Intermediary Based Asset Pricing and the Cross-Sections of Exchange Rate Returns

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September 17, 2018

Abstract

I investigate whether fluctuations in the capital ratio of financial intermediaries provide an economic source of risk for the various cross-sections of exchange rate returns. I find that intermediary capital risk significantly prices the carry trade and the joint cross-section of a variety of currency portfolios, beating out consumption and market factors, thus signifying the relevance of financial intermediaries as a fundamental economic source of global risk. I show that intermediary capital risk is a component of the previously identified high-minus-low (HML) carry factor of Lustig, Roussanov, and Verdelhan (2011), shedding light upon the fundamental economic sources of risk contained within a global risk factor whose interpretation remains ambiguous. In addition, I show that intermediary capital risk serves as a more relevant factor for the pricing of exchange rate risk than the dollar and global dollar factors identified by Verdelhan (2018), shares common variation with the latter, and that the global dollar factor purged of US-specific risk helps price the cross-section of exchange rates. Furthermore, I document the eroded profitability of portfolio based currency strategies following 2010, decomposing returns to show that their performance declined due to compressed relative interest rate differentials and increased exchange rate depreciation.

1 Introduction

Exchange rates have been a long-standing puzzle for researchers in international macroeconomics and finance. Early work by Meese and Rogoff (1983) identified the exchange rate disconnect, namely the failure of empirical models utilizing monetary and macroeconomic fundamentals as regressors in outperforming a random walk in out-of-sample forecasts of exchange rates, despite the use of ex-post realized values that theory suggests should be relevant in exchange rate determination. The uncovered interest parity, one of the main tenets of international finance that dictates exchange rates must adjust to equate returns across countries with differing interest rates, has also failed as Hansen and Hodrick (1980) and Fama (1984) show that currencies with higher interest rates tend to appreciate rather depreciate, contradicting this basic relationship and giving rise to the forward premium puzzle and the profitable carry trade strategy that invests in high interest rate currencies through borrowing in low interest rate currencies. Since the advent of these studies, scholars have been in search of a cohesive explanation and mechanism to address these empirical irregularities that contradict the seemingly well-founded theory.

Recent progress has been made on the theoretical front, introducing the notion of financial intermediaries and shocks into open economy models that help alleviate some of the inconsistencies between the models and data (Gabaix and Maggiori 2015, Itskhoki and Mukhin 2017). The intuition in these models is that empirically consistent exchange rate movements require the presence of constrained agents whose risk-bearing capacities influence exchange rate fluctuations due to their role as the marginal investors holding these assets. Figure 6 displays the composition of foreign exchange volume from the Bank for International Settlements Triennial FX survey (2016) over the past decade and a half. The decomposition shows that an overwhelming portion of exchange rate turnover is attributed to financial institutions, with the latest survey in 2016 showing over 90% of financial institution turnover, supportive of the outsize importance and relevance of financial intermediaries as holders and traders of foreign exchange, as opposed to households which have historically been of focus in the asset pricing literature.

FIGURE 6 HERE

In standard asset pricing theory, the value of an asset is determined by the marginal investor's trade-off between current and future consumption in combination with the asset's prospective cash-flows, where the marginal investor is the agent holding the asset. The relative value of consumption is given by the marginal utility or pricing kernel of this agent, and thus asset prices and expected returns should jointly fluctuate with her marginal utility. Intuitively, assets that provide poor returns when the marginal investor is encountering low consumption, and thus high marginal utility, should provide higher expected returns as otherwise the agent would have no incentive to hold this riskier asset. Traditional asset pricing models have focused on households as the marginal investors, a by-product of representative agent models where households are the sole bearers of assets, and have investigated the relevance of measures of households marginal utility such as consumption growth to test the theory. These models however have generally failed and/or entertain implausible coefficients for risk aversion (Mehra and Prescott 1984, Lustig and Verdelhan 2007).

The outsize importance of financial intermediaries in the trading and holding of financial assets motivates a shift towards the analysis of the marginal utilities and pricing kernels of these more relevant agents in both theory and empirics, suggesting that we must focus on their presumably central role in asset pricing instead of that of households. The recently well-developed closed-economy macro-finance literature has shown that models with realistic time-varying risk premia (Brunnermeier and Sannikov 2014, He and Krishnamurthy 2013, Garleanu and Pedersen 2011) hinge on the presence of constrained financial intermediaries as the marginal investors. The level of constraint of these intermediaries, whether through a measure of their leverage, equity capital ratio, or margin, thus enters in as a state variable and determinant of their marginal utility, and assets are then priced via the following mechanism: when intermediaries are more constrained, their marginal utilities will be high as they would prefer higher consumption or wealth but are unable to borrow or lever up due to their constraint. It is then the covariance of asset returns with these determinants of marginal utility that dictate the size and presence of risk premia as assets that provide poor returns during periods of high constraints and consequently marginal utility must yield larger expected returns to compensate for this downside risk.

This intuition can be extended to foreign exchange markets. When the marginal utility of intermediaries is high, perhaps due to negative shocks that their lower net-worth and constrains their ability to trade or absorb losses, currencies that depreciate are considered risky assets as they lose value during bad times, and should provide higher expected returns to compensate for this downside risk. Similarly currencies that appreciate when intermediaries are more constrained should provide little to no excess returns as they serve as insurance or hedges in the face of adverse shocks. This risk based interpretation of the excess returns of exchange rates motivates the recent risk-based studies of exchange rates and the approach of this paper.

I formally examine the validity of this mechanism by looking at the relevance of fluctuations in the capital ratios of financial intermediaries, examining whether these financial shocks are priced into the cross-section of foreign exchange excess returns across portfolios of various strategies above and beyond other economic factors, namely consumption growth, the broader market's returns, and currency specific factors, namely the high-minus-low (HML) carry factor found by Lustig, Roussanov, and Verdelhan (2011) and the dollar and global factors found by Lustig, Roussanov, and Verdelhan (2014) and Verdelhan (2018). Intuitively when intermediaries have high capital ratios, they should be relatively less constrained as they hold more capital to absorb losses whereas when the capital ratio deteriorates, they have less loss-absorbing capacity and may have to be more conservative in their trading choices, highly valuing assets that still provide returns and provide a reprieve from the loss in capital. While the recent literature has mainly focused on the identification of novel cross-sections of returns and identifying common variation across exchange rates through portfolio based methods, little has been said about the fundamental economic determinants of the sources of risk that drive the heterogeneity in the excess returns of exchange rates. I delineate the relevance of fluctuations in intermediary capital as an economic source of risk embedded in the various cross-sections of foreign exchange returns and assess whether it is distinct from or a merely component of the previously identified risk factors that do not yet have definitive economic interpretations.

I find that intermediary capital risk is a significant risk factor for the pricing of the carry trade and joint cross-section of foreign exchange portfolio returns above and beyond that of consumption growth factors and the broader equity market, namely currencies that more positively co-vary with fluctuations in intermediary capital provide higher excess returns and vice-versa, in line with intuition and providing support for relevance of the risk-bearing capacity of financial intermediaries as an economic source of risk for exchange rates. Intermediary capital fails to emerge as a significantly priced risk factor for its own cross-section of currencies sorted by betas with the intermediary capital shocks and for other cross-sections of currency portfolios such as the dollar, momentum, volatility, and value when tested independently, indicative of either a lack of significant differences in excess returns across dimensions distinct from the carry, or the fact that intermediary capital risk may not be as relevant as other sources of risk for these other cross-sections. Closer inspection of the cross-sections reveals that most currency strategies, including the carry, stagnated from 2010 onwards due to increased exchange rate depreciation and compressed interest rate differentials that eroded returns, supporting the former notion. However when combining all strategies and examining the entire cross-section of all currency portfolios, I again find a significant price of intermediary capital risk. The evidence thus implies that while we may not be able to find a significant price of risk for intermediary capital when examining each cross-section in isolation due to a lack of dispersion in excess returns, pooling the information in all cross-sections identifies the prominence of intermediary capital as a fundamental economic source of risk.

I next show that while intermediary capital risk serves a significant risk factor relative to other proposed economic risk factors, it is subsumed by the portfolio-generated HML carry factor as intermediary capital risk is no longer significant upon inclusion of the significantly priced HML carry risk factor. This finding does not preclude the relevance of intermediary capital risk and in fact clarifies its role in relation to previously identified sources of global risk embedded in the cross-section of exchange rates. The fact that the price of intermediary capital risk is previously significant and subsequently overshadowed by the HML risk factor shows that it may be one source of risk contained within the HML risk factor. Previous studies have shown the relevance of the HML risk factor, but have not yet identified its economic determinants with respect to financial shocks. The results here suggest that HML carry is the dominant risk factor for exchange rates and that intermediary capital shocks are one economic source of risk embedded within it.

In addition to the findings on the interplay of intermediary capital risk with the global risk contained in the HML carry risk factor, I also provide an analysis of its connection with the dollar and global dollar factors of Lustig, Roussanov, and Verdelhan (2014) and Verdelhan (2018). I find that intermediary capital risk maintains its relevance when compared to these two factors and that the relevance of the risk embedded in the dollar factors for the cross-section of exchange rates hinges on the isolation of the global risk embedded in the dollar factors by parsing out the US-specific component of risk. The global dollar factor is significantly priced in the wider cross-section of currency returns, whereas the dollar factor itself, un-purged of US-specific risk, is not.

I proceed to examine whether intermediary capital shocks help explain some component of the HML carry and global dollar factors, given that I hypothesize that intermediary capital risk serves an one economic source of shocks embedded in these two factors, while also exploring the relevance of other economic sources of global economic risk such as consumption growth, risk aversion, volatility, liquidity, US monetary policy, and real economic activity. I find that intermediary risk is both a consistent and robust determinant of the risk embedded within the carry trade, consistent with the economic relevance of intermediary risk for the pricing of foreign exchange. I also document the relevance of proxies for risk aversion, liquidity, and US real activity for carry trade returns in line with previous studies and theory.

The paper proceeds as follows. Section II discusses where this paper lies in the broader literature. Section III describes the core data, portfolio construction methodology, various summary statistics, and a discussion of the eroded profitability of systematic currency strategies following 2010. Section IV outlines the regression specifications and displays and discusses the empirical results. Section V concludes.

2 Literature Review

This paper relates to a few strands of literature, most notably that on intermediary based asset pricing and the portfolio, risk-based studies of exchange rates. More broadly it leans on intuition coming from recent international general equilibrium models including finanical shocks and intermediaries.

The notion of intermediary based asset pricing has been identified and tested by previous researchers, but a deeper examination of its relevance in exchange rates has not. Adrian, Etula, and Muir (2014) were the first to empirically test its performance in asset pricing, using the leverage of the US broker dealer sector as the proxy for the marginal value of wealth of financial intermediaries, and finding significant prices of intermediary risk for excess returns on various portfolios US equities and bonds, and out-performance in a variety of other metrics, above and beyond that of mainstream asset pricing models. He, Kelly, and Manela (2017) perform a more expansive assessment, constructing their proxy for the marginal value of wealth of intermediaries via the net worth, or capital ratio, of primary dealers with the New York Fed, and testing their factor on stocks, bonds, CDS, exchange rates, and commodities, finding a significant risk price of intermediary capital. It is important to note that these two seminal papers have conflicting findings, as Adrian, Etula, and Muir (2014) find evidence for pro-cyclical leverage and a positive price of intermediary leverage risk, whereas He, Kelly, and Manela (2017) find evidence for counter-cyclical leverage and a positive price of intermediary capital risk, contradictory as leverage should simply be the inverse of the capital ratio thus the prices of risk should be inverted as well. While macro-finance models can generate both results depending on whether the intermediary has an debt or equity constraint respectively, I follow He, Kelly, Manela (2017) as their measure of intermediary shocks is available at the monthly level in contrast to the quarterly frequency of the leverage measure from Adrian, Etula, and Muir (2014). My paper departs from both by shifting focus primarily to the foreign exchange market and studying the relevance and interplay of intermediary shocks against that of previously established risk factors in the empirical foreign exchange asset pricing literature, in search of an economic interpretation of the global shocks that affect foreign exchange returns.

Adrian, Etula, and Shin (2015) show that measures of short-term US dollar funding, namely primary dealer repos and commercial paper outstanding, forecast appreciations of the dollar, and estimate a dynamic asset pricing model following Adrian, Crump, and Moench (2015) to find significant prices of carry and short-term dollar funding risk for the entire cross-section of individual currency excess returns. I deviate from their work by focusing on test portfolios of foreign exchange returns and uncovering whether there is a distinct cross-section of intermediary risk-based currency returns. I also link the intermediary shocks back to their relationship with the HML carry and global dollar factors.

The empirical international finance literature on exchange rates has shifted towards portfolio based tests of risk premia and the identification of novel cross-sections of currency excess returns.

This was first applied by Lustig and Verdelhan (2007) who form portfolios of currencies based on their interest rate differentials and go on to find significant prices of consumption risk in the cross-section of exchange rate returns, arguing that exposure to US consumption risk explain the carry trade and the forward premium puzzle. Lustig, Roussanov, and Verdelhan (2011) continue this approach, finding that the cross-section of currency excess returns are driven by two factors, namely a level and slope factor, the former being the average level of the dollar, and the latter being the difference in excess returns of high and low interest rate currency portfolios. They show that sorting currencies by their forward discounts as a proxy for interest rate differentials leads to a monotonic relationship in excess returns by portfolio, and identify the high-minus-low (HML) carry risk factor, culminating in an affine model of exchange rates in the vein of Backus, Foresi, and Telmer (2001), that identifies the necessity of heterogeneous loadings on a global factor, which is proxied by the HML carry factor, to generate the carry cross-section of currency excess returns.

The level or dollar factor is explored in subsequent papers, Lustig, Roussanov, and Verdelhan (2014) and Verdelhan (2017), that identify cross-sections of currency returns distinct from the carry trade hinged on going long foreign currencies and short the US dollar when the average forward discount is positive, with the risk being the depreciation of foreign currencies when bad shocks hit precisely when US volatility and thus US investor marginal utility is high. Verdelhan (2018) highlights the share of systematic variation in bilateral exchange rates, noting the outsize importance of the average change in the US dollar against all foreign currencies in the explained variation of exchange rate movements, identifies a separate cross-section based on heterogeneous co-movements with the average level of the dollar, namely dollar betas, and establishes the notion of a global dollar factor by taking the high minus low of dollar beta sorted portfolio excess returns to isolate the global risk factor driving this separate cross-section that is purged of US-specific risk.

I borrow from and build upon this line of papers by forming portfolios of currencies as test assets, sorted by forward discounts as in Lustig, Roussanov, and Verdelhan (2011), dollar betas as in Verdelhan (2018), and a variety of other cross-sections previously identified in the literature (Asness, Moskowitz, and Pedersen (2013), Menkhoff et al. 2011, 2012), and utilize the identified risk factors, namely the HML carry, dollar, and global dollar factors to compare to the intermediary capital shocks. My goal is similar to theirs in the sense of trying to find another cross-section of currency returns and risk, but also complements their work as I examine the interplay between the intermediary shocks and their identified factors, and cross-sections of portfolio returns. More importantly, given their portfolio based approach at identifying risk factors, their papers do not explicitly identify the economic source of the shocks contained within the HML carry and dollar risk factors or an explanation of the heterogeneous loadings on these shocks in the lens of their affine exchange rate models. Lustig and Verdelhan (2007), Hassan (2013), Ready, Roussanov, and Ward (2015), Richmond (2016), and Jiang (2018) provide a variety of explanations for the cross-section of carry trade returns due to consumption risk, country size, commodity exporters, trade networks, and fiscal risks, respectively, and I look to add to this literature by examining whether intermediary capital risk can also provide an economic explanation of the carry trade. The economic interpretations behind dollar betas and the shocks contained in the dollar and global dollar factors are less widely studied and I approach both from the lens of financial intermediaries.

The empirical intermediary based asset pricing is based on the closed economy macro-finance literature, which hinges upon the existence of constrained financial intermediaries, but this has also been explored in the open economy setting. Brunnermeier and Sannikov (2014), He Krishnamurthy (2013), Danielsson, Shin, and Zigrand (2011), Adrian and Boyarchenko (2012), Garleanu and Pedersen (2011), Brunnermeier and Pedersen (2009) contain macro-finance models with constrained intermediaries, whose relative risk-bearing capacities, net worth, and/or leverage matter for the behavior of risk premia and thus asset prices. This has been extended to the open economy, primarily in Gabaix and Maggiori (2015) who show that an open economy model with a constrained global financier/bank that intermediates all international bond trades produces intuitive exchange rate movements that emphasize the role of the risk-bearing capacity of financial intermediaries and portfolio flows in exchange rate determination. Their paper also contains theoretical predictions regarding the carry trade and the risk-bearing capacity of financial intermediaries, which I confirm in both asset pricing and standard regression tests. Itskhoki and Mukhin (2017) emphasize the role of financial shocks in general equilibrium open economy models to produce empirically consistent exchange rate movements. This paper seeks to validate the role of financial intermediaries for consistent exchange rate behavior by measuring whether risks emanating from their existence can account for the cross-sectional heterogeneity in excess returns across currencies. I however abstract from writing down a full structural open economy model with constrained financial intermediaries, leaving that open to future research.

3 Data

3.1 Currencies

I obtain daily spot and forward data from Datastream, combining Barclays and WM/Reuters data as the former extends farther back but with less currencies, whereas the latter contains the more currencies. To remain consistent with previous studies, I splice the datasets in January 1997, namely I use Barclays data prior this date and only WM/Reuters data after. I obtain an end-of-the-month series for each currency from January 1983 to March 2018 subject to availability. All spot and forward rates are expressed in US dollars, or quoted as foreign currency units per dollar. The dataset covers the following countries: Australia, Austria, Belgium, Canada, Hong Kong, Czech Republic, Denmark, euro area, Finland, France, Germany, Greece, Hong Kong, Hungary, India, Indonesia, Ireland, Italy, Japan, Kuwait, Malaysia, Mexico, Netherlands, New Zealand, Norway Philippines, Poland, Portugal, Saudi Arabia, Singapore, South Africa, South Korea, Spain, Sweden, Switzerland, Taiwan, Thailand, Turkey, the United Arab Emirates, and the United Kingdom. Countries that adopted the euro are kept until January 1999, and I contrast with the existing literature by omitting the pegged currencies, Hong Kong, Saudi Arabia, and the United Arab Emirates. My results are robust to the inclusion of the pegged currencies.

To remain consistent with the previous literature, I delete observations as in Lustig, Verdelhan, and Roussanov (2011) and corresponding papers due to large failures of covered interest parity: South Africa from July 1985 to August 1985, Malaysia from August 1998 to June 2005, Indonesia from December 2005 to May 2007, Turkey from October 2000 to November 2001, and United Arab Emirates from June 2006 to November 2006. Note that since the financial crisis there have been widespread deviations in covered interest parity (Du, Tepper, Verdelhan 2017), but I abstain from deleting observations in the latter part of the sample given the prevalence of deviations for most developed countries.

3.2 Intermediary Capital Shocks

I obtain data on the equity capital ratio of financial intermediaries and the corresponding shocks directly from He, Kelly, and Manela (2017), available at both monthly and quarterly frequencies. They obtain the set of primary dealers vis-à-vis the New York Fed, namely the financial intermediaries that trade directly with the Federal Reserve in open market operations, from the NY Fed's website. They then hand-match these dealers to data on their public holding companies from CRSP, Compustat and Datastream in order to construct the aggregate primary dealer capital ratio:

$$\eta_t = \frac{\sum_i MarketEquity_{i,t}}{\sum_i \left(MarketEquity_{i,t} + BookDebt_{i,t}\right)}$$

where $MarketEquity_{i,t}$ is the share price times number of shares outstanding on the last day of the quarter and $BookDebt_{i,t}$ is total assets less common equity.

Note that the capital ratios aggregate and thus value weight capital ratios rather than average across dealers. Although the ideal would be to weight each dealer by their relative share of intermediation in each respective asset, my case being foreign exchange, this data is not readily available and thus the value weighting serves as second best under the implicit assumption that dealers with larger values of market equity intermediate relatively more in volume.

To obtain the capital ratio shocks, He, Kelly and Manela (2017) estimate a first order auto-regression on the capital ratio series and take the residual as the shock. Formally:

$$\eta_t = \rho_0 + \rho\eta_{t-1} + u_t$$

The shock is then scaled to obtain a growth rate:

$$CShock_t = u_t/\eta_{t-1}$$

Figure 2 plots the equity capital ratio and capital shock series. We observe that equity capital ratios tend to be pro-cyclical, in line with the intuition that bad shocks to intermediary capital coincide with bad times and higher values of marginal utility.

FIGURE 2 HERE

Table 1 displays the summary statistics for both the level of intermediary capital ratio and capital shocks. We observe that intermediaries on average have 6.3% of capital to assets, ranging from as high as 13.4% in 1998 to a low of 2.2% in the midst of the Global Financial Crisis in 2009. Shocks to the capital ratio, as measured by the scaled residual of an autoregressive model, are our primary variables of interest. The series appears stationary, with a mean of .001, but is volatile, ranging from as low as -.28 to .4, with a standard deviation of .068. Economically, these suggest that the largest negative shock reduced the intermediary capital ratio by almost a third of its previous value and a one-standard deviation shock is causes the capital ratio to fluctuate by 7%.

TABLE 1 HERE

Given that most of the following analysis will be done at the monthly level, it is important to note that most of the variation in the intermediary capital ratio and shock will come solely from fluctuations in the market value of equity, as balance sheet data is only available at the quarterly frequency at best. To show that these intermediary shocks are not solely coming from broad stock market fluctuations, I compute correlations of the intermediary capital shock series with the returns of the S&P 500 financials only, excluding financials indices, and the Fama-French global market. Looking at the correlations in Table 2, it is apparent that 1) intermediary capital shocks coincide with fluctuations in the financials sector of the S&P 500 and 2) these shocks are not overwhelming correlated with the broader market, suggestive of some orthogonality in terms of shocks. In other words, some of the variation in the intermediary shock series comes from shocks solely affecting the risk-bearing capacity of financial intermediaries, rather than the entire economy and market.

Table 2 HERE

3.3 Excess Returns

Let s_t and f_t denote the log spot and forward rates respectively, both defined in foreign currency units per dollar. An increase denotes an appreciation of the dollar and depreciation of the foreign currency in question. Buying or going long a currency by engaging in a forward contract today and selling it tomorrow yields a log excess return of:

$$RX_{t+1} = f_t - s_{t+1}$$

Note that we can decompose this return into gains stemming from exchange rate movements and, if covered interest parity holds, interest rate movements:

$$RX_{t+1} = f_t - s_t + s_t - s_{t+1} \approx i_t^* - i_t - \Delta s_{t+1}$$

The log excess return is thus approximately the interest rate differential less exchange rate depreciation.

Portfolio Construction

As pioneered by Lustig and Verdelhan (2007) for foreign exchange, who were influenced by Fama-French (1993) and the subsequent empirical asset pricing literature, recent studies in the international finance literature have focused on using portfolio methods to identify and explain cross-sections of currency returns. Currencies are ranked and sorted into portfolios based on some country-specific characteristic such as their forward discount or exposure to some factor, analogous to sorting equities on size or book-to-market ratios, upon which one takes the average excess returns of the currencies in each portfolio. The main benefit of this approach is that the averaging of multiple currencies in each portfolio should purge each portfolio of country-specific idiosyncratic shocks and isolate the variation in excess returns due solely to the criterion of the portfolio sorts and thus relative exposure to a source of risk, with the main drawback being the sharp decrease in sample size.

This paper adopts the portfolio construction approach and constructs a variety of test asset portfolios for currencies in order to examine whether intermediary capital shocks price these various cross-sections and the broader cross-section of currencies overall, and reveal their own cross-section of excess returns.

Intermediary Capital Shock Portfolios

In order to determine whether exposure to intermediary shocks constitute an independent cross-section of returns, I construct portfolios of currencies sorted by "intermediary capital shock" betas. I obtain the latter by running the following 36-month rolling window regression:

$$RX_{i,t} = \alpha_i + \beta_i^{CS} CShock_t + \epsilon_{i,t}$$

I sort currencies based on their time-varying co-movements with the intermediary shocks, $\beta_{i,t}^{CS}$, estimated via rolling regressions, and form six portfolios based on these sensitivities. Intuitively, the high portfolio contains currencies that provide poor returns that coincide with poor intermediary shocks, whereas the low portfolio contains currencies that are appreciate upon realizations of bad shocks. If the intermediary shocks capture a significant risk factor, then we should observe a monotonic relationship between exposures to the risk factor and excess returns. I examine this formally both via summary statistics and asset pricing tests shortly.

High-Minus-Low (HML) Carry Portfolios and Factor

A commonly known, yet puzzling trading strategy has been the carry trade, namely going long or purchasing the currencies of countries with high interest rates, typically the Australian and New Zealand dollars, while funding these investments by shorting or selling currencies of countries with lower interest rates, such as the Japanese yen and Swiss franc. The carry trade has been predicated on failures of the uncovered interest parity, as theory suggests that higher interest rate countries' currencies should depreciate sufficiently to offset interest rate differentials and equate returns across currencies, a prediction inconsistent with the data.

To generate the cross-section of portfolios that represent the carry trade, I follow Lustig, Roussanov, and Verdelhan (2011) and sort currencies by their forward discounts, $f_t - s_t$. Recall that if covered interest parity holds, this is approximately equal to the interest rate differential against the dollar, namely $f_t - s_t \approx i_t^* - i_t$, and thus sorting currencies by forward discounts is essentially sorting by interest rates. I split the currencies into 6 portfolios so that the first portfolio contains the lowest interest rate currencies, while the sixth portfolio contains the highest interest rate currencies.

To obtain the HML carry risk factor, I take the difference in the excess returns between the top and bottom portfolios, which is equivalent to going long high interest currencies by shorting low interest currencies. This is a zero-cost investment that exploits the cross-sectional variation in excess returns contingent on interest differentials and isolates the excess return given if one were to have full exposure to the risk factor embodied in the cross-section of carry trade returns. An investor that is long the carry trade is compensated for taking on the risk that when bad shocks are realized, currencies with high interest rates tend to depreciate, while those with low interest rates tend to appreciate, thus providing poor returns to the strategy during bad times, rationalizing higher expected returns at all other times as compensation for this downside risk.

Dollar Portfolios and Global Dollar Factor

Verdelhan (2018) identifies an additional risk factor and cross-section of currency excess returns, distinct from that of the traditional carry trade. He first estimates the co-movement of each currency's spot exchange rate changes with the average spot rate changes of all currencies against the dollar, obtaining each currency's dollar beta. He then sorts currencies into six portfolios based on these dollar betas, generating a cross-section of currency portfolios with monotonically increasing levels of co-movement with the average of movements in the dollar, which he argues is also monotonically increasing in excess returns. The portfolios sorted by dollar betas are what I call the dollar portfolios.

Similar to Verdelhan (2018), the dollar portfolios are obtained by first running 36-month window rolling regressions of the excess return of a specific currency against average excess return of going long all foreign currencies and shorting the dollar. I depart from his construction as I find the strategy constructed from the univariate specification on excess returns to be more profitable, but both strategies have the same interpretation - high dollar beta currencies provide higher returns when the dollar on average depreciates and vice versa. Thus high dollar beta currencies are those whose excess returns are most sensitive to average changes in the dollar as they depreciate by more than low dollar beta currencies when shocks that appreciate the dollar are realized. Formally for each currency I run:

$$RX_{i,t} = \alpha_i + \beta_i^{DOL} DolRX_t + \epsilon_{i,t}$$

With the rolling regressions, I obtain a set of time-varying dollar betas, $\beta_{i,t}^{DOL}$ for each currency, i, which I use to sort currencies into six portfolios whose excess returns are the average of the excess returns of the currencies contained in each. Furthermore, following Verdelhan (2018), I condition these portfolios by shorting portfolios if the average forward discount of advanced economies is negative as forward discounts contain information about future returns (Hassan and Mano 2017).

To obtain the global dollar factor, I take the difference between the high and low dollar beta portfolios to obtain a zero-cost investment that goes long high dollar beta currencies and short dollar beta currencies. Differencing the two dollar portfolios purges the US-specific information component of the dollar factor if we assume that all portfolios equally load onto US specific risk, and isolates the global risk factor differentially exposed to in the cross-section of dollar-beta sorted currencies.[1] Note that in contrast to the dollar strategy itself, I do not take into account going long or short depending on the average level of forward discounts in order to omit information contained in the average forward discounts and isolate the shocks that solely affect average excess returns against the dollar. Although slightly more nuanced, the risk embodied in these portfolios is that when shocks occur that cause the dollar to appreciate, high dollar beta currencies tend to depreciate more than low dollar beta currencies, and thus going long the former and short the latter as a zero-cost strategy bears the risk of poor returns in times of dollar appreciation and justifies higher expected returns at all other times.

[1] Verdelhan (2018) provides a full affine model that illustrates this mechanism formally.

Momentum Portfolios

I construct a set of momentum portfolios, following Menkhoff et al. (2011). Currencies are ranked based on their excess returns in the previous month, with the idea being that winners continue their out-performance while losers extend their losses. I construct six portfolios as in the other cases with the highest portfolio containing the currencies that have the highest lagged excess returns and vice-versa for the lowest portfolio. A momentum factor can also be extracted as in the previous cases by taking the difference between the high and low portfolios, forming a zero-cost strategy that goes long previously well-performing currencies and short poor performers.

Volatility Portfolios

Menkhoff et al. (2012) examine the carry trade from the perspective of foreign exchange volatility, positing that carry trade returns are rationalized because it performs poorly during bouts of high volatility. I construct a measure of monthly foreign exchange volatility as in their paper:

$$\sigma_t^{FX} = \frac{1}{T_t} \sum_{\tau \in T_t} \left[\sum_{i \in N_\tau} \left(\frac{|\Delta s_{\tau,i}|}{N_\tau} \right) \right]$$

Monthly foreign exchange volatility is equal to the daily average of absolute daily log returns, averaged over all trading days in a given month. Volatility-sorted portfolios are then constructed by regressing each currency's excess returns on the residuals of an AR(1) model of the σ_t^{FX} series and sorting currencies by their past β_t^{vol} in a series of rolling regressions.

Currencies with the most positive covariances with volatility innovations should yield low excess returns as they can be viewed as a hedges against volatility that give high returns at times when volatility is high. On the other hand, currencies with little or no covariance with volatility should yield higher excess returns as they serve as risky assets that may pay off poorly when volatility is elevated. Note then that the pattern of excess returns and high-minus-low are constructed opposite all of the other portfolios, as the "high" portfolio here is now the one with the lowest exposure.

Value Portfolios

Lastly, I construct currency value portfolios as in Asness, Moskowitz, and Pedersen (2013). Currencies are sorted by their value, computed as the 5-year change in purchasing power parity given by the negative ratio of the log average spot rate from 4.5 to 5.5 years ago and the log spot rate today less the difference in inflation between the foreign country and the US, as measured by changes in the CPI.

The intuition is that currencies with large increases in their PPP have become more undervalued because higher PPP's, equivalent to real exchange rates, imply that the domestic currency is too weak given the relative price levels. The domestic currency eventually needs to appreciate against the dollar in order to push the real exchange rate back to unity and equate purchasing power across currencies, hence investing in the currency now provides good value as it will eventually appreciate and yield higher excess returns down the line.

Note that the construction of these portfolios differs from Asness, Moskowitz, and Pedersen (2013) as we do not focus only on G10 currencies and generate a larger number of portfolios, namely six versus their three.

3.4 Portfolio Summary Statistics

Table 3 displays summary statistics for each of the portfolios described in the previous sections. Moments are annualized and in percentage terms, namely means are multiplied by 12, whereas standard deviations are multiplied by $\sqrt{12}$. I display each portfolio's mean excess return, standard deviation, and Sharpe ratio to elucidate which strategies appear to be the most profitable before conducting the formal asset pricing tests.

The intermediary capital shock portfolios do not display monotonically increasing mean excess returns, but suggest profitability. The top portfolio indeed yields the highest mean return of 2.4%, whereas the bottom portfolio yields a negative return of -1.3%. Combined, a high minus low portfolio of going long the top and short the bottom portfolio appears mildly profitable, with a mean excess return of 3.5% per annum and a Sharpe ratio of .38. However given the lack of a discernible pattern in mean excess returns across portfolios, it is unlikely that intermediary capital shocks constitute their own cross-section.

The carry and momentum portfolios are almost and definitely monotonically increasing in returns across portfolios respectively, with the high minus low, or zero-cost-investment, strategies yielding mean excess returns of 7.1% and 6.1% per annum. The pattern of increasing mean excess returns supports the existence of a risk-based explanation of foreign exchange returns as it shows that currencies with higher forward discounts or larger previous momentum, both of which implicitly proxy for larger exposures to some source of global risk, grant higher mean excess returns as compensation for greater risk exposure. With Sharpe ratios of .69 and .52 respectively, these strategies appear profitable with decent risk-to-return trade-offs.

For the dollar portfolios, we almost have a monotonic increase in excess returns as we move along portfolios with larger dollar exposure, with the exception of the outsize return in the second highest portfolio. Note that these portfolios are conditional on the average forward discount, namely they are dynamic as I choose whether to go long or short the currencies against the dollar depending on if the average forward discount is positive or negative respectively. The top portfolio has a mean excess return of 4.2%, while the high-minus-low yields 3.6% per annum with a Sharpe ratio of .34. Note that in contrast to the carry and momentum portfolios, the high-minus-low does worse than simply going long the top portfolio as shorting the bottom portfolio does not yield additional returns.

The lowest of the volatility portfolios containing currencies that are least exposed to foreign exchange volatility exhibit the highest returns compared to those that are relatively more exposed. This is in line with intuition as the currencies in the high portfolio tend to provide higher returns when volatility is high, and thus serve as insurance or a hedge that should yield lower excess returns at all other times. The low minus high yields a mean excess return of 3% with a Sharpe ratio of .31, improving upon the return of only the low portfolio due to the shorting of the high portfolio.

Finally for the value portfolios, while we do not obtain a strict monotonic pattern in excess returns, we observe a significant spread between the high and low portfolios. The best value portfolio yields a mean excess return of 3.6% per annum, while the worst value portfolio performs poorly with a mean loss of 2.9% per annum. The high-minus-low thus provides significant mean excess returns at 5.8% and a Sharpe ratio of .51, comparable to the momentum cross-section.

Table 3 Here

Figure 3 Here

Figure 3 displays the cumulative returns from investing $1 in each portfolio. As was suggested by the summary statistics, an investor would have increased their initial investments to under $10 and a little over $6 if following the carry trade and momentum high-minus-low strategies respectively. Furthermore for the cross-section of carry and momentum portfolios, the cumulative returns appear to almost be monotonically increasing across portfolios, in line with the summary statistics. These build support for the existence of a a risk-based explanation to the cross-sectional returns as it appears that increased loadings or exposure to potential risk factors and shocks lead to consistently improved returns.

Cumulative returns to the dollar strategy are less impressive, as the initial outlay increases to a little less than three-fold by 2014 before persistently declining since then. An investor would be better off only going long the top portfolios as indicated by their larger cumulative and excess returns without shorting the bottom portfolio, which recall has positive mean excess returns and erode profitability. All portfolios however decline from 2015 onwards, presumably due to dollar appreciation.

The intermediary capital portfolios do not display monotonicity in terms of cumulative returns, but the high-minus-low portfolio does steadily increased the initial outlay 2.5 times over the sample period. The cumulative return peaks in 2015 before sharply dropping and stagnating since then. The volatility portfolios display mild capital gains up until 2009 in which we observe a sharp drop for all portfolios other. There is a recovery following this sharp drop, but returns essentially stagnate from then on.

Cumulative returns from the value strategy appear consistently profitable, although not to the magnitude of the carry and momentum strategies. An initial investment increases four fold by the end of the sample, but note the periods of persistently declines, most notably from 2004 to 2007, 2010 to 2012, and 2014 to 2015. In contrast to all other strategies, the value strategy is unique in consistently being profitable over the past 3 years.

3.5 Eroded Profitability of FX Strategies

As was hinted in the cumulative return plots, nearly all of the currency strategies other than value do not appear to be profitable after 2010, as cumulative returns very marginally increase, stagnate, or fall altogether. I examine the decomposed returns of each cross-section to identify the key drivers of excess returns and how they change after 2010. I find that exchange rate strategies decline in profitability due to a combination of compressed interest rate differentials and relative dollar appreciation from 2010 onwards. A more detailed discussion with the full set of decompositions by portfolio, is relegated to the appendix.

Table 4 displays the high-minus-low returns for each of the currency strategies, decomposed into the attribution from the forward discount, or equivalently interest rate differential, and exchange rate movements. It is evident that mean excess returns are higher before 2010, with some strategies such as the dollar, momentum, and volatility providing mean losses providing dismal performance from 2010 onwards.

Table 4 Here

The intermediary capital strategy initially generates excess returns through a combination of carry at 3.6% and relative exchange rate appreciation of 1%. Note that these returns are attributed to the differences in forward discounts and exchange rate movements between the top and bottom portfolios, namely the high intermediary capital shock beta currencies on average had a 3.6% spread in the forward discount over the bottom, and on average appreciated relative to the bottom currencies, yielding a pre-2010 mean excess return of 4.6%.

In panel B, observe that both the forward discount/carry spread has declined to 1% and that the high currencies now depreciate relative to the bottom currencies, eroding returns by .5%. It is thus apparent that the intermediary capital shock strategy has experienced decreased mean excess returns due to a combination of interest rate differential compression and unfavorable spot exchange rate movements.

The carry exhibits the same decline in mean excess returns due to a compression of interest rate spreads. Before 2010, the bulk of the profitability of the carry trade stemmed from outsize interest rate differentials as indicated by a difference in average forward discounts of 15.2%. This was offset by 6.1% of exchange rate depreciation of the top carry currencies relative to the bottom, yielding a mean excess return of 9.1% per annum. As with the intermediary capital strategy, the excess return attributed to the difference in forward discounts, or equivalently the carry component, declined from 2010 onwards, decreasing by over half to 7.2% per annum. Relative spot exchange rate movements remained relatively similar, and thus it appears that the carry trade has declined primarily due to a compression of interest rate differentials, which may be attributed to broad central bank easing following the Global Financial Crisis and the corresponding low-interest rate monetary policy regimes.

The dollar strategy attributes most of its excess returns to favorable exchange rate movements. The bulk of profits stem from the appreciation of high to low dollar beta currencies, at 3.6% before 2010, which in combination to a 1.4% carry yielded a 5.1% mean excess return. However from 2010 onwards, the high dollar beta currencies on average depreciated by more than their low equivalents, eroding returns by 1.9% rather than contributing to them, leaving a mean loss of .5%. Given the relative stability of the difference in average forward discounts, it is apparent that the dollar strategy suffered mainly due to broad based currency depreciation that affected high dollar beta currencies by more than their low counterparts.

Before 2010, the momentum strategy benefits from a combination of exchange rate movements and carry, with the former generating 4.8% and the latter adding 3.7% to yield mean excess returns of 8.5% per annum. Following 2010, both components decline as the strategy faces compressed relative interest rate differentials at .3%, and exchange rate depreciation at 1.8% as opposed to the previous appreciation that generated over half of mean excess returns, resulting in very poor post-2010 mean excess returns at -1.6% per annum. This strategy thus suffers due to a combination of lower carry and relative depreciation.

The volatility strategy erodes primarily due to relative exchange rate depreciation. While relative carry decreased from 3.8% to 2.9%, the decline in mean excess returns is mainly due to the shift of low volatility beta currencies from appreciating relative to the high beta currencies, to depreciating by 2.9%.[2] The carry and spot rate components thus nullify each other and yield a mean excess return of 0% in the post-2010 period.

Value is the only strategy that retains some semblance of profitability following 2010. The strategy mainly derives its profits from favorable exchange rate appreciation, consistent with intuition as high value currencies are precisely those that are undervalued and expected to appreciate over time. Before 2010, the high value currency portfolio on average appreciates by 8.2% relative to the low value portfolio, and while this does decline to 6.2% in the post 2010, relative appreciation remains a positive contributor to the value strategy's mean excess returns.

The carry component detracts from value strategy returns in both partitions of the sample. Consistent with previous findings relative forward discounts decreased from -1.8% to -2.1% in the pre- and post-2010 periods, both of which dampened returns. Value profitability however remained robust due to the outsize contribution of favorable exchange rate movements, yielding mean excess returns of 6.4% and 4.1% in the pre- and post- periods, respectively.

It is thus apparent that all currency strategies have declined in profitability from the recent period following the Global Financial Crisis. Strategies whose returns relied heavily on the carry component, namely the intermediary capital shock, carry, and momentum strategies, suffered due to compressed relative interest rate differentials as proxied by forward discounts, whereas all strategies faced decreased profitability due to unfavorable spot exchange rate movements. In particular, the dollar, momentum, and volatility strategies faced relative portfolio depreciation in contrast to previously beneficial mean portfolio appreciation, resulting in poor returns in the past decade. The value strategy is unique in remaining profitable in the recent period, deriving the bulk of its returns from relative currency appreciation and containing negative carry throughout.

My results suggest that global low interest rate monetary policies may have been responsible for the steep declines in systematic exchange rate strategies in combination with broad based dollar appreciation that yielded unfavorable relative currency depreciation. Given the eroded profitability of exchange rate strategies, I reiterate that the lack of identification of significant risk prices may

[2]Recall that for the volatility strategy, the "high" currencies, namely those that outperform, are actually those with lower betas.

be due to compressed returns in the recent period.

4 Empirical Results

4.1 Spot Changes and Intermediary Shocks

I first examine whether intermediary capital shocks contain any information content above and beyond that of the HML carry and dollar factors. Recall that the former takes the difference between exchange rate changes of the currencies with the largest and smallest forward discounts, which approximate the interest rate differentials, while the latter reflects the average of all exchange rate changes. Formally I run the following country by country:

$$\Delta s_{i,t} = \alpha_i + \beta_i^{HML} HML_{-i,t} + \beta_i^{DOL} Dol_{-i,t} + \beta_i^{CS} CShock_t + \epsilon_{i,t} \tag{1}$$

Note that $HML_{-i,t}$ and $Dol_{-i,t}$ exclude the country on the left-hand-side to avoid regressing on the same variable. This regression estimates the size and direction of exchange rate movements with respect to systematic variations. For example, if the dollar on average appreciates by a 1%, β_i^{DOL} yields the amount country i's currency depreciates in percentage terms.

The results for the G11 currencies are displayed in Table 5. Column (1) displays the sensitivities of exchange rate movements to the carry trade. We observe a positive co-movement of traditionally risky currencies, such as the Australian and New Zealand dollars, with that of the carry trade, namely when the carry trade appreciates, these currencies do as well, in line with intuition. Similarly for traditional safe haven, low interest currencies such as the Japanese yen and Swiss franc, we observe negative coefficients, suggesting that these currencies appreciate when the carry trade is depreciating.

Table 5 Here

Column (2) displays the systematic co-movements of currencies with the average changes of the dollar. Here we observe that all coefficients are robustly significant and positive, expected given that we are looking at bilateral exchange rates vis-a-vis the dollar. The heterogeneity of the coefficients around 1 is of interest, as observe that Australia, Canada, the United Kingdom, Japan, and New Zealand each depreciate less than one-for-one with the average depreciation against the dollar, while Switzerland, Denmark, Europe, Norway, and Sweden depreciate by more than the average. There appears to be no commonality for why these currencies move less than the average, but this is open to future research.

My contribution is the addition of the intermediary capital shock and the corresponding elasticities. We observe that the Australian, Canadian, and New Zealand dollars all have significant and negative coefficients. Recall that a negative intermediary capital shock means a decrease in their equity capital ratio, which is suggestive of tighter financial conditions and times of higher marginal utility. When primary dealers are hit with negative shocks, the aforementioned currencies tend to depreciate, in line with their reputation as riskier currencies as they yield poor returns when intermediaries need them most. In terms of economic magnitude, a one standard deviation intermediary capital shock is associated with approximately a half of a percent in depreciation. In contrast, if we instead look at the haven currencies, namely the Japanese yen and Swiss franc, we observe positive coefficients, with economic magnitudes of a quarter and half a percent appreciation respectively. Consistent with intuition, safe haven currencies tend to appreciate when bad shocks hit.

Columns (4)–(6) display the R^2's of the regressions with only the HML, HML and intermediary capital shock, and the full specification. We can see that the intermediary capital shock adds some explained variation above and beyond that of just the carry trade, suggesting that intermediary capital shocks provide some additional information content above and beyond that of the carry itself. The full specification has quite high R^2's, up to 83% for the Danish krone, and 78% for the euro, showing that average changes in the dollar in fact accounts for an outsize portion of exchange rate movements, as found by Verdelhan (2018). In other words, currencies appear to share a large amount of systematic variation, as a lot of their movements are linked to broader movements of the dollar against all currencies.

Table 6 Here

Table 6 displays the results for emerging market currencies. Column (1) shows us that that the vast majority of emerging market currencies positively co-move with the carry trade, the exceptions being the Czech krona, Hungrian forint, and Kuwaiti dinar. Column (2) again shows that all emerging market currencies positively co-move with the average level of the dollar with some level of heterogeneity in magnitude, but the majority moving less than the average against the dollar. While Column (3) only yields a few significant estimates, note that they are all negative and similar in magnitude to the risky advanced economy currencies. If we take the stance that emerging market currencies are generally risky, this is consistent with theory, namely negative intermediary capital shocks are associated with emerging market currency depreciation. Finally as before, we observe a moderate increase in explained variation by adding in the intermediary capital shock and the average change in the dollar increases the explained variation tremendously.

4.2 Pricing of Intermediary Capital Risk

I now shift to the examination of the pricing of intermediary capital risk in the cross-section of foreign exchange returns. I perform a series of asset pricing exercises to establish the relevance of intermediary capital as a risk factor, comparing its performance to the market return and global consumption growth to establish its role as a fundamental economic source of global risk embedded in the cross-section of foreign exchange returns. I then assess the significance of intermediary capital risk in combination with the HML carry, dollar, and global dollar factors to shed light upon its relationship with these previously identified exchange rate factors.

I show the following in turn: First, intermediary capital shocks provide an economic source of risk behind the carry trade, overshadowing consumption growth factors, displaying the relevance of financial intermediaries' pricing kernels over those of households. Although intermediary capital shocks do not constitute their own separate cross-section of returns, the results show that they do matter for the carry trade and the joint cross-section of currency portfolios. Second, the HML carry factor subsumes the risk embedded in the intermediary capital shocks and prices the entire cross-section of currency portfolios, pointing towards intermediary capital risk as a component of the broader HML carry risk. In addition, the global component of the dollar factor as a proxy for broader global shocks matters for the cross-section of excess returns, whereas the dollar factor un-purged of US-specific risk does not.

My estimation of the prices of risk follows the standard two-stage Fama-MacBeth procedure. In the first stage, for each test portfolio I run a time series regression of its excess returns on a constant and the candidate risk factors to obtain a set of portfolio-specific betas. Formally:

$$RX_{i,t} = \alpha_i + \beta_i' f_t + \epsilon_{i,t} \text{ for } i = 1, ..., N \tag{2}$$

where f_t is a vector of factors and β_i is the vector of factor loadings, and N is the number of test portfolios. In the second stage, I estimate the prices of risk by running a cross-sectional regression for each time period t and then take the average to obtain the final estimates:

$$RX_{i,t} = \lambda_t \beta_i' + \nu_{i,t} \text{ for } t = 1, \ldots, T \tag{3}$$

The coefficient of interest is $\lambda = \sum \lambda_t / T$, namely the vector of risk prices for each factor. I estimate the first stage betas with ordinary least squares, and compute the second stage risk prices using the pooled mean group estimator. Per Burnside's (2011) critique of Lustig and Verdelhan (2007), I construct GMM standard errors following Cochrane (2005) to alleviate concerns about standard errors as our second stage regressors, namely the first stage betas, are estimated.[3]

Before diving into the results, note that in contrast to previous studies that use the US market return, I employ the Fama French global market return as my control risk factor. I utilize the Feng et al. (2017) two-pass procedure, using machine learning techniques as the immense number of pre-existing factors in the empirical asset pricing literature make the selection of baseline factors both tedious and inconsistent, given the difference in estimates depending on which factors are included in the asset pricing regressions. I perform this control factor selection procedure as empirical asset pricing studies for exchange rates have not yet carefully found the correct factors to

[3]One other option is the Shanken (1992) correction. Suppose we have N test portfolios, K factors, and T periods. Per Cochrane (2005), the Shanken (1992) corrected variance-covariance is computed as:

$$V = \frac{1}{T}\left((\beta'\beta)^{-1}\beta'\Sigma\beta(\beta'\beta)^{-1}(1+\lambda'\Sigma_f^{-1}\lambda) + \Sigma_f\right)$$

where β' is an $N \times K$ matrix containing the estimated betas from the first stage in Equation 2, $\Sigma = Cov(\epsilon_t',' \epsilon_t)$ is the $N \times N$ variance-covariance matrix of the residuals from Equation 2, λ' is an $K \times 1$ vector of the estimated average risk prices from Equation 3, and $\Sigma_f = Cov(f_t', f_t)$ is the $K \times K$ variance-covariance matrix of the factors.

serve as controls in baseline specifications, making studies generally incomparable. I fill this void by formally identifying the Fama French global market return as the most relevant control factor in comparison to other factors for exchange rates, and argue that future studies of exchange rate risk factors should always be compared to this baseline. Interested readers are encouraged to refer to the appendix where I provide a full discussion of the factor selection procedure.

4.3 Intermediary Capital As An Economic Risk Factor

Table 7 displays the results from the asset pricing tests of intermediary capital shocks with the global market return and consumption growth to examine the relevance of financial intermediary capital risk in the pricing of foreign exchange risk. I depart from the previous literature in using the Fama French global market return given its survival in the factor selection procedure, and also employ a wider set of exchange rate portfolios when testing for the significance of intermediary capital risk.[4]

Table 7 Here

Column (1) shows the risk prices estimated on the cross-section of six currency portfolios sorted by intermediary capital shock betas. If intermediary capital risk constitutes its own cross-section of excess returns, I expect a significant and positive price of intermediary capital risk as currencies that depreciate upon realizations of negative intermediary capital shocks provide lower excess returns and are thus deemed risky, compensating investors for the aforementioned risk by providing higher expected returns at all other times. We do not observe a significant price of intermediary capital risk or the global market, providing poor support for the existence of this independent cross-section of exchange rate excess returns.

However shifting to Column (2), we observe a significant price of intermediary risk for the cross-section of carry trade portfolios sorted by forward discounts. Intermediary capital risk is priced into the carry trade at 5.9% per annum, implying that currencies with high intermediary

[4]He, Kelly, and Manela (2016) test their factor against the carry trade and momentum portfolios from Lustig, Roussanov, and Verdelhan (2011) and Menkhoff et al. (2012), finding significant and positive prices of risk. I augment their results by extending the sample period up to the end of 2017 and testing on additional cross-sections of exchange rates from the literature.

betas, or portfolios with returns that positively co-move more with the intermediary capital shock, are compensated for taking on the risk of low returns when bad shocks erode intermediary capital. This provides support for intermediary capital risk as one fundamental economic source of risk embedded in exchange rates as investors appear to be rewarded for holding currencies that depreciate when intermediary capital declines. Notice that intermediary capital risk is priced despite the presence of the global market return, showing that it contains more information than equity prices - I interpret this as reflecting the outsize importance of intermediary capital as proxying for the risk-bearing capacity of relevant financial intermediaries that theory suggests.

This result is not limited to the cross-section of the carry trade - it also holds for the joint cross-section of exchange rate portfolios. Column (4) displays the risk price estimates from the sample that simultaneously employs all of the constructed portfolios, namely intermediary capital, carry, dollar, momentum, volatility, and value as described in Section 3.3, each of which presumably capture different sources of risk and anomalies in exchange rates. I find a significant price of intermediary capital risk at 2.1% per annum. While smaller in magnitude than the estimate from the carry trade portfolios alone, this finding supports the importance of intermediary capital in the pricing of exchange rates as using the broader set of portfolios identifies one economic source of global risk that is embedded within exchange rates, invariant to the type of sorting and portfolio construction. Furthermore given the low excess returns of all other cross-sections of exchange rates, it is not surprising that I obtain a smaller estimate.[5]

An additional finding is the significance of the global market return for the entire cross-section of foreign exchange returns at 10.1% per annum. Previous studies have had difficulties explaining exchange rate excess returns with the market return (Daniel, Hodrick, and Lu 2017), but I find that it is global market risk that may be the relevant factor, at least for the wider cross-section of exchange rate excess returns. The significance of this estimate is in line with its relevance as a baseline control factor and supports the two-stage factor selection procedure.

The significance of the intermediary capital shock for the risk pricing of the carry trade and

[5] I also test each cross-section independently in the appendix. None of the other cross-sections of foreign exchange returns exhibit significant intermediary capital risk prices when estimated individually, but this could be due to the depressed returns in the past decade as indicated in Section **??**.

the wider cross-section of foreign exchange excess returns leads one to question whether this is a distinct economic source of risk, independent of the consumption growth risk found by Lustig and Verdelhan (2007). I examine this notion by performing my asset pricing tests with US durable and non-durable consumption growth as additional risk factors, to determine whether it is consumption growth, intermediary shocks, or a combination of the two that account for excess returns in exchange rates.

Column (3) of Table 7 displays the results from the Fama MacBeth regressions with intermediary capital shocks and durable and non-durable US consumption growth as risk factors for the carry trade. I find that intermediary risk is still significantly and positively priced at 4.2% per annum, while the consumption factors are not priced. My results thus suggest that intermediary capital risk is more important in explaining the carry trade than consumption risk, supportive of the notion that the pricing kernel of financial intermediaries is more relevant for the pricing of exchange rate risk than that of households, and providing evidence for open economy models with financial intermediaries.

This finding is again extended to the entire cross-section of foreign exchange portfolios as indicated in Column (5). As before, we find a smaller, but significant price of intermediary risk at 2.1% per annum, verifying the robust importance of intermediary capital risk for the cross-section of exchange rate returns. In contrast to estimates with the carry trade alone, I also obtain a positive and significant price of durable consumption risk, providing support for Lustig and Verdelhan's (2007) original finding. However given the significance of intermediary risk for both carry and entire cross-sections, I interpret this as highlighting the larger importance of the financial intermediary's pricing kernel over that of the households. It is important to keep in mind that I am not claiming that households are completely irrelevant to pricing exchange rates or asset pricing in general, merely that financial intermediaries may be more relevant given the recent success of the theory and my more robust findings in support of intermediary capital risk.

In summary, I have found that intermediary capital shocks are a significantly priced risk factor for the cross-section of carry trade returns and the wider cross-section of all currency portfolio returns. While I do not find that intermediary capital risk constitutes its own separate cross-section of excess returns, my findings highlight the relevance of the risk-bearing capacity of financial intermediaries, supportive of recent theories in open economy models with financial intermediaries and the risk-based interpretation of exchange rate risk premia. Furthermore, I have shown that intermediary capital risk remains a significantly priced risk factor when compared to another leading fundamental economic source of risk, household consumption, providing evidence for intermediary based theories of asset pricing that help explain the carry trade anomaly in the context of open economy macroeconomic models with a central role for financial intermediaries - fluctuations in intermediary capital are indeed a significant economic source of risk that helps generate and explain risk premia in exchange rates.

4.4 Intermediary Shocks vs. Portfolio FX Factors

I now shift gears to investigate whether intermediary capital shocks provide additional information content and serve as a risk factor beyond that of previously identified exchange rate risk factors. I estimate the prices of risk for the carry trade and joint cross-section of exchange rate returns using the intermediary capital shocks, HML carry, average dollar, and global dollar excess returns as risk factors. The intuition is that if the HML carry and dollar strategies offer excess returns, the covariances or betas with their returns represent relative exposures to sources of global risk that underlie the existence of excess returns. If intermediary capital shocks serve as a distinct source of risk from these two factors, we expect significant prices of intermediary risk in addition to that of the HML carry and dollar factors. On the other hand, if the risk embedded in intermediary capital shocks is merely a component of these factors, we expect to see insignificant risk prices as they presumably will be subsumed by the HML carry and dollar factors that contain a wider set of shocks and risk. I show evidence for the latter point, highlighting the role of fluctuations in intermediary capital as an economic source of global risk contained within the HML carry factor.

Column (1) in Table 8 displays results from the comparison of intermediary capital shocks and the HML carry factor for the carry trade portfolios. The HML carry factor completely subsumes the significance of the intermediary capital shock as only HML carry risk is now priced into the cross-section of the carry trade at 7.8% per annum whereas the price of intermediary capital risk is now insignificant. We observe the robust significance of the price of HML carry risk again in the full sample with all cross-sections tested simultaneously at 8.1% per annum in Column (6). Both estimates are significant at the 1% level, displaying the dominant role of the global risk embedded in the HML carry factor in pricing foreign exchange returns.

TABLE 8 HERE

The significance of the HML carry factor over the previously significant intermediary capital shocks provides new information about the interaction between the two. In my baseline specifications, I find that intermediary capital shocks serve as the most relevant risk factor in the pricing of both the carry trade and the wider cross-section of exchange rate returns. The fact that the inclusion of the HML carry factor removes this significance, and that it takes the place of the intermediary capital risk factor at an even higher level of significance suggests that intermediary capital risk is embedded within the HML carry factor. The HML carry factor appears to contain a broader array of global shocks as evident by its more dominant role in pricing the risks located within the cross-section of exchange rate returns and intermediary capital shocks merely serve as one economic source of risk contained within this factor.

Columns (2)-(3) and (7)-(8) of Table 8 compare intermediary capital to the dollar and global dollar factors for the carry trade and joint cross-sections respectively. In both cases, we find the robust significance of the price of intermediary capital risk for the carry and full cross-sections as before at 5.6% and between 2.8% and 3.5% respectively, further supporting the role of intermediary capital as a fundamental economic source of risk. The dollar factor itself fails to serve as significant risk factor, but the global dollar factor enters in as a priced risk factor at 10.8% per annum for the combined sample.

The finding that dollar risk is not priced whereas global dollar risk is sheds light upon how heterogeneous exposure to global shocks help explain the cross-section of foreign exchange returns. Despite my early confirmation of Verdelhan's finding that a large amount of exchange rate fluctuations are explained by average changes in the dollar, I find here that it is only the global component that matters, namely risks that are purged of US specific risk. This is surprising as we would expect a risk factor that contains more information to have a higher likelihood of being significantly priced in the cross-sections.

Columns (4) and (9) of Table 8 display the results of the asset pricing tests with the HML and dollar factors simultaneously as risk factors. It is again apparent that the HML carry factor subsumes the intermediary capital shock as we observe significant prices of risk for the cross-sections of the carry trade and all portfolios at 8.4% and 8.8% per annum respectively, while intermediary capital shocks are not significantly priced for any of the cross-sections. Furthermore note that dollar risk is never significantly priced, despite earlier findings that a large amount of exchange rate fluctuations are explained by average changes in the dollar, which presumably represent one source of risk, consistent with my previous findings when comparing intermediary capital and dollar risk.

Columns (5) and (10) of Table **??** display a similar exercise but using the global dollar factor, which recall is the difference in excess returns between high and low dollar-beta currency portfolios. While the average dollar excess return itself contains information about US-specific shocks as the bilateral exchange rate vis-à-vis the dollar must contain some information about the US pricing kernel, when we take the difference between the dollar portfolios, we purge US-specific shocks and isolate the global source of risk present in the average excess returns against the dollar. As we can see, HML carry risk is again significantly priced for the carry trade and all portfolios at 8.4% and 7.5% per annum respectively. Furthermore note that in contrast to the specification without US risk purged, we now obtain a significant risk price for the global dollar factor for the entire cross-section of foreign exchange returns at 10.3%. This confirms the previous results comparing only intermediary capital and the dollar factors, showing that global risk is most pertinent in the pricing of exchange rate risk.

My asset pricing tests have thus illuminated a few things. Intermediary capital shocks provide an economic source of risk behind the carry trade and the broader cross-section of foreign exchange, overshadowing consumption growth factors, despite not constituting their own cross-section. Furthermore, the HML carry factor subsumes the risk embedded in the intermediary capital shocks and prices the entire cross-section of currency portfolios, suggesting that intermediary capital risk is contained within the HML carry factor. Finally, the global component of the dollar factor as a proxy for broader global shocks appears more relevant than the dollar factor alone for the cross-section of excess returns, showing that it is global risk that is priced and one must purge country-specific idiosyncratic risk to identify this.

4.5 Determinants of the FX Factors

In the previous sections, I showed the relevance of intermediary capital shocks for the pricing of risk in cross-sections of foreign exchange returns, but also found that it was subsumed by the HML carry factor. Given that the latter is formed via portfolio methods and thus its economic determinants and sources of risk are ambiguous, I aim to uncover the economic sources of the shocks contained in the HML carry factor. For completeness, I also look to examine the sources of shocks contained in the global dollar factor, given its outsize role in explained variation of bilateral exchange rate movements.

I answer this question by examining the contemporaneous correlations of candidate shocks on the excess returns of each factor, a simple exercise that identifies the most meaningful shocks for these risk factors. My candidate shocks are inspired by Verdelhan (2018) who suggests fundamental economic shocks coming from the risk-bearing capacity of intermediaries, monetary policy, risk aversion, liquidity, and real activity. I proxy for each in turn using the He, Kelly, and Manela (2017) intermediary capital shocks as before, the Nakamura and Steinsson (2014) high frequency identified US monetary policy shocks, changes in the level of VIX, changes in the Libor-OIS spread, the Chicago Fed's National Activity Index, and durable and non-durable US consumption growth, respectively. The regression specification is:

$$RX_t = \alpha + \beta' f_t + \epsilon_t \tag{4}$$

where

$$f_t = [CShock_t, \Delta DurableC_t, \Delta NonDurableC_t, \Delta VIX_t, \Delta LibOIS_t, CFNAI_t, MPShock_t]$$

.

Table 9 displays the results of this previous regression, where Columns (1)-(4) examine the HML carry factor. The univariate specification in Column (1) shows that intermediary capital shocks indeed positively co-move with the HML carry factor, supporting the notion that fluctuations in intermediary capital are a fundamental economic source of risk contained in the cross-section of the carry trade. Furthermore given that the HML carry factor also prices the entire cross-section of foreign exchange portfolios, this serves as evidence that intermediaries and their capital play a central role in the pricing of broader exchange rate risk.

Table 9

Column (2) examines the role of consumption growth; if households are relevant, I expect a positive and significant correlation of durable and/or non-durable consumption growth with the HML carry factor. Consistent with the asset pricing tests, I find an insignificant correlation between consumption growth and the HML carry factor, whereas intermediary capital shocks remain significantly positive. The evidence thus points towards the importance of financial intermediaries over households as the relevant marginal investor whose marginal utility matters for the pricing of foreign exchange.

Column (3) assesses whether other economic sources of risk are components of the risk embedded in the HML carry factor and whether they wash out the importance of intermediary capital. Intermediary capital shocks remain a robust component of the HML carry factor, retaining their level of significance and only mildly decreasing in magnitude. For the other economic sources of risk, we observe negative and significant correlations of the HML carry factor with changes in the VIX and Libor-OIS spreads, and a marginally positive correlation with real activity as measured by the Chicago Fed's National Activity Index. Given the VIX's role as a proxy for broader risk aversion and equity market volatility, this finding is consistent with the previous literature (Brunnermeier, Nagel, and Pedersen 2008, Clarida, Davis, Pedersen 2009) that shows the carry trade does poorly at times of high volatility and risk aversion. Similarly, the negative relationship between the HML carry return and changes in the Libor-OIS spread suggest that times of higher funding costs and/or low liquidity are associated with poor returns for the carry trade.

The significance of the Chicago Fed National Activity Index sheds light upon the relevance of real activity for the shocks embedded within the HML carry factor. The positive estimate is in line with intuition, as we expect real activity to be expanding during good times which coincide with excess returns for the carry trade, whereas when adverse global shocks hit, carry trade returns should erode as currencies that are more exposed to the shocks depreciate. This finding is encouraging as while this paper argues for the outsize relevance of financial intermediaries and consequently financial activity, negative shocks that affect real activity and production should also serve as an economic global source of risk that should be relevant for the pricing of foreign exchange risk.

In terms of explained variation, the univariate specification shows that intermediary shocks account for 7% of the variation in the HML carry factor. Consumption factors do not increase the R^2 or adjusted R^2 by much, again supportive of the dominant role of financial intermediaries over households for the pricing of exchange rate risk. The full specification reaches an adjusted R^2 of 28.7%, showing that while intermediary capital risk is a component of the total risk contained in the HML carry factor, other economic sources of risk such as risk aversion, liquidity, and real activity also play a significant role.

Columns (5)-(8) display similar specifications for the global dollar factor. In the baseline specifications in Column (5) and (6), I do not find a significant correlation with intermediary capital shocks, suggestive that intermediary capital risk is distinct from that contained within the global dollar factor. However upon controlling for other economic sources of risk, I obtain a positive and significant estimate for the intermediary capital shocks.[6] Given that intermediary capital risk was not subsumed by the global dollar factor in the asset pricing tests yet I find a positive correlation signifies that while intermediary capital risk may not be wholly contained in the global dollar factor, they do share some common variation.

With regards to the other economic determinants, liquidity, as proxied by the Libor-OIS spread, is negatively correlated with the global dollar factor, consistent with the intuition that global risk and liquidity are negatively correlated. In bad times, when liquidity becomes thin, investors shift

[6]Note that the sample size significantly decreases upon controlling for the Libor-OIS spread, which is only available from 2002, and the Nakamura and Steinsson monetary policy shocks which are only available up to 2014. A univariate specification run from 2002 onwards displays a significant price of intermediary capital risk, suggesting that the linkage between the global dollar factor and intermediary capital shocks arose in the last two decades.

their portfolios towards safer assets and safe haven currencies, which include US treasury bonds and the dollar. The dollar appreciates upon the realization of these capital flows and currencies that depreciate the most vis-a-vis the dollar yield poorer excess returns. Given that the global dollar factor reflects being long these currencies, the strategy suffers and the risk of being long currencies more exposed to depreciation against the dollar is realized.

It is surprising that my proxy for real activity, the Chicago Fed National Activity Index, is marginally significant, albeit with the correct positive sign, as the global dollar is presumably purged of US-specific risk. Given the marginal significance, I interpret this finding as reflecting US real activity serving as a weak proxy for broader global real activity, but it could also be the case that differencing the dollar portfolios does not fully purge the factor from US-specific risk. This could arise if for example currencies pairs vis-a-vis the dollar are differentially exposed to US-specific shocks.[7]

In Columns (4) and (8), I assess whether the global dollar and HML carry factors are jointly determined and significantly co-vary. This specification clarifies whether one of these factors subsumes the other or they share common variation. I find that neither serves as a significant covariate with the other, supporting Verdelhan's (2018) finding that these factors represent two orthogonal sources of global risk.

I have thus confirmed the previous hypothesis that intermediary capital risk is an economic source of risk that is contained within the HML carry factor. My findings on the relevance of other economic sources of risk such as risk aversion, liquidity, and, marginally, real activity reveal that the HML carry factor contains a broad array of economic shocks including but not limited to intermediary capital risk, and that further work must be done to uncover other economic sources of risk embedded within the HML carry factor that plays such a dominant role in the pricing the cross-sections of foreign exchange.

Fluctuations in intermediary capital also appear to be related the the global dollar factor, although this relationship significantly arises in the past two decades. Liquidity and real activity risk are embedded within this factor in line with intuition, but note that the significance of my

[7] This however is inconsistent with Verdelhan's (2018) affine model of exchange rates.

proxy of real US activity is counterintuitive, given that the global factor should be purged of US specific risk. This leads me to posit that US real activity may serve as a proxy for broader real activity risk that captured by fluctuations in the global dollar factor.

5 Conclusion

Does intermediary capital matter for the various cross-sections of exchange rate excess returns? I find that the answer is yes for explaining the carry trade and the joint cross-section of exchange rates. Intermediary capital shocks carry a significant risk price for both, above and beyond that of the Fama French global market return as well as durable and non-durable consumption growth, pointing towards the central relevance of financial intermediaries in the pricing of exchange rates that overshadows households, and identifying a fundamental economic source of risk that underlies the cross-section of foreign exchange returns. Intermediary capital risk does not constitute its own unique cross-section as my constructed intermediary capital portfolios do not demonstrate monotonicity with respect to excess returns and intermediary capital shock betas, but the strategy appears mildly profitable with a decent Sharpe ratio over the whole sample. Furthermore while intermediary capital shocks do not explain the cross-sections of intermediary capital, dollar, momentum, volatility, and value when examined independently, I do obtain a significant risk price when jointly testing all cross-sections, once again lending credence to its relevance for exchange rates.

Given that intermediary capital risk is significantly priced into the carry trade and joint cross-section of currency portfolios, I compare it to Lustig and Verdelhan's (2011) HML carry factor to examine whether intermediary capital shocks contain additional information beyond one of the most relevant global risk factors. My results show that the HML carry factor is the most dominant pricing factor in the carry and joint cross-sections of exchange rates and that its presence in the asset pricing tests removes the significant risk price of intermediary capital. Combining this result with my previous findings suggests that intermediary capital risk must be a component of the global risk embedded within the portfolio generated HML carry factor as it is significantly priced in the carry cross-section in all other specifications without the factor that presumably subsumes it.

I verify this claim by showing that intermediary capital shocks positively and significantly correlate with the HML carry factor. I also find that intermediary capital shocks positively correlate with the global dollar factor, suggesting that the risk emanating from fluctuations in intermediary capital is contained not only in the global risk that underlies the carry trade, but also that contained in the risk that drives the average excess returns of the dollar, purged of US-specific risk. Shifting to other candidate economic determinants, I show that changes in the VIX and Libor-OIS spread, proxies for market volatility, uncertainty, and liquidity, are negatively correlated with carry trade returns, in line with empirical findings by previous researchers and the theoretical predictions in the macro-finance literature. I also show evidence for the relevance of real activity in the HML carry factor.

In addition to my analysis with the HML carry factor, I also explore the interaction of intermediary capital shocks with the dollar and global dollar factors identified by Verdelhan (2018) to assess its relative performance against these previously identified exchange rate risk factors. I again find that intermediary capital risk is significantly priced above and beyond these factors, displaying the importance of the idiosyncratic risk embedded in this proxy for the risk-bearing capacity of financial intermediaries that serves as an economic source of global risk. As before, the intermediary capital shock helps price the joint cross-section of a variety of exchange rate portfolios, and I uncover the relevance of the global dollar factor, purged of US-specific risk, for the pricing of this wider cross-section. In contrast, the dollar factor itself which still contains US-specific risk fails to be significantly priced, showing that the risk premia in the cross-section of exchange rates stems from the isolation of global shocks, as inclusion of US-specific risk appears to dilute the relevant information contained in dollar factor.

Focusing on the global dollar factor, I find that intermediary capital shocks positively correlate with this global factor only after controlling for a variety of other potential shocks. This finding however is primarily due to the linkage between the two arising in the past two decades. Furthermore I uncover the significance of liquidity and surprisingly US real activity for the global dollar factor.

My findings thus show that intermediary capital shocks help us better understand existing exchange rate factors, serving as a fundamental economic source of risk that generates the carry trade and broader joint cross-sections of exchange rate excess returns. Future work may be done in terms of finding better measures of intermediary capital shocks and perhaps constructing shocks for other participants in the foreign exchange markets, namely buy-side investors such as hedge funds, asset managers, and other institutional investors. It may very well be the case that we are missing a key piece of the intermediary asset pricing puzzle by not utilizing their pricing kernels as a risk factor and I leave this exercise open to future research.

6 References

1. Adrian, Tobias & Boyarchenko, Nina, 2012. ”Intermediary leverage cycles and financial stability,” Staff Reports 567, Federal Reserve Bank of New York, revised 01 Feb 2015.

2. Adrian, Tobias & Crump, Richard K. & Moench, Emanuel, 2015. ”Regression-based estimation of dynamic asset pricing models,” Journal of Financial Economics, Elsevier, vol. 118(2), pages 211-244.

3. Adrian, Tobias & Etula, Erkko & Muir, Tyler, 2014. ”Financial Intermediaries and the Cross-Section of Asset Returns,” Journal of Finance, American Finance Association, vol. 69(6), pages 2557-2596, December.

4. Adrian, Tobias & Etula, Erkko & Shin, Hyun Song, 2009. ”Risk appetite and exchange Rates,” Staff Reports 361, Federal Reserve Bank of New York, revised 10 Dec 2015.

5. Adrian, Tobias & Moench, Emanuel & Shin, Hyun Song, 2013. ”Dynamic leverage asset pricing,” Staff Reports 625, Federal Reserve Bank of New York, revised 01 Dec 2014.

6. Bertaut, Carol C. & Judson, Ruth, 2014. ”Estimating U.S. Cross-Border Securities Positions: New Data and New Methods,” International Finance Discussion Papers 1113, Board of Governors of the Federal Reserve System (U.S.).

7. Brunnermeier, Markus K. & Nagel, Stefan & Pedersen, Lasse H., 2009. ”Carry Trades and Currency Crashes,” NBER Chapters,in: NBER Macroeconomics Annual 2008, Volume 23, pages 313-347 National Bureau of Economic Research, Inc.

8. Brunnermeier, Markus K. & Pedersen, Lasse Heje, 2009. ”Market Liquidity and Funding Liquidity,” Review of Financial Studies, Society for Financial Studies, vol. 22(6), pages 2201-2238, June.

9. Brunnermeier, Markus K. & Sannikov, Yuliy, 2014. ”A Macroeconomic Model with a Financial Sector,” American Economic Review, American Economic Association, vol. 104(2), pages 379-421, February.

10. Burnside, Craig & Eichenbaum, Martin & Rebelo, Sergio 2011. ”Carry Trade and Momentum in Currency Markets,” Annual Review of Financial Economics, Annual Reviews, vol. 3(1), pages 511-535, December.

11. Burnside, Craig, 2011. ”The Cross Section of Foreign Currency Risk Premia and Consumption Growth Risk: Comment,” American Economic Review, American Economic Association, vol. 101(7), pages 3456-3476, December.

12. Burnside, Craig & Eichenbaum, Martin & Kleshchelski, Isaac & Rebelo, Sergio, 2011. ”Do Peso Problems Explain the Returns to the Carry Trade?,” Review of Financial Studies, Society for Financial Studies, vol. 24(3), pages 853-891.

13. Clarida, Richard & Davis, Josh & Pedersen, Niels, 2009. ”Currency carry trade regimes: Beyond the Fama regression,” Journal of International Money and Finance, Elsevier, vol. 28(8), pages 1375-1389, December.

14. Cochrane, John H. 2005. Asset pricing. Princeton, N.J.: Princeton University Press.

15. Danielsson, Jon & Song Shin, Hyun & Zigrand, Jean-Pierre, 2011. "Balance sheet capacity and endogenous risk," LSE Research Online Documents on Economics 43141, London School of Economics and Political Science, LSE Library.

16. Danielsson, Jon & Song Shin, Hyun & Zigrand, Jean-Pierre, 2011. "Balance sheet capacity and endogenous risk," LSE Research Online Documents on Economics 43141, London School of Economics and Political Science, LSE Library.

17. Della Corte, Pasquale & Riddiough, Steven J. & Sarno, Lucio, 2016. "Currency Premia and Global Imbalances," Review of Financial Studies, Society for Financial Studies, vol. 29(8), pages 2161-2193.

18. Du, Wenxin & Tepper, Alexander & Verdelhan, Adrien, 2017. "Deviations from Covered Interest Rate Parity," NBER Working Papers 23170, National Bureau of Economic Research, Inc.

19. Fama, Eugene F., 1984. "Forward and spot exchange rates," Journal of Monetary Economics, Elsevier, vol. 14(3), pages 319-338, November.

20. Fama, Eugene F. & French, Kenneth R., 1993. "Common risk factors in the returns on stocks and bonds," Journal of Financial Economics, Elsevier, vol. 33(1), pages 3-56, February.

21. Gabaix, Xavier & Maggiori, Matteo, 2015. "International Liquidity and Exchange Rate Dynamics," The Quarterly Journal of Economics, Oxford University Press, vol. 130(3), pages 1369-1420.

22. Gârleanu, Nicolae & Pedersen, Lasse Heje, 2011. "Margin-based Asset Pricing and Deviations from the Law of One Price," Review of Financial Studies, Society for Financial Studies, vol. 24(6), pages 1980-2022.

23. Itskhoki, Oleg & Mukhin, Dmitry, 2017. "Exchange Rate Disconnect in General Equilibrium," NBER Working Papers 23401, National Bureau of Economic Research, Inc.

24. Hansen, Lars Peter & Hodrick, Robert J, 1980. "Forward Exchange Rates as Optimal Predictors of Future Spot Rates: An Econometric Analysis," Journal of Political Economy, University of Chicago Press, vol. 88(5), pages 829-853, October.

25. Hassan, Tarek A., 2013. "Country Size, Currency Unions, and International Asset Returns," Journal of Finance, American Finance Association, vol. 68(6), pages 2269-2308, December.

26. He, Zhiguo & Kelly, Bryan & Manela, Asaf, 2017. "Intermediary asset pricing: New evidence from many asset classes," Journal of Financial Economics, Elsevier, vol. 126(1), pages 1-35.

27. He, Zhiguo & Krishnamurthy, Arvind, 2013. "Intermediary Asset Pricing," American Economic Review, American Economic Association, vol. 103(2), pages 732-770, April.

28. Jiang, Zhengyang, Fiscal Cyclicality and Currency Risk Premium (March 29, 2018). Available at SSRN: https://ssrn.com/abstract=3059245

29. Lustig, Hanno & Roussanov, Nikolai & Verdelhan, Adrien, 2011. "Common Risk Factors in Currency Markets," Review of Financial Studies, Society for Financial Studies, vol. 24(11), pages 3731-3777.

30. Lustig, Hanno & Roussanov, Nikolai & Verdelhan, Adrien, 2014. "Countercyclical currency risk premia," Journal of Financial Economics, Elsevier, vol. 111(3), pages 527-553.

31. Lustig, Hanno & Verdelhan, Adrien, 2007. "The Cross Section of Foreign Currency Risk Premia and Consumption Growth Risk," American Economic Review, American Economic Association, vol. 97(1), pages 89-117, March.

32. Meese, Richard A. & Rogoff, Kenneth, 1983. "Empirical exchange rate models of the seventies : Do they fit out of sample?," Journal of International Economics, Elsevier, vol. 14(1-2), pages 3-24, February.

33. Menkhoff, Lukas & Sarno, Lucio & Schmeling, Maik & Schrimpf, Andreas, 2012. "Currency momentum strategies," Journal of Financial Economics, Elsevier, vol. 106(3), pages 660-684.

34. Menkhoff, Lukas & Sarno, Lucio & Schmeling, Maik & Schrimpf, Andreas, 2012. "Carry Trades and Global Foreign Exchange Volatility," Journal of Finance, American Finance Association, vol. 67(2), pages 681-718, April.

35. Mueller, Philippe & Tahbaz-Salehi, Alireza & Vedolin, Andrea, 2017. "Exchange Rates and Monetary Policy Uncertainty," Journal of Finance, American Finance Association, vol. 72(3), pages 1213-1252, June.

36. Nakamura, Emi & Steinsson, Jón, 2014. "High Frequency Identification of Monetary Non-Neutrality: The Information Effect," NBER Working Papers 19260, National Bureau of Economic Research, Inc.

37. Ready, Robert & Roussanov, Nikolai & Ward, Colin, 2017. "Commodity Trade and the Carry Trade: A Tale of Two Countries," Journal of Finance, American Finance Association, vol. 72(6), pages 2629-2684, December.

38. Richmond, Robert, Trade Network Centrality and Currency Risk Premia (August 2016). Available at SSRN: https://ssrn.com/abstract=2607735

39. Shanken, Jay, 1992. "On the Estimation of Beta-Pricing Models," Review of Financial Studies, Society for Financial Studies, vol. 5(1), pages 1-33.

40. Verdelhan, Adrien, 2017. "The Share of Systematic Variation in Bilateral Exchange Rates," Journal of Finance, American Finance Association, vol. 73(1), pages 375-418, February.

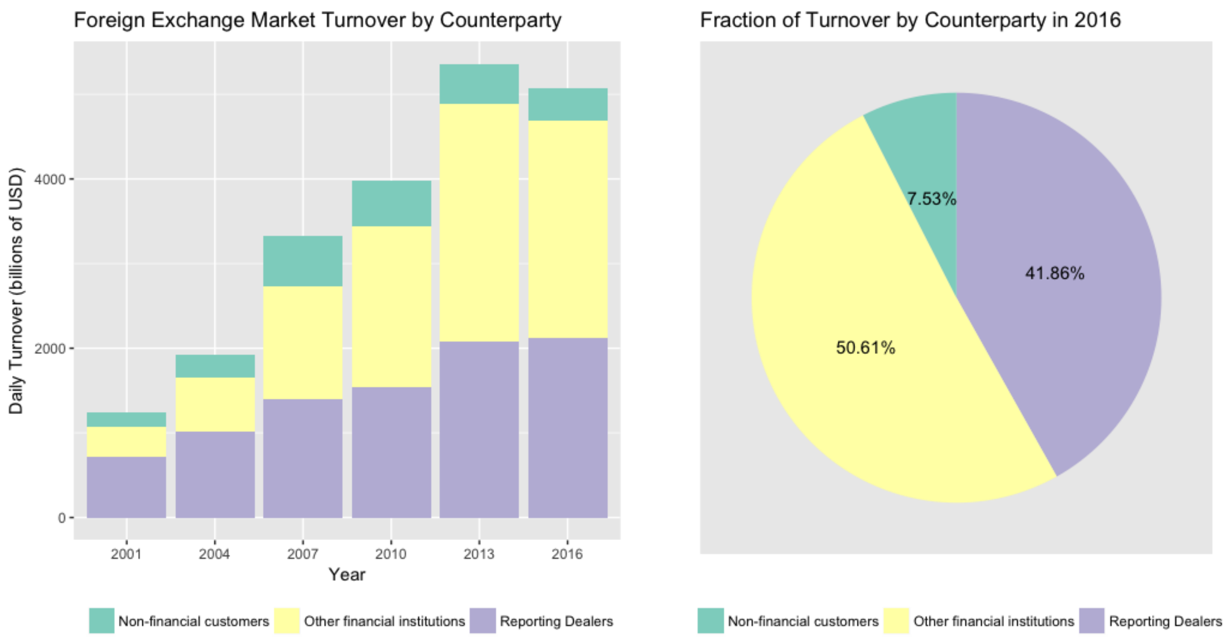

Figure 1: Daily Foreign Exchange Turnover Breakdown
Notes: Data comes from the Bank from International Settlements' Triennial FX Survey (2016). Turnover includes all foreign exchange instruments on a net-net basis from all countries to all other countries.

Statistic	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
Capital Ratio	574	0.063	0.024	0.022	0.045	0.076	0.134
Capital Shock	574	0.001	0.068	−0.280	−0.040	0.040	0.396

Table 1: Summary Statistics for Intermediary Capital

	CShock	SPX Fin	SPX ex Fin	FF Global
CShock	1.00	0.84	0.49	0.65
SPX Fin	0.84	1.00	0.58	0.70
SPX ex Fin	0.49	0.58	1.00	0.64
FF Global	0.65	0.70	0.64	1.00

Table 2: Correlations of Intermediary Shocks and Equity Indices
Notes: Correlations are estimated for the intermediary shock series and the monthly returns of the S&P 500 Financials only, S&P 500 excluding Financials, and Fama French Global Market

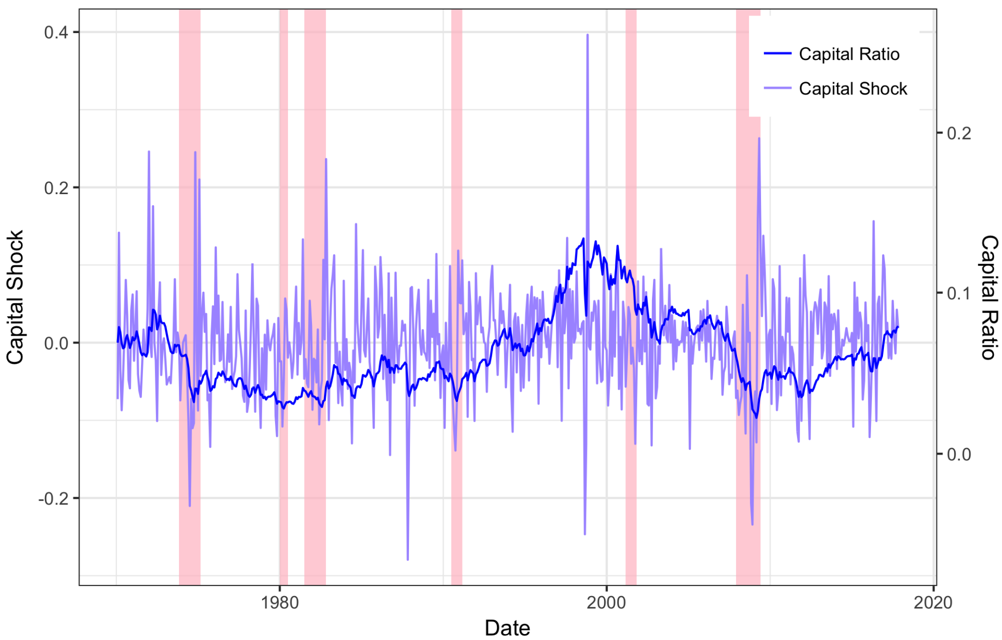

Figure 2: Intermediary Capital Ratio and Shock Series
Notes: The shaded bars indicate US NBER recessions.

	1	2	3	4	5	6	HML
Capital							
Mean	-1.31	0.71	-0.19	0.12	0.66	2.37	3.54
SD	8.15	8.68	8.34	8.85	9.16	9.26	9.31
Sharpe	-0.16	0.08	-0.02	0.01	0.07	0.26	0.38
Carry							
Mean	-1.74	-0.48	1.82	2.80	2.26	5.35	7.08
SD	9.72	8.14	8.14	8.65	9.51	10.51	10.29
Sharpe	-0.18	-0.06	0.22	0.32	0.24	0.51	0.69
Dollar							
Mean	0.46	1.84	2.14	2.75	4.68	4.16	3.59
SD	5.34	5.77	8.31	9.93	10.30	11.11	10.54
Sharpe	0.09	0.32	0.26	0.28	0.45	0.37	0.34
Momentum							
Mean	-1.97	0.50	1.44	2.83	2.97	4.07	6.05
SD	12.05	9.12	8.77	8.88	8.71	8.83	11.59
Sharpe	-0.16	0.06	0.16	0.32	0.34	0.46	0.52
Volatility							
Mean	2.50	-0.32	0.75	-0.19	1.09	-0.45	2.99
SD	10.82	9.49	8.57	8.36	7.62	7.51	9.73
Sharpe	0.23	-0.03	0.09	-0.02	0.14	-0.06	0.31
Value							
Mean	-2.86	1.00	0.07	-0.66	3.07	3.63	5.79
SD	12.05	10.08	10.34	9.91	11.12	8.82	11.32
Sharpe	-0.24	0.10	0.01	-0.07	0.28	0.41	0.51

Table 3: Portfolio Excess Return Summary Statistics

Notes: Columns (1) - (6) represent the lowest to the highest of the six sorted portfolios for each cross-section. HML reflects the difference in excess returns of the highest portfolio (6) minus the lowest portfolio (1). All moments are annualized, with means multiplied by 12 and standard deviations scaled by $\sqrt{12}$. Sharpe Ratios are taken as the ratio between the two.

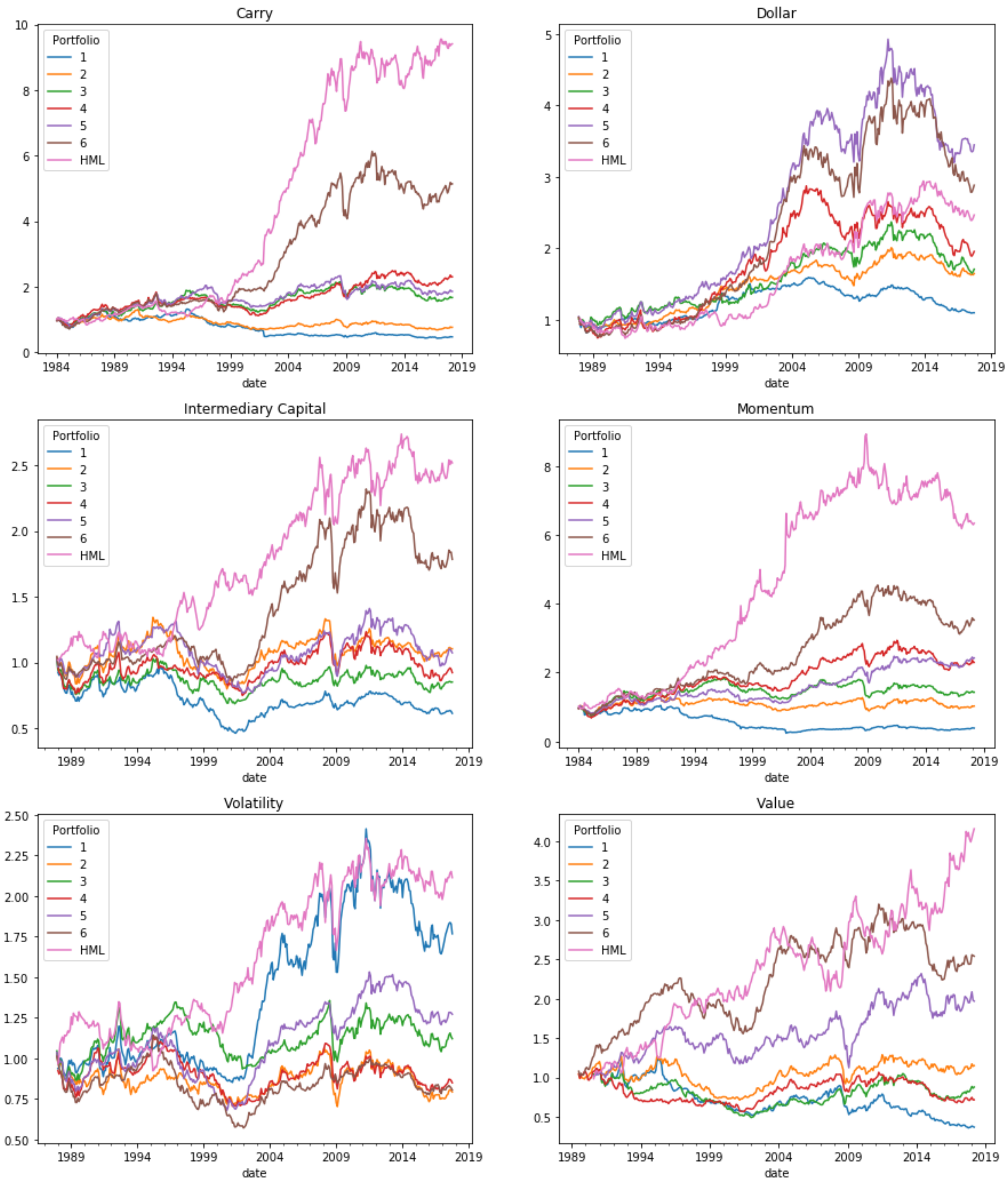

Figure 3: Cumulative Returns of FX Portfolio Strategies

Notes: These plots reflect cumulative returns of investing in an individual portfolio in each respective cross-sectional sort. Each portfolio's excess return is calculated as the average excess return of the currencies sorted into the respective portfolio. Portfolio 1 is the lowest sort, Portfolio 6 is the highest sort, and HML is the difference in average excess returns between portfolios 6 and 1.

Panel A: Pre-2010

	Capital	Carry	Dollar	Momentum	Volatility	Value
Δs_{t+1}						
Mean	-0.99	6.06	-3.62	-4.80	-0.29	-8.15
SD	9.54	10.16	10.80	11.16	9.91	11.40
$\Delta f_t - s_t$						
Mean	3.62	15.15	1.43	3.66	3.76	-1.78
SD	0.99	5.37	0.91	5.20	0.84	1.18
ΔRX_{t+1}						
Mean	4.61	9.09	5.05	8.46	4.05	6.37
SD	9.52	11.07	10.83	12.66	9.99	11.50
Sharpe	0.48	0.82	0.47	0.67	0.41	0.55

Panel B: 2010 - 2017

	Capital	Carry	Dollar	Momentum	Volatility	Value
Δs_{t+1}						
Mean	0.48	6.37	1.86	1.83	2.88	-6.19
SD	8.74	7.14	9.65	6.87	8.95	11.00
$\Delta f_t - s_t$						
Mean	0.99	7.18	1.33	0.28	2.89	-2.13
SD	0.56	0.34	0.47	0.85	0.46	0.54
ΔRX_{t+1}						
Mean	0.51	0.81	-0.54	-1.55	0.01	4.06
SD	8.70	7.18	9.64	6.93	8.96	11.08
Sharpe	0.06	0.11	-0.06	-0.22	0.00	0.37

Panel C: Full Sample

	Capital	Carry	Dollar	Momentum	Volatility	Value
Δs_{t+1}						
Mean	-0.60	6.13	-2.18	-3.24	0.54	-7.58
SD	9.32	9.52	10.52	10.33	9.67	11.27
$\Delta f_t - s_t$						
Mean	2.93	13.27	1.41	2.86	3.53	-1.88
SD	0.95	4.80	0.82	4.58	0.77	1.04
ΔRX_{t+1}						
Mean	3.54	7.14	3.59	6.11	2.99	5.69
SD	9.31	10.33	10.54	11.63	9.73	11.37
Sharpe	0.38	0.69	0.34	0.52	0.31	0.50

Table 4: Portfolios Decomposed

Notes: Each column represents the decomposition of the high-minus-low for each respective cross-section of foreign exchange. Changes are computed as the mean differences in the averages of spot exchange rate depreciation, forward discounts, and excess returns of currencies between the high and low portfolios.

Table 5: Systematic Variation in Exchange Rate Changes (Developed)

Country	HML	Dol	CShock	R2 (HML)	R2 (HML, CS)	R2 (All)
Australia	0.20***	0.80***	-0.08***	8.13%	11.13%	37.02%
Canada	0.10***	0.42***	-0.08***	6.80%	13.66%	32.37%
Switzerland	-0.29***	1.35***	0.09***	0.65%	1.37%	71.92%
Denmark	-0.26***	1.33***	0.03***	0.58%	0.33%	83.87%
Euro	-0.32***	1.35***	0.04**	-0.45%	3.92%	78.91%
United Kingdom	-0.06	0.92***	0.02	-0.13%	-0.32%	47.07%
Japan	-0.28***	0.65***	0.05**	3.49%	3.69%	24.02%
Norway	-0.10***	1.25***	-0.01	-0.20%	0.39%	69.79%
New Zealand	0.02	0.93***	-0.09***	1.75%	5.57%	37.60%
Sweden	-0.14***	1.25***	-0.03*	-0.25%	1.01%	69.10%

Notes: This table displays the coefficients from the regression in Equation 1 for the set of developed countries. The first three columns display the respective betas, while the latter three columns display the R^2 of regressions including only the HML, HML and intermediary shock, and the full set of regressors. Standard errors are Newey-West heteroskedasticity auto-correlation consistent with 12 lags.

Table 6: Systematic Variation in Exchange Rate Changes (Emerging)

Country	HML	Dol	CShock	R2 (HML)	R2 (HML, CS)	R2 (All)
Czech Republic	-0.31***	1.48***	-0.00	0.01%	3.48%	65.10%
Hungary	-0.16***	1.61***	-0.00	0.96%	6.60%	66.25%
Indonesia	0.21	1.00***	-0.12	2.89%	5.32%	10.76%
India	0.10**	0.50***	-0.01	9.46%	11.46%	34.14%
Korea	-0.07	1.06***	-0.07**	7.51%	16.29%	53.56%
Kuwait	-0.05***	0.21***	0.00	-0.40%	1.01%	36.51%
Mexico	0.19***	0.47***	-0.11***	15.19%	24.91%	34.36%
Malaysia	0.36***	0.70***	0.05**	25.17%	24.74%	48.17%
Philippines	0.23***	0.44***	0.02	12.23%	12.06%	24.74%
Poland	-0.02	1.61***	-0.06**	9.21%	20.46%	74.59%
Singapore	0.00	0.52***	-0.01	0.32%	1.15%	54.34%
Thailand	0.24***	0.66***	0.04	8.32%	7.98%	24.39%
Turkey	0.33***	0.83***	0.01	13.14%	13.44%	29.17%
Taiwan	0.02	0.45***	-0.01	3.80%	7.04%	39.25%
South Africa	0.11	0.99***	-0.08***	2.61%	4.81%	28.44%

Notes: This table displays the coefficients from the regression in Equation 1 for the set of emerging countries. The first three columns display the respective betas, while the latter three columns display the R^2 of regressions including only the HML, HML and intermediary shock, and the full set of regressors. Standard errors are Newey-West heteroskedasticity auto-correlation consistent with 12 lags.

Table 7: Risk Price of Intermediary Capital Shocks vs. Global Market Return and Consumption

	Dependent variable:				
	Int. Capital	Carry Trade		All Cross-Sections	
	(1)	(2)	(3)	(4)	(5)
$\beta_{IntCapital}$	0.011	0.059***	0.042**	0.021*	0.021**
	(0.012)	(0.022)	(0.018)	(0.011)	(0.010)
$\beta_{FFGlobalMkt}$	0.066	0.202		0.101*	
	(0.080)	(0.136)		(0.058)	
$\beta_{DurableCons}$			-0.004		0.018**
			(0.020)		(0.009)
$\beta_{NonDurableCons}$			0.002		0.004
			(0.003)		(0.004)
Observations	1,968	1,968	2,436	11,480	11,900
R^2	0.840	0.808	0.783	0.653	0.655
Note:			*p<0.1; **p<0.05; ***p<0.01		

Notes: This table displays estimates of the risk prices from the second stage of the Fama MacBeth regression. Column (1) displays results for the cross-section of intermediary capital shock beta sorted portfolios, Columns (2)-(3) examine the carry trade, and Columns (4)-(5) show estimates on the entire joint cross-section of currency strategy portfolios. The first stage time series regression is estimated for each portfolio by ordinary least squares, while the second stage involves a cross-sectional regression for each time, t of excess returns on estimated betas across all test assets/portfolios. I employ the second stage using the pooled mean groups estimator. Standard errors are constructed following the GMM methodology as in Cochrane (2005).

Table 8: Risk Price of Intermediary Capital Shocks vs. FX Factors

	Dependent variable:									
	Carry Trade					All Cross-Sections				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\beta_{IntCapital}$	0.015	0.056^{**}	0.056^{***}	-0.047	-0.027	0.005	0.028^{**}	0.035^{**}	0.011	0.019
	(0.043)	(0.024)	(0.022)	(0.087)	(0.077)	(0.011)	(0.011)	(0.016)	(0.011)	(0.014)
$\beta_{HMLCarry}$	0.078^{***}			0.084^{***}	0.084^{***}	0.081^{***}			0.088^{***}	0.075^{***}
	(0.019)			(0.019)	(0.019)	(0.022)			(0.023)	(0.022)
β_{Dollar}		0.013		0.019			0.018		0.019	
		(0.104)		(0.115)			(0.022)		(0.022)	
$\beta_{GlobalDollar}$			-0.005		0.131			0.108^{***}		0.103^{***}
			(0.190)		(0.219)			(0.041)		(0.037)
$\beta_{FFGlobalMkt}$	0.073	0.293^{*}	0.245	-0.357	-0.327	0.044	-0.026	-0.088	-0.146^{*}	-0.133
	(0.272)	(0.160)	(0.176)	(0.558)	(0.470)	(0.061)	(0.091)	(0.100)	(0.085)	(0.097)
Observations	1,968	1,968	1,968	1,968	1,968	11,480	11,480	11,480	11,480	11,480
R^2	0.884	0.886	0.883	0.923	0.922	0.674	0.675	0.691	0.695	0.712

$^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

Notes: This table display estimates of the risk prices from the second stage of the Fama MacBeth regression. Columns (1)-(5) display results for the cross-section of the carry trade, while Columns (6)-(10) employ the joint cross-section of all currency strategy portfolios. The first stage time series regression is estimated for each portfolio by ordinary least squares, while the second stage involves a cross-sectional regression for each time, t of excess returns on estimated betas across all test assets/portfolios. I employ the second stage using the pooled mean groups estimator. Standard errors are constructed following the GMM methodology as in Cochrane (2005).

Table 9: Determinants of Foreign Exchange Factors

	Dependent variable:							
	HML Carry				Global Dollar			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$CShock_t$	0.121***	0.125***	0.103***	0.083***	0.071	0.068	0.200***	0.184***
	(0.021)	(0.021)	(0.031)	(0.032)	(0.045)	(0.045)	(0.045)	(0.039)
$\Delta DurableC_t$		−0.071	−0.013	−0.003		−0.017	−0.102	−0.100
		(0.066)	(0.078)	(0.076)		(0.069)	(0.107)	(0.103)
$\Delta NonDurableC_t$		−0.144	−0.094	−0.104		0.266	0.103	0.117
		(0.194)	(0.339)	(0.334)		(0.261)	(0.484)	(0.480)
ΔVIX_t			−0.041***	−0.038***			−0.027	−0.020
			(0.013)	(0.013)			(0.019)	(0.019)
$\Delta LibOIS_t$			−0.021***	−0.018**			−0.028***	−0.025**
			(0.008)	(0.007)			(0.011)	(0.010)
$CFNAI_t$			0.003*	0.003*			0.004**	0.003*
			(0.002)	(0.001)			(0.002)	(0.002)
$MPShock_t$			−0.119	−0.109			−0.097	−0.078
			(0.085)	(0.085)			(0.093)	(0.092)
$GDol_t$				0.101				
				(0.077)				
HML_t								0.154
								(0.125)
Observations	406	406	147	147	358	358	147	147
R^2	0.072	0.077	0.321	0.331	0.023	0.025	0.332	0.343
Adjusted R^2	0.070	0.070	0.287	0.293	0.020	0.017	0.299	0.305

*p<0.1; **p<0.05; ***p<0.01

Notes: This table displays the estimates of the specification in Equation 4. Columns (1)-(4) and Columns (5)-(8) contain the HML carry and global dollar factor as dependent variables, respectively. Standard errors are Newey-West heteroskedasticity and auto-correlation consistent with optimal lag lengths following Andrews (1991)