method, such as the generalized method of moments (GMM), and test the overidentifying restrictions. Finally, one could linearize the SDF, M_{t+1}, with a Taylor series expansion, estimate a linear time series or a return-beta model and evaluate whether the risk factors explain the expected returns. The next subsections describe those testing procedures.

2.6 Testing a calibrated SDF

Our initial approach to risk adjustment will be to follow the lead of Lustig and Verdelhan (2007) and use an extended version of the C-CAPM. They in turn use the model of Yogo (2006) in which a representative agent has Epstein-Zin preferences over durable consumption D_t and nondurable consumption C_t. Utility is given by

$$U_t = \left\{(1-\delta)u(C_t, D_t)^{1-(1/\sigma)} + \delta E_t\left[U_{t+1}^{1-\gamma}\right]^{1/\kappa}\right\}^{1/[1-(1/\sigma)]} \tag{6}$$

where δ is the time discount factor, γ is a measure of risk aversion, σ is the elasticity of intertemporal substitution in consumption, and $\kappa = (1-\gamma)/\big(1-(1/\sigma)\big)$.

The one-period utility function is given by

$$u(C, D) = \left\{(1-\alpha)C^{1-(1/\rho)} + \alpha D^{1-(1/\rho)}\right\}^{1/\left(1-(1/\rho)\right)} \tag{7}$$

where α is the weight on durable consumption and ρ is the elasticity of substitution between durable and nondurable consumption. Yogo (2006) shows that the stochastic discount factor takes the form

$$M_{t+1} = \left[\delta \left(\frac{C_{t+1}}{C_t}\right)^{-1/\sigma} \left(\frac{v(D_{t+1}/C_{t+1})}{v(D_t/C_t)}\right)^{1/\rho - 1/\sigma} R_{W,t+1}^{1-1/\kappa}\right]^{\kappa} \quad (8)$$

Where

$v\left(\frac{D}{C}\right) = \left[1 - \alpha + \alpha\left(\frac{D}{C}\right)^{1-1/\rho}\right]^{1/(1-1/\rho)}$ and $R_{W,t}$ is the return on the market portfolio.

This model, the Epstein-Zin durable consumption CAPM (EZ-DCAPM) nests two other models of interest, the durable consumption CAPM (DCAPM) and the CCAPM. The DCAPM holds if we impose the restriction $\gamma = 1/\sigma$. The CCAPM holds if in addition we impose $\rho = \sigma$. The stochastic discount factor in (8) satisfies the familiar Euler equation in (3).

To provide an initial assessment of the performance of these models we carry out a calibration exercise similar to that in Lustig and Verdelhan (2007). We choose parameter values identified in Yogo (2006): $\sigma = 0.023, \alpha = 0.802, \rho = 0.700$. Then we use sample data on durable and non-durable consumption and the return on the market portfolio to generate pricing errors $E\left(M_{t+1}R_{t+1}^{ei}\middle|I_t\right) = 0$, where R_{t+1}^{ei} is the excess return to portfolio pi, and $i = 1, \ldots, 12$.[49] The coefficient of relative risk aversion γ is chosen to minimize the sum of squared pricing errors in the EZ-DCAPM. Table 2 presents these results. All models clearly perform very poorly; the R^2 is negative in every case. The maximum Sharpe ratios and price of risk are substantially different from those reported in Table 4 of Lustig and Verdelhen (2007). Since their test assets are currency portfolios sorted according to interest differential we would expect these numbers to be similar. The portfolios with the highest returns have negative betas (p1 has a beta of -1.97). This implies that the portfolio return covaries positively with M. Since M is high in bad times when marginal utility is high and consumption is low, these portfolios act as consumption hedges and would be expected to earn relatively low returns according to the theory.

2.7 Linear factor models

Researchers linearize the SDF with a first order Taylor approximation and then assess the model's fit of the data with that linear system. Although it is not clear how well the linear model

[49] Recall that portfolios p1 to p12 each consist of 25 currency-rule pairs, ranked every 20 days by ex-ante Sharpe ratio. P1 contains strategies 1 to 25; p2 contains strategies 26 to 50 and so on.

approximates the SDF, this procedure makes estimation somewhat easier and is consistent with the literature.

Therefore, we consider the class of linear SDFs that take the form

$$M_t = a + b' f_t \tag{9}$$

where a is a scalar, b is a $k \times 1$ vector of parameters and f_t is a $k \times 1$ vector of demeaned factors that explain asset price returns. Then the constant a in (9) is not identified and we can normalize it to unity.[50] We hypothesize that the SDF prices portfolios of excess trading rule returns, x_t, in which case equation (3) implies that

$$E(M_{t+1} x_{t+1} | I_t) = 0 \tag{10}$$

The unconditional version of (10) is

$$E(Mx) = E[(1 + b'f)x] = 0 \tag{11}$$

from which it follows that

$$E(x) = -\,E(xf')b = -\,E(xf')\Sigma_f^{-1} \cdot \Sigma_f b = \beta'\lambda \tag{12}$$

where $\Sigma_f$is the factor covariance matrix, $\beta = \Sigma_f^{-1} E(xf)$ is a $k \times 1$ vector of coefficients in a regression of x_t on f_t and $\lambda = -\Sigma_f b$ is a $k \times 1$ vector of factor risk premia.

The model (12) is a return-beta representation. It implies that an asset's expected return is proportional to its covariance with the risk factors. The assets expected excess return will also generally covary through time with the factors.

$$x_{it} = a_i + \beta_i' \tilde{f}_t + \varepsilon_{it} \qquad t = 1, \dots, T, \qquad i = 1, \dots, N \tag{13}$$

where $\tilde{f}_t$ is the non-demeaned factor at time t. In the special case that the factors, $\tilde{f}_t$, are excess returns, then the intercepts (a_i) in the time series representation (13) are zero. We can see this by first noting that the expectation of the factor must satisfy (12) because we have assumed that the factor is also a return.

$$E(\tilde{f}) = \beta_f \lambda = \lambda \tag{14}$$

where the second equality follows because β_f must equal one because the factor covaries perfectly with itself. Second, we take expectations in (13) and solve for the constant

$$a_i = E(x_i) - \beta_i' E(\tilde{f}) = \beta_i' \lambda - \beta_i' \lambda = 0 \tag{15}$$

The second equality in (15) uses (12) and (14).

For these cases in which the factor is itself an excess return —e.g., the CAPM—one can test the model by regressing a set of N excess returns to "test assets" on the factor, as in (13), and then directly testing whether the constants (a_i) are zero.

[50] For any pair, $\{a, b\}$, such that $E[(a + b'f)x] = 0$, any $\{ca, cb\}$ where *c* is a real constant would also satisfy the equation because $E[(ca + cb'f)x] = 0$. Therefore, only the ratio *b/a* matters and one can normalize *a* to 1 or to any other constant.

For tests of more general sets of factors, Fama-MacBeth (1973) suggest a two-stage procedure that first estimates the βs for each test asset with the time series regression (13).[51] The second stage then estimates the factor prices λ from a cross-sectional regression of average excess returns from the test assets on the betas.

$$E(x_i) = \beta_i'\lambda + \alpha_i, \quad (16)$$

where λ is the coefficient to be estimated and α_is are the pricing errors. The model implies no constant in (16) but one is often included with the reasoning that it will pick up estimation error in the riskless rate. A large value of α_i, or a significant change in the fit of the model with a constant indicates a poor fit (Burnside (2011)). For a set of test assets, the variation of the betas in (14) determines the precision of the estimated factor risk premia, λ. If the betas do not vary sufficiently, then λ is not identified and the test is inconclusive.

The standard errors in the second stage of the Fama-MacBeth do not account for the fact that the regressors ($\hat{\beta}_i'$) are generated regressors. Shanken (1992) suggests a correction to account for this issue. One can use GMM to simultaneously estimate both (13) and (16), obtaining the identical point estimates as the 2-stage procedure but properly accounting for cross-sectional correlation, heteroskedasticity and the uncertainty about $\hat{\beta}_i'$ in the covariance matrix of the parameters (see Cochrane, 2005 chapter 10).

$$\begin{aligned} &E\left(R_{i,t} - a_i - \beta_i\tilde{f}_t\right) = 0 \\ &E\left(\left(R_{i,t} - a_i - \beta_i\tilde{f}_t\right)\tilde{f}_t\right) = 0 \qquad \text{for } t = 1,2,\ldots T \text{ and } i = 1,2,\ldots N \\ &E\left(R_{i,t} - \beta_i\lambda\right) = 0 \end{aligned} \quad (17)$$

In our empirical exercises, we estimate the beta-return models with GMM and present three sets of standard errors —OLS, Shanken and GMM—in the interest of comparison.

2.8 Results

2.8.1 CAPM models of the returns to p1 through p12

Figure 1 showed that the ex post Sharpe ratios of the technical strategies varied with their ex ante rank. That is, past returns tend to predict future returns. Does the risk-adjustment affect the expected cross-section of returns?

As a benchmark we first look at whether the CAPM can explain the excess returns to the 12 portfolios, P1-P12, which consist of strategies 1-25, 26-50,…276-300, respectively. The

[51] Fama-MacBeth (1973) originally used rolling regressions to estimate the βs and cross-sectional regressions at each point in time to estimate a λ and α_i for each time period, then using averages of those estimates to get overall estimates. The time series of λ and α_i estimates could then be used to estimate standard errors for the overall estimates that correct for cross-sectional correlation.

model has a single factor, the market excess return, and so we consider the following regression equation for each portfolio:

$$x_{d,t} = \alpha + \beta R_{m,t} + \varepsilon_t \quad (18)$$

where x_d is the excess return to the dynamic portfolio strategy and R_m is the market excess return. The model requires that the intercept, alpha, not be significantly different from zero. A positive alpha would imply that the model fails to explain the return.

Panel A of Table 3 shows the results for regression (13) for the 12 portfolios. The risk-adjustment leaves the mean return (alphas) essentially unchanged for all 12 portfolios. Portfolio P1, for example, has a highly significant monthly alpha of 0.39, or 4.68 percent per annum. The prices of risk (λ) are not identified because there is no statistically significant variation in the first-stage betas (see the last columns of Panel A). In addition, the estimated λs depend on whether a constant is included in the second stage regression or not; this suggests that the model does not fit well. The highly significant alphas suggest that the market factor cannot "explain" the excess returns to the technical portfolios and the negative betas indicate that the returns are not even positively correlated with the market returns. We conclude that the CAPM fails to explain the excess returns of the dynamic portfolio strategies.

We turn to the quadratic CAPM in Table 3.

$$x_{d,t} = \alpha + \beta_{Rm} R_{m,t} + \beta_{R_m^2} R_{m,t}^2 + \varepsilon_t \quad (19)$$

Here too, the coefficients on the market (β_{R_m}) are all negative, which would tend to indicate that the market risk did not explain the forex portfolio returns, but the quadratic terms usually have significantly positive coefficients ($\beta_{R_m^2}$) and the right-most columns show that these coefficients jointly differ from zero and from each other. The significantly positive $\beta_{R_m^2}$ values suggest that market volatility influences dynamic technical portfolio returns. Menkhoff et al. (2012a) document a similar phenomenon for carry trade returns. But the risk-adjusted returns (i.e., the alphas) for the top two portfolios remain positive and highly significant. When the constant is included in the cross-sectional regression, the R2 rises from 0.11 to 0.18 but the constant is not statistically significant. The price of risk for the quadratic market return is 0.31 and statistically significant. The quadratic CAPM might partially explain some of the excess returns of the dynamic portfolio strategies.

We next examine Carhart's (1997) four-factor extension of the three-factor model of Fama and French (1993) where the risk factors are the excess return on the U.S. stock market (R_M), the size factor (R_{SMB}), the value factor (R_{HML}) and the momentum factor (R_{UMD}).[52]

$$x_{dt} = \alpha + \beta_M R_{M,t} + \beta_{SMB} R_{SMB,t} + \beta_{HML} R_{HML,t} + \beta_{UMD} R_{UMD,t} + \varepsilon_t \tag{20}$$

Panel A of Table 3 shows that the alphas for the top portfolios are positive and highly significant and the coefficients on the regressors are generally negative (R_M, R_{SMB} and R_{HML}) or insignificant (R_{UMD}). The rightmost columns of Panel A show that one cannot reject the nulls of no variation in any of the four beta vectors. This indicates that one cannot conclusively identify the price of risk for these factors. Perhaps because of this lack of identification, the prices of factor risk estimated by cross-sectional regression for both SMB and HML are negative, which is inconsistent with estimates derived from the sample mean. As noted above, when the factors are tradable excess returns then factor means are equal to prices of risk. The factor means in our sample are 0.58% (R_M), 0.24% (R_{SMB}), 0.29% (R_{HML}) and 0.68% (R_{UMD}). There is no evidence that the four-factor model explains the excess returns to the dynamic portfolio strategies.

2.8.2 Consumption-based models of the returns to p1 through p12

We now turn to examining whether consumption-based models of asset pricing can explain the returns to the 12 portfolios of dynamic strategies. The C-CAPM relates asset returns to the real consumption growth of a risk-averse representative agent, as in equation (8).

We first consider three variations of the linear approximation of the factor model in (8), the C-CAPM, D-CAPM and EZ-DCAPM (Yogo (2006)).

$$E[x_{jt}] = b_1 \mathrm{cov}(\Delta c_t, x_{jt}) + b_2 \mathrm{cov}(\Delta d_t, x_{jt}) + b_3 \mathrm{cov}(r_{W,t}, x_{jt}) \tag{21}$$

where Δc_t and Δd_t are log nondurable and durable consumption growth respectively, and $r_{W,t}$ is the log return on the market portfolio. The linear approximation for the most general of these nested models, the EZ-DCAPM, uses nondurables plus services, durables and the market excess return as factors. This factor model has a beta representation as given in equations (13) and (16) above. This allows us to estimate the factor prices, λ, and portfolio betas, βi.

$$x_{i,t} = a_i + \beta_{c,i}\Delta c_t + \beta_{d,i}\Delta d_t + \beta_{W,i} r_{W,t} + \varepsilon_{i,t} \tag{22}$$

$$E(x_{i,t}) = \beta_{c,i}\lambda_c + \beta_{d,i}\lambda_d + \beta_{W,i}\lambda_W \tag{23}$$

[52] Fama and French (1993) showed that 3-factors, market return, firm size and book-to-market ratios very effectively explained the returns of certain test assets. The factors used in equation (15) are returns to zero-investment portfolios that are simultaneously long/short in stocks that are in the highest/lowest quantiles of the sorted distribution. For example, the small-minus-big (SMB) portfolio takes a long position in small firms and a short position in large firms.

where $\lambda = \Sigma_{ff} b$ [53], $\beta = \Sigma_{ff}^{-1} \Sigma_{fx}$, Σ_{ff} is the factor covariance matrix and Σ_{fx} is the covariance matrix between the test returns and the factors. The D-CAPM and C-CAPM restrict $\beta_{W,i}$ and the pair, $\{\beta_{d,i}, \beta_{W,i}\}$ to equal zero, respectively. We can infer the utility function parameter values from the estimates of the coefficients on the factors in the linear model, as in Lustig and Verdelhan (2007), see equation (4) in that paper.

Table 4, Panel A presents the results of the times series regressions. All models, C-CAPM, D-CAPM and EZ-DCAPM perform poorly. For the C-CAPM we find that none of the betas are significant at the 5 percent level. The beta for portfolio p1 is significant at the 10 percent level but has the wrong (negative) sign. Most of the betas for the D-CAPM and EZ-DCAPM are also insignificant. The right-most columns of Panel A show that the beta vectors all vary significantly from zero and from each other, permitting identification of the prices of risk.

Panel B shows the results of the cross-sectional regressions for each model estimated with and without a constant. Including constants appears to change the fit of the C-CAPM and D-CAPM models: The constants are not significant at the one-side 10 percent level and change the R2s from negative to positive levels. The negative R2s are damning: They indicate that a simple constant would explain the expected returns better than the model.

The EZ-DCAPM model appears to fit better. The constant is not significant and the R2 is sizable, at 0.61 and does not change much with the addition of the constant. The price of risk for non-durable consumption in the EZ-DCAPM model is statistically significant but negative, –2.24 percent. This negative price of risk is implausible, since the theory predicts that it should be positive in the case where the coefficient of risk aversion $\gamma > 1$, and the elasticity of substitution in consumption $\sigma < 1$. The estimate of σ in Yogo (2007) for the EZ-DCAPM is 0.210.

We find in all cases that the coefficient of risk aversion is estimated to be significantly negative. The reason for this can be seen clearly in the case of the C-CAPM. From equation (5) above we know that

$$E(x) = -\frac{cov(M,x)}{E(M)}.$$

We know that $E(M)$ must be positive by the Fundamental Theorem of Asset Pricing and so it follows that if an asset has a positive expected excess return it must covary negatively with the SDF. The SDF (M), in turn, is marginal utility, which will covary negatively with consumption. In the case of the C-CAPM where the single factor is consumption growth, this means that the model predicts that returns to the higher ranking dynamic portfolio strategies should be positively correlated with consumption growth. In fact, we find the reverse: the

[53] b defined in equation (21)

dynamic portfolio strategies tend to perform well in states when consumption growth is low, and thus provide a hedge against consumption risk. To be consistent with the model such strategies should earn negative excess returns. Figure 2 displays the actual mean excess return to each portfolio ($E(x_i)$) versus the predicted return ($\beta_i{}'\lambda$) for the cross-sectional regressions that include a constant. Intriguingly, there does appear to be a positive relationship between the predicted and actual return for all three models, CCAPM, DCAPM and EZ-DCAPM. Recall, however, that the prices of risk are implausibly signed and that the cross-section regression should exclude the constant.

If one excludes the constant from the regression, the actual returns exceed the predicted return for all but one return for the CCAPM and DCAPM cases (Figure 3). This suggests that the CCAPM and DCAPM don't fully explain the returns. But the lower left panel of Figure 3 illustrates that the EZ-DCAPM does appear to provide a nice positive relationship between the predicted and actual returns. This apparent relation is misleading, however: It ignores the negative R2s and negative prices of nondurable consumption risk.

2.8.3 Foreign-exchange-based models of the technical returns

Consumption-based models have generally failed to explain risk adjusted returns to many assets so the results in Table 4 come as no surprise. This failure of consumption-based models has led researchers to look for other risk factors that might proxy for future investment opportunities. In the context of stock returns it has become commonplace to work with factors that are the returns to various stock portfolios (see Fama and French (1993) and Carhart (1997)).

Lustig, Roussanov and Verdelhan (2011) have recently applied this general idea to the foreign exchange market. They form currency portfolios on the basis of interest rates. Portfolio 1 contains those currencies with the lowest interest rates, portfolio 6 those currencies with the highest interest rates. The portfolios are rebalanced at the end of each month. From these portfolios Lustig et al. (2011) construct two risk factors. The first factor, which they denote RX, is the average currency excess return to going short in the dollar and long in the basket of six foreign currency portfolios. The second factor, HMLFX, is the return to a strategy that borrows low interest rate currencies (portfolio 1) and invests in high interest rate currencies (portfolio 6), in other words a carry trade.[54]

Can these factors explain the cross-sectional variation in expected returns across the 12 technical portfolios that were sorted on past Sharpe ratio? We examine this question with the

[54] RX and HML_{FX} are very similar to the first two principal components of the returns to the 6 portfolios.

Fama-MacBeth two-stage estimation of the beta-return models using the RX factor and the HMLFX factor as risk factors. This provides us with estimates of the factor risk premia (λ_{RX} and $\lambda_{HML_{FX}}$) and the parameters of the model. Because the factors are tradable we can test the model by comparing the estimates of the risk premia with the factor means. We reject the model if they differ significantly.

Panel A of Table 5 shows that the betas on the RX factor are small and always insignificant. However, for eight of the dynamic portfolios the betas on the HMLFX factor are significantly negative at the ten percent level and all of the point estimates are negative. The signs of the betas suggest that the returns to the technical trading rules tend to be high when the carry trade returns are low. The HMLFX betas for portfolios p1, p3, p4, and p5 are not significant, however, and the alphas for the top five portfolios are often significant and always higher than the unadjusted mean returns. The fact that the constants are higher than the unadjusted mean returns indicates that accounting for HMLFX and RX risk actually deepens the puzzle of the profitability of technical trading rules. These results make it seem unlikely that any risk factor that explained the carry trade could also explain the technical returns.

In the second stage regression we find that the price of risk for the HMLFX factor is 2.08 and is highly significant, and the R2 is 0.35 (Table 5, Panel B). But the constant in the regression is 0.22 and is also highly significant. The mean of the HMLFX is 0.69%. When the constant is excluded, the R2 becomes negative. We conclude that although the HMLFX factor appears to have some explanatory power for the cross-section of dynamic portfolio returns, it can account for at most 45 percent of the observed cross-sectional spread between p1 and p12.

Menkhoff, Sarno, Schmeling and Schrimpf (2012a) find that global foreign exchange volatility is an important factor in explaining carry trade returns. To investigate this factor's explanatory power for our technical returns, we estimate a global volatility factor in a manner very similar to that of Menkhoff, Sarno, Schmeling and Schrimpf (2012a). We first calculate the monthly return variance for each of the available exchange rates at each month in our sample and then calculate a global foreign exchange volatility factor from the first principal component of the monthly variances. Vol1 is the series of innovations of an AR1 process fit to this principal component while Vol2 is the first difference in this principal component. We then estimate a beta representation using these volatility factors and a dollar exposure factor that they note is very similar to the Lustig, Roussanov and Verdelhan (2011) RX factor. Menkhoff, Sarno, Schmeling and Schrimpf (2012a) denote this the DOL factor in their work.

Table 6 displays the results from the GMM estimation of the beta system. Panel A of Table 6 shows that the betas on RX are not jointly statistically significant nor significantly different from each other. Thus the price of RX risk is not identified. In contrast, betas on the volatility factors are positive and highly significant but do not appear to capture any of the cross-sectional spread in returns. That is, there is no obvious pattern to the betas from the low to high ranking portfolios.

Turning to Panel B of Table 6, when one includes a constant in the cross-sectional equation, there is no evidence for a negative price of volatility risk, as the theory would predict. Specifically, the prices of risk on VOL1 and VOL2 are insignificant and the R2s of the second stage regressions are negative if no constant is permitted. In addition, the constant terms are significant. In other words, the volatility factor picks up time series variation in returns which is common to all portfolios, but the model does not explain the cross-sectional spread in returns, or the level of returns for portfolios p1 and p2.

Researchers have also explored skewness as a risk factor for carry trade returns (Rafferty (2012)) and the cross-section of equity returns (Amaya, Christoffersen, Jacobs, and Vasquez (2011). To investigate whether exposure to skewness can generate the returns to the technical trading rules, we form a skewness factor, a tradable portfolio that is long (short) currencies in the highest (lowest) skewness quintile in a given month. We then estimate the beta representation for such a model and present those results in Table 7.

Panel A of Table 7 shows that the betas are all positive and highly significant. One cannot, however, reject the hypothesis that they are all equal to each other, precluding strong identification of the prices of risk. In Panel B, the constant in the cross-sectional regression is marginally significant and the exclusion of this constant reduces the R2 from a healthy 0.25 to a very modest 0.09. Without the constant, the price of risk is 0.82 and statistically significant. These results suggest that exposure to skewness does account for some technical trading rule returns, although its explanatory power is fairly limited.

2.9 Discussion and conclusion

Researchers have long documented the profitability of technical analysis in foreign exchange rates. Studies that found positive results include Poole (1967), Dooley and Shafer (1984), Sweeney (1986), Levich and Thomas (1993), Neely, Weller and Dittmar (1997), Gençay (1999), Lee, Gleason and Mathur (2001) and Martin (2001)).

Despite such a substantial record of documented gains, the reasons for this success remain mysterious. Neely (2002) appears to rule out the central bank intervention explanation suggested by LeBaron (1999). To investigate the possibility of data snooping, data mining and publication bias, Neely, Weller and Ulrich (2009) analyze the performance of rules in true out-of-sample tests that occur long after an important study. They conclude that data snooping, data mining and publication bias are unlikely explanations but that the adaptive markets hypothesis is plausible.

It remains possible, however, that technical trading rule profitability results from exposure to some sort of risk. Recently, several authors have considered modern techniques for risk adjustment of the carry trade or momentum rules in foreign exchange markets. The goal of this paper has been to apply a broad range of risk adjustment techniques to determine whether there is any evidence that exposure to risk plausibly explains the profitability of technical analysis in the foreign exchange market.

We examine many types of risk adjustment models, including the CAPM, a four factor model, several consumption-based models, and factors motivated by the carry trade puzzle, volatility measures and skewness. Although skewness might have some modest explanatory power, no model of risk adjustment can plausibly explain the very robust findings of the profitability of technical analysis in the foreign exchange market.

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Table 2.1 Data Description

Currency Group	Country	Currency abbreviation versus the USD	# of trading obs	Trading start date	Trading end date	Mean TC	STD of Annualized FX Return
Advanced	Australia	AUD	9008	4/7/1976	12/31/2012	3.1	11.6
Advanced	Canada	CAD	9344	1/2/1975	12/31/2012	2.9	6.7
Advanced	Euro Area	EUR	9717	4/3/1973	12/31/2012	3.0	10.6
Advanced	Japan	JPY	9599	4/3/1973	12/28/2012	3.0	10.5
Advanced	New Zealand	NZD	6027	8/3/1987	12/31/2012	3.9	12.4
Advanced	Norway	NOK	6515	1/2/1986	12/31/2012	3.4	11.6
Advanced	Sweden	SEK	7278	1/3/1983	12/28/2012	3.3	11.4
Advanced	Switzerland	CHF	9697	4/3/1973	12/31/2012	3.1	12.0
Advanced	UK	GBP	9338	1/2/1975	12/31/2012	2.9	9.9
Dev. Europe	Czech Republic	CZK	5049	1/5/1993	12/31/2012	5.2	12.4
Dev. Europe	Hungary	HUF	4466	1/2/1995	12/28/2012	10.3	14.3
Dev. Europe	Hungary/Switzerland	HUF_CHF	4165	1/3/1996	12/28/2012	10.5	12.0
Dev. Europe	Poland	PLN	3918	2/24/1997	12/31/2012	7.1	14.6
Dev. Europe	Russia	RUB	3055	8/1/2000	12/28/2012	3.6	7.4
Dev. Europe	Turkey	TRY	2769	1/2/2002	12/31/2012	12.9	15.4
Latin America	Brazil	BRL	3330	5/3/1999	12/31/2012	6.0	16.8
Latin America	Chile	CLP	4359	6/1/1995	12/28/2012	5.9	9.5
Latin America	Japan/Mexico	JPY_MXN	3887	1/4/1996	12/28/2012	4.6	16.9
Latin America	Mexico	MXN	4220	1/4/1996	12/31/2012	4.6	10.5
Latin America	Peru	PEN	4252	4/1/1996	12/31/2012	5.3	5.0
Other	Israel	ILS	3750	7/20/1998	12/31/2012	8.1	7.8
Other	Israel/Euro Area	ILS_EUR	2552	1/2/2003	12/31/2012	8.5	10.2
Other	South Africa	ZAR	4394	4/3/1995	12/31/2012	8.7	16.4
Other	Taiwan	TWD	3605	1/5/1998	12/28/2012	5.0	5.3
Adv. Cross Rates	Switzerland/UK	CHF_GBP	9169	1/3/1975	12/31/2012	3.0	9.8
Adv. Cross Rates	Australia/UK	AUD_GBP	8920	4/7/1976	12/31/2012	3.2	12.4
Adv. Cross Rates	Canada/UK	CAD_GBP	9217	1/2/1975	12/31/2012	3.0	10.3
Adv. Cross Rates	Japan/UK	JPY_GBP	8982	1/2/1975	12/28/2012	3.0	12.2
Adv. Cross Rates	Euro Area/UK	EUR_GBP	9187	1/2/1975	12/31/2012	3.0	8.1
Adv. Cross Rates	Australia/Switzerland	AUD_CHF	8848	4/7/1976	12/31/2012	3.2	14.4
Adv. Cross Rates	Canada/Switzerland	CAD_CHF	9150	1/3/1975	12/31/2012	3.1	12.4
Adv. Cross Rates	Japan/Switzerland	JPY_CHF	9338	4/3/1973	12/28/2012	3.2	11.7
Adv. Cross Rates	Euro Area/Switzerland	EUR_CHF	9602	4/3/1973	12/31/2012	3.2	5.9
Adv. Cross Rates	Canada/Australia	CAD_AUD	8894	4/7/1976	12/31/2012	3.2	10.3
Adv. Cross Rates	Japan/Australia	JPY_AUD	8633	4/7/1976	12/28/2012	3.2	15.3
Adv. Cross Rates	Euro Area/Australia	EUR_AUD	8861	4/7/1976	12/31/2012	3.2	12.8
Adv. Cross Rates	Japan/Canada	JPY_CAD	8968	1/2/1975	12/28/2012	3.1	12.7
Adv. Cross Rates	Euro Area/Canada	EUR_CAD	9158	1/2/1975	12/31/2012	3.1	10.7
Adv. Cross Rates	Japan/Euro Area	JPY_EUR	9347	4/3/1973	12/28/2012	3.1	11.3
Adv. Cross Rates	New Zealand/Australia	NZD_AUD	5943	8/3/1987	12/31/2012	3.9	8.7

Notes: The table depicts the 21 exchange rates versus the USD and 19 non-USD cross rates used in our sample along with the starting and ending dates of the samples, number of trading dates, average transaction cost, and standard deviation of annualized log returns.

Table 2.2 Calibration

	C-CAPM	D-CAPM	EZ-CCAPM	EZ-DCAPM
$std_T[M]/E_T[M]$	0.93	1.22	0.92	1.22
$var_T[M]/E_T[M]$	0.60	0.61	0.59	0.61
MAE (in %)	1.32	0.96	1.33	0.96
R^2	-1.50	-0.13	-1.50	-0.13

Notes: The sample is 1978–2010 (annual data). The returns are those to portfolios p1 to p12, as described in the text. The first two rows report the maximum Sharpe ratio (row 1) and the price of risk (row 2). The last two rows report the mean absolute pricing error (in percentage points) and the R2. Following Yogo (2006), we fixed sigma (σ) at 0.023 (EZ-CCAPM and EZ-DCAPM), alpha (α) at 0.802 (DCAPM and EZ-DCAPM), delta (δ) at 0.98, and rho (ρ) at 0.700 (DCAPM, EZ-DCAPM). Gamma (γ) is fixed at 41.16 to minimize the mean squared pricing error in the EZ-DCAPM.

Table 2.3 Results for CAPM, Quadratic CAPM and Carhart model for portfolios p1-p12

Panel A: Time Series Regressions														
	p1	p2	p3	p4	p5	p6	p7	p8	p9	p10	p11	p12	β1=…=βn=0 p-value	β1=…=βn p-value
CAPM														
Constant	0.39 ***	0.25 ***	0.21 ***	0.13 *	0.20 ***	0.07	0.14 **	0.14 **	0.12 *	0.13 **	0.11 *	0.08		
Rm β	-0.04 *	-0.05 **	-0.04 *	-0.04 *	-0.03	-0.05 **	-0.05 ***	-0.04 *	-0.05 ***	-0.04 **	-0.04 *	-0.04 **	0.18	0.78
R^2	0.01	0.02	0.01	0.02	0.01	0.02	0.03	0.02	0.03	0.03	0.02	0.03		
Quad.CAPM														
Constant	0.26 ***	0.17 **	0.12 *	0.05	0.14 **	0.00	0.09	0.07	0.05	0.09	-0.02	-0.03		
Rm β	-0.03	-0.04 *	-0.03	-0.04 *	-0.02	-0.04 **	-0.05 ***	-0.03	-0.05 ***	-0.04 ***	-0.03 *	-0.03 **	0.09	0.77
Rm^2 β	0.65 ***	0.39	0.46	0.38	0.25	0.35	0.23	0.32	0.33	0.20	0.60 **	0.52 ***	0.00	0.00
R^2	0.04	0.03	0.03	0.03	0.02	0.04	0.03	0.03	0.04	0.03	0.05	0.06		
Carhart														
Constant	0.41 ***	0.27 ***	0.21 ***	0.13 *	0.17 ***	0.07	0.13 *	0.13 **	0.11	0.12 **	0.08	0.08		
Rm β	-0.04 *	-0.05 **	-0.03	-0.04 **	-0.02	-0.04 *	-0.03	-0.03	-0.04 **	-0.03	-0.02	-0.03	0.03	0.13
SMB β	-0.05 *	-0.04 *	-0.04	-0.02	-0.02	-0.03	-0.03 *	-0.03	-0.04 *	-0.04 *	-0.03	-0.05 ***	0.49	0.94
HML β	-0.06 *	-0.03	-0.02	-0.02	0.01	-0.01	0.01	0.01	0.01	0.01	0.02	0.00	0.17	0.15
UMD β	0.03 *	0.02	0.02	0.02	0.03 **	0.02	0.02	0.02	0.02 *	0.03 **	0.03 **	0.01	0.27	0.70
R^2	0.04	0.03	0.02	0.02	0.02	0.04	0.03	0.03	0.05	0.04	0.03	0.05		
Mean R	0.37	0.23	0.19	0.11	0.18	0.05	0.11	0.12	0.09	0.11	0.09	0.06		

Table 2.3 - continued

Panel B: Cross Sectional Regressions						
	CAPM		Quad. CAPM		Carhart	
Rm λ	3.34	-3.29	2.99	-0.61	3.16	2.27
	(2.13) *	(-2.59) **	(1.92) *	(-0.47)	(2.23) *	(1.57)
	[1.70]	[-2.08] *	[1.44]	[-0.37]	[1.09]	[0.70]
	{1.44}	{-2.02} *	{1.26}	{-0.33}	{1.06}	{0.62}
Rm^2 λ			0.17	0.31		
			(1.70)	(3.88) ***		
			[1.31]	[3.10] **		
			{1.31}	{3.10} **		
SMB λ					-1.64	-2.41
					(-1.01)	(-2.04) *
					[-0.49]	[-0.91]
					{-0.44}	{-0.90}
HML λ					-3.76	-3.50
					(-3.76) ***	(-3.72) ***
					[-1.83]	[-1.67]
					{-1.92} *	{-1.70}
UMD λ					4.01	5.37
					(2.08) *	(3.58) ***
					[1.01]	[1.60]
					{1.08}	{1.60}
Constant	0.28		0.18		0.09	
	(3.11) **		(2.00) *		(0.82)	
	[2.55] **		[1.50]		[0.38]	
	{2.33} **		{1.29}		{0.35}	
R^2	0.05	-0.16	0.18	0.11	0.73	0.72

Notes: Monthly data 06/1977 – 12/2012. Factors are the excess return on the U.S. stock market (R_m), the size factor (SMB), the value factor (HML) and the momentum factor (UMD). t-statistics are indicated in parentheses. ( ) t-statistics based on OLS standard errors. [ ] t-statistics based on Shanken standard errors. { } t-statistics based on GMM standard errors. Significance levels: *** 1%, ** 5%, * 10%.

Table 2.4 Results for C-CAPM, D-CAPM and EZ-DCAPM model for portfolios p1-p12

Panel A: Time Series Regressions														
	p1	p2	p3	p4	p5	p6	p7	p8	p9	p10	p11	p12	β1=…=βn=0 p-value	β1=…=βn p-value
C-CAPM														
Constant	5.95 ***	3.36 **	2.56	1.14	2.14	0.89	1.18	2.39 **	1.12	0.91	0.29	0.68		
Nondurables β	-0.99 **	-0.44	-0.29	0.09	0.09	-0.05	0.19	-0.67	-0.11	0.20	0.46	-0.11	0.00	0.00
R^2	0.11	0.02	0.01	0.00	0.00	0.00	0.00	0.07	0.00	0.01	0.03	0.00		
D-CAPM														
Constant	4.75 ***	4.66 ***	2.93	3.22 **	3.90	1.37	2.78	3.76 *	1.83	1.30	0.33	0.32		
Nondurables β	-1.55 ***	0.16	-0.12	1.05 *	0.90	0.17	0.92	-0.04	0.22	0.37	0.48	-0.27	0.00	0.00
Durables β	0.56	-0.61 *	-0.17	-0.97 **	-0.82	-0.23	-0.74 *	-0.64	-0.33	-0.18	-0.02	0.17	0.03	0.03
R^2	0.14	0.07	0.01	0.09	0.09	0.01	0.08	0.14	0.02	0.01	0.03	0.01		
EZ-DCAPM														
Constant	5.73 ***	5.46 **	3.56	4.82 ***	5.24 **	2.32	3.52	4.35 **	2.04	1.81	1.49	0.85		
Nondurables β	-1.33 **	0.34	0.02	1.41 *	1.20	0.38	1.09	0.10	0.27	0.49	0.74	-0.16	0.00	0.00
Durables β	0.37	-0.76	-0.29	-1.29 **	-1.08	-0.41	-0.89	-0.75	-0.37	-0.28	-0.25	0.06	0.00	0.00
Market β	-0.07	-0.05	-0.04	-0.11 **	-0.09 **	-0.06	-0.05	-0.04	-0.01	-0.04	-0.08	-0.04	0.00	0.00
R^2	0.20	0.12	0.04	0.23	0.21	0.07	0.12	0.17	0.02	0.03	0.15	0.04		
Mean R	4.57	2.76	2.16	1.26	2.27	0.81	1.44	1.46	0.97	1.19	0.94	0.53		

Table 2.4 - continued

Panel B: Cross Sectional Regressions						
	C-CAPM		D-CAPM		EZ-DCAPM	
Nondurables λ	-1.95	-3.09	-1.90	-3.20	-2.03	-2.24
	(-4.08) ***	(-5.28) ***	(-4.19) ***	(-5.19) ***	(-4.26) ***	(-5.14) ***
	[-2.79] **	[-2.55] **	[-2.94] **	[-2.20] *	[-2.43] **	[-2.60] **
	{-3.08} **	{-2.76} **	{-3.29} ***	{-2.02} *	{-2.44} **	{-2.65} **
Durables λ			-1.76	-4.77	-1.61	-1.89
			(-2.66) **	(-3.72) ***	(-2.48) **	(-2.83) **
			[-1.85] *	[-1.51]	[-1.43]	[-1.39]
			{-2.06} *	{-1.31}	{-1.43}	{-1.46}
Market λ					-19.32	-26.95
					(-2.63) **	(-3.28) ***
					[-1.40]	[-1.47]
					{-1.56}	{-1.21}
Constant	1.43		1.48		0.58	
	(2.42) **		(2.68) **		(0.97)	
	[1.49]		[1.67]		[0.49]	
	{1.54}		{1.68}		{0.41}	
Parameters						
γ	-84.32	-133.94	-82.33	-139.40	-91.89	-102.72
	(-4.08) ***	(-5.28) ***	(-4.19) ***	(-5.17) ***	(-4.27) ***	(-5.23) ***
	[-2.79] **	[-2.55] **	[-2.93] **	[-2.19] *	[-2.41] **	[-2.61] **
	{-3.08} **	{-2.76} **	{-3.28} ***	{-2.01} *	{-2.45} **	{-2.66} **
σ					-0.09	-0.11
					(-3.28) **	(-3.32) ***
					[-1.99] *	[-1.61]
					{-2.14} *	{-1.32}
α			-0.06	0.50	0.01	0.12
			(-0.26)	(2.35) **	(0.06)	(0.54)
			[-0.18]	[1.00]	[0.06]	[0.26]
			{-0.19}	{0.87}	{0.04}	{0.26}
R^2	0.50	-1.10	0.50	-0.45	0.65	0.61

Notes: Annual data 1978 – 2010. Nondurables (Δc_t) and Durables (Δd_t) are log nondurable (plus services) and durable consumption growth respectively, and Market ($r_{W,t}$) is the log return on the market portfolio. t-statistics are indicated in parentheses. ( ) t- statistics based on OLS standard errors. [ ] t- statistics based on Shanken standard errors. { } t- statistics based on GMM standard errors. Significance levels: *** 1%, ** 5%, * 10%.

Table 2.5: Results for LV model for portfolios p1-p12

Panel A: Time Series Regressions

	p1	p2	p3	p4	p5	p6	p7	p8	p9	p10	p11	p12	β1=…=βn=0 p-value	β1=…=βn p-value
Constant	0.35 ***	0.20 ***	0.17 **	0.06	0.12	0.04	0.10	0.09	0.12	0.15 *	0.11	0.10		
Rx β	-0.02	-0.03	-0.04	-0.02	-0.02	-0.02	0.01	-0.02	-0.06	-0.04	-0.02	0.01	0.19	0.19
HML_{fx} β	-0.03	-0.07 *	-0.05	-0.05	-0.03	-0.08 **	-0.09 **	-0.07 *	-0.09 **	-0.10 **	-0.09 **	-0.09 **	0.11	0.12
R^2	0.00	0.02	0.01	0.01	0.01	0.03	0.04	0.02	0.05	0.06	0.04	0.04		
Mean R	0.32	0.15	0.12	0.02	0.10	-0.02	0.04	0.04	0.04	0.07	0.04	0.04		

Panel B: Cross Sectional Regression

Constant	0.22	
	(2.66) **	
	[2.04] *	
	{1.84} *	
Rx λ	-0.29	-1.73
	(-0.53)	(-2.32) **
	[-0.41]	[-1.78]
	{-0.39}	{-1.68}
HML_{fx} λ	2.08	-0.32
	(2.96) **	(-0.49)
	[2.29] **	[-0.38]
	{1.78}	{-0.31}
R^2	0.35	-0.24

Note: Monthly data 11/ 1983 – 12/2012. Rx- the average currency excess return to going short in the dollar and long in the basket of six foreign currency portfolios. HMLFX - the return to a strategy that borrows low interest rate currencies and invests in high interest rate currencies, in other words a carry trade. t-statistics are indicated in parentheses. ( ) t- statistics based on OLS standard errors. [ ] t- statistics based on Shanken standard errors. { } t- statistics based on GMM standard errors. Significance levels: *** 1%, ** 5%, * 10%.

Table 2.6 Results for volatility factors for portfolios p1-p12

Panel A: Time Series Regressions														
	p1	p2	p3	p4	p5	p6	p7	p8	p9	p10	p11	p12	β1=…=βn=0 p-value	β1=…=βn p-value
Constant	0.29 ***	0.12 **	0.11 *	-0.01	0.08	-0.05	0.01	0.03	0.02	0.04	0.02	0.01		
Rx β	-0.01	-0.03	-0.03	-0.01	-0.01	-0.01	0.01	-0.02	-0.05	-0.04	-0.02	0.01	0.30	0.24
VOL1 β	2.33 **	2.15 **	1.71	2.51 **	1.70 **	2.93 ***	1.94 **	1.75 *	2.60 **	2.63 **	2.01	2.63 **	0.00	0.01
R^2	0.03	0.03	0.02	0.05	0.03	0.07	0.03	0.03	0.06	0.07	0.04	0.06		
Constant	0.32 ***	0.15 **	0.13 **	0.02	0.10	-0.02	0.04	0.05	0.05	0.08	0.05	0.04		
Rx β	-0.01	-0.03	-0.03	-0.01	-0.01	-0.01	0.02	-0.02	-0.05	-0.03	-0.02	0.01	0.32	0.26
VOL2 β	1.86 **	1.92 **	1.67 *	2.39 ***	1.73 ***	2.83 ***	2.22 ***	1.62 **	2.72 ***	2.64 ***	1.77 **	2.17 **	0.00	0.01
R^2	0.02	0.03	0.03	0.05	0.03	0.08	0.05	0.03	0.08	0.09	0.03	0.05		
Mean R	0.32	0.15	0.12	0.02	0.10	-0.02	0.04	0.04	0.04	0.07	0.04	0.04		

Table 2.6 - continued

Panel B: Cross Sectional Regression				
Constant	0.19		0.28	
	(2.21) *		(3.09) **	
	[2.03] *		[2.37] **	
	{1.91} *		{2.42} **	
Rx λ	-0.02	-0.22	-0.55	-0.64
	(-0.04)	(-0.39)	(-0.96)	(-1.10)
	[-0.04]	[-0.38]	[-0.74]	[-1.04]
	{-0.03}	{-0.41}	{-0.68}	{-1.06}
VOL1 λ	-0.05	0.03		
	(-1.90) *	(1.24)		
	[-1.75]	[1.20]		
	{-1.62}	{1.35}		
VOL2 λ			-0.10	0.03
			(-3.25) ***	(1.04)
			[-2.52] **	[0.99]
			{-2.22} *	{1.01}
R^2	0.06	-0.11	0.22	-0.17

Note: Monthly data 11/ 1983 – 12/2012. Rx- the average currency excess return to going short in the dollar and long in the basket of six foreign currency portfolios. VOL1 - volatility innovations measured by the residuals from AR(1). VOL2 - volatility innovations measured by first difference. t-statistics are indicated in parentheses. ( ) t- statistics based on OLS standard errors. [ ] t- statistics based on Shanken standard errors. { } t- statistics based on GMM standard errors. Significance levels: *** 1%, ** 5%, * 10%.

Table 2.7 Results for skewness factor for portfolios p1-p12

Panel A: Time Series Regressions

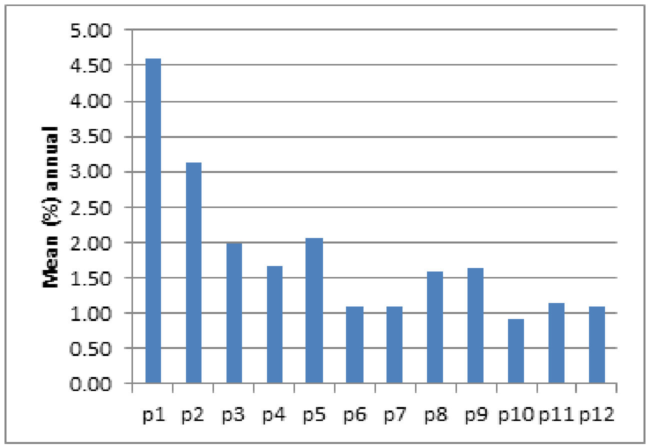
	p1	p2	p3	p4	p5	p6	p7	p8	p9	p10	p11	p12	β1=…=βn=0 p-value	β1=…=βn p-value
Constant	-0.73 ***	-0.78 ***	-0.86 ***	-0.91 ***	-0.71 ***	-0.93 ***	-0.87 ***	-0.91 ***	-0.96 ***	-0.91 ***	-0.85 ***	-0.90 ***		
SKEW	0.20 ***	0.20 ***	0.19 ***	0.19 ***	0.16 ***	0.18 ***	0.18 ***	0.19 ***	0.19 ***	0.19 ***	0.17 ***	0.17 ***	0.00	0.35
R^2	0.18	0.19	0.22	0.22	0.19	0.22	0.21	0.26	0.25	0.27	0.21	0.26		
Mean R	0.37	0.23	0.19	0.11	0.18	0.05	0.11	0.12	0.09	0.11	0.09	0.06		

Panel B: Cross Sectional Regression

Constant	-0.64	
	(-2.78) **	
	[-1.78]	
	{-1.83} *	
SKEW λ	4.31	0.82
	(3.45) ***	(2.73) **
	[2.16] *	[2.73] **
	{2.33} **	{3.15} ***
R^2	0.25	0.09

Note: Monthly data 06/1977 – 12/2012. SKEW – return of a portfolio that is long currencies in the highest skewness (positive) quintile and short currencies in the lowest (negative) skewness quintile for a given month. t-statistics are indicated in parentheses. ( ) t- statistics based on OLS standard errors. [ ] t- statistics based on Shanken standard errors. { } t- statistics based on GMM standard errors. Significance levels: *** 1%, ** 5%, * 10%.

Figure 2.1 Return, standard deviation and Sharpe ratio statistics from sorted portfolios p1 to p12



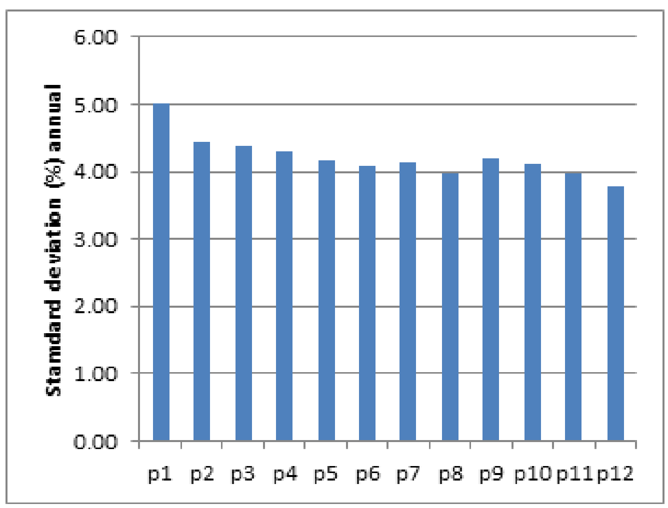


Figure 2.1 - continued

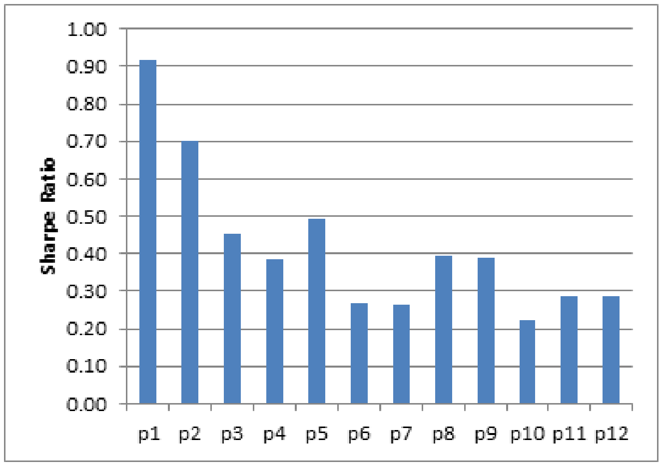


Figure 2.2 Actual mean annual returns vs. predicted returns for portfolios p1 through p12 (cross sectional regression with a constant) 1978-2010

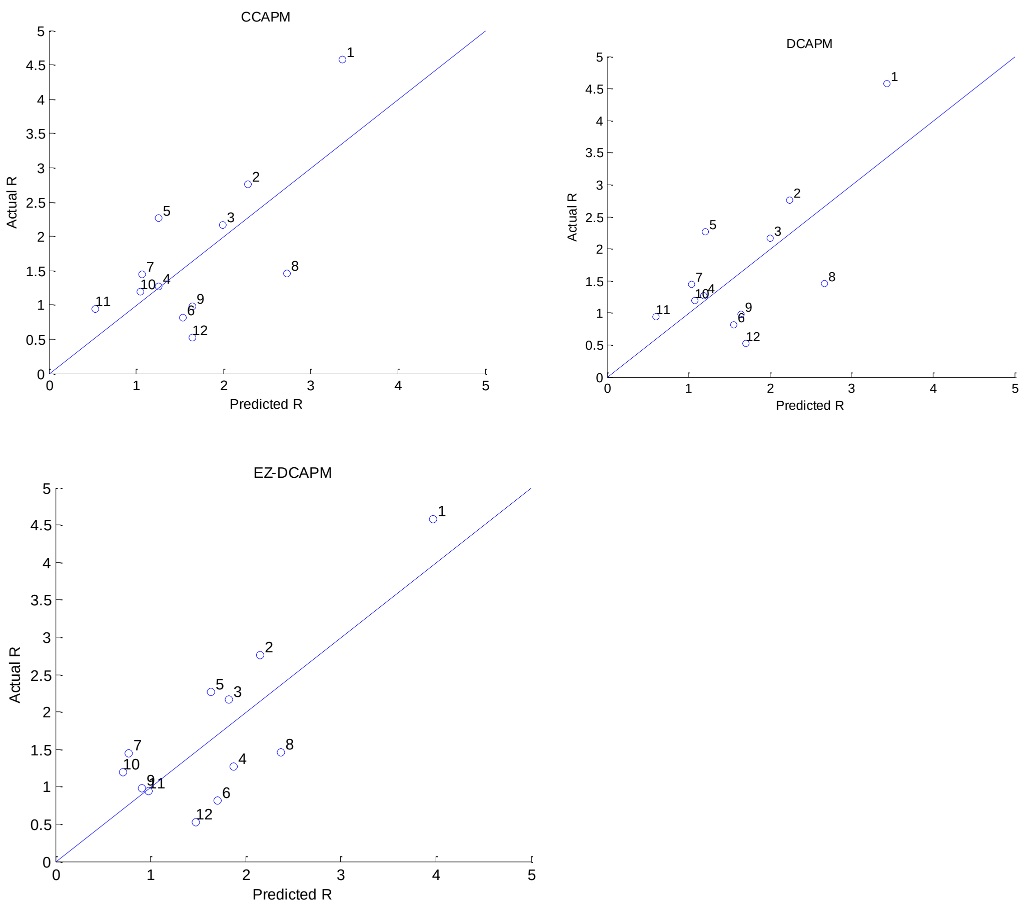
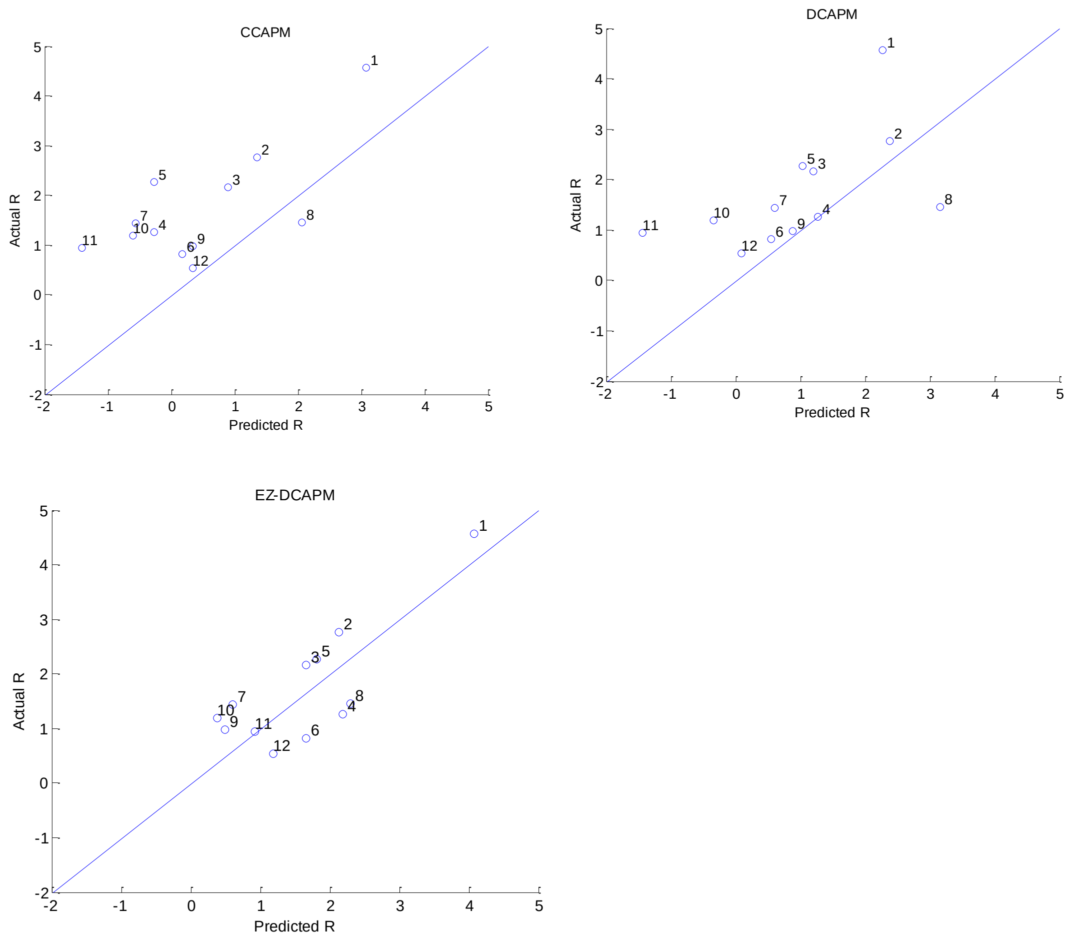


Figure 2.3 Actual mean annual returns vs. predicted returns for portfolios p1 through p12 (cross sectional regression without a constant) 1978-2010



3 CHAPTER
FOREIGN EXCHANGE MOVEMENTS AND CROSS-COUNTRY FUND ALLOCATION DECISIONS

3.1 Introduction

The number and size of US-based international equity mutual funds has grown tremendously over the last 30 years driven by the increased interest in global investment. In 1984 there were only 24 equity mutual funds in the United States with an international focus[55] with size ranging from $1 million to $500 million[56]. In contrast, in 2014 this number totaled 940 funds with size ranging from $8.5 million to $8.5 billion.

Despite this huge growth, the exploration of factors impacting the performance of international equity mutual funds is just beginning. The current literature on the performance and allocation of international mutual funds focuses on several specific areas. Chan et al. (2005) and Lau et al. (2010) study what macroeconomic and geopolitical factors determine home bias and what its impact on the cost of capital is. Chan & Covrig (2012) and Maffett (2012) explore the impact of information asymmetry and reporting opacity on trading of international equity. Turtle & Zhang (2012) examine how regime switching models explain the returns of international mutual funds. However, due to the scarcity of detailed holdings data for this type of funds, our understanding of the performance of international equity mutual funds is far from complete.

From the practitioners' perspective, it is known that the success of investment in international equity markets is a function of the stock picking ability of the manager within the particular foreign market as well as the (un)favorable foreign exchange (FX) rate movements against the domestic currency. Further, recent academic studies in the foreign exchange literature highlight the relationship between international equity investments and foreign exchange movements. For example, Chang (2013) notes that cross-country equity flows are an important and increasingly large driver of FX demand. Further, Kal (2011) emphasizes that cross-country capital flows affect the relationship between exchange rates and economic fundamentals.

The objective of this paper is to study in more detail the relationship between currency returns and the cross country equity flows of U.S. international equity mutual funds. Specifically, we are interested in the question of whether fund managers are able to anticipate FX changes that will affect their returns and whether they change their equity allocation across different currencies to take advantage of/counteract these changes. Most importantly, we want to examine whether

[55] Excluding single country focus
[56] 5th and 95th percentile of fund size for that year

managers can avoid value destruction by minimizing exposure to underperforming currencies. In the context of international institutional fund managers, the study of market timing has been limited to portfolio reallocation in response to crashes in country equity market returns (Glassman & Riddick 2006)[57] or in response to country past return momentum (Busse et al. 2013). Therefore, to the best of our knowledge this is the first study that comprehensively explores the cross-country fund allocation decision of international equity mutual funds in response to foreign exchange rate movements.

In this study, we utilize a new detailed dataset on the equity holdings and currency exposure of close to 1,500 US-based international mutual funds during the period 1984-2014. The main advantage of this dataset is that it allows us to explore directly the relationship between cross-country equity flows and currency returns by tracking changes in the fund holdings rather than drawing indirect conclusion from fund return-based market-timing models like the Henriksson-Merton measure. We use two approaches by studying currency movements with regard to both: relative portfolio weight changes and changes in absolute (dollar) investment.

The rest of the paper is organized as follows: in the first section we describe the data, then we detail the methodology and lastly we present the results and conclusions.

3.2 Data

The current paper utilizes a custom dataset commissioned from Morningstar, which provides the equity holdings of US based open-ended international mutual funds[58]. The dataset covers the period from 1984 to 2014 and includes close to 1500 mutual funds.

We examine open ended mutual funds which specifically focus on international investment. We eliminate funds that can invest only in one country/currency (for example funds focusing solely on Japan, China, India, etc.), because we want to explore how fund managers make choices between different currencies. The funds selected fall into the following Morningstar Global Categories: Asia Equity, Asia ex-Japan Equity, Emerging Markets Equity, Europe Equity Large Cap, Global Equity, Global Equity Large Cap, Global Equity Mid/Small Cap, and Latin America Equity. Further, it has to be noted that the sample does not include index funds.

[57] The sample covers $40B worth of US pension fund monies for the period 1985 – 1990.
[58] For the purposes of this paper the term "international mutual funds" will mean US based mutual funds which focus on international/global investment.

The Morningstar portfolio holdings data utilizes a proprietary collection procedure and strong relationships with investment managers to allow collection of 98% of holdings information directly from fund companies, transfer agents and custodians. Therefore, holdings data is reported on a monthly basis for a majority of funds, although there are some funds that report less frequently (quarterly). In comparison, the Thompson Reuters mutual fund holdings data has quarterly frequency. In our sample, 76% of funds report holdings monthly, 3% report on a bi-monthly frequency, and 20% report quarterly. Additionally, we limit our analysis to funds that have holdings data for at least a 12 month period.

Examples of items included in our dataset are: the fund identification number, the reporting date of holdings, the previous reporting date, the type of holdings, number of shares invested, share change, market value of investment (in US dollar terms), percent portfolio weight of investment and most importantly the currency of the investment.

Information on foreign exchange rate daily levels is acquired through Datastream and the Federal Reserve Board's H.10 Report. The time period of available information varies from currency to currency. Country level macro data including interest rates, inflation level and Gross Domestic Product is sourced through the International Monetary Fund eLibrary. Interest rates are proxied by Government Treasury Bill rates, or if they are not available, we use rates on short term Government Bonds. Inflation indexes are proxied by consumer price indices. Macro level data are available at quarterly frequency.

Table 1 provides summary statistics for the mutual fund sample. The number of international mutual funds in the sample starts at 24 in 1984 and increases gradually to 104 in the beginning of the 1990s. However, by the beginning of 2000 the number of funds has grown to 630, and by the end of the sample period in 2014 it reaches 940. Figure 1 Panel A shows the increase in the number of funds over time.

Table 1 also shows the distribution in the size of the mutual funds over the years with information about its median, 5th and 95th percentile, and standard deviation. Figure 1 Panel B graphs the time series of fund size in US dollars. The median fund in 1984 has $71.8M of investments. The 1990's are marked by gradual increase in fund assets, while the 2000's exhibit rapid run-up until their peak at $416M in 2007. Following the great decline during the financial crisis, median size has recovered to $307M in 2014. The time series average during the sample period is $150M. At the same time, there is considerable cross-sectional variation in the size of the funds. The average fund in the 5th percentile has $5M of investments, while the average fund in the 95th percentile is over $3B.

The last column of Table 1 demonstrates the number of currencies in which one fund invests in a particular year. The average number of currencies in which a fund invests is 18 over the sample period. Panel C in Figure 1 shows the time series trend. The (median) number of currencies that a fund invests in starts at 10 in 1984 and grows gradually to about 24 in the mid-1990's and decreases gradually to 14 in 2014.

3.3 Methodology: Changes in relative portfolio weights vs. currency movements

3.3.1 GT measure

In the first part of our analysis, we study the performance of international mutual funds in terms of their ability to correctly respond to changes in exchange rates through a modified version of the GT measure introduced by Daniel et al (1997).

For every mutual fund, we calculate the portfolio weight of a particular currency (w_t) by summing the weights of all stocks which are denominated in that currency for the reporting date. The reporting frequency of holdings varies by mutual fund. The majority of funds (76%) report holdings monthly. For funds that report less frequently (quarterly, semiannually), w_t is filled in with the most recently reported portfolio weight. In order to be included in the analysis, a fund has to have holdings data for at least a 12 month period.

Additionally, we calculate the monthly returns for a particular currency (R_t) as the percentage change in the exchange rate relative to the US dollar. When $R_t > 0$, the foreign currency appreciates relative to the dollar.

We then construct the performance measure $GT_{j,t}$ as follows:

$$GT_{j,t} = \sum_{i=1}^{k} \Delta w_{j,i,t}\, R_{i,t},$$

where $\Delta w_{j,i,t} = w_{j,i,t} - w_{j,i,t-1}$ is the change in the portfolio weight for fund j in currency i for month t; k is the number of currencies in which the fund invests. Therefore, we estimate $GT_{j,t}$ during every month *t* for every fund *j* separately, by multiplying the monthly change in the fund currency weight by the currency return and summing across all k currencies that the fund invests in. For funds that report less frequently than monthly, the $\Delta w_{j,i,t}$ will be zero for months for which there is no update of holdings, thus not impacting the total measure $GT_{j,t}$.

Further, we estimate a comprehensive performance measure for every fund j, by taking a time series average of $GT_{j,t}$, which results in the measure GT_j. We will also refer to it as GT(fund).

$$GT_j = \frac{1}{T}\sum_{t=1}^{T} GT_{j,t}$$

If we conjecture that mutual fund managers make the right currency bets, then we will expect them to load on currencies by increasing their weight ($\Delta w_{j,i,t} > 0$) in periods in which currencies appreciate ($R_{i,t} > 0$) and we would expect that they will decrease their exposure ($\Delta w_{j,i,t} < 0$) in periods in which currencies depreciate ($R_{i,t} < 0$). Therefore, in this case GT_j should be positive.

To make comparisons between fund measures easier we also standardize the GT_j measure by the standard deviation of $GT_{j,t}$ to arrive at $GT_j\ standardized$. We will also refer to it as $GT_j\ t-stat$.

$$GT_j\ standardized = \frac{GT_j}{\sigma_{GT_{j,t}}}$$

Further, to examine the performance of all mutual fund managers in relation to their currency positions, we construct a cross sectional average of GT_j across all funds.

$$GT = \frac{1}{N}\sum_{j=1}^{N} GT_j$$

where N indicates the number of mutual funds.

A potential concern with the above measure is that some of the change in the currency portfolio weight maybe due to the appreciation or depreciation of the relevant currency during the reporting period rather than the deliberate rebalancing on part of the manager. To address this concern we also compute an adjusted $GT_j\ adj$ measure. In this case, instead of computing the currency portfolio weight change relative to its value last period, we compute the difference relative to what the last period weight would have been if it grew at the currency rate of return. The denominator in the formula is an adjustment for the weights to sum up to one.

$$GT_{j,t}\ adj = \sum_{i=1}^{k}\left(w_{i,t} - \frac{w_{i,t-1}\,(1+R_{i,t})}{\sum_{i=1}^{k} w_{i,t-1}\,(1+R_{i,t})}\right) R_{i,t}$$

3.3.2 lGT measure

The previous performance measure GT assesses the contemporaneous ability of mutual fund managers to change their portfolio weight to currencies that perform well or poorly.

However, we are also interested in the question of whether managers have foresight with respect to future movements in exchange rates and whether they position their portfolios in advance to benefit from it. Therefore, we construct an additional measure of performance $lGT_{j,t}$ which incorporates the lagged change in currency weights rather than the contemporaneous one. Thus, for every fund j in month t we estimate

$$lGT_{j,t} = \sum_{i=1}^{k} \Delta w_{j,i,t-1} \, R_{i,t}$$

where: $\Delta w_{j,i,t-1} = w_{j,i,t-1} - w_{j,i,t-2}$ is the lagged change in the portfolio weight for fund j in currency i for month t; k is the number of currencies in which the fund invests. We estimate $lGT_{j,t}$ every month t for every fund j separately, by multiplying the lagged monthly change in the fund currency weight by the current FX return and summing across all k currencies that the fund invests in. Then we create a comprehensive performance measure for every fund j, by taking a time series average of $lGT_{j,t}$, which results in the measure lGT_j. We will also refer to it as lGT(fund).

$$lGT_j = \frac{1}{T} \sum_{t=1}^{T} lGT_{j,t}$$

If we conjecture that mutual fund managers have predictive ability for currency movements, then we will expect them to load in advance on currencies by increasing their weight ($\Delta w_{j,i,t-1} > 0$) before periods in which currencies appreciate ($R_{i,t} > 0$) and we will expect that they will decrease their exposure ($\Delta w_{j,i,t-1} < 0$) prior to periods in which currencies depreciate ($R_{i,t} < 0$). In such a case, the estimated value of lGT_j should be positive.

To make comparisons between fund measures easier we also standardize the lGT_j measure by the standard deviation of $lGT_{j,t}$ to arrive at $lGT_j \; standardized$. We will also refer to it as $lGT_j \; t - stat$.

$$lGT_j \; standardized = \frac{lGT_j}{\sigma_{lGT_{j,t}}}$$

Further, to examine the performance of all mutual fund managers, we construct a cross sectional average of lGT_j across all funds.

$$lGT = \frac{1}{N} \sum_{j=1}^{N} lGT_j$$

where N indicates the number of mutual funds.

3.3.3 GT_c measure

The GT and lGT measures assess the ability of a mutual fund managers to forecast movements in all invested currencies at the same time. However, it is possible that managers could have a better understanding of the mechanics behind some currencies and not others. Therefore, we repeat the analysis with measures which assess the ability to manage a particular currency in isolation.

$$GT\_c_{\ j,i,t} = \Delta w_{j,i,t}\, R_{i,t}$$

where $\Delta w_{j,i,t} = w_{j,i,t} - w_{j,i,t-1}$ is the change in the portfolio weight for fund j in currency i for month t.

Further, we estimate a comprehensive performance measure for every fund-currency pair by taking a time series average of $T\_c_{\ j,i,t}$. The resulting measure $GT\_c_{\ j,i}$ accesses the performance of the manager of fund j in relation to just currency i. Thus, every fund j will have k-number of such measures.

$$GT\_c_{\ j,i} = \frac{1}{T}\sum_{t=1}^{T} GT\_c_{\ j,i,t}$$

Then to examine the performance of all mutual fund managers in relation to currency i, we construct a cross sectional average of $GT\_c_{\ j,i}$ across all funds.

$$GT\_c_{\ i} = \frac{1}{N}\sum_{j=1}^{N} GT\_c_{\ j,i}$$

where N indicates the number of mutual funds that invest in a particular currency i.

Finally, one can construct the lagged equivalent $lGT\_c_{\ i}$ for every currency, by plugging in $\Delta w_{j,i,t-1}$ instead of $\Delta w_{j,i,t}$ in the $GT\_c_{\ j,i,t}$ formula.

3.4 Methodology: Changes in absolute (dollar) investment vs. currency movements

3.4.1 Aggregate level regression analysis

In the previous section we studied how changes in relative equity investment (portfolio weights) relate to currency returns. Alternatively, we can explore the relationship between FX movements and international equity flows by studying how changes in absolute equity investment impact currency demand. To begin with, we construct several aggregate level variables by accumulating data across funds.

Firstly, we construct $marketvalue_{i,t}$ as the absolute equity investment (market value) in currency i, aggregated across all funds during quarter t. Then we take the percentage change in that variable to arrive at:

$$\%\Delta marketvalue_{i,t} = \frac{marketvalue_{i,t} - marketvalue_{i,t-1}}{marketvalue_{i,t-1}}$$

A positive value for this variable indicates that in aggregate funds are increasing their exposure to currency i, while a negative value indicates that managers in aggregate are decreasing their exposure to the currency.

The second variable, $D_{\%\Delta marketvalue_{i,t}>0}$, is a dummy equal to 1 if $\%\Delta marketvalue_{i,t}$ is positive for quarter t, indicating that the aggregate equity investment in currency i has increased; and zero otherwise.

The third variable, $\%\Delta marketvalue_{i,t-1}$, is the lagged value of $\%\Delta marketvalue_{i,t}$, indicating the percentage change in the absolute equity investment in currency i, aggregated across all funds, in quarter t-1.

On the basis of these variables we analyze three different regression models. The first model is specified as:

$$R_{i,t} = \beta_0 + \beta_1 \%\Delta marketvalue_{i,t} + \beta_2 \Delta interest_{i,t} + \beta_3 \Delta\, inflation_{i,t} + \beta_4 \Delta\, gdp_{i,t}$$

where $R_{i,t}$ is the quarterly return for currency i for time t. In addition to the main variable of interest $\%\Delta marketvalue_{i,t}$, we also control for macroeconomic factors, which have been used in the literature as determinants of exchange rate movements. The first macro control variable is $\Delta interest_t$, which is the interest rate differential between the United States and the country in which currency i is used. Interest rates are proxied by the rates on Government Treasury Bills or if these are not available by short term Government Bond rates. $\Delta\, inflation_{i,t}$ is the inflation rate differential between the United States and the country in which currency i is used. Inflation is calculated on the basis of consumer price indices for the respective countries. $\Delta\, gdp_{i,t}$ is the GDP (gross domestic product) growth differential between the United States and the country in which currency i is used.

The second regression uses the dummy variable instead of the continuous one:

$$R_{i,t} = \beta_0 + \beta_1 D_{\%\Delta marketvalue_{i,t}>0} + \beta_2 \Delta interest_{i,t} + \beta_3 \Delta\, inflation_{i,t} + \beta_4 \Delta\, gdp_{i,t}$$

Lastly, the third regression model explores the impact of the lagged continuous variable in addition to the contemporaneous dummy:

$$R_{i,t} = \beta_0 + \beta_1 D_{\%\Delta marketvalue_{i,t}>0} + \beta_2 \%\Delta marketvalue_{i,t-1} + \beta_3 \Delta interest_{i,t} + \beta_4 \Delta\, inflation_{i,t} + \beta_5 \Delta\, gdp_{i,t}$$

These regressions are intended to explore whether in aggregate the change in absolute equity investment in a currency conveys additional information about the currency's demand, beyond the other macroeconomic factors. The frequency of the data is quarterly due to the availability of the macroeconomic factors.

3.4.2 Fund level regression analysis

To enrich the regression analysis, we also explore how the relationship between currency returns and changes in absolute equity investment in that currency varies across individual fund managers. Therefore, we repeat the previous regressions by substituting the aggregate level equity investment changes by the individual changes for every fund.

Thus the regressions are transformed to:

$$R_{it} = \beta_0 + \beta_1 \%\Delta marketvalue_{j,i,t} + \beta_2 \Delta interest_{i,t} + \beta_3 \Delta\, inflation_{i,t} + \beta_4 \Delta\, gdp_{i,t}$$

$$R_{it} = \beta_0 + \beta_1 D_{\%\Delta marketvalue_{j,i,t}>0} + \beta_2 \Delta interest_{i,t} + \beta_3 \Delta\, inflation_{i,t} + \beta_4 \Delta\, gdp_{i,t}$$

$$R_{it} = \beta_0 + \beta_1 D_{\%\Delta marketvalue_{j,i,t}>0} + \beta_2 \%\Delta marketvalue_{j.i,t-1} + \beta_3 \Delta interest_{i,t} + \beta_4 \Delta\, inflation_{i,t} + \beta_5 \Delta\, gdp_{i,t}$$

where $\%\Delta marketvalue_{j,i,t} = \frac{marketvalue_{j,i,t} - marketvalue_{j,i,t-1}}{marketvalue_{j,i,t-1}}$ is the percentage change in the absolute equity investment in currency i, for fund j in quarter t.

Similarly, $D_{\%\Delta marketvalue_{j,i,t}>0}$ and $\%\Delta marketvalue_{j,i,t-1}$ are also fund specific.

Therefore, for every currency we run the regressions separately for every fund j that invests in the currency i. As a last step, we explore the cross-sectional distribution of the coefficients on the market value variables across all funds.

3.5 Results: Changes in relative portfolio weights vs. changes in currency values

3.5.1 GT and lGT measures – All currencies

In the first part of our analysis, we are going to study the relationship between changes in the currency portfolio weights in international mutual funds and currency returns. Thus, we direct our attention to the GT and lGT measures described in the Methodology section. The GT measure examines whether mutual fund managers are able to detect contemporaneous FX movements and change their portfolio weights to take advantage of the beneficial movements or whether they are able to avoid value destruction. If that indeed is the case, we expect a positive GT measure.

Table 2 Panel A presents the key statistics for the GT measure. Figure 2 Panel A illustrates the histogram for GT_j across the sample of 1467 mutual funds and Panel B the histogram for $GT_j\ standardized$. The measures are estimated with a monthly frequency and we limit our analysis to funds that have holdings data for at least a 12 month period.

The results in Table 2 Panel A indicate that 80.7% of the 1467 mutual funds have positive GT_j measures. Similarly, Figure 2 Panels A and B show that the majority of the distribution mass in GT_j and $GT_j\ standardized$ lie to the right of zero. This means that most funds increase their portfolio weights to a particular currency when it has positive returns and decrease the weights to that currency when it has negative returns. The cross sectional average for all funds gives the GT measure of 0.016, which however is not statistically significant (t-stat of 0.446), indicating that the average fund does not create or destroy significant value through their currency management.

Further, we explore whether any funds have the ability to create value or destroy it by adjusting the portfolio weights to a particular currency. Interestingly, we find that there are no funds that have statistically significant GT_j measures. This indicates that according to this measure, there are no funds that significantly destroy (or create) value through their exposure to foreign currency.

The conclusion that the average fund does not create or destroy significant value is also robust to the use of the adjusted GT measure - $GT_j\ adj$. The results are presented in Table 2 Panel C and Figure 2 Panels E and F. The analysis shows that the distribution of . $GT_j\ adj$ across all funds is more centered around zero and the cross sectional average is not significantly different from zero.

In the previous analysis, we constructed the cross sectional average GT over the full sample period from 1984 to 2014. Next, we examine whether this measure has significant changes over time. For this purpose, firstly we estimate the GT measure annually by just taking the return and portfolio weights information available for a particular year. Table 3 Panel A shows the annual estimates of the GT measure from 1984 to 2013. In 25 out of the 30 years the GT measure is positive. However, none of them are statistically different from zero. We repeat the exercise with 5 year estimation horizons – the results are presented in Table3 Panel B. In this case, 24 out of the 26 estimates are positive, but again none of them are significantly different from zero. Thus, the GT measure does not vary much over time and the conclusions that we draw from Table 2 are not a function of the time period.

Next, we turn our attention the lGT measure which examines whether mutual fund managers are able to predict FX movements and change beforehand their portfolio weights to take advantage of the beneficial movements or whether they are able to avoid value destruction. If that indeed is the case, we expect a positive lGT measure. Table 2 Panel B presents the key statistics for the lGT measure. Figure 2 panel C illustrates the histogram for lGT_j across the sample of 1467 mutual funds and Panel D the histogram for $lGT_j\ standardized$. In these figures, it is noticeable that the distributions of lGT_j and $lGT_j\ standardized$ are more centered around zero than the distribution of the contemporaneous measures. As indicated in Table 2 Panel B, 53% of the mutual funds have positive lGT_j measures, which indicates that they increase their portfolio weights towards currencies that will appreciate the following period. The cross sectional average for all funds lGT is 0.003, which is not statistically significant (t-stat of 0.068), meaning that the average fund does not create or destroy significant value through increasing its weights to appreciating currencies. Similarly, we find that there are no funds that have statistically significant lGT_j measures. Thus, according to this measure there are no funds that significantly destroy value through their exposure to foreign currency.

3.5.2 GT_c and lGT_c measures – Currency by currency

In the previous section, we explored the ability of a mutual fund manager to foresee movements in all currencies that the fund invests in at the same time and act accordingly. However, it is also possible that it is easier for managers to forecast certain currencies better than others. Therefore, we modify the previous GT measure to include only one currency at a time for each fund, which results in the GT_c measure described in the Methodology section.

Table 4 Panel A presents the key statistics for the GT_c measure. Figure 3 panel A illustrates the histogram for GT_c_j across the sample of 31,122 fund-currency pairs and Panel B the histogram for $GT\_c_j\ standardized.$ The results show that 60.6 % of the fund-currency pairs have positive GT_c_j measures. Similarly, Figure 3 Panels A and B show that there is a slight tilt of the distribution of GT_c_j to the right of zero. The cross sectional average for all fund-currency pairs GT is 0.001, which is not statistically significant (t-stat of 0.104). This evidence suggests that the average fund does not create or destroy significant value by managing its currencies one at a time. Actually, by comparing the percentages of positive GT_j and GT_c_j measures, one can conclude that funds are better at managing their weights relative to all currencies at once than to each currency at a time.

Next, we take a look of the ability of funds to alter their portfolio weights to each currency separately beforehand in anticipation of currency movements by exploring the lGT_c_j measure presented in Table 4 Panel B and Figure 4 Panels C and D. The distribution of lGT_c_j is more centered around zero than the distribution of the contemporaneous measure with 50.6% of the fund-currency pairs having positive lGT_c_j measures. Similarly, the cross sectional average for all fund-currency pairs lGT is 0.000, which is not statistically significant (t-stat of 0.019). This evidence indicates again that funds are better at managing contemporaneous changes in foreign exchange rates than foreseeing future changes.

Further, we want to explore whether on average mutual fund managers are better at predicting changes in certain currencies compared to other currencies. For this purpose, we estimate a cross sectional average of the $GT\_c_{j,i}$ measures for one currency at a time across all funds that invest in it, $GT\_c_{\ i} = \frac{1}{N}\sum_{j=1}^{N} GT\_c_{\ j,i}$. A similar cross sectional average is constructed for lGT_c_j, $lGT\_c_{\ i} = \frac{1}{N}\sum_{j=1}^{N} lGT\_c_{\ j,i}$. Table 5 presents the results. In the first column of the table, one can find the abbreviation of the reference currency, in columns 2 and 4 - the cross sectional averages $GT\_c_{\ i}$ and $lGT\_c_{\ i}$ and in columns 3 and 5 - the respective t-statistics for the cross-sectional averages. Almost all cross sectional averages are very close to zero and have insignificant t-statistics. The only exception is the ZMW (the Zambian Kwacha) with a negative $GT\_c_{\ i}$ measure and significant t-statistic of -14.66, which indicates a destruction of value. However, the investment in this currency is small and therefore does not have a meaningful impact on the overall performance of the international funds. The evidence from the $GT\_c_{\ i}$ measure indicates that in almost all cases, on average the management of individual currencies does not create or destroy value. Similar results are seen for the lagged performance measure lGT_c_i.

3.5.3 GT and lGT measures – Most active funds

Additionally, we explore whether the subsample of funds that are most active in changing their currency portfolio weights tend to perform differently than the whole sample and specifically whether they erode value with their increased activity.

As an initial step to isolate the subsample of the most active funds, we measure the time series volatility of the change in the currency weight for every fund-currency pair. Then for every fund, we average the volatility across all currencies in which the fund invests in. Finally, we rank all funds according to their average volatility and designate the funds that fall into the decile with the highest volatility as the subsample of the most active funds (the funds that change their currency portfolio weights the most). Then, we apply the GT and lGT analysis to this subsample. The results are presented in Table 6 and Figure 4.

Panel A of Table 6 shows that 60.7% out of the 145 most active funds have positive GT_j measures, indicating that they increase their portfolio weights in the currencies when they tend to have positive returns and decrease them when they have negative returns. The average cross sectional measure GT is 0.017 and not statistically different from zero (t-stat 0.202). The conclusion that the average fund does not create or destroy significant value is also robust to the usage of the adjusted GT measure - $GT_j\ adj$. The analysis shows that the distribution of. $GT_j\ adj$ across all funds is more centered around zero and the cross sectional average is not significantly different from zero. Similarly, in terms of the lGT_j measure, 50.4% of the most active funds have positive measures. The average cross sectional measure lGT is 0.009 and not statistically different from zero (t-stat 0.119). This evidence suggests that on average the most active funds do not perform differently from the whole sample and most importantly they do not erode significant value through their active changes in the currency portfolio weights.

Overall, from the results on the GT and lGT measures, we can conclude that the majority of mutual funds are better at managing contemporaneous changes in currency movements than predicting future changes. Additionally, mutual fund managers do not have an advantage in predicting certain currencies over others. Most importantly however, it has to be noted that international mutual funds are not eroding value through their exposure to particular currencies even in the case of the most active funds.

3.6 Results: Changes in absolute (dollar) investment vs. changes in currency values

3.6.1 Aggregate level regression analysis

In the second part of our analysis, we explore the relationship between currency movements and the changes in absolute equity investments of mutual funds in that currency. As a first step, we examine how this relationship holds on the aggregate level by performing the following regressions:

$$R_{it} = \beta_0 + \beta_1 \%\Delta marketvalue_{i,t} + \beta_2 \Delta interest_{i,t} + \beta_3 \Delta\, inflation_{i,t} + \beta_4 \Delta\, gdp_{i,t}$$

$$R_{it} = \beta_0 + \beta_1 D_{\%\Delta marketvalue_{i,t}>0} + \beta_2 \Delta interest_{i,t} + \beta_3 \Delta\, inflation_{i,t} + \beta_4 \Delta\, gdp_{i,t}$$

$$R_{it} = \beta_0 + \beta_1 D_{\%\Delta marketvalue_{i,t}>0} + \beta_2 \%\Delta marketvalue_{i,t-1} + \beta_3 \Delta interest_{i,t} + \beta_4 \Delta\, inflation_{i,t} + \beta_5 \Delta\, gdp_{i,t}$$

where we regress the quarterly returns of a particular currency on a set of control macroeconomic variables (interest rate differential, inflation differential and GDP growth differential)[59] and the set of variables of interest: $\%\Delta marketvalue_{i,t}$ - percentage change of the absolute equity investment in a particular currency, aggregated across all funds, $\%\Delta marketvalue_{i,t-1}$- its first lag and $D_{\%\Delta marketvalue_{i,t}>0}$, is a dummy variable equal to 1 if $\%\Delta marketvalue_{i,t}$ is positive. The currencies chosen are the ones that have the highest quarterly absolute dollar investment and that are not subject to a fixed regime.

Figure 5 plots the level of aggregate equity investment in a particular currency vs. the exchange rate level for the top 8 currencies. There are several trends that can be noticed in the graphs. The level of aggregate equity investment in each currency has increased dramatically over the last 30 years. For example, the level of aggregate equity investment for 2014Q2 in the British pound is close to $250B, in the Japanese Yen –$200B, in the euro - $300B, in thr Swiss franc $115B, in the Canadian dollar - 50B, in the South Korean Won - $55B, in the Australian dollar - $40B, and the Swedish krona -$35B. The growth in the equity investment for most currencies picked up in the beginning of the 1990s, which was followed by a decrease for a few years in the

[59] More details about these variables are available in the methodology section

early 2000's and resulted in a huge run-up until 2008. During the financial crisis the equity investment in a lot of currencies decreased dramatically, but since 2009 levels have rebounded. Further, general upward and downward trends in the aggregate equity investment in the currency tend to correlate with upward and downward trends in the foreign exchange rates.

The aggregate level regression analysis is presented in Table 7. The table is divided into 20 panels, each of which contains the three regressions from above applied to a particular currency[60]. In column one in every panel, we study the relationship between currency returns and the contemporaneous percentage change in the aggregate equity investment in that currency, $\%\Delta marketvalue_{i,t}$. For example in Panel A where we focus on the movements of the British pound (GBP), $\%\Delta marketvalue_{i,t}$ measures the percentage change in the aggregate equity investment of the US mutual funds in the UK (equity, denominated in British pounds). We find a positive and statistically significant relationship between the % change in aggregate investment and the returns on the pound (coefficient of 0.05, significant at the 5% level). This indicates that in times when mutual funds have higher aggregate investment in UK equity, the GBP tends to appreciate (positive currency return). Similar positive and significant relationship is also documented for the BRL (Brazilian real), MXN (Mexican peso), THB (Thai baht), PHP (Philippine peso), PLZ (Polish zloty) and (HUF) Hungarian forint for a total of seven out of 20 currencies explored.

In column 2 in every panel, we substitute the continuous variable with the dummy variable $D_{\%\Delta marketvalue_{i,t}>0}$ equal to 1 if $\%\Delta marketvalue_{i,t}$ is positive or equivalently indicating an increase in the aggregate equity investment in the particular currency. In the case of the GBP in Panel A, we find a positive and significant relationship between the dummy variable and the currency returns (coefficient 0.032, significant at the 1% level). This indicates that in times when the aggregate equity investment of US mutual funds in the UK increases, the British Pound appreciates on average by 3.2% which is also an economically meaningful number. Similar positive and significant relationship is also documented for the EUR (Euro), CAD (Canadian dollar), KRW (South Korean won), AUD (Australian dollar), SEK (Swedish krona), BRL (Brazilian real), MXN (Mexican peso), THB (Thai baht), NOK (Norwegian krone), PHP (Philippine peso), ILS (Israeli sheqel), PLZ (Polish zloty), NZD (New Zealand dollar), HUF

[60] Panel A – (GBP) the British pound, Panel B– (JPY) the Japanese yen, Panel C – (EUR) the euro, Panel D – (CHF) the Swiss franc, Panel E – (CAD) the Canadian dollar, Panel F – (KRW) the South Korean won, Panel G – (AUD) the Australian dollar, Panel H – (SEK) the Swedish krona, Panel I – (BRL) the Brazilian real, Panel J – (ZAR) the South African rand, Panel K – (MXN) the Mexican peso, Panel L – (THB) the Thai baht, Panel M – (NOK) the Norwegian krone, Panel N – (PHP) the Philippine peso, Panel O – (ILS) the Israeli sheqel, Panel P – (PLZ) the Polish zloty, Panel Q – (CLP) the Chilean peso, Panel R – (CZK) the Czech Republic koruna, Panel S – (NZD) New Zealand dollar, Panel T – (HUF) the Hungarian forint.

(Hungarian forint) for a total of 15 out of 20 currencies explored. Therefore, in times when the aggregate equity investment in the particular currency increases, the currency appreciates in the range of 1.9% to 7.6% or an average of 4% across the 15 currencies, which is also economically meaningful.

In column 3 of every panel, we add the lagged continuous variable $\%\Delta marketvalue_{i,t-1}$ to the contemporaneous dummy variable $D_{\%\Delta marketvalue_{i,t}>0}$ to explore whether managers are able to foresee beforehand the direction of currency movements. In these regressions, the contemporaneous dummy continues to be significant with magnitudes similar to the results in column 2. However, in most cases we do not find a significant relationship between the currency returns and the lagged %marketvalue variable. The only exceptions are: the EUR where there is a positive relationship with coefficient of 0.01, significant at the 10% level, which would mean that funds have higher aggregated investment in the currency in the period before the appreciation happens; and the NZD with a negative coefficient -0.002, significant at the 5% level. This finding suggests that for the majority of currencies explored, the lagged change in aggregate investment does not have a predictive power for currency movements.

The aggregate level regression analysis shows that there is a significant positive relationship between the contemporaneous change in aggregate equity investment in a particular currency and currency returns, but no such connection is seen relative to the lagged values of aggregate equity investment.

3.6.2 Fund level regression analysis

We repeat the previous regressions by substituting the aggregate equity investment changes with the individual equity investment changes for every fund. Thus, we perform fund level regressions for every fund that invests in the particular currency. Ultimately, we are interested in the cross-sectional distribution of coefficients for the marketvalue variables across all funds to determine whether certain funds increase their investment in a particular currency when it appreciates or even more importantly whether they destroy value through inappropriate currency positions.

Table 8 presents the coefficient t-stat distributions of interest. Panel A displays the key statistics from the cross-sectional distribution of the $\%\Delta marketvalue_{i,t}$ coefficient t-stats from regression 1 in Table 7. The panel specifies the reference currency, the number of funds investing in the currency, the number and percent of positive t-statistics, the number and % of significantly positive and significantly negative t-statistics along with the median and mean t-stats. For example, there are 981 funds that have invested in GBP- denominated equity. Out of these, 77.5% of funds have a $\%\Delta marketvalue_{i,t}$ coefficient greater than zero. Furthermore, 22% of the funds have significantly positive coefficients at the 1% level indicating that in times when the fund has higher investment in UK equity, the GBP tends to appreciate. On the other hand, only 1% of the funds have significantly negative coefficients at the 1% level indicating that in times when the fund has higher investment in UK equity, the GBP tends to depreciate. The coefficient t-stat distribution can be observed in more detail in Panel A of Figure 6. The graph clearly demonstrates that the majority of the distribution mass is to the right of zero as well as the heavy right tail.

The trends in the coefficient t-stat distributions are fairly similar for the majority of currencies. For all currencies (with the exception of ZAR), more than 50% of the funds have positive $\%\Delta marketvalue_{i,t}$ coefficients. Further, for 17 out of the 20 currencies this percentage is higher than 70%. Additionally, the percentage of funds having significant positive coefficients (median of 12.8%) is always higher than the percent of funds with significantly negative coefficients (median of 1.5%). The t-stat distributions of the first 6 currencies can be found in Figure 6 (Panels A, C, E, G, I, K). All of them demonstrate thicker right tails and thinner left tails. This evidence suggests that there is a significant part of funds that have higher equity investment in the particular currency in times of currency appreciation and lower equity investment in times of its depreciation. More importantly, very few funds have significantly negative coefficients, which could indicate value destruction through the wrong positioning relative to the FX movement.

Next, we explore the distribution of the coefficient t-stats of the lagged variable, $\%\Delta marketvalue_{i,t-1}$(which corresponds to the regressions in column 3 from Table 7). Table 8 Panel C presents the results. For comparative reasons in Panel B, we have the distribution of the t-stats for the contemporaneous dummy variable $D_{\%\Delta marketvalue_{i,t}>0}$from the same regression[61]. Taking the British pound as an example, the percent of funds with positive $\%\Delta marketvalue_{i,t-1}$ coefficients is 35%, relative to the 84% of the contemporaneous variable. Additionally, only 3% of funds have significantly positive lagged coefficients (relative to 10% for the contemporaneous measure) which would indicate that mutual funds have higher equity investment in the currency

[61] The conclusions and trends in Panel B based on the dummy contemporaneous variable are the same as in Panel A based on the continuous contemporaneous variable.

before the period that it appreciates. On the other hand, 7% of funds have significantly negative lagged coefficients (relative to 0.1% for the contemporaneous measure) which would indicate that mutual funds have lower equity investment in the currency before the period that it appreciates.

Comparing the t –stat distributions of the lagged variables and the contemporaneous variables in Figure 6 and the data in Panels C and B, one can see that the distribution of the lagged variables are shifted to the left, they are more centered around zero and have thinner right tails and thicker left tails. The median percent of funds (across the 20 currencies) with significantly positive lagged coefficients is 5% and the median percent of funds with significantly negative lagged coefficients is 4.6%. This evidence could suggest that it is harder for funds to predict future currency changes than it is to detect contemporaneous changes. But more importantly, there are not many funds that tend to significantly destroy value through their exposure to currencies.

3.7 Conclusion

In this paper, we study in detail the relationship between currency returns and cross-country equity flows on the part of U.S. international equity mutual funds. Specifically, we are interested in the question of whether mutual funds are able to take advantage of beneficial currency movements and more importantly whether they destroy value through inappropriate country/currency positions.

We find that 80% of the funds increase their portfolio exposure to a particular currency (by increasing the relevant country allocation) when it has positive returns and decrease the exposure to that currency when it has negative returns. A little over half of the mutual funds increase their portfolio weights towards currencies that appreciate the following period. Thus, funds are better at managing contemporaneous changes in currency movements rather than at predicting future changes. Further, the average fund does not create or destroy significant value through its country allocation decisions.

Most funds are better at managing their portfolio weights relative to all currencies at the same time rather than considering currencies separately. Moreover, mutual fund managers do not have an advantage in predicting certain currencies over others. Most importantly however, it has to be noted that international mutual funds are not eroding value through their currency management even in the case of the most active funds. The last finding is especially important from a practical standpoint because it suggests that currency derivatives may not be necessary for hedging the returns of the average international equity mutual fund.

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Table 3.1 Summary statistics

		Fund Size				N Currencies
Year	N	Median	5th Percentile	95th Percentile	Standard Deviation	Median
1984	24	71,800,000	1,039,959	542,000,000	212,000,000	10
1985	24	80,000,000	19,700,000	566,000,000	261,000,000	11
1986	36	123,000,000	2,514,991	1,470,000,000	360,000,000	11
1987	42	187,000,000	3,540,854	863,000,000	466,000,000	14
1988	55	79,900,000	1,040,162	771,000,000	268,000,000	14
1989	61	55,500,000	2,308,736	799,000,000	334,000,000	16
1990	77	62,000,000	3,670,926	944,000,000	378,000,000	17
1991	104	44,300,000	3,335,136	928,000,000	381,000,000	17
1992	135	42,400,000	5,679,773	1,060,000,000	416,000,000	17
1993	198	86,100,000	7,835,866	1,350,000,000	590,000,000	19
1994	276	109,000,000	6,474,933	1,690,000,000	763,000,000	20
1995	323	104,000,000	4,872,000	1,780,000,000	954,000,000	22
1996	384	122,000,000	6,638,421	2,590,000,000	1,330,000,000	23
1997	445	139,000,000	10,100,000	2,710,000,000	1,770,000,000	24
1998	538	111,000,000	4,856,001	2,700,000,000	1,780,000,000	23
1999	567	131,000,000	6,588,315	3,220,000,000	2,050,000,000	23
2000	630	137,000,000	5,809,973	2,900,000,000	2,500,000,000	22
2001	706	86,000,000	3,587,165	2,380,000,000	1,960,000,000	22
2002	719	81,800,000	3,310,145	1,760,000,000	1,790,000,000	22
2003	733	87,900,000	2,791,805	2,220,000,000	1,880,000,000	18
2004	689	146,000,000	3,749,184	2,970,000,000	2,890,000,000	17
2005	694	242,000,000	4,934,926	4,610,000,000	4,540,000,000	18
2006	725	333,000,000	6,948,929	6,360,000,000	5,430,000,000	18
2007	772	416,000,000	10,300,000	8,200,000,000	7,300,000,000	18
2008	856	250,000,000	4,191,730	5,440,000,000	5,700,000,000	17
2009	884	179,000,000	4,189,709	4,560,000,000	4,480,000,000	17
2010	899	215,000,000	4,377,958	5,380,000,000	5,440,000,000	16
2011	951	210,000,000	3,031,119	5,610,000,000	5,700,000,000	16
2012	989	181,000,000	4,011,539	5,760,000,000	5,900,000,000	15
2013	980	243,000,000	5,449,021	7,070,000,000	6,900,000,000	15
2014	940	307,000,000	8,681,140	8,450,000,000	8,090,000,000	14
Average		150,409,677	5,340,659	3,150,096,774		18

Fund size is measured as the total investment of a fund in US dollars. N is the number of funds. N currencies is the number of currencies in which a fund invests in.

Table 3.2 GT and lGT measure distribution - All currencies

Panel A

GT(fund) t-stats							GT	
N	t>0		t>0 (α=10%)		t<0 (α=10%)		avg	t-stat
	#	%	#	%	#	%		
1467	1184	80.7	0	0.0	0	0.0	0.016	0.446

Panel B

lGT(fund) t-stats							lGT	
N	t>0		t>0 (α=10%)		t<0 (α=10%)		avg	t-stat
	#	%	#	%	#	%		
1467	778	53.0	0	0.0	0	0.0	0.003	0.068

Panel C

GT(fund) adj t-stats							GT adj	
N	t>0		t>0 (α=10%)		t<0 (α=10%)		avg	t-stat
	#	%	#	%	#	%		
1467	744	51%	0	0.0	0	0.0	0.001	0.120

GT(fund) is $GT_j = \frac{1}{T}\sum_{t=1}^{T} GT_{j,t}$ where $GT_{j,t} = \sum_{i=1}^{k} \Delta w_{j,i,t}\, R_{i,t}$; $\Delta w_{j,i,t}$ - the change in the portfolio weight of currency i, for fund j for month t.; $R_{i,t}$ - the monthly return for currency i; k - the number of currencies in which the fund invests in. GT is the cross sectional average of all GT(fund). lGT(fund) is $lGT_j = \frac{1}{T}\sum_{t=1}^{T} lGT_{j,t}$ where $lGT_{j,t} = \sum_{i=1}^{k} \Delta w_{j,i,t-1}\, R_{i,t}$; lGT is the cross sectional average of all lGT(fund). GT(fund) adj is $GT_j\, adj = \frac{1}{T}\sum_{t=1}^{T} GT_{j,t}\, adj$ where $GT_{j,t}\, adj = \sum_{i=1}^{k}\left(w_{i,t} - \frac{w_{i,t-1}\,(1+R_{i,t})}{\sum_{i=1}^{k} w_{i,t-1}\,(1+R_{i,t})}\right) R_{i,t}$ GT adj is the cross sectional average of all GT(fund) adj. The table presents- the number of funds (N), the number and percentage of positive t-statistics (t>0); the number and percentage of positive and significant t stats at the 10% significance level (t>0, α=10%); the number and percentage of negative and significant t stats at the 10% significance level (t<0, α=10%).

Table 3.3Time series variation of GT

Pane A : Annual Estimates of GT

	GT	
Year	avg	t-stat
2013	0.006	0.246
2012	0.006	0.190
2011	0.009	0.138
2010	-0.001	-0.002
2009	0.042	0.331
2008	0.032	0.364
2007	0.008	0.203
2006	0.017	0.065
2005	0.002	0.065
2004	0.018	0.528
2003	0.055	0.251
2002	0.049	0.098
2001	0.005	0.048
2000	0.031	0.108
1999	0.013	0.225
1998	0.034	0.095
1997	0.026	0.365
1996	-0.001	-0.031
1995	-0.002	-0.036
1994	0.013	0.109
1993	-0.006	-0.069
1992	0.001	0.025
1991	0.055	0.143
1990	0.026	0.551
1989	0.007	0.167
1988	0.004	0.061
1987	0.027	0.523
1986	0.023	0.681
1985	0.018	0.289
1984	-0.014	-0.628

Table 3.3 - continued

Panel B. Five Year Estimates of GT

		GT	
Start Year	**End Year**	**avg**	**t-stat**
2009	2013	0.013	0.134
2008	2012	0.019	0.306
2007	2011	0.017	0.263
2006	2010	0.021	0.424
2005	2009	0.022	0.381
2004	2008	0.013	0.224
2003	2007	0.021	0.369
2002	2006	0.028	0.120
2001	2005	0.018	0.215
2000	2004	0.028	0.382
1999	2003	0.038	0.188
1998	2002	0.041	0.083
1997	2001	0.018	0.184
1996	2000	0.019	0.184
1995	1999	0.015	0.174
1994	1998	0.018	0.214
1993	1997	0.010	0.217
1992	1996	-0.001	-0.019
1991	1995	0.002	0.059
1990	1994	0.007	0.066
1989	1993	-0.003	-0.031
1988	1992	0.007	0.161
1987	1991	0.061	0.160
1986	1990	0.019	0.486
1985	1989	0.012	0.403
1984	1988	0.015	0.317

Table 3.4 GT_c and lGT_c measures distribution –
Currency by currency

Panel A

GT_c (fund) t-stats							GT	
N	t>0		t>0 (α=10%)		t<0 (α=10%)		avg	t-stat
	#	%	#	%	#	%		
31122	18874	60.6	0	0.0	0	0.0	0.001	0.104

Panel B

lGT_c (fund) t-stats							lGT_c	
N	t>0		t>0 (α=10%)		t<0 (α=10%)		avg	t-stat
	#	%	#	%	#	%		
31122	15695	50.4	0	0.0	0	0.0	0.000	0.019

GT_c(fund) is $GT\_c_{\ j,i} = \frac{1}{T}\sum_{t=1}^{T} GT\_c_{\ j,i,t}$ where $GT\_c_{\ j,i,t} = \Delta w_{j,i,t}\ R_{i,t}$; $\Delta w_{j,i,t}$ - the change in the portfolio weight of currency i, for fund j for month t.; $R_{i,t}$ - the monthly return for currency i; GT is the cross sectional average of all GT_c(fund). lGT_c(fund) is $lGT\_c_{\ j,i} = \frac{1}{T}\sum_{t=1}^{T} lGT\_c_{\ j,i,t}$ where $lGT\_c_{\ j,i,t} = \Delta w_{j,i,t-1}\ R_{i,t}$; lGT is the cross sectional average of all lGT(fund). The table presents- the number of funds (N), the number and percentage of positive t-statistics (t>0); the number and percentage of positive and significant t stats at the 10% significance level (t>0, α=10%); the number and percentage of negative and significant t stats at the 10% significance level (t<0, α=10%).

Table 3.5 GT_c and lGT_c measures– Currency by currency

FX	GT_c		lGT_c		FX	GT_c		lGT_c	
	avg	t-stat	avg	t-stat		avg	t-stat	avg	t-stat
ARS	0.0002	0.15	-0.0001	-0.01	KWD	-0.0001	-0.43	0.0008	0.48
ATS	-0.0002	-0.10	-0.0004	-0.07	KYD	-0.0001	-0.74	-0.0016	-0.60
AUD	0.0017	0.34	-0.0002	-0.02	KZT	-0.0044	-0.40	-0.0006	-0.05
BDT	-0.0005	-0.37	-0.0015	-0.39	LBP	0.0001	0.54	-0.0001	-0.34
BEF	-0.0001	-0.02	-0.0002	-0.04	LKR	-0.0005	-0.17	-0.0003	-0.04
BGN	0.0002	0.69	0.0003	0.10	LRD	0.0000	-0.50	-0.0224	-0.49
BIF	-0.0005	-0.26	0.0025	0.60	LTL	0.0001	0.69	0.0077	0.47
BMD	0.0000	-0.11	0.0000	-0.08	LUF	-0.0004	-0.17	-0.0005	-0.08
BRL	0.0010	0.09	0.0017	0.11	LVL	0.0001	0.50	-0.0007	-0.43
BWP	-0.0002	-0.46	0.0001	0.04	MAD	-0.0001	-0.04	-0.0002	-0.11
BZD	0.0000	0.30	0.0022	0.39	MUR	-0.0003	-0.52	-0.0008	-0.31
CAD	0.0006	0.16	0.0008	0.07	MXN	0.0004	0.09	0.0001	0.02
CHF	0.0004	0.06	0.0002	0.02	MYR	0.0009	0.17	0.0001	0.02
CLP	-0.0001	-0.05	0.0007	0.09	NGN	-0.0002	-0.06	0.0005	0.15
CNY	0.0000	-0.02	0.0000	0.01	NLG	-0.0013	-0.23	0.0004	0.03
COP	0.0001	0.04	0.0011	0.18	NOK	0.0006	0.29	-0.0003	-0.03
CYP	0.0003	0.11	0.0001	0.01	NZD	0.0001	0.04	0.0011	0.06
CZK	0.0003	0.17	-0.0001	-0.02	OMR	0.0000	-0.12	0.0000	-0.29
DEM	-0.0013	-0.23	0.0010	0.04	PEN	-0.0002	-0.08	0.0001	0.04
DKK	0.0003	0.13	0.0005	0.04	PGK	0.0003	0.21	0.0010	0.14
ECS	-0.0013	-0.55	-0.0047	-0.27	PHP	0.0005	0.15	0.0002	0.02
EEK	0.0012	0.43	0.0022	0.20	PKR	-0.0003	-0.15	-0.0004	-0.12
EGP	0.0001	0.13	-0.0003	-0.12	PLZ	0.0006	0.15	0.0002	0.03
ESP	-0.0008	-0.09	-0.0001	-0.02	PTE	-0.0006	-0.22	0.0001	0.02
EUR	0.0102	0.33	-0.0005	-0.05	QAR	0.0000	-0.08	0.0000	0.00
FIM	-0.0002	-0.03	0.0001	0.01	ROL	0.0009	0.67	0.0012	0.20
FRF	-0.0011	-0.15	0.0002	0.03	RON	0.0008	0.61	0.0010	0.26
GBP	0.0007	0.09	0.0005	0.06	RUB	0.0026	0.40	-0.0004	-0.03
GHC	-0.0007	-0.52	-0.0002	-0.03	SAR	0.0000	0.08	0.0000	-0.02
GHS	-0.0008	-0.25	-0.0025	-0.53	SEK	0.0003	0.10	0.0006	0.06
GRD	-0.0001	-0.02	0.0001	0.02	SGD	0.0003	0.11	0.0002	0.04
HKD	0.0000	0.04	0.0000	-0.03	SIT	-0.0013	-0.56	0.0005	0.09
HRK	0.0002	0.15	0.0001	0.02	SKK	0.0003	0.49	0.0000	0.00
HUF	0.0004	0.18	-0.0003	-0.02	THB	0.0007	0.27	0.0015	0.04
IDR	0.0019	0.22	-0.0003	-0.03	TRL	0.0004	0.04	0.0008	0.07
IEP	-0.0005	-0.10	0.0001	0.01	TRY	0.0012	0.41	0.0003	0.04
ILS	0.0001	0.07	0.0005	0.07	TWD	0.0003	0.10	-0.0001	-0.03
INR	0.0008	0.21	0.0003	0.05	UAH	0.0006	0.36	0.0010	0.80
ISK	-0.0017	-0.20	-0.0248	-0.49	VEB	-0.0002	-0.06	-0.0001	-0.01
ITL	0.0001	0.01	0.0004	0.03	VND	-0.0003	-0.60	0.0000	-0.07
JOD	-0.0001	-0.18	-0.0001	-0.19	ZAR	0.0012	0.23	0.0007	0.05
JPY	0.0032	0.20	0.0001	0.00	ZMK	0.0006	0.36	-0.0039	-1.09
KES	0.0002	0.13	-0.0005	-0.25	ZMW	-0.0004	-14.66	-0.0197	-0.99
KHR	0.0000	1.04	0.0015	0.79	ZWD	0.0014	0.39	-0.0060	-0.17
KRW	0.0012	0.16	-0.0003	-0.03					

The table shows the cross sectional average of the GT_c(fund) and lGT_c(fund) measures and their t-statistics. FX is the reference currency.

Table 3.6 GT and lGT measures distribution – Most active funds subsample

Panel A

GT(fund) t-stats							GT	
N	t>0		t>0 (α=10%)		t<0 (α=10%)		avg	t-stat
	#	%	#	%	#	%		
145	88	60.7	0	0.0	0	0.0	0.017	0.202

Panel B

lGT(fund) t-stats							lGT	
N	t>0		t>0 (α=10%)		t<0 (α=10%)		avg	t-stat
	#	%	#	%	#	%		
145	84	57.9	0	0.0	0	0.0	0.009	0.119

Panel C

GT(fund) adj t-stats							GT adj	
N	t>0		t>0 (α=10%)		t<0 (α=10%)		avg	t-stat
	#	%	#	%	#	%		
145	76	52%	0	0.0	0	0.0	0.020	0.107

The table focuses on the subsample of most active funds, funds that change their currency weights the most. GT(fund) is $GT_j = \frac{1}{T}\sum_{t=1}^{T} GT_{j,t}$ where $GT_{j,t} = \sum_{i=1}^{k} \Delta w_{j,i,t}\, R_{i,t}$; $\Delta w_{j,i,t}$ - the change in the portfolio weight of currency i, for fund j for month t.; $R_{i,t}$ - the monthly return for currency i; k - the number of currencies in which the fund invests in. GT is the cross sectional average of all GT(fund). lGT(fund) is $lGT_j = \frac{1}{T}\sum_{t=1}^{T} lGT_{j,t}$ where $lGT_{j,t} = \sum_{i=1}^{k} \Delta w_{j,i,t-1}\, R_{i,t}$; lGT is the cross sectional average of all lGT(fund). GT(fund) adj is $GT_j\, adj = \frac{1}{T}\sum_{t=1}^{T} GT_{j,t}\, adj$ where $GT_{j,t}\, adj = \sum_{i=1}^{k}\left(w_{i,t} - \frac{w_{i,t-1}\,(1+R_{i,t})}{\sum_{i=1}^{k} w_{i,t-1}\,(1+R_{i,t})}\right) R_{i,t}$ GT adj is the cross sectional average of all GT(fund) adj. The table presents- the number of funds (N), the number and percentage of positive t-statistics (t>0); the number and percentage of positive and significant t stats at the 10% significance level (t>0, α=10%); the number and percentage of negative and significant t stats at the 10% significance level (t<0, α=10%)..

Table 3.7 Regression analysis – Aggregate level

	Panel A - GBP			Panel B - JPY			Panel C - EUR		
	[1]	[2]	[3]	[1]	[2]	[3]	[1]	[2]	[3]
%Δmarketvalue	0.050 **			0.000 *			0.009		
D(%Δmarketvalue>0)		0.032 ***	0.034 ***		-0.006	-0.006		0.053 **	0.055 ***
%Δmarketvalue - lag 1			0.010			0.000			0.010 *
Δinterest	0.061	-0.047	0.000	-0.274	-0.272	-0.002	-0.243	-0.459	-0.004
Δinflation	1.421	1.153	1.020	-1.420	-1.506	-1.533	0.061	-0.586	-0.790
Δ gdp growth	-0.101	0.018	0.030	-0.584	-0.531	-0.552	-0.462	-0.394	-0.296
constant	-0.005	-0.021 **	-0.023 **	0.027 **	0.031 **	0.030 **	-0.004	-0.041 **	-0.043 **
Adj. R^2	0.086	0.068	0.062	0.012	0.047	0.005	-0.009	0.176	0.171
N	106	106	106	120	120	119	61	61	59
Period	88Q1/14Q3			84Q2/14Q3			99Q1/14Q3		

	Panel D - CHF			Panel E - CAD			Panel F - KRW		
	[1]	[2]	[3]	[1]	[2]	[3]	[1]	[2]	[3]
%Δmarketvalue	0.000			0.000			0.028		
D(%Δmarketvalue>0)		-0.006	-0.007		0.019 **	0.020 ***		0.051 **	0.055 ***
%Δmarketvalue - lag 1			0.000			0.001			0.009
Δinterest	-0.417	-0.426	-0.004	-0.071	-0.162	-0.002	0.211	0.101	0.002
Δinflation	-0.185	-0.192	-0.222	0.479	0.615	0.655	0.165	-0.130	-0.475
Δ gdp growth	-0.483	-0.499	-0.445	-0.543	-0.566	-0.535	0.081	0.100	0.080
constant	0.017 **	0.021 *	0.021 *	0.001	-0.012 *	-0.013 **	0.006	-0.023 *	-0.025 **
Adj. R^2	-0.009	-0.007	-0.022	-0.005	0.067	0.065	0.051	0.120	0.119
N	122	122	121	122	122	121	110	110	105
Period	84Q2/14Q3			84Q2/14Q3			84Q3/14Q3		

	Panel G - AUD			Panel H - SEK			Panel I - BRL		
	[1]	[2]	[3]	[1]	[2]	[3]	[1]	[2]	[3]
%Δmarketvalue	0.000			-0.001			0.036 **		
D(%Δmarketvalue>0)		0.040 ***	0.040 ***		0.025 **	0.024 **		0.076 **	0.074 ***
%Δmarketvalue - lag 1			0.000			0.000			-0.007
Δinterest	-0.005 *	-0.005 **	-0.005 **	-0.186	-0.176	-0.002	0.270	0.229	0.002
Δinflation	0.423	0.037	0.182	0.923	0.753	0.712	-0.775	-1.190	-1.121
Δ gdp growth	1.214 **	0.641	0.636	-0.026	-0.008	-0.006	-0.007	0.039	0.063
constant	-0.011	-0.042 ***	-0.042 ***	-0.001	-0.017 *	-0.016	0.017	-0.032 *	-0.029
Adj. R^2	0.049	0.136	0.137	-0.016	0.026	0.012	0.068	0.173	0.164
N	122	122	121	122	122	121	77	77	77
Period	84Q2/14Q3			84Q2/14Q3			95Q1/14Q3		

Table 3.7 - continued

	Panel J - ZAR			Panel K - MXN			Panel L - THB		
	[1]	[2]	[3]	[1]	[2]	[3]	[1]	[2]	[3]
%Δmarketvalue	-0.027			0.086 ***			0.014 **		
D(%Δmarketvalue>0)		-4.212	-4.708		0.048 **	0.047 ***		0.046 **	0.050 ***
%Δmarketvalue - lag 1			-0.054			-0.010			0.006
Δinterest	9.172	6.911	0.150	-0.057	-0.098	-0.001	0.012	-0.269	-0.002
Δinflation	-72.678	-26.210	-39.896	-0.001	-0.001	-0.001	2.477	2.719 *	2.710 *
Δ gdp growth	-83.514	-58.917	-53.503	0.558 ***	0.496 **	0.526 ***	-0.151	-0.077	-0.062
constant	0.376	3.637	4.683	-0.064	-0.086 *	-0.079	0.001	-0.031 **	-0.034 ***
Adj. R^2	-0.025	-0.010	-0.017	0.237	0.175	0.166	0.098	0.225	0.219
N	103	103	99	84	84	84	86	86	86
Period	84Q2/14Q3			93Q4/14Q3			93Q2/14Q3		

	Panel M - NOK			Panel N - PHP			Panel O - ILS		
	[1]	[2]	[3]	[1]	[2]	[3]	[1]	[2]	[3]
%Δmarketvalue	0.026			0.040 **			0.008		
D(%Δmarketvalue>0)		0.023 ***	0.031 **		0.045 **	0.047 ***		0.022 **	0.024 **
%Δmarketvalue - lag 1			0.022			0.006			0.010
Δinterest	-0.007 *	-0.007 *	-0.008 *	0.393 *	0.194	0.002	0.047	0.010	0.001
Δinflation	2.018 **	1.918 **	1.673 **	-0.422	-0.242	-0.187	0.796 *	0.731 *	0.615
Δ gdp growth	-0.115	-0.075	-0.042	0.049	0.050	0.045	0.088	0.054	0.063
constant	-0.015 *	-0.028 ***	-0.035 ***	0.006	-0.027 **	-0.030 **	0.002	-0.011	-0.011
Adj. R^2	0.126	0.141	0.147	0.124	0.180	0.171	0.055	0.117	0.124
N	87	87	86	78	78	78	83	83	83
Period	84Q2/14Q3			94Q1/14Q3			94Q1/14Q3		

	Panel P - PLZ			Panel Q - CLP			Panel R - CZK		
	[1]	[2]	[3]	[1]	[2]	[3]	[1]	[2]	[3]
%Δmarketvalue	0.002 **			0.004			0.005		
D(%Δmarketvalue>0)		0.041 **	0.042 **		0.003	0.006		0.015	0.018
%Δmarketvalue - lag 1			0.000			0.004			0.008
Δinterest	0.231	0.122	0.001	-0.093	-0.054	-0.001	0.090	0.040	0.000
Δinflation	0.574	0.605	0.595	1.812	1.774	1.837	0.000	0.000	-0.001
Δ gdp growth	-0.140	-0.098	-0.098	-0.541 ***	-0.530 **	-0.517 **	-0.161	-0.157	-0.179
constant	0.019	-0.016	-0.016	-0.006	-0.006	-0.009	-0.024	-0.033	-0.059
Adj. R^2	0.052	0.118	0.104	0.104	0.097	0.086	-0.014	-0.004	-0.010
N	68	68	68	57	57	57	75	75	74
Period	95Q2/13Q1			96Q2/10Q2			94Q2/13Q2		

Table 3.7 - continued

	Panel S - NZD			Panel T - HUF		
	[1]	[2]	[3]	[1]	[2]	[3]
%Δmarketvalue	0.002			0.008 *		
D(%Δmarketvalue>0)		0.043 ***	0.044 ***		0.045 **	0.047 ***
%Δmarketvalue - lag 1			-0.002 **			0.002
Δinterest	-0.093	-0.077	-0.001	0.200	0.147	0.002
Δinflation	-0.539	-0.927	-0.700	0.547	0.600	0.568
Δ gdp growth	-0.234	-0.111	-0.335	-0.039	-0.046	-0.051
constant	0.000	-0.024 **	-0.025 **	0.014	-0.013	-0.012
Adj. R^2	-0.015	0.134	0.147	0.065	0.106	0.095
N	107	107	105	78	78	78
Period	87Q3/14Q3			95Q2/14Q3		

The dependent variable in every regression is the quarterly return of the respective currency from the given panel. $marketvalue_{i,t}$ is the absolute equity investment (market value) in currency i, aggregated across all funds during quarter t. $\%\Delta marketvalue$ is the percentage change in that variable. $D_{\%\Delta marketvalue>0}$ is a dummy equal to 1 if $\%\Delta marketvalue$ is positive for quarter t, indicating that the aggregate equity investment in currency i has increased; and zero otherwise. $\%\Delta marketvalue - lag$ 1 is the lagged value of $\%\Delta marketvalue$. $\Delta interest_t$, is the interest rate differential between the United States and the country in which currency i is used. $\Delta\ inflation_{i,t}$ is the inflation rate differential between the United States and the country in which currency i is used. $\Delta\ gdp_{i,t}$ is the GDP (gross domestic product) growth differential between the United States and the country in which currency i is used. Significance levels: *** 1%, ** 5%, * 10%.
Panel A – (GBP) the British pound, Panel B– (JPY) the Japanese yen, Panel C – (EUR) the euro, Panel D – (CHF) the Swiss franc, Panel E – (CAD) the Canadian dollar, Panel F – (KRW) the South Korean won, Panel G – (AUD) the Australian dollar, Panel H – (SEK) the Swedish krona, Panel I – (BRL) the Brazilian real, Panel J – (ZAR) the South African rand, Panel K – (MXN) the Mexican peso, Panel L – (THB) the Thai baht, Panel M – (NOK) the Norwegian krone, Panel N – (PHP) the Philippine peso, Panel O – (ILS) the Israeli sheqel, Panel P – (PLZ) the Polish zloty, Panel Q – (CLP) the Chilean peso, Panel R – (CZK) the Czech Republic koruna, Panel S – (NZD) New Zealand dollar, Panel T – (HUF) the Hungarian forint.

Table 3.8 Coefficient t- stat distribution – Fund level regressions

Panel A

			t-stats							
Variable	FX	N	t>0		t>0 (α=1%)		t<0 (α=1%)		Median	Mean
			#	%	#	%	#	%		
%Δmarketvalue	GBP	981	760	77.5	216	22.0	12	1.2	1.08	1.95
	JPY	828	479	57.9	43	5.2	25	3.0	0.25	0.23
	EUR	880	750	85.2	193	21.9	5	0.6	1.59	1.50
	CHF	825	502	60.8	60	7.3	27	3.3	0.31	0.34
	CAD	657	500	76.1	78	11.9	13	2.0	0.80	0.87
	KRW	678	545	80.4	136	20.1	10	1.5	1.26	1.28
	AUD	716	569	79.5	144	20.1	11	1.5	1.18	1.28
	SEK	683	508	74.4	85	12.4	13	1.9	0.86	0.95
	BRL	540	427	79.1	80	14.8	6	1.1	1.10	1.15
	ZAR	404	184	45.5	24	5.9	2	0.5	-0.31	0.39
	MXN	506	393	77.7	51	10.1	9	1.8	1.01	0.93
	THB	384	279	72.7	50	13.0	6	1.6	0.67	0.88
	NOK	574	406	70.7	51	8.9	11	1.9	0.77	0.72
	PHP	227	157	69.2	21	9.3	5	2.2	0.70	0.65
	ILS	298	214	71.8	29	9.7	10	3.4	0.60	0.64
	PLZ	186	157	84.4	75	40.3	1	0.5	1.10	1.29
	CLP	159	127	79.9	94	59.1	1	0.6	0.10	0.15
	CZK	132	98	74.2	38	28.8	0	0.0	1.07	1.07
	NZD	225	172	76.4	55	24.4	2	0.9	1.28	1.43
	HUF	160	115	71.9	20	12.5	2	1.3	0.69	0.82

The table presents the distribution of the coefficient t-stats from the individual fund level regressions. Panel A shows the results for the $\%\Delta marketvalue$ variable from the regression:

$$R_{it} = \beta_0 + \beta_1 \%\Delta marketvalue_{j,i,t} + \beta_2 \Delta interest_{i,t} + \ \beta_3 \Delta\ inflation_{i,t} + \beta_4 \Delta\ gdp_{i,t}$$

Panel B shows the results for the $D_{\%\Delta marketvalue>0}$ variable and Panel C shows the results for the $\%\Delta marketvalue - lag\ 1$ variable from the regression:

$$R_{it} = \beta_0 + \beta_1 D_{\%\Delta marketvalue_{j,i,t}>0}\ + \beta_2 \%\Delta marketvalue_{j.i,t-1} + \ \ \beta_3 \Delta interest_{i,t} + \ \beta_4 \Delta\ inflation_{i,t} + \beta_5 \Delta\ gdp_{i,t}$$

The tables list- the reference currency(FX), the number of funds (N), the number and percentage of positive t-statistics (t>0); the number and percentage of positive and significant t stats at the 1% significance level (t>0, α=1%); the number and percentage of negative and significant t stats at the 1% significance level (t<0, α=1%), the median and mean t-stats.

Table 3.8 - continued

Panel B

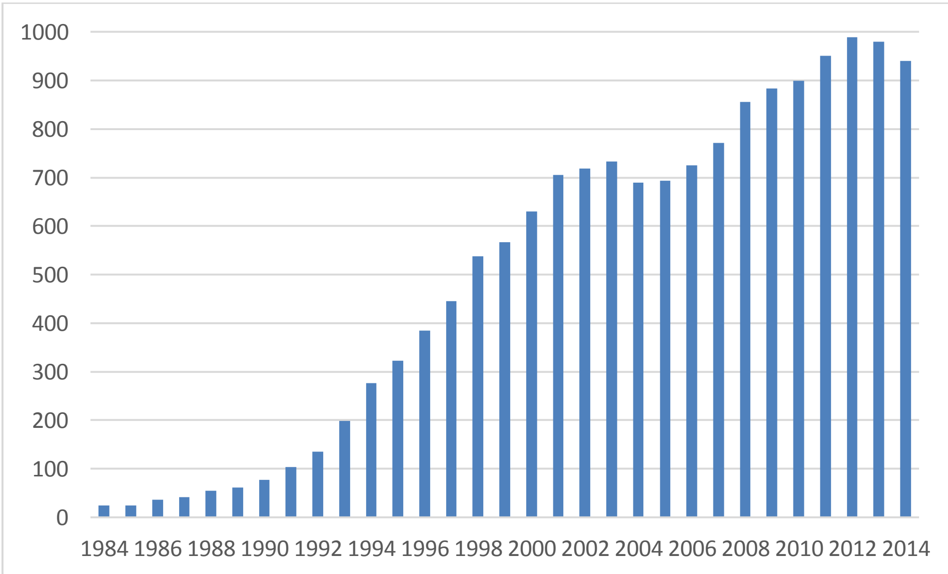
Variable	FX	N	t>0		t>0 (α=1%)		t<0 (α=1%)		Median	Mean
			#	%	#	%	#	%		
D(%Δmarketvalue>0)	GBP	921	773	83.9	98	10.6	1	0.1	1.22	1.16
	JPY	786	351	44.7	13	1.7	14	1.8	-0.11	-0.13
	EUR	836	756	90.4	227	27.2	1	0.1	1.77	1.73
	CHF	784	535	68.2	46	5.9	5	0.6	0.53	0.61
	CAD	609	507	83.3	79	13.0	3	0.5	1.03	1.12
	KRW	639	544	85.1	96	15.0	0	0.0	1.25	1.27
	AUD	667	525	78.7	95	14.2	1	0.1	1.10	1.14
	SEK	629	505	80.3	77	12.2	2	0.3	0.96	1.07
	BRL	499	443	88.8	72	14.4	0	0.0	1.35	1.34
	ZAR	370	208	56.2	13	3.5	1	0.3	0.49	-1.02
	MXN	464	378	81.5	52	11.2	1	0.2	1.14	1.08
	THB	333	256	76.9	29	8.7	2	0.6	0.85	0.84
	NOK	523	423	80.9	57	10.9	1	0.2	1.01	1.03
	PHP	199	156	78.4	28	14.1	0	0.0	0.92	0.91
	ILS	255	190	74.5	16	6.3	3	1.2	0.76	0.68
	PLZ	187	169	90.4	78	41.7	0	0.0	0.92	1.13
	CLP	152	137	90.1	102	67.1	1	0.7	0.63	0.45
	CZK	129	105	81.4	37	28.7	1	0.8	0.74	0.88
	NZD	192	171	89.1	42	21.9	1	0.5	1.45	1.52
	HUF	160	121	75.6	24	15.0	1	0.6	0.93	0.90

Panel C

Variable	FX	N	t>0		t>0 (α=1%)		t<0 (α=1%)		Median	Mean
			#	%	#	%	#	%		
%Δmarketvalue - lag1	GBP	921	324	35.2	29	3.1	66	7.2	-0.54	-0.43
	JPY	786	499	63.5	117	14.9	14	1.8	0.51	0.69
	EUR	836	451	53.9	46	5.5	47	5.6	0.14	0.10
	CHF	784	333	42.5	25	3.2	39	5.0	-0.23	-0.24
	CAD	609	287	47.1	29	4.8	39	6.4	-0.12	-0.18
	KRW	639	397	62.1	37	5.8	25	3.9	0.39	0.36
	AUD	667	330	49.5	19	2.8	29	4.3	-0.02	-0.07
	SEK	629	344	54.7	35	5.6	32	5.1	0.13	0.12
	BRL	499	264	52.9	24	4.8	24	4.8	0.11	0.00
	ZAR	370	134	36.2	10	2.7	6	1.6	-0.59	-0.31
	MXN	464	200	43.1	11	2.4	39	8.4	-0.26	-0.48
	THB	333	163	48.9	15	4.5	20	6.0	-0.09	-0.12
	NOK	523	251	48.0	21	4.0	31	5.9	-0.09	-0.09
	PHP	199	100	50.3	6	3.0	6	3.0	-0.20	-0.20
	ILS	255	125	49.0	13	5.1	10	3.9	-0.03	-0.08
	PLZ	187	113	60.4	67	35.8	4	2.1	-0.34	-0.30
	CLP	152	131	86.2	103	67.8	2	1.3	0.30	0.41
	CZK	129	76	58.9	31	24.0	7	5.4	-0.12	-0.25
	NZD	192	125	65.1	10	5.2	3	1.6	0.36	0.40
	HUF	144	69	47.9	8	5.6	5	3.5	-0.13	-0.16

Figure 3.1 Summary Statistics

Panel A: Number of Funds



Panel B: Size of Median Fund ($)

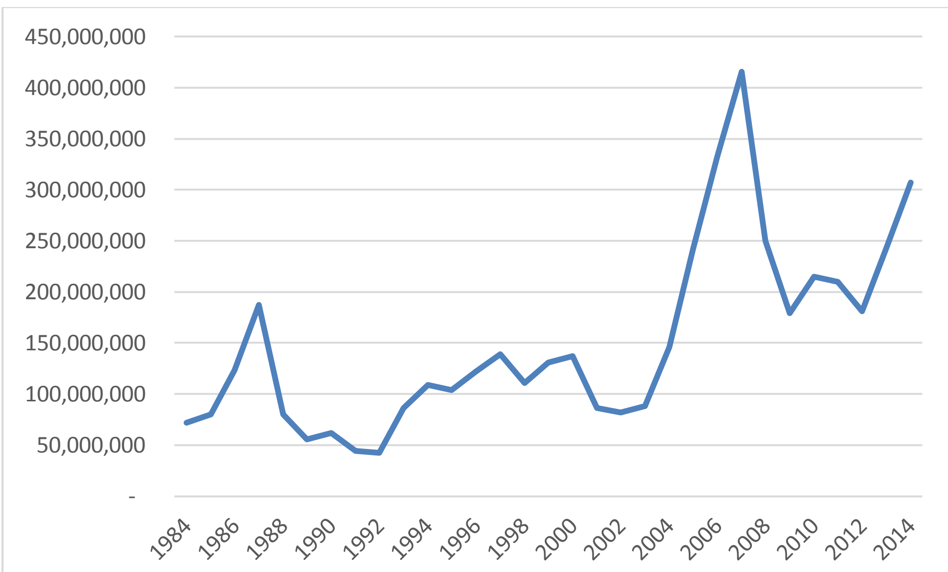


Figure 3.1 - continued

Panel C: Number of Currencies

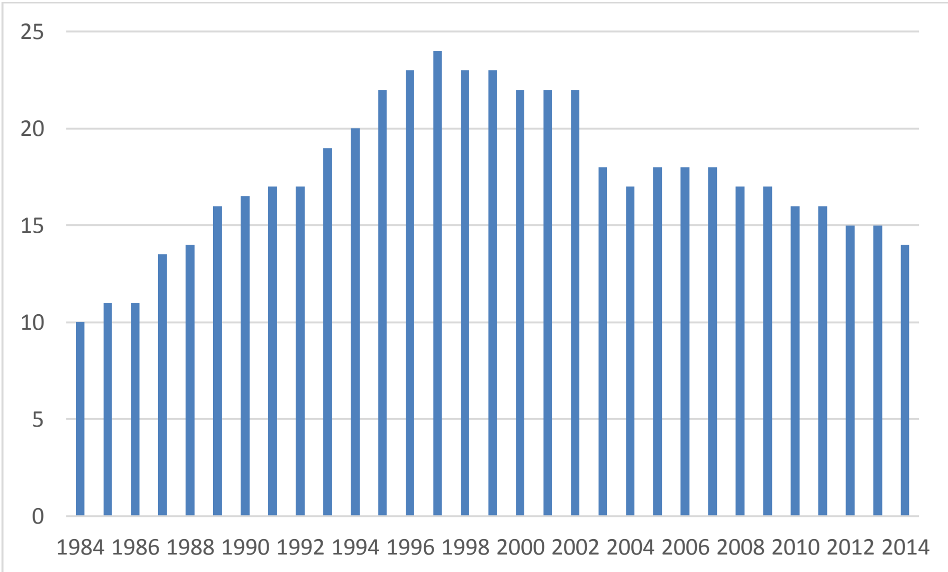
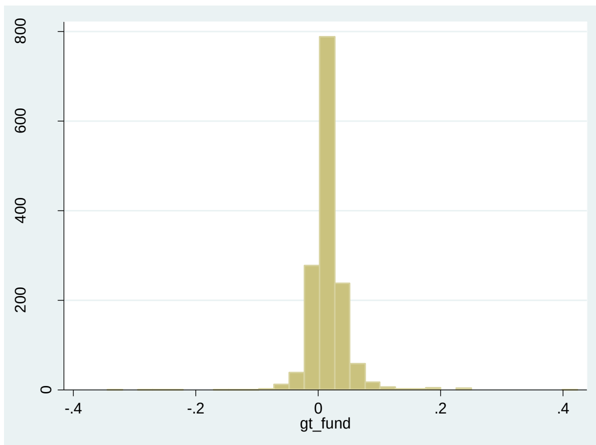
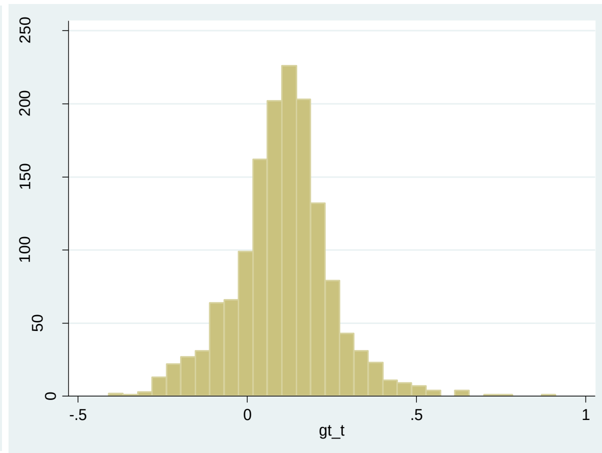


Figure 3.2 Histograms of GT and lGT measures – All currencies

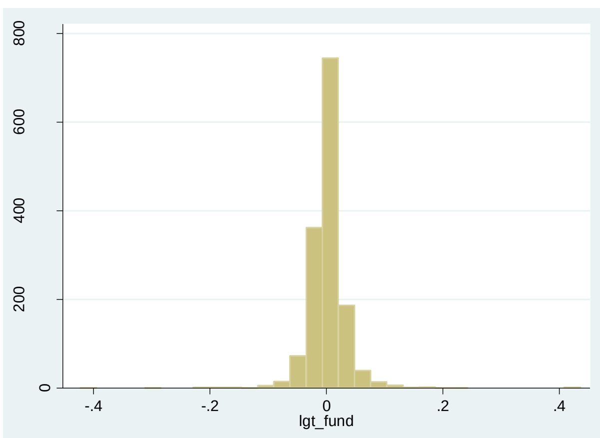
Panel A: GT(fund)



Panel B: GT(fund) t-stats



Panel C: lGT(fund)



Panel D: lGT(fund) t-stats

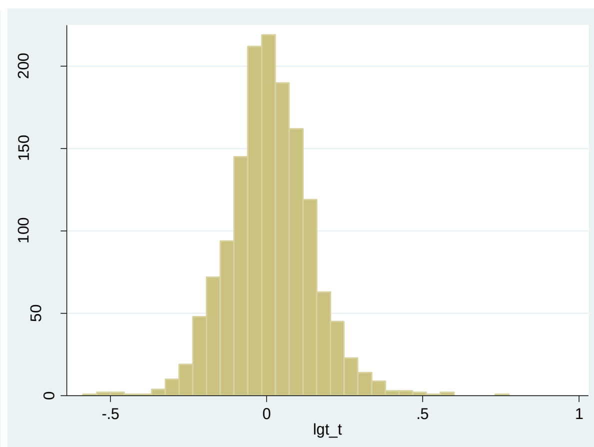
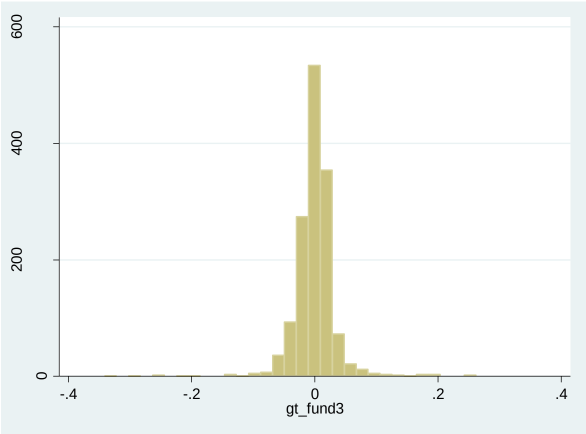


Figure 3.2 - continued

Panel E: GT(fund) adj



Panel F: GT(fund) adj t-stats

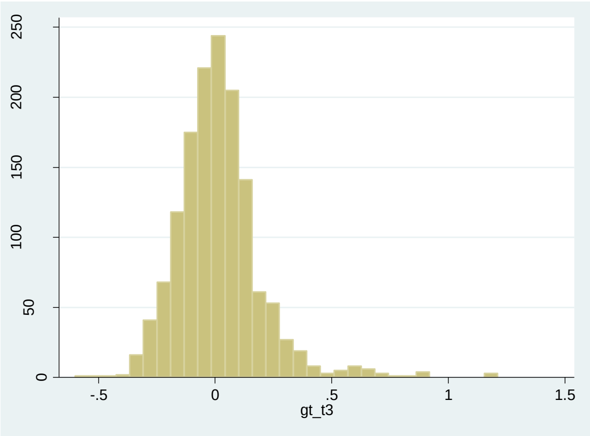
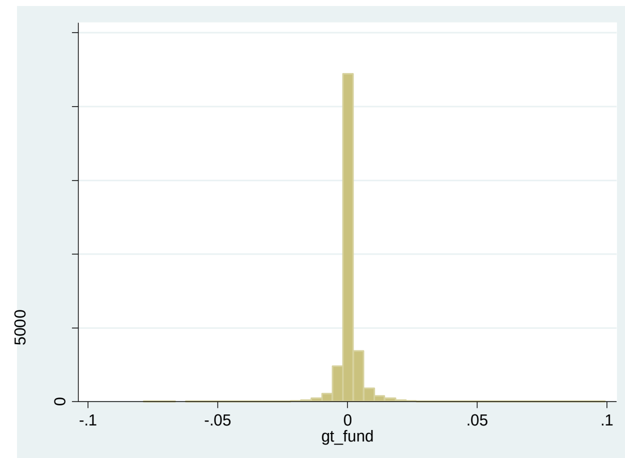
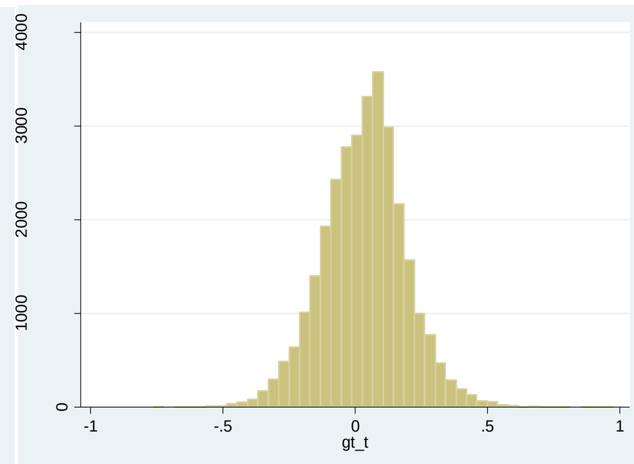


Figure 3.3 Histograms of GT_c and lGT_c measures – Currency by currency

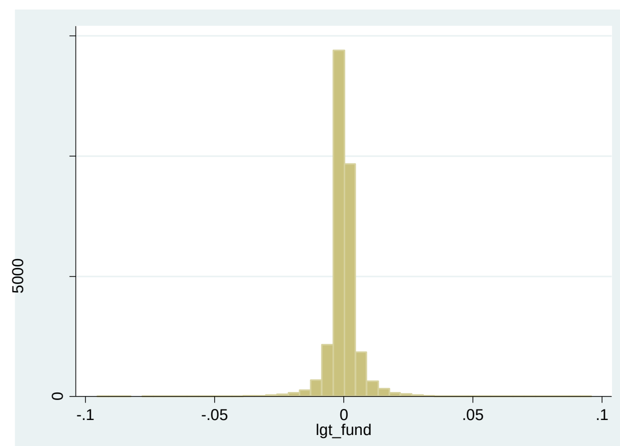
Panel A: GT_c (fund)



Panel B: GT_c (fund) t-stats



Panel C: lGT_c (fund)



Panel D: lGT_c (fund) t-stats

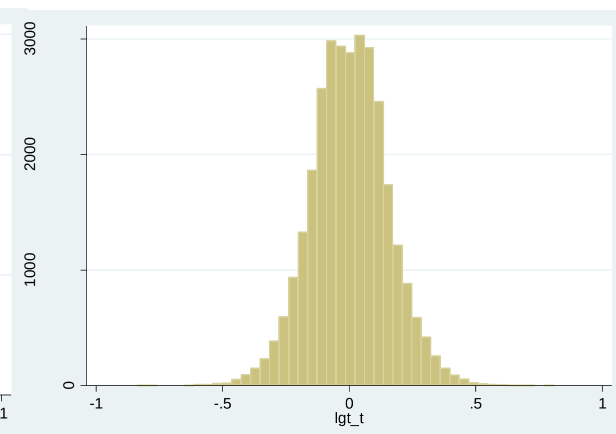
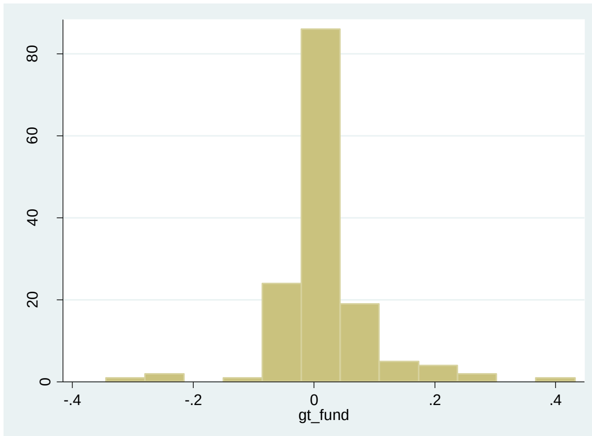
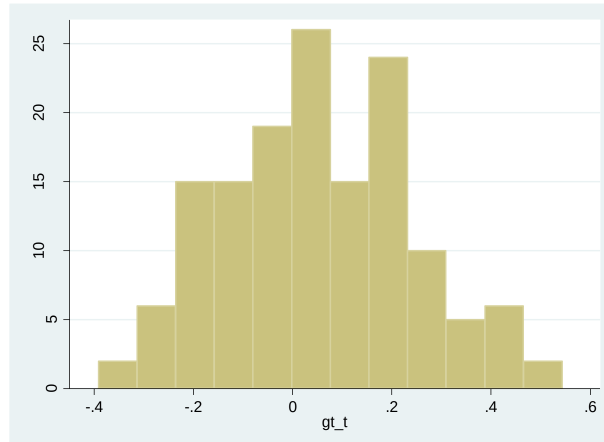


Figure 3.4 Histograms of GT and lGT measures – Most active funds

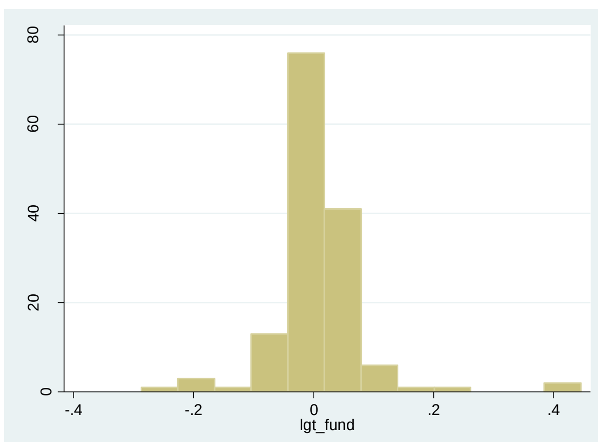
Panel A: GT(fund)



Panel B: GT(fund) t-stats



Panel C: lGT(fund)



Panel D: lGT(fund) t-stats

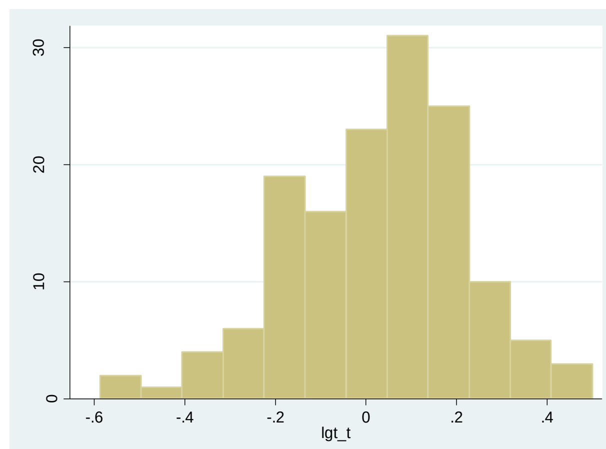
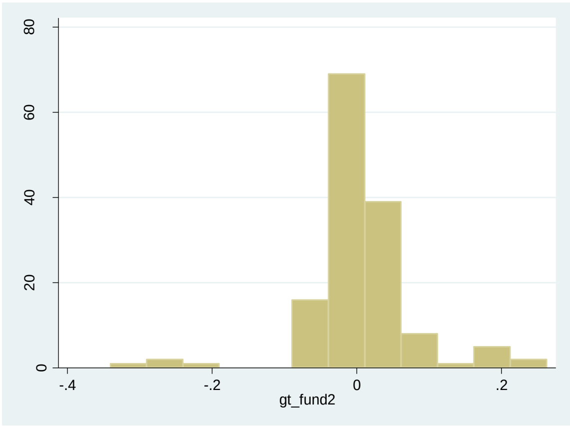


Figure 3.4 - continued

Panel E: GT(fund) adj



Panel F: GT(fund) adj t-stats

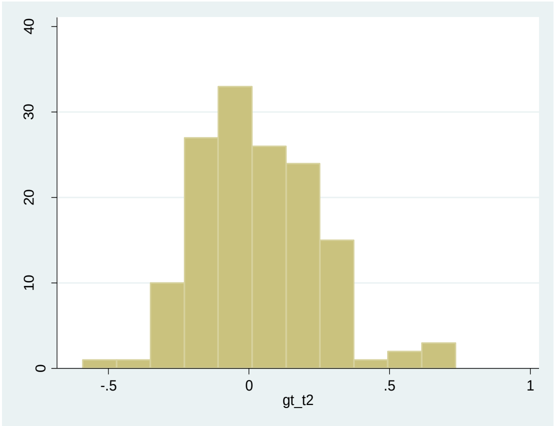


Figure 3.5 Market value of equity investment in a particular currency vs FX level

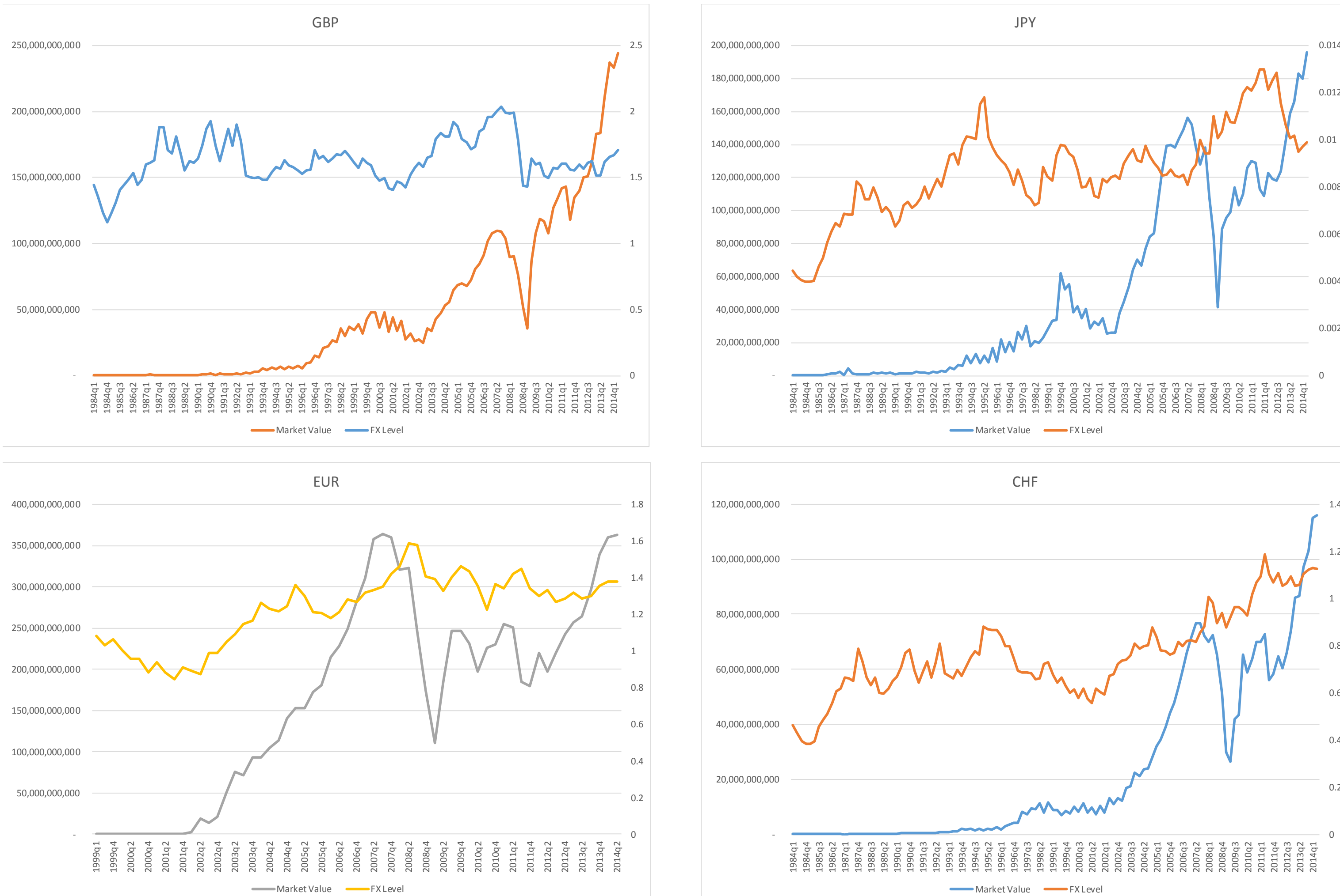
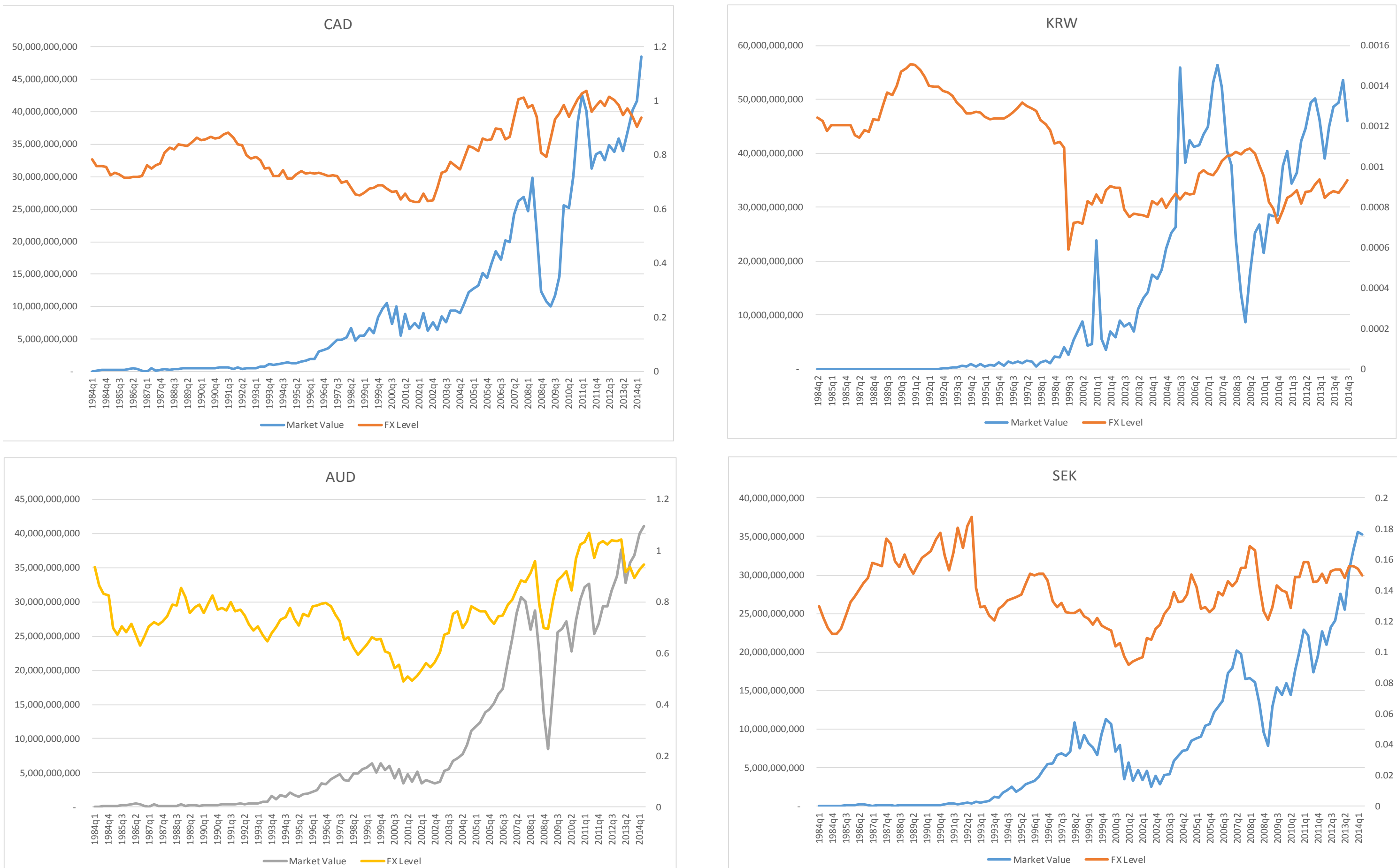


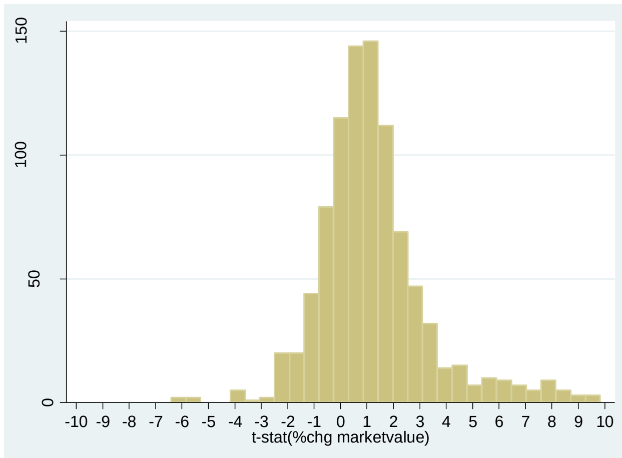
Figure 3.5 - continued



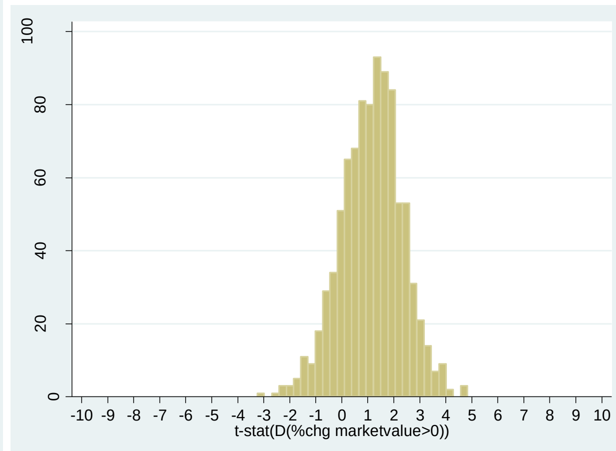
The graphs plot the aggregate market value in US dollars of equity investment in a particular currency (left axis) vs. the foreign exchange rate level USD/Foreign Currency (right axis).

Figure 3.6 Coefficient t-stat histograms

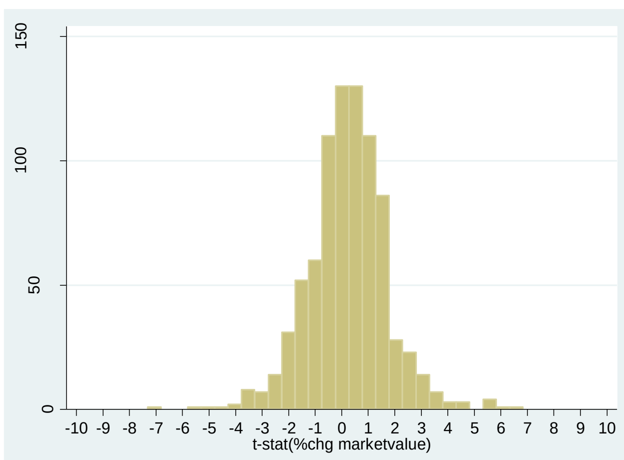
Panel A: GBP $\%\Delta marketvalue_{i,t}$



Panel B: GBP $\%\Delta marketvalue_{i,t-1}$



Panel C: JPY $\%\Delta marketvalue_{i,t}$



Panel D: JPY $\%\Delta marketvalue_{i,t-1}$

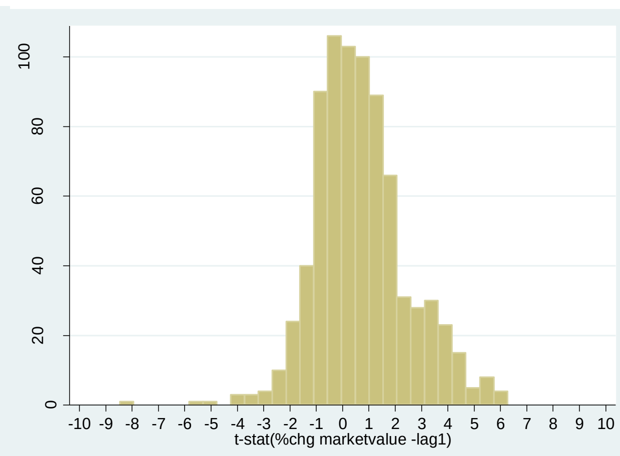
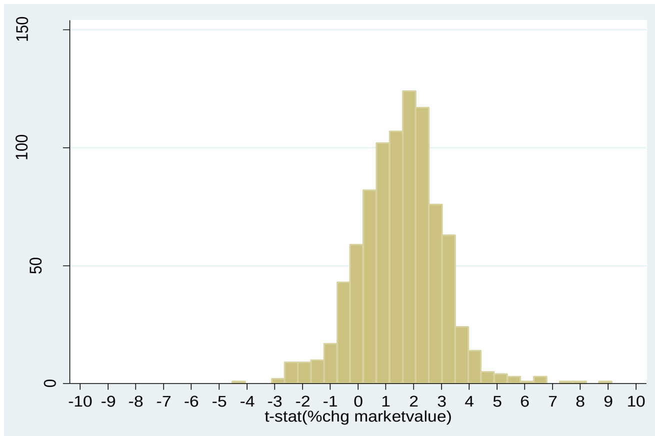
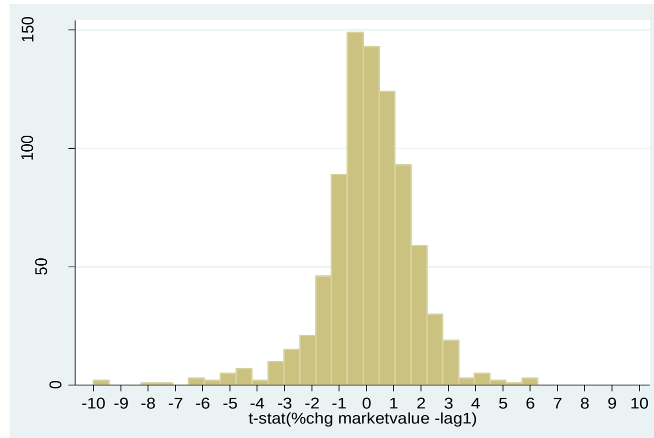


Figure 3.6 - continued

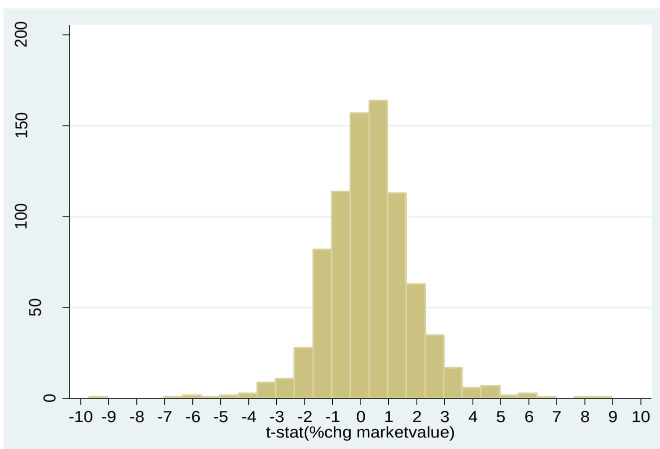
Panel E: EUR $\%\Delta marketvalue_{i,t}$



Panel F: EUR $\%\Delta marketvalue_{i,t-1}$



Panel G: CHF $\%\Delta marketvalue_{i,t}$



Panel H: CHF $\%\Delta marketvalue_{i,t-1}$

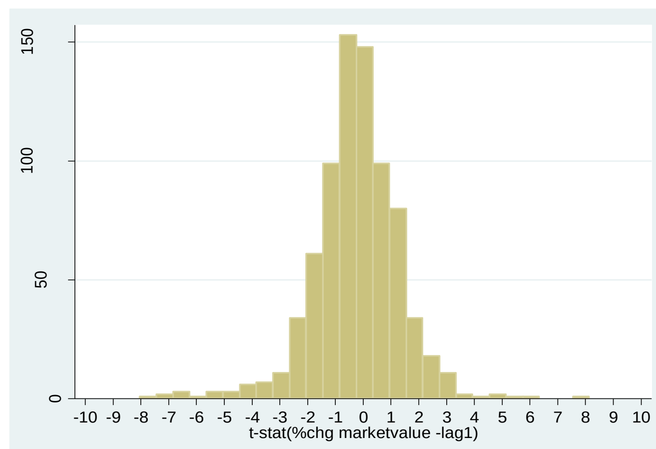
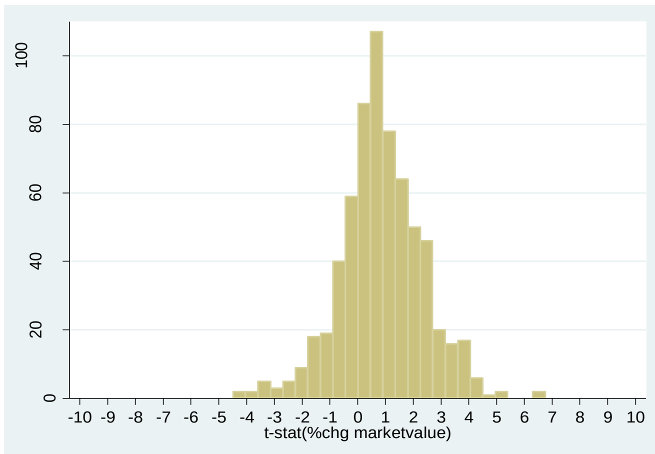
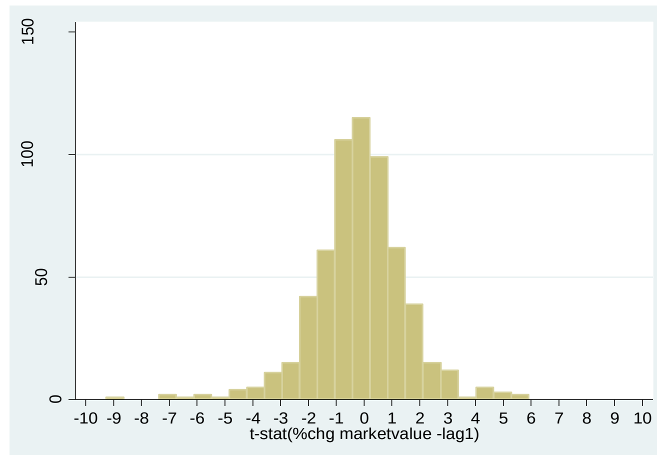


Figure 3.6 - continued

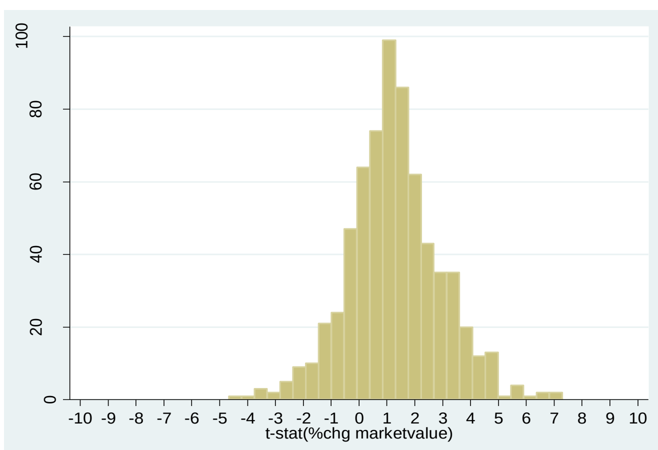
Panel I: CAD $\%\Delta marketvalue_{i,t}$



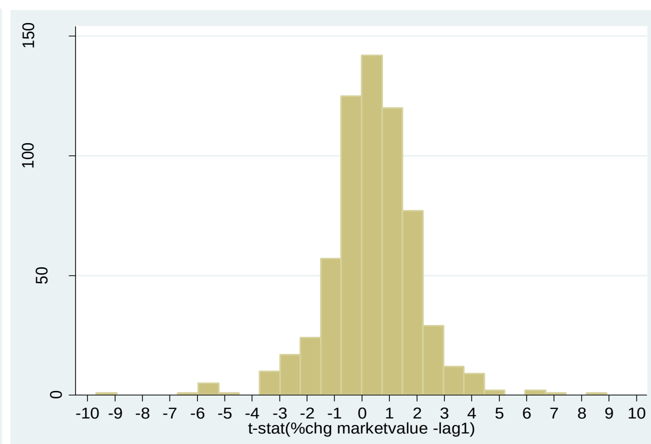
Panel J: CAD $\%\Delta marketvalue_{i,t-1}$



Panel K: KRW $\%\Delta marketvalue_{i,t}$



Panel L: KRW $\%\Delta marketvalue_{i,t-1}$



APPENDIX

Variable	Definition
Acquisitions/ TA	Acquisitions to assets: cash outflows from acquisitions divided by the book value of assets.
Capex	Capital expenditure to assets: capital expenditure divided by the book value of assets.
Capital Issuance	Capital Issuance Dummy: an indicator variable equal to one if net debt issuance is greater than 1% or if net equity issuance is greater than 1%, and zero otherwise.
Cash ratio	Cash ratio: cash holdings scaled by book value of assets
CF/TA	Cash flow to assets: earnings before interest and tax (EBIT) minus interest expense, minus taxes, minus common dividends scaled by the book value of assets.
CR	Concentration Ratio:the percentage of industry sales (market share) concentrated in the top four companies with largest sales.
CR_{high}	High concentration ratio: a dummy variable equal to one if a firm belongs to an industry with a CR between 80% and 100%,corresponding to high concentration industry or low competition.
CR_{low}	Low concentration ratio: a dummy variable equal to one if a firm belongs to an industry with a CR between 0% and 50%,corresponding to low concentration industry or high competition.
CR_{med}	Medium industry concentration: encompasses all other firms.
Depreciation/TA	Depreciation to assets: depreciation expense divided by book value of assets.
Dividend dummy	Dividend dummy: equals one when the company pays common dividends and is zero otherwise.
EBIT/TA	EBIT to assets: earnings before interest and tax divided by total book assets.
FA/TA	Fixed assets to total assets: fixed assets divided by total assets.
Industry σ	Industry sigma is measured as the standard deviation of industry cash flow to assets: for each-firm year the standard deviation of cash flow to assets is calculated for the previous 10 years and these estimates are averaged for each year across two-digit SIC codes.
Lag Dividend	Lag Dividend: dividend dummy lagged one year.
Leverage	Leverage: long term debt divided by book assets.
MB	Market-to-book ratio: book value of asset minus the book value of equity plus the market value of equity scaled by the book value of assets.
MB_{high}	High Market-to-Book ratio: equal to one if MB ratio is higher than the 75th percentile, zero otherwise.
MB_{low}	Low Market-to-Book ratio: equal to one if MB ratio is lower than the 25th percentile, and zero otherwise.
MB_{med}	Medium Market-to-book ratio: all remaining companies.

Variable	Definition
Net debt issuance	Net debt issuance: short term debt for the current year plus long term debt for the current year minus short term deb for the previous year minus long term debt for the previus year, scaled by last year's book assets.
Net equity issuance	Net equity issuance: the difference between the sale of common and preffered stocks and the pruchase of common and preffered stock for the current year, scaled by last year's book assets.
NWC / TA	Net working capital to assets: the difference between current assets and current liabilities minus cash holdings, scaled by the book value of assets.
R&D / TA	R&D to assets: research and development expense scaled by book assets.
RE/TE	Retained Earnings to Total Equity: retained earnings scaled by total equity.
ROA	Return on assets: net income divided by book assets.
Size	Size: the natural log of book assets for a given year.
TE/TA	Total Equity to Total Assets: total common equity to total book assets.
β^{*}_{FX}	The coefficient estimated from the augmented Fama-French model in equation [1]. A firm with negative foreign exchange rate sensitivity or $\beta^*_{FX} < 0$ will have adverse stock price effects as result of U.S. dollar appreciation and benefit from its depreciation. A firm with positive foreign exchange rate sensitivity or $\beta^*_{FX} > 0$ will have adverse stock price effects as result of U.S. dollar depreciation and benefit from its appreciation.
β_{FX}	Foreign exchange rate exposure (fxbeta): the absolute value of the coefficient estimated from the augmented Fama-French model in equation [1]. The augmented FF model is applied to 60-month moving-window regressions with lag of one year every time to allow for potential temporal instability in firm exposure.