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

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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 significantly prices the carry trade and the joint cross-section of a variety of currency portfolios, 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 high-minus-low (HML) carry factor of Lustig, Roussanov, and Verdelhan (2011), shedding light upon the economic sources of risk contained within this global risk factor. In addition, I show that intermediary capital remains relevant when compared with 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 full cross-section of foreign exchange portfolios.

JEL Classification: F31, G12, G15.

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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 to out-perform 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 (UIP), one of the main tenets of international finance that dictates exchange rates must adjust in expectation 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. 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). At the core of these models is the notion that empirically consistent exchange rate movements require the presence of constrained agents who intermediate and participate in foreign exchange markets. Their role as the marginal investors in these markets causes fluctuations in their risk-bearing capacities to influence exchange rate movements and consequently serve a central role in exchange rate determination. The risk-based interpretation suggests that if currencies pay off poorly when these intermediaries are more constrained, precisely when they have lower wealth and highly value an additional unit of wealth, these currencies are deemed as risky and should provide higher expected returns to compensate for this downside risk. From a general equilibrium perspective, risky currencies depreciate upon the realization of negative shocks that erode financial intermediaries' risk-bearing capacity in order to set up a future appreciation that yields higher expected returns in order to incentivize agents to hold these currencies.

Figure 1 displays the composition of foreign exchange volume from the Bank for International

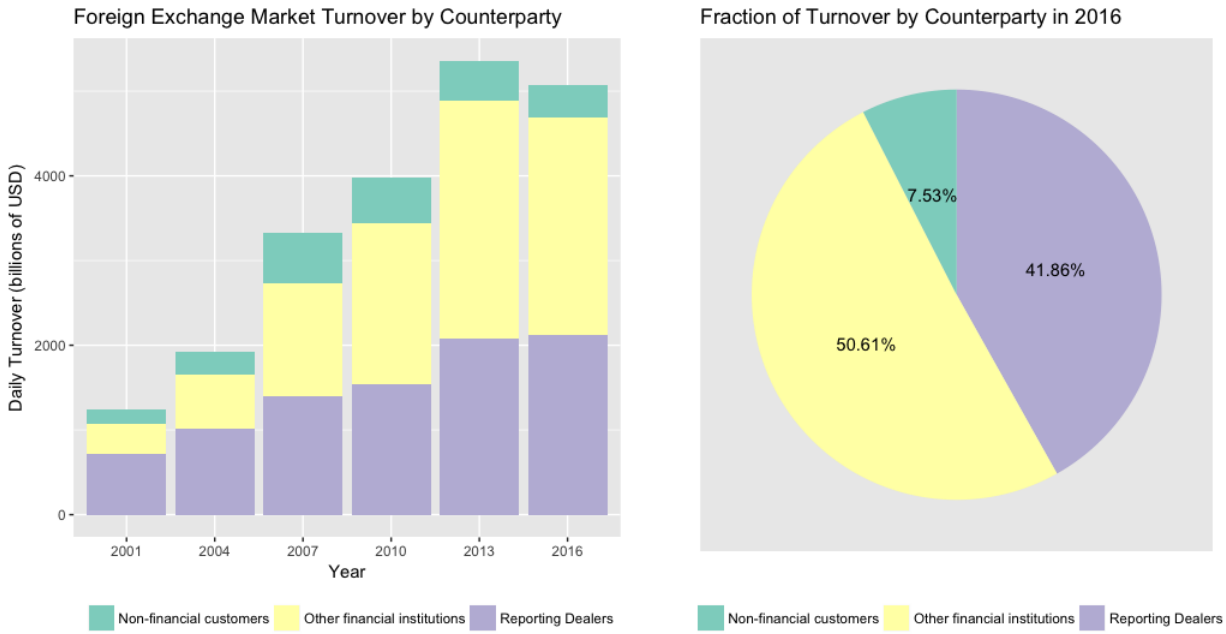

Figure 1: Daily Foreign Exchange Turnover Breakdown
Notes: Data comes from the Bank for International Settlements' Triennial FX Survey (2016). Turnover includes all foreign exchange instruments on a net-net basis from all countries to all other countries.

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 displaying financial institution turnover of over 90% of the total. The turnover data demonstrates 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.

Motivated by the recent theory and the outsize contribution of financial intermediaries to foreign exchange turnover, I formally ask whether financial intermediaries matter for the pricing of foreign exchange. If the open economy macro-finance theory holds true and financial intermediaries matter, I expect fluctuations in their risk-bearing capacity to be a significantly priced risk factor in the cross-section of exchange rate returns. Furthermore, the theory predicts a positive price of risk as currencies whose returns more positively co-vary with intermediary capital should yield the highest excess returns as compensation for the risk of depreciation and losses when intermediary capital erodes.

I confirm both of these predictions, finding that fluctuations in intermediary capital, a proxy for their risk-bearing capacity, commands a significantly positive risk price for the carry trade and the joint cross-section of a variety of currency portfolios. The significance of intermediary capital risk for the carry trade indicates that the existence of constrained intermediaries at the center of foreign exchange markets may provide one explanation for the failure of the uncovered interest parity as currencies with high interest rates may not depreciate enough and in fact appreciate due to compensation for the risk of larger depreciations and losses when intermediary capital erodes and agents become more constrained. The relevance of intermediary capital for the wider joint cross-section suggests that intermediary capital risk underlies a wide range of exchange rate risk premia and thus serves as a systematic source of global risk. My evidence thus validates open economy models with a central role for financial intermediaries in foreign exchange markets as I confirm the risk-based interpretation of exchange rate risk premia through the lens of financial intermediaries.

Following my confirmation of intermediary-based asset pricing models for exchange rates, I assess their performance in comparison to a traditional consumption-based asset pricing model. This exercise serves to elucidate whether financial intermediaries or households are the most relevant marginal investors, revealing whether models actually require financial intermediaries. I find that intermediary capital risk remains significant for both the carry trade and joint cross-section upon inclusion of consumption growth, consistent with intermediary-based asset pricing as it is intermediary capital risk rather than household consumption risk that prices foreign exchange, in line with intermediaries' roles as the marginal investors.

I also compare fluctuations in intermediary capital to previously identified exchange rate factors, namely the high-minus-low (HML) carry and dollar and global dollar factors of Lustig, Roussanov, and Verdelhan (2011, 2014) and Verdelhan (2018), in order to determine whether the risk-bearing capacity of financial intermediaries serves as one economic explanation for the risk contained within these factors. While factors constructed through portfolio-based methods provide an appealing proxy for underlying and generally unobservable risk factors, the economic sources of these risks are not clearly identified. I seek to fill this void by delineating whether intermediary capital serves as an independent source or one of the many sources of risk contained within these factors, shedding light upon the economic content of the HML carry and global dollar factors. I find that the HML carry factor serves as the most robust pricing factor for exchange rates, subsuming the previously significant intermediary capital risk, thus providing evidence that intermediary capital risk serves as a sub-component of the HML carry factor which contains a wider set of economic shocks and risk. Intermediary capital appears to be an independent and more relevant source of exchange rate risk compared to the dollar and global dollar factors, but intermediary capital does positively co-vary with the latter factor, suggestive that some of the risk contained within the global dollar factor is related to the risk-bearing capacity of financial intermediaries.

Taking a step back, recall that 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. Assets that provide poor returns when the marginal investor encounters low consumption, and equivalently 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 this theory. These models however have generally failed and/or entertain implausible coefficients for risk aversion (Mehra and Prescott 1985, 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 requirements, thus enters 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 are 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 dictates the size and presence of risk premia as assets that provide poor returns during periods of high constraints and consequently high 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 lower their net worth and constrain 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. Similarly, currencies that appreciate when intermediaries are more constrained should provide lower expected returns as they serve as insurance or hedges in the face of adverse shocks. This risk-based interpretation of exchange rate returns motivates the recent portfolio-based studies of exchange rates and the approach of this paper.

I confirm 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 exchange rate returns across portfolios of various strategies above and beyond other economic factors, namely consumption growth and the broader market return, and currency-specific factors such as the HML carry, dollar, and global dollar factors. I construct and employ currency portfolios to mitigate the influence of idiosyncratic country-specific risk and more accurately estimate betas while also assessing whether the risk premia captured by a wide range of cross-sections of currencies may be rationalized by the central role of financial intermediaries, a potential economic source of systematic global risk. While the recent literature has mainly focused on the identification of novel cross-sections of returns and sources of 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 currency returns. 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 merely a component of the previously identified risk factors that do not yet have definitive economic interpretations.

As alluded to before, I find that intermediary capital is a significant risk factor for the pricing of the carry trade and joint cross-section of foreign exchange portfolio returns when compared to consumption growth and the broader equity market. Currencies that more positively co-vary with fluctuations in intermediary capital, or high intermediary capital beta currencies, provide higher excess returns and vice-versa, in line with intuition and providing support for the relevance of the risk-bearing capacity of financial intermediaries as an economic source of risk for exchange rates. My results confirm the validity of this mechanism as I show that intermediary capital commands a significant and positive risk price when examining the carry trade in isolation and the joint cross-section of currency portfolios covering a diverse set of risk premia. My findings show that financial intermediaries provide one explanation for the forward premium puzzle and failure of the uncovered interest parity, rationalizing the higher excess returns captured by high interest rate currencies through a risk-based interpretation of exchange rate movements, while also identifying intermediary capital as a source of global risk that underlies a broad set exchange rate risk premia.

I also show that while intermediary capital risk serves as 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 or only marginally significant upon the inclusion of the robustly 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 carry risk factor shows that it may be one source of risk contained within the latter factor. Previous studies have shown the relevance of the HML carry risk factor, but have not yet conclusively 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 HML carry risk factor, I also provide an analysis of its connection with the dollar and global dollar factors of Lustig, Roussanov, and Verdelhan (2011) 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 obtained 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 is not.

I proceed to formally examine whether intermediary capital shocks 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 candidate sources of global risk. I find that intermediary capital is a robust source of risk contained within the HML carry factor, consistent with the economic relevance of intermediary risk for the pricing of foreign exchange. I also document the relevance of other economic sources of risk, namely risk aversion, liquidity, and US real activity for the HML carry factor, in line with previous studies and theory, and the co-movement of intermediary capital, liquidity, and US real activity for the global dollar factor, shedding light upon potential economic sources of risk contained within this less studied factor.

The paper proceeds as follows. Section 2 discusses where this paper lies in the broader literature. Section 3 describes the core data, portfolio construction methodology, and various summary statistics. Section 4 outlines the regression specifications, and displays and discusses the empirical asset pricing results. Section 5 examines the economic determinants of the portfolio-based exchange rate factors. Section 6 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 the intuition from closed economy macro-finance models and seeks to validate recent open economy general equilibrium models that include financial intermediaries and shocks.

The notion of intermediary-based asset pricing has been identified and tested by previous researchers, but a deeper examination of its relevance for exchange rates has not. Adrian, Etula, and Muir (2014) were the first to empirically test for the relevance of intermediaries in asset pricing, using the leverage of the US broker dealer sector as a proxy for the marginal value of wealth of financial intermediaries to find significant prices of intermediary risk for the excess returns of various portfolios of 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 test their factor on stocks, bonds, credit default swaps, 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. These findings are contradictory as leverage should simply be the inverse of the capital ratio and thus the prices of risk should be inverted as well. While macro-finance models can generate both results depending on whether the intermediary has a debt or equity constraint respectively, I follow He, Kelly, and 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 to the foreign exchange market, employing a wider set of exchange rate cross-sections and studying the relevance and interplay of intermediary shocks against previously established risk factors in the empirical foreign exchange asset pricing literature in search of an economic interpretation for the global shocks that drive foreign exchange returns.

Related to the connection between financial shocks and exchange rates, 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 the relationship between the carry trade and intermediary capital to uncover whether intermediary capital prices the carry trade and thus helps explains the forward premium puzzle, and the joint cross-section of currency portfolios to identify the existence of a systematic global risk factor with a meaningful economic interpretation. 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 find significant prices of consumption risk in the cross-section of exchange rate returns, arguing that exposure to US consumption risk explains the carry trade and the forward premium puzzle. Lustig, Roussanov, and Verdelhan (2011) continue this approach and find that the cross-section of carry trade returns is driven by two factors, namely a level and slope factor. 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 factor that is significantly priced in the cross-section and highly correlated with the currency slope factor. In addition, they find that the level factor is highly correlated with the average excess returns of foreign currencies against the dollar and establish this level factor as the dollar factor. Building on Backus, Foresi, and Telmer (2001), they interpret their findings through the lens of an affine model of exchange rates that identifies the necessity of heterogeneous loadings on a global factor that can be proxied by the HML carry factor in order to theoretically generate the cross-section of carry trade returns.

The level or dollar factor is explored in subsequent papers, namely Lustig, Roussanov, and Verdelhan (2014) and Verdelhan (2018). These papers 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 of depreciation of foreign currencies when bad shocks hit in times with high US volatility and thus high US investor marginal utility. This paper can rationalize this mechanism as US investor marginal utility may be proxied by the risk-bearing capacity of financial intermediaries if they are indeed the marginal investors in currency markets. 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, or what he calls the dollar factor, in the explained variation of exchange rate movements. He identifies a separate cross-section based on heterogeneous movements relative to this dollar factor, namely the dollar betas, and establishes the notion of a global dollar factor by taking the difference between high and low dollar beta sorted portfolios to isolate the global risk factor driving this separate cross-section that is purged of US-specific risk. He then finds that this cross-section of dollar portfolios is distinct from the carry trade and rationalizes its existence by positing an affine model with two orthogonal global shocks to generate both cross-sections, each of which can be proxied by the HML carry and global dollar factors. My paper seeks to shed light upon the economic content of these factor in relation to intermediary-based asset pricing.

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. 2012a, 2012b), and utilize the identified risk factors, namely the HML carry, dollar, and global dollar factors to compare to the intermediary capital shocks. I employ portfolios to reduce the influence of idiosyncratic, country-specific risk and combine portfolios from this diverse set of cross-sections to assess whether financial intermediaries serve as a source of systematic global risk that is present in exchange rate risk premia. My goal is similar to this line of research as I attempt to find another cross-section of currency returns and risk, but also complement it by examining the interplay between the intermediary shocks, previously identified exchange rate factors, and various cross-sections of currency portfolio returns. More importantly, given the portfolio-based approach of identifying risk factors, previous papers do not explicitly identify the economic source of the shocks contained within the HML carry and global dollar risk factors or an explanation of the heterogeneous loadings on these shocks in the lens of affine exchange rate models, although Lustig, Roussanov, and Verdelhan (2011) and Verdelhan (2018) do draw some connections between equity market volatility and the HML carry factor, and systematic exposure to global capital flows and the global dollar factor, respectively.

There also exists an immense literature on the carry trade and this paper contributes by highlighting that fluctuations in intermediary capital serve as one economic explanation behind its existence. Lustig and Verdelhan (2007) find the significance of US consumption growth, borrowing from Yogo's (2006) D-CAPM model to show that currency portfolios sorted on interest rate differentials align with consumption betas, providing evidence in support of consumption-based asset pricing as applied to foreign exchange. Burnside (2011) debates their findings on the basis of econometric issues, arguing that after accounting for the estimated regressors problem associated with the first-stage consumption betas and properly adjusting standard errors, he finds no significant risk price of consumption growth. My work builds upon both by comparing the relevance of intermediary capital to that of consumption growth, constructing standard errors that correct for the estimated first stage betas, and clarifying whether it is intermediaries or households that price the carry trade and broader cross-section of exchange rate returns. This exercise serves to distinguish between traditional consumption- and intermediary-based asset pricing models and validate whether the introduction of financial intermediaries into open economy models is warranted.

A series of papers examines the relevance of crash risk and peso problems to account for the carry trade. Brunnermeier, Nagel, and Pedersen (2008) identify the negative skewness of the carry trade, revealing the presence of infrequent, but large carry trade draw-downs and show that increases in global risk aversion coincide with carry trade losses. Burnside et al. (2011) argue for the relevance of peso problems as they find that traditional risk factors fail to price the carry trade, while the hedged carry trade provides lower returns compared to the traditional un-hedged version, indicative of compensation for downside risk. They proceed to show that the peso problem stems from high values of the marginal investor's stochastic discount factor in the peso state rather than large losses. Jurek (2014) provides a similar analysis and constructs a crash-neutral carry trade by hedging with out-of-the-money options, but he comes to a different conclusion. He shows that although the hedged carry trade provides slightly lower returns compared to the un-hedged version, there still exist significant excess returns to both and compensation for a peso state can only account for one-third of carry trade returns, which he interprets as an inability of peso problems to fully account for the existence of the carry trade. Lettau, Maggiori, and Weber (2014) document the downside-CAPM model that significantly prices the carry trade and a wide variety of assets, arguing for the asymmetry between risk premia associated with market declines and increases. Farhi and Gabaix (2016) introduce rare disaster risk into an open economy model, suggesting that some countries have higher interest rates because their currencies disproportionately depreciate when disasters arrive and investors must be compensated for this disaster risk through positive expected returns.

This paper connects to this literature by showing that financial intermediaries' risk-bearing capacity can be one way to rationalize crash risk. Burnside et al.'s (2011) finding that marginal utilities are disproportionately high in peso states for which the carry trade is compensated for is consistent with intermediary-based asset pricing as in times when intermediary capital is low and they are constrained, their marginal utility of wealth and thus stochastic discount factor is high, with risk premia sharply rising when intermediaries are almost or fully constrained. One class of peso event can then be financial crises in which intermediaries are constrained and demand higher risk premia, consistent with the closed-economy intermediary-based asset pricing literature. Similarly, down-side and disaster risk can be viewed through the lens of intermediary-based asset pricing as currencies that more positively load onto intermediary capital risk should disproportionately depreciate upon realizations of large negative capital shocks that lead intermediaries to become increasingly or completely constrained.[1] Furthermore, the relevance of global risk-aversion can also be interpreted through intermediary-based asset pricing as intermediaries with lower risk-bearing capacities should endogenously become more risk averse, thus commanding higher risk-premia

[1]This paper does not explicitly account for non-linearities in the asset pricing tests. Non-linearities are however explicitly modeled in the closed economy macro-finance literature, e.g. He and Krishnamurthy (2013) and Brunnermeier and Sannikov (2014).

and I confirm Brunnermeier, Nagel, and Pedersen's (2008) finding that risk aversion is negatively associated with carry trade returns.

Menkhoff et al. (2012), Hassan (2013), Daniel, Hodrick, and Lu (2017), Ready, Roussanov, and Ward (2017), Richmond (2016), and Jiang (2018) provide a variety of alternate explanations for the cross-section of carry trade returns due to volatility risk, country size, dollar and equity risk, 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. I go beyond these papers by assessing whether intermediary capital accounts for not only the carry trade, but also the joint cross-section of a variety of currency portfolios, showing that intermediary-based asset pricing alone provides an elegant and fundamental economic explanation to the forward premium puzzle and reveals an economic risk factor that underlies a wide set of exchange rate risk premia. In addition, the economic interpretations behind the shocks contained in the dollar and global dollar factors identified by Lustig, Roussanov, and Verdelhan (2011) and Verdelhan (2018) are less widely studied and I approach both through the lens of financial intermediaries, and a provide a formal analysis of potential determinants of the global dollar factor.[2]

The empirical intermediary-based asset pricing literature is based predictions from the closed economy macro-finance literature that hinges upon the existence of constrained financial intermediaries. Brunnermeier and Sannikov (2014), He and Krishnamurthy (2013), Danielsson, Shin, and Zigrand (2011), Adrian and Boyarchenko (2012), Garleanu and Pedersen (2011), Brunnermeier and Pedersen (2009) explore 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. Most closely related to this paper is He and Krishnamurthy (2013) who construct a model in which financial intermediaries serve as the marginal investors in risky assets as households are restricted from holding these assets and can only gain exposure by funding intermediaries who invest on their behalf. Intermediary net worth, and equivalently risk-bearing

[2] In the online appendix I explore whether capital flow elasticities to fluctuations in intermediary capital align with the dollar betas, finding a positive relationship between the two. My results point towards capital flows in relation to intermediary capital as an economic rationale behind the pattern of dollar betas.

capacity, plays a central role as households only invest up to a fraction of the intermediary's net worth, which can be interpreted as providing an incentive for intermediaries to optimally choose their portfolios as poor choices will negatively erode their capital and dry up their funding, leaving them more constrained. Non-linearities arise in the model as when the intermediary becomes fully constrained, risk premia sharply rise, in contrast to the unconstrained region.

The notion of financial intermediaries in macroeconomic models has also been extended to the open economy. Gabaix and Maggiori (2015) develop an open economy model with a constrained global financier/bank that intermediates all international bond trades and show that their model 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 as they show that carry trade returns erode upon realizations of shocks that negatively impact the intermediary's risk-bearing capacity and that intermediaries must be compensated for holding currencies that depreciate upon the realization of tighter financial conditions - I confirm their theoretical predictions in both asset pricing and standard regression tests. Itskhoki and Mukhin (2017) emphasize the role of financial shocks in general equilibrium open economy models, namely through a UIP wedge, to produce empirically consistent exchange rate movements. The financial shocks in their model can be interpreted as fluctuations in the risk-bearing capacity of financial intermediaries that drive deviations from the UIP as more constrained intermediaries will be less inclined to remove and balance deviations in the UIP and must be compensated via higher expected returns to hold high interest rate currencies that run the risk of depreciation. This paper thus 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 and the predictions of the models are borne out in the data. 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 full set of currencies. To remain consistent with previous studies, I splice the datasets in January 1997, using the Barclays data prior to this date and only the 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 of Hong Kong, Saudi Arabia, and the United Arab Emirates.

To remain consistent with the previous literature, I delete the following observations as in Lustig, Roussanov, and Verdelhan (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 2018), 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 on Asaf Manela's website. 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 New York Fed's website. They then hand-match these dealers to data on their respective public holding companies from CRSP, Compustat, and Datastream in order to construct the aggregate primary dealer capital ratio, η_t, defined as follows:

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

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

Note that the capital ratios aggregate and thus value-weight 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 outside of proprietary surveys, 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

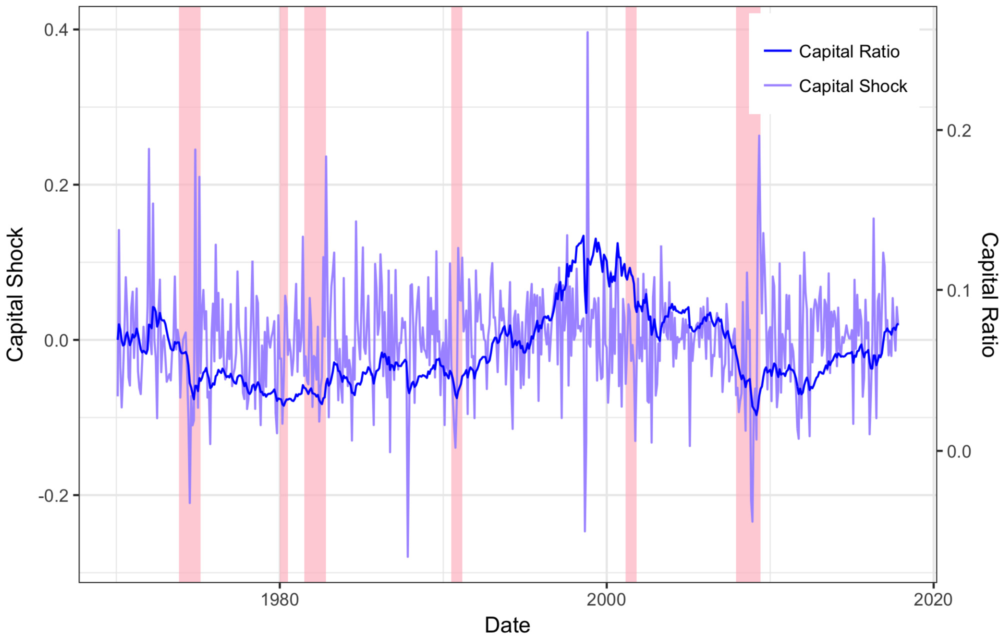

Figure 2: Intermediary Capital Ratio and Shock Series
Notes: The shaded bars indicate US NBER recessions.

coincide with periods of financial turbulence as evident by the sharp drops during the months containing Black Monday in 1987, the Russian default in 1998, and the Global Financial Crisis in 2008.

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 equity 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 causes the capital ratio to fluctuate by 7%.

Given that 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

Statistic	N	Mean	SD	Min	25th Pct	75th Pct	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

best. To show that intermediary shocks do not solely come from broad stock market fluctuations, I compute correlations of the intermediary capital shock series with the returns of the S&P 500 financials and excluding financials indices, and the Fama-French global market. Looking at the correlations in Table 2, it is apparent that intermediary capital shocks coincide with fluctuations in the financials sector of the S&P 500 and that 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 market and economy.

3.3 Excess Returns

Let s_t and f_t denote the log spot and forward rates respectively 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 to buy the foreign currency and sell it on the spot market in the future 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:

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

where i_t^* is the foreign interest rate and i_t is the US interest rate. The log excess return is thus approximately equal to 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 a country- or currency-specific characteristic such as their forward discount or exposure to a 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 idiosyncratic country-specific 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.[3] In addition as explained in Cochrane (2005), utilizing portfolios of assets rather than the assets themselves enhances the measurement of betas as portfolios tend to have lower residual variance and more stable betas over time, mitigating measurement error issues in the asset pricing tests. Furthermore, given that characteristics may be highly variable for currencies, measuring betas using portfolios sorted by characteristics provides more stable estimates as characteristic-specific betas may be less volatile.

This paper adopts the portfolio construction approach and constructs a variety of currency portfolios in order to examine whether intermediary capital shocks price the carry trade, the broader

[3]Note that given the limited number of currencies, this approach of nullifying idiosyncratic risk is of course not as effective compared to equities which are more numerous.

joint cross-section, and reveal their own cross-section of excess returns. I discuss each in turn.

Intermediary Capital Shock Portfolios

In order to determine whether exposure to intermediary shocks constitutes a new and 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 should provide higher excess returns as they provide poor returns when negative intermediary shocks arrive, whereas the low portfolio contains currencies that appreciate or depreciate by relatively less than high beta currencies upon realizations of negative shocks. If the intermediary shocks capture a significant risk factor, 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. It comprises of going long or purchasing the currencies of countries with high interest rates, typically the Australian or New Zealand dollars, while funding these investments by shorting or selling currencies of countries with lower interest rates, such as the Japanese yen or Swiss franc, in the context of G10 currencies. The carry trade is predicated on the failure of the uncovered interest parity as theory suggests that higher interest rate countries' currencies should depreciate sufficiently to offset interest rate differentials and equate expected returns across currencies, a prediction inconsistent with the data as the strategy yields sizeable returns. This anomaly gives rise to the forward premium puzzle.

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, $f_t{-}s_t$, rebalancing every month. Recall that if covered interest parity holds, then 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 rate currencies by shorting low interest rate 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. This rationalizes higher expected returns at all other times as compensation for this risk and the HML carry factor proxies for the underlying global risk factor.[4]

Dollar Portfolios and Global Dollar Factor

Verdelhan (2018) identifies an additional risk factor and cross-section of currency excess returns, distinct from the 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 of the dollar which he argues is also monotonically increasing in excess returns. I call these portfolios sorted by dollar betas the dollar portfolios.

Similar to Verdelhan (2018), my dollar portfolios are obtained by first running 36-month window rolling regressions of the excess return of a specific currency against the average excess return of

[4] Lustig, Roussanov, and Verdelhan (2011) rationalize the existence of the carry trade in an affine model of exchange rates and show that countries must be heterogeneously exposed to a global shock. Differencing the top and bottom portfolios is equivalent to isolating this global shock.

going long all foreign currencies against the dollar. I depart from his construction with spot rates as I find the strategy constructed from the univariate specification with excess returns to be more profitable, but both strategies have the same interpretation - high dollar beta currencies provide higher returns when the dollar depreciates on average against all currencies 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 cause the dollar to broadly appreciate are realized. 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 may contain information about future returns.

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 that each currency or portfolio is differentially exposed to in the cross-section.[5] 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.

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

Momentum Portfolios

In addition to the intermediary capital, carry, and dollar portfolios, I construct a set of momentum portfolios, following Menkhoff et al. (2012a). Currencies are ranked on their previous month's excess returns with the idea that winners continue their out-performance while losers extend their losses. I construct six portfolios as with the other cross-sections, with the highest portfolio containing the currencies that have the largest 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. (2012b) examine the carry trade from the perspective of foreign exchange volatility, positing that carry trade returns are rationalized because the strategy performs poorly during bouts of high volatility. I construct a measure of monthly foreign exchange volatility as in their paper:

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

where $|\Delta_{\tau,i}|$ is the absolute log change in the spot rate of currency i on day τ. T_t and N_τ signify the number of trading days in a given month and currencies on a given day, respectively. Monthly foreign exchange volatility is equal to the monthly average of the daily averages of absolute daily log spot changes. 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, i.e.

$$rx_{i,t} = \alpha_i + \beta_i^{Vol} Vol_t + \epsilon_{i,t}$$

where Vol_t is the residual from the first order autoregression of the volatility series.[6]

[6] I also construct the portfolios with the difference in the volatility series as the factor and find qualitatively similar results.

Currencies with the largest covariances with volatility innovations should yield low excess returns as they perform similar to hedges against volatility, yielding high returns in bouts of elevated volatility. On the other hand, currencies with little or no covariance with volatility should yield higher excess returns as they may depreciate and pay off poorly when volatility is elevated. Note that the pattern of excess returns and high-minus-low are constructed opposite all of the other portfolios as the “high” portfolio here contains currencies with the lowest exposures and volatility betas.

Value Portfolios

Finally, 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 (PPP) nr real exchange rate (RER) 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.

$$Value_{i,t} = log\left(\frac{RER_{i,t}}{RER_{i,t-60}}\right) = -log(\frac{\bar{s}_{t-55,t-65}}{s_t}) - \left[log\left(\frac{P_t^f}{\bar{P}_{t-55,t-65}}\right) - log\left(\frac{P_t}{\bar{P}_{t-55,t-65}}\right)\right]$$

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 I do not focus only on G10 currencies and generate a larger number of portfolios, namely six versus their three.

	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	-0.45	1.09	-0.19	0.75	-0.32	2.50	2.99
SD	7.51	7.62	8.36	8.57	9.49	10.82	9.73
Sharpe	-0.06	0.14	-0.02	0.09	-0.03	0.23	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.

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 definitively monotonically increasing in returns across portfolios with the high-minus-low, or zero-cost-investment, strategies yielding mean excess returns of 7.1% and 6.1% per annum respectively. 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 fifth, or 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. 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 top volatility portfolio contains currencies that are the least exposed to foreign exchange volatility and exhibits the highest returns compared to those that are relatively more exposed.[7] This is in line with intuition as the currencies in the bottom portfolio, which have the higher

[7]Recall that the top volatility portfolio, namely portfolio 6, contains currencies with the lowest volatility betas, whereas the bottom portfolio contains those with the highest volatility betas. I use this convention to remain consistent with the other portfolios in which the top portfolio contains risky currencies, while the bottom has the least risky.

volatility betas, 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 high-minus-low yields a mean excess return of 3% with a Sharpe ratio of .31, improving upon the return of only the top portfolio due to the shorting of the bottom 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.

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. This builds support for the existence of a risk-based explanation for the cross-section of returns as it appears that increased loadings or exposure to potential risk factors and shocks are associated with consistently higher 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 declining persistently since then. An investor would have been better off only going long the top portfolios as indicated by the larger cumulative and excess returns without shorting the bottom portfolio, which recall has positive mean excess returns and erodes 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. There is a recovery following this sharp drop, but returns essentially stagnate

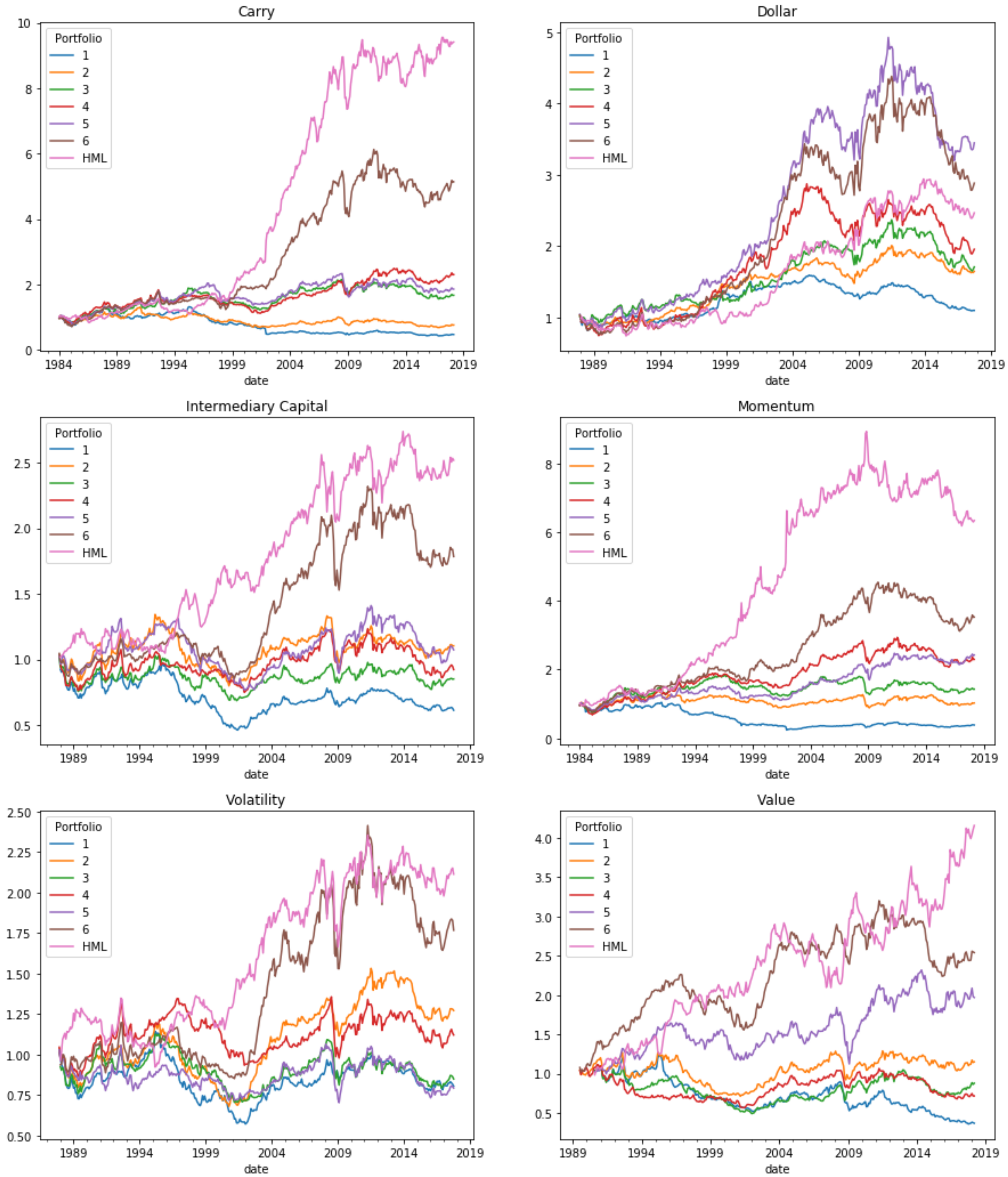

Figure 3: Cumulative Returns of FX Portfolio Strategies

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.

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 persistent 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.[8]

4 Empirical Results

I shift now to a formal empirical analysis of the relationship between intermediary capital and exchange rate movements. I begin with a brief analysis of exchange rate movements with the intermediary capital shocks and the HML carry and dollar factors to assess whether currencies exhibit the predicted patterns, namely whether risky currencies depreciate and safe haven currencies appreciate when negative capital shocks are realized. I then proceed to conduct asset pricing tests to evaluate the relevance of intermediary capital compared to the market return and consumption growth. My findings align with the theoretical predictions outlined in the introduction and literature review, supporting the central role of financial intermediaries in exchange rate determination and providing evidence in favor of open economy, intermediary-based asset pricing models.

The latter part of this section examines the interplay of intermediary capital with the HML carry, dollar, and global dollar factors. My asset pricing tests display the dominance of the HML carry factor as a significant source of risk for exchange rates and the subsumption of intermediary capital risk upon inclusion of the HML carry factor suggests that intermediary capital risk is one of the many sources of risk embedded within the HML carry factor. My results with the dollar and global dollar factor maintains the relevance of financial intermediaries, and shows that the global component of dollar risk, as isolated by the global dollar factor, significantly prices the joint

[8]Note that nearly all of the strategies except value appear to reach peaks in 2010 and have not been nearly as profitable since then. I examine this further in the online appendix by deconstructing portfolio returns into interest rate and exchange rate depreciation components for the pre- and post-2010 periods for each cross-section and find that a combination of compressed interest rate differentials and unfavorable dollar appreciation lead to declines in currency strategy returns.

cross-section of exchange rate portfolios.

4.1 Spot Changes and Intermediary Shocks

I first examine whether intermediary capital shocks contain any information content beyond that held in the spot changes of the HML carry and dollar factors. The former takes the difference between exchange rate changes of the currencies with the largest and smallest forward discounts, which proxy for interest rate differentials, while the latter reflects the average of all exchange rate changes against the dollar. I estimate the following for each currency:

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

Note that $HML_{-i,t}$ and $Dol_{-i,t}$ exclude the currency 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 variation. For example, if the dollar on average appreciates by one percent, β_i^{Dol} yields the amount country i's currency depreciates in percentage terms.

The results for the G11 currencies are displayed in Table 4. Column (1) displays the sensitivities of exchange rate movements to the risks contained within carry trade as measured by spot rate movements. 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 rate currencies such as the Japanese yen and Swiss franc, we observe negative coefficients, suggesting that these currencies appreciate when the carry trade is depreciating.

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, which is 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 the currencies of Australia, Canada, the United Kingdom, Japan, and New Zealand each depreciate less than one-for-one with the average depreciation against the dollar, while those of Switzerland, Denmark, Europe, Norway, and Sweden depreciate by more than the average. There appears to be no commonality for why these currencies move more or less

Table 4: Systematic Variation in Exchange Rate Changes (Developed)

Country	HML (1)	Dol (2)	CShock (3)	R2 (HML) (4)	R2 (HML, CS) (5)	R2 (All) (6)
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.

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 the intermediary capital ratio, 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 a half percent appreciation respectively. Consistent with intuition, safe haven currencies tend to appreciate when negative intermediary capital 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, respectively. We can see that the intermediary capital shock adds some explained variation, suggesting that intermediary capital shocks provide some additional

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

Country	HML (1)	Dol (2)	CShock (3)	R2 (HML) (4)	R2 (HML, CS) (5)	R2 (All) (6)
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.

information content above and beyond that of the carry trade itself. The full specification has quite high R^2's of up to 83% for the Danish krone and 78% for the euro, showing that average changes in the dollar account 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 broad movements of the dollar against all currencies.

Table 5 displays the results for emerging markets currencies. Column (1) shows that the vast majority of emerging markets 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 moves by less than the average against the dollar. While Column (3) only yields a few significant estimates, note that they are mostly negative and similar in magnitude to the risky advanced economy currencies. If we take the stance that emerging markets currencies are risky, this is consistent with theory as negative intermediary capital shocks are associated with emerging markets 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 conduct an examination into the pricing of intermediary capital risk in the cross-section of foreign exchange returns. I perform a series of asset pricing tests to establish the relevance of intermediary capital as a risk factor, comparing its performance to the market return and global consumption growth in order 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 exchange rate factors.

I show the following in turn: First, intermediary capital shocks provide an economic source of risk that underpins the carry trade, robust to the inclusion of consumption growth which reflects the relevance of financial intermediaries' pricing kernels over those of households. Although intermediary capital shocks do not constitute their own, independent cross-section of returns, the results show that they do matter for the carry trade and the joint cross-section of all currency portfolios. Second, the HML carry factor subsumes the risk embedded in the intermediary capital shocks and prices both the carry trade and 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 global shocks independent of those contained within the HML carry factor 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 for portfolio i, 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 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 $\hat{\lambda} = \sum \hat{\lambda}_t / T$, 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.[9]

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 which employs 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 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.[10] Interested readers are encouraged to refer to

[9]Another option is the Shanken (1992) correction. Suppose we have N test portfolios, K factors, and T periods. Per Cochrane (2005), the Shanken 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.

[10]My selection procedure also highlights the S&P 500 excluding financials as a factor, but for parsimony I only include the results with the global market return given the limited number of test portfolios, especially for the carry trade. The results with this other control factor in lieu of the global market are included in the online appendix and results are similar.

the online appendix where I provide a full discussion of the factor selection procedure.

4.3 Intermediary Capital as an Economic Risk Factor

Table 6 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 by 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.[11]

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 at bad times 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, thus eliminating the existence of this independent cross-section of exchange rate excess returns.

However moving 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 high interest rate currency portfolios have high intermediary capital betas as their returns more positively co-move with the intermediary capital shocks, and are thus compensated for the risk of low returns when intermediary capital erodes. This provides support for intermediary capital as a fundamental economic source of risk embedded in exchange rates and provides an explanation for the forward premium puzzle as investors appear to be rewarded for holding high interest rate currencies that run the risk of depreciation when intermediary capital declines. Notice that intermediary capital risk is priced

[11] He, Kelly, and Manela (2017) test their factor against the carry trade and momentum portfolios from Lettau, Maggiori, and Weber (2014) 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 a wider set of currency portfolios to capture additional cross-sections of exchange rates from the literature.

Table 6: Risk Price of Intermediary Capital Shocks vs. Global Market Return and Consumption

	Intermediary Capital	Carry Trade			All Cross-Sections		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\beta_{IntCapital}$	0.011	0.059^{***}	0.042^{**}	0.079	0.026^{**}	0.025^{**}	0.023^{*}
	(0.012)	(0.022)	(0.018)	(0.079)	(0.011)	(0.010)	(0.014)
$\beta_{FFGlobalMkt}$	0.066	0.202		0.326	0.107^{*}		0.154^{**}
	(0.080)	(0.136)		(0.637)	(0.057)		(0.069)
$\beta_{DurableCons}$			−0.049	−0.237		0.085	0.084
			(0.241)	(0.942)		(0.107)	(0.093)
$\beta_{NonDurableCons}$			0.030	0.118		0.077^{*}	0.079^{**}
			(0.041)	(0.309)		(0.044)	(0.033)
Observations	1,968	1,968	2,436	1,968	11,772	11,772	11,772
R^2	0.840	0.808	0.783	0.904	0.625	0.591	0.712
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)-(4) examine the carry trade, and Columns (5)-(7) 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).

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 all currency portfolios. Column (5) 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 captures different sources of risk premia and anomalies in exchange rates. I find a significant price of intermediary capital risk at 2.6% 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 systematic economic source of global risk that is embedded within a wide number of exchange rate risk premia, 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.[12]

An additional finding is the significance of the global market return for the entire cross-section of foreign exchange returns at 10.7% 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 the wider cross-section of foreign exchange excess returns leads one to question whether it is a distinct economic source of risk independent of the consumption growth risk found by Lustig and Verdelhan (2007). One could argue that intermediaries are just a veil for households, and that intermediary capital risk may just proxy for household consumption growth risk. If this is true, models with financial intermediaries may then be adding an additional layer of complexity that

[12] I also test each cross-section independently in the online 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.

is not necessarily warranted. 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. This exercise clarifies the relevance of financial intermediaries versus households in the pricing of exchange rates.

Column (3) of Table 6 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 significant and positively priced at 4.2% per annum, while the consumption growth factors are not priced. My results show that intermediary capital risk is more important than household consumption risk in explaining the carry trade as investors appear to be compensated for co-movement of exchange rate returns with fluctuations in the financial intermediaries' pricing kernel rather than that of households. My findings validate the notion that open economy models require constrained intermediaries at the center of asset markets in order to account for the failure of the UIP and existence of the forward premium puzzle as the prediction and pattern of high interest rate currencies more positively co-varying with intermediary capital and thus subject to larger relative depreciations upon the realization of negative intermediary capital shocks is borne out in the data.

This finding is again extended to the entire cross-section of foreign exchange portfolios as indicated in Column (6). As before, we find a smaller, but significant price of intermediary risk at 2.5% per annum, verifying the robust importance of intermediary capital risk for the joint cross-section of exchange rate returns. In contrast to estimates with the carry trade alone, I also obtain a positive and significant price of non-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 the be more relevant marginal investor given the recent success of the theory and my more robust findings in support of intermediary capital risk.

My results provide support for the importance of including constrained financial intermediaries in open economy macro-economic models in order to reconcile some of the inconsistencies between the theory and data.

Columns (4) and (7) serve as robustness checks by controlling for the global market return as well. For the carry trade I find that in contrast to before, none of the factors are now significant as displayed in Column (4). However, I rationalize this finding in two ways: first, note that the global market return is correlated with the intermediary capital shocks as displayed in Table 2 and thus its inclusion may dilute the significance of intermediary capital risk, especially if the relevant components of consumption growth and the capital shocks are also partially contained within the global market return. Second, given that I only have six portfolios in the carry trade cross-section, the regression has almost as many regressors as test portfolios - the risk prices may then be mis-estimated and the lack of significance may be a by-product of this.[13]

On the other hand, the full specification in Column (7) for the joint cross-section retains the significance of intermediary capital risk. Risk prices are presumably more precisely estimated in this larger sample given the increased number of portfolios and I find that intermediary capital is again a significant and positively priced risk factor for exchange rates at 2.3% per annum. The risk price of intermediary capital decreases in the level of significance, which I attribute to dilution due to the inclusion of the global market return, which is also significantly priced at 15.4% per annum. Given that non-durable consumption growth remains significantly priced, my results thus suggest that while financial intermediaries have the more robust pricing kernels, the risk embedded in consumption growth also plays a role, consistent with Lustig and Verdelhan (2007) and intuition as one would expect real shocks to be relevant for a wider set of exchange rate risk premia.

To visualize the effectiveness of intermediary capital in pricing the cross-sections of foreign exchange, Figures 4 and 5 display scatter plots of mean portfolio returns against intermediary capital betas. Figure 4 shows that the carry trade portfolios are monotonically increasing both in mean excess returns and intermediary capital betas, implying that the carry trade and forward

[13] I have also run specifications with only one type of consumption growth risk that include the global market return. I find significance for intermediary capital risk in the specification with only intermediary capital shocks, non-durable consumption growth, and the Fama French global market return.

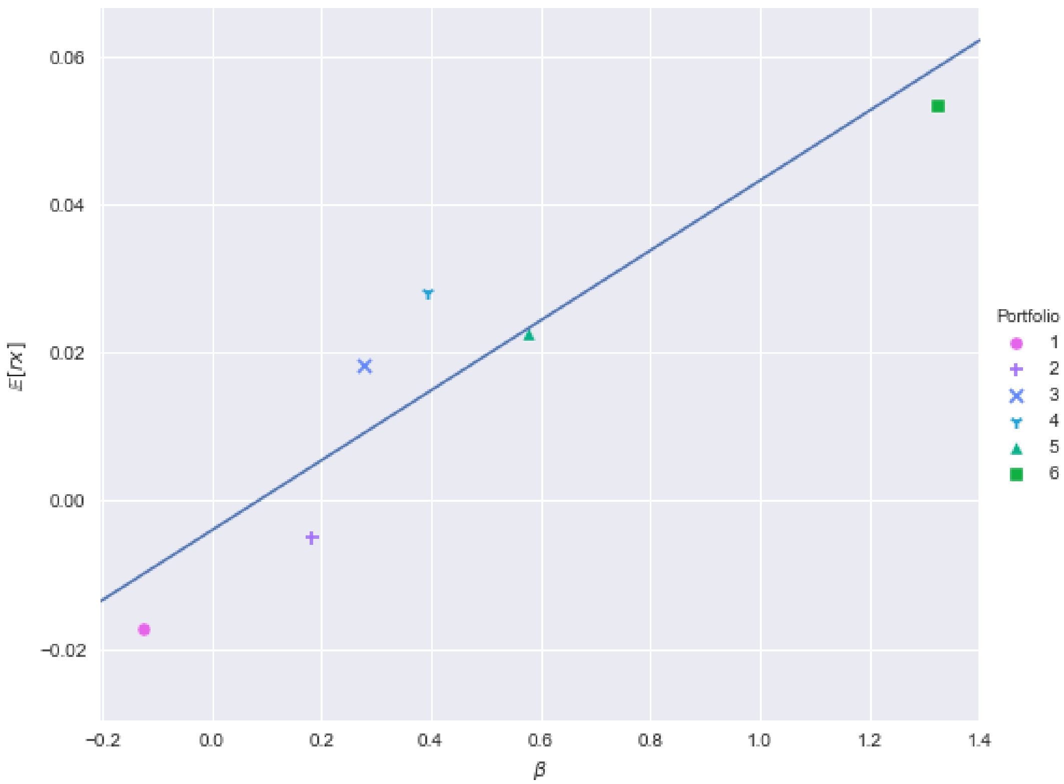

Figure 4: Carry Trade Mean Excess Returns and Intermediary Capital Betas

This figure displays the mean excess returns of each portfolio of the carry trade cross-section, namely currencies sorted on forward discounts. The x-axis contains intermediary capital betas, estimated for each portfolio by regressing its excess returns across the whole sample on a constant and the intermediary capital shock. The line reflects the best fit for the relationship between average portfolio returns and betas.

premium puzzle may be explained through the lens of intermediary capital risk as it is apparent that higher interest rate currencies are precisely those that are more exposed to intermediary capital shocks. These currencies enjoy higher excess returns because their larger co-movement with intermediary capital leads to depreciations and losses when intermediary capital erodes, coinciding with times of high intermediary marginal utility that require increased compensation and risk premia for downside risk.

Figure 5 displays the analogous plot for the joint cross-section of all currency portfolios. I obtain a similar pattern as with the carry portfolios - high portfolios enjoy higher excess returns and coincide with larger intermediary capital betas, while lower portfolios yield lower excess returns and have lower and even negative intermediary capital betas. Risky currency portfolios are again those that exhibit larger mean excess returns which are rationalized by relatively larger co-movements with intermediary capital, while the safer currency portfolios exhibit low or even negative co-movement with intermediary capital, in line with the intuition that currencies which appreciate upon the realization of negative intermediary capital shocks serve as hedges and should provide lower returns. Although not strict, I do observe a generally monotonic relationship between portfolios and intermediary capital betas as the bottom left, middle, and top right of the plot contain the low and less risky, intermediate, and high and most risky portfolios, respectively.

It is important to note that this pattern holds despite the different measures upon which each cross-section is sorted and constructed. The robust pattern between intermediary capital betas and portfolio excess returns is invariant to the sorting characteristic, lending credence to the notion that intermediary capital risk in fact underpins a wide set of exchange rate risk premia and thus serves a systematic source of global risk. Currency portfolios that are deemed as risky due to their larger exposure to risk factors are also more exposed to fluctuations in intermediary capital, implying that intermediary capital risk is embedded and compensated for in a variety of cross-sections of exchange rates and risk premia.

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. My results point towards the central role that financial intermediaries play in open economy models in order to give rise to deviations in the UIP and the forward premium puzzle as high interest rate currency portfolios provide higher mean excess returns as compensation for larger exposures to fluctuations in intermediary capital. I also show that intermediary capital risk underpins a number of exchange rate risk premia as the positive relationship between intermediary capital betas and risky portfolios holds for the joint cross-section, invariant to the criteria of sorting, thus providing evidence in favor of intermediary risk-bearing capacity as a systematic source of global risk.

Furthermore, I find that intermediary capital risk remains a significantly priced risk factor when compared to household consumption risk, providing evidence in support of financial intermediaries as the marginal investors in open economy asset pricing models as opposed to households. The evidence is strongest for the carry trade as intermediary capital risk is significantly priced whereas

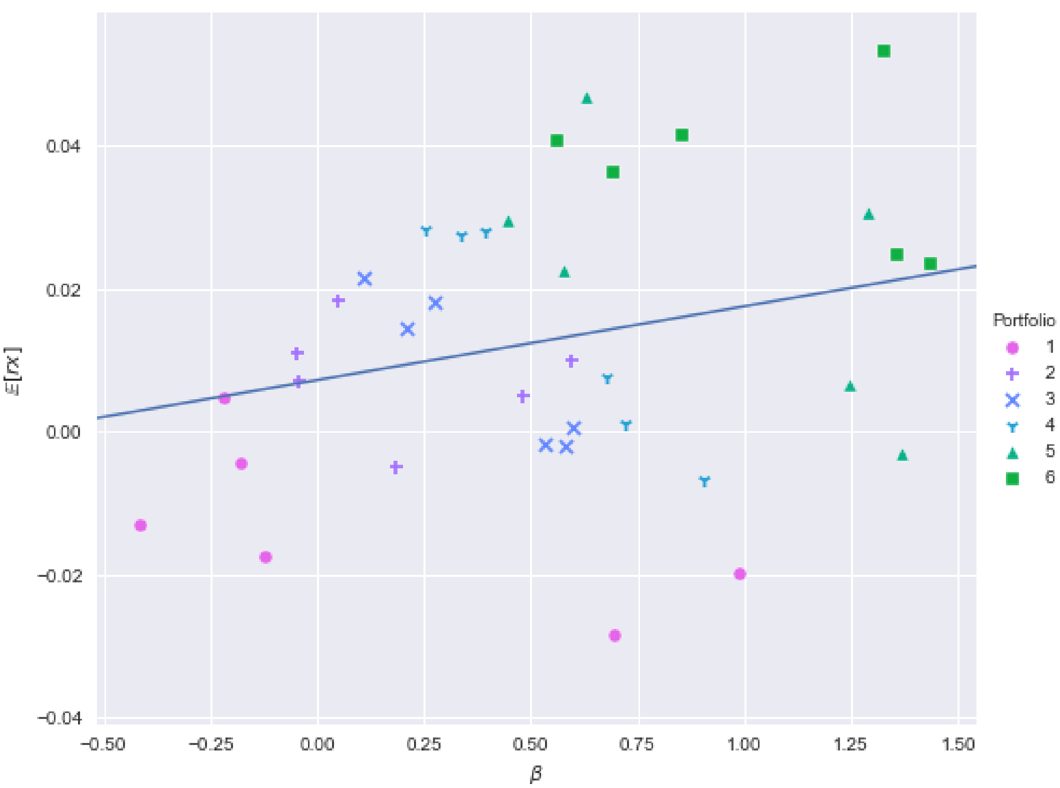

Figure 5: Mean Excess Returns and Intermediary Capital Betas

This figure displays the mean excess returns of each portfolio of the joint cross-section of exchange rates, which includes six portfolios for intermediary capital, carry, dollar, momentum, volatility, and value. The x-axis contains intermediary capital betas, estimated for each portfolio by regressing its excess returns across the whole sample on a constant and the intermediary capital shock. The line reflects the best fit for the relationship between average portfolio returns and betas.

consumption risk is not, consistent with the notion that open economy models require constrained intermediaries to resolve some of the discrepancies between theory and empirics. While my results do not preclude the relevance of households in the pricing of exchange rate risk as non-durable consumption growth risk is significantly priced in the joint cross-section, the more robust evidence in favor of intermediary capital risk leans towards the larger relevance of the intermediaries.

4.4 Intermediary Shocks vs. Portfolio FX Factors

I now investigate whether intermediary capital shocks provide additional information content and serve as a risk factor beyond 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, dollar, and global dollar factors as risk factors. The intuition is that if the HML carry and global dollar factors 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 within their respective cross-sections. 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, dollar, and global dollar factors. On the other hand, if the risk embedded in intermediary capital shocks is merely a component of these factors, we expect insignificant risk prices as they should be subsumed by 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 7 compares the 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 priced into the cross-section of the carry trade at 7.8% per annum whereas the price of intermediary capital risk is now insignificant. This is not surprising as we expect the risks embedded within the carry trade to wholly account for its cross-sectional variation, but it is of interest that intermediary capital risk is now no longer significantly priced. We observe the robust significance of the price of HML carry risk again in the full sample with all cross-sections tested simultaneously at 7% per annum in Column (6). Both

Table 7: Risk Price of Intermediary Capital Shocks vs. FX Factors

	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	0.014	0.031^{***}	0.035^{**}	0.019^{*}	0.023^{*}
	(0.043)	(0.024)	(0.022)	(0.087)	(0.077)	(0.011)	(0.011)	(0.014)	(0.011)	(0.013)
$\beta_{HMLCarry}$	0.078^{***}			0.084^{***}	0.084^{***}	0.070^{***}			0.074^{***}	0.065^{***}
	(0.019)			(0.019)	(0.019)	(0.023)			(0.023)	(0.023)
β_{Dollar}		0.013		0.019			0.016		0.018	
		(0.104)		(0.115)			(0.023)		(0.022)	
$\beta_{GlobalDollar}$			−0.005		0.131			0.088^{**}		0.087^{**}
			(0.190)		(0.219)			(0.040)		(0.038)
$\beta_{FFGlobalMkt}$	0.073	0.293^{*}	0.245	−0.357	−0.327	0.069	0.003	−0.046	−0.066	−0.082
	(0.272)	(0.160)	(0.176)	(0.558)	(0.470)	(0.058)	(0.085)	(0.081)	(0.079)	(0.081)
Observations	1,968	1,968	1,968	1,968	1,968	11,772	11,772	11,772	11,772	11,772
R^2	0.884	0.886	0.883	0.923	0.922	0.647	0.648	0.658	0.670	0.680

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

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).

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. The global risks proxied by the HML carry factor appear to be important for the pricing of a wide set of exchange rate risk premia, not just the carry trade itself.

The significance of the HML carry factor over the previously significant intermediary capital shocks provides new information about the interaction between these two risk factors. 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-sections of exchange rate returns and intermediary capital shocks merely serve as one economic source of risk contained within it.

Columns (2)-(3) and (7)-(8) of Table 7 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 3.1% 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 8.8% per annum for the joint cross-section.

The finding that dollar risk is not priced whereas global dollar risk is sheds light upon how heterogeneous exposures to global shocks help explain the cross-section of foreign exchange returns. Despite my early confirmation of Verdelhan's (2018) 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, namely risks that are purged of US-specific risk, that matters for pricing the cross-section. 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-section. Note however that

Lustig, Roussanov, and Verdelhan (2011) show that the dollar factor is akin to a level factor as all currencies load onto it equally. It is not surprising then that it contains no significant pricing power as there is no heterogeneity in exposure to this risk factor, so it should not account for the cross-sectional heterogeneity in returns. On the other hand, the global component of this factor should be differentially loaded upon as shown by Verdelhan (2018), allowing an assessment of its risk pricing and relevance for the cross-section of exchange rate returns.

Columns (4) and (9) of Table 7 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 is the dominant pricing factor as we observe significant prices of risk for the cross-sections of the carry trade and all portfolios at 8.4% and 7.2% per annum respectively. Intermediary capital is again subsumed for the carry trade, but it is marginally significant for the joint cross-section with a risk price of 1.9%. The results show that while intermediary capital serves as a relevant risk factor for both the carry and joint cross-sections in absence of the HML carry factor, the HML carry factor serves as the more dominant pricing factor, either mitigating or eliminating the relevance of intermediary capital entirely. I interpret this as evidence that the HML carry factor encapsulates a wider array of sources of global risk of which intermediary capital is one. 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 without the HML carry factor.

Columns (5) and (10) of Table 7 display a similar exercise but instead using the global dollar factor, which recall is the difference in excess returns between high and low dollar-beta currency portfolios. While the dollar factor itself contains information about US-specific shocks as bilateral exchange rates 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. HML carry risk is again significantly priced for the carry trade and all portfolios at 8.4% and 6.5% per annum respectively. As in the case with the dollar factor, intermediary capital risk is also marginally priced at 2.3% per annum for the joint cross-section, but not the carry. 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 8.7% per annum. This confirms the previous result that global risk is pertinent in the pricing of exchange rate risk and contains risks that are independent of those contained within the HML carry factor.

One might ask whether the marginal significance of intermediary capital risk in the joint cross-section in the specifications in Columns (9) and (10) invalidates the claim that intermediary capital is contained within the HML carry factor as it should be insignificant upon the inclusion of the factor that subsumes it. Concerns may be alleviated under the assumption that the HML carry factor contains a number of risks, which include intermediary capital. It could be the case that there are times when intermediary capital fluctuates, but other risks contained in the HML carry factor also move, nullifying the effect of intermediary capital risk on the carry trade and leaving a net zero effect on the HML carry factor. However if intermediary capital risk is still relevant for exchange rate risk premia, the capital shock alone would capture this variation, whereas it would be overlooked and awash if only proxied by the HML carry factor. I posit that the marginal significance of intermediary capital risk despite the inclusion of the HML carry factor captures this relationship.

Figure 6 displays the scatter plot of mean portfolio returns and HML carry betas for all cross-sections. As with the intermediary capital betas, we observe a relatively monotonic relationship between mean portfolio excess returns and exposure to the HML carry factor as measured by each portfolio's HML carry beta. Lower, less risky portfolios are contained in the bottom left of the plot, while the risky, high portfolios occupy the upper right of the plot. The plot thus supports the notion that the HML carry factor contains sources of global risk that currency portfolios are all differentially exposed to, with the most exposed yielding the highest excess returns as compensation for HML carry risk and the least exposed yielding lower returns due to the relative safety in the face of adverse shocks that erode the HML carry factor.

My asset pricing tests have thus illuminated the following: first, intermediary capital shocks provide an economic source of risk behind the carry trade and the broader cross-section of

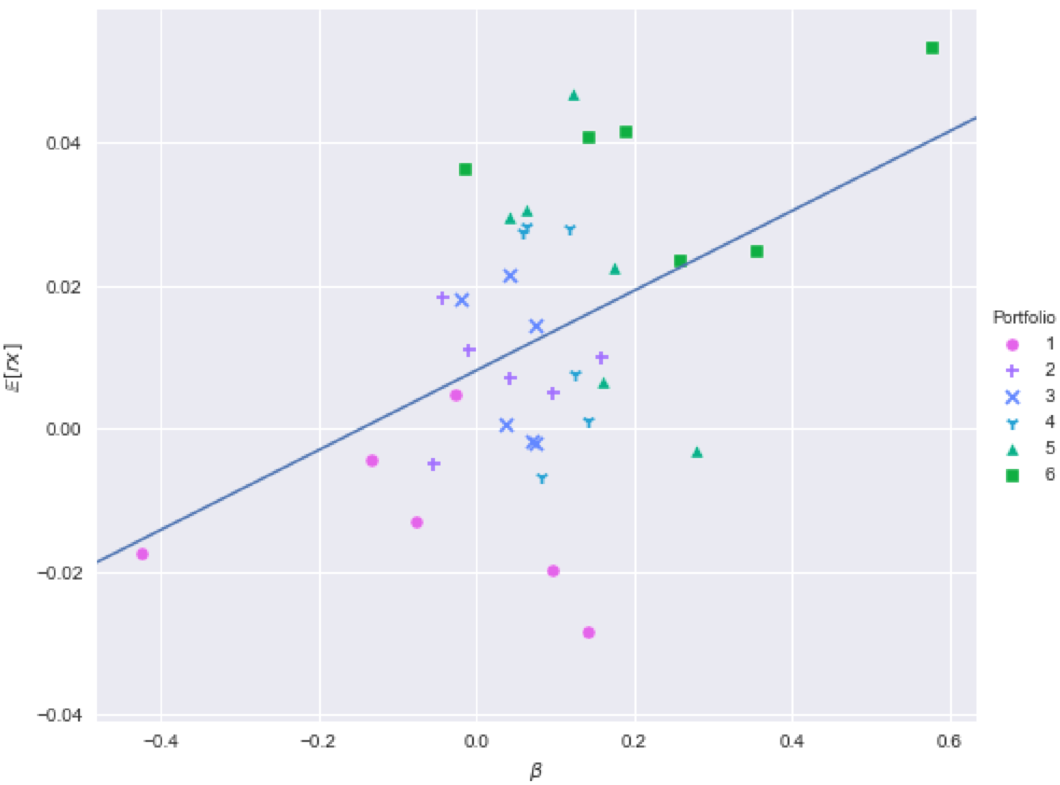

Figure 6: Mean Excess Returns and HML Carry Betas

Notes: This figure displays the mean excess returns of each portfolio of the joint cross-section of exchange rates, which includes six portfolios for intermediary capital, carry, dollar, momentum, volatility, and value. The x-axis contains HML carry betas, estimated for each portfolio by regressing its excess returns across the whole sample on a constant and the HML carry factor. The line reflects the best fit for the relationship between average portfolio returns and betas.

currency portfolios, improving upon consumption growth factors despite not constituting their own cross-section. Intermediary capital risk thus provides an explanation for the existence for the carry trade and forward premium puzzle, and provides an economic source of global risk that is systematically contained in a large number of cross-sections of exchange rates and their corresponding risk premia. Second, the HML carry factor subsumes the risk embedded in the intermediary capital shocks and more dominantly prices the carry trade and entire cross-section of currency portfolios, suggesting that intermediary capital risk is contained within the HML carry factor. Third, intermediary capital remains a robust economic source of risk for exchange rates in both the carry and joint cross-section when compared to the dollar and global dollar factors. 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 joint cross-section of currency portfolios, showing that it is global risk that is priced and that one must fully purge idiosyncratic, country-specific risk to identify this relationship.

5 Determinants of the FX Factors

In the previous sections, I showed that intermediary capital shocks price the carry trade and the joint cross-section of currency portfolios, but also found that they were 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 within it. 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 with the excess returns that proxy for each factor, a simple exercise that identifies the most meaningful shocks behind these risk factors. My candidate shocks are inspired by Verdelhan (2018) who suggests fundamental economic shocks coming from the risk-bearing capacity of intermediaries, US 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 the 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 8 displays the results of this 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 and equivalently the HML carry factor. Furthermore given that the HML carry factor also prices the entire cross-section of foreign exchange portfolios, this provides further evidence that intermediaries and their capital play a central role in the pricing of broader exchange rate risk.

Column (2) examines the role of consumption growth; if households are relevant and their pricing kernels matter for the existence of the carry trade, 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 again points towards the importance of financial intermediaries over households as the relevant marginal investors whose marginal utilities matter for the pricing of foreign exchange and existence of the forward premium puzzle.

Column (3) assesses whether other economic sources of risk are embedded within 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

Table 8: 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 factors as dependent variables, respectively. Standard errors are Newey-West heteroskedasticity and auto-correlation consistent with optimal lag lengths following Andrews (1991) 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 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 positive excess returns for the carry trade, whereas when adverse real global shocks hit, carry trade returns should erode as currencies that are more exposed to the shocks depreciate while the safer currencies that are used as funding appreciate. This finding is encouraging because while this paper argues for the outsize relevance of financial intermediaries and consequently financial activity, negative shocks that affect real activity and production that should also serve as an additional economic source of global risk are found to be relevant determinants of the dominant HML carry factor that underlies 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. However given that these determinants only explain up to a third of the variation in the HML carry factor, there is still much work to be done in uncovering its other economic determinants.

Columns (5)-(8) display similar specifications for the global dollar factor. In the baseline specifications in Columns (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.[14] Given that intermediary capital risk was not subsumed by the global dollar factor in the asset pricing tests yet I find a positive correlation here signifies that while intermediary capital risk may not be wholly contained in the global dollar factor, they do share some common variation, namely shocks that affect intermediary capital may also affect other sources of risk embedded within the global dollar factor.

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 inversely related. In bad times when liquidity becomes thin, investors shift 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 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.[15]

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

[14] 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.

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

subsumes the other or they share common variation outside of the aforementioned economic determinants. 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 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. Further work must be done to uncover other economic sources of risk embedded within the HML carry factor which I have shown plays a dominant role in the pricing of risk embedded within 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 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 is captured by fluctuations in the global dollar factor, but may also suggest that individual currencies differentially load onto US-specific risk. One can rationalize the latter point through the lens of heterogeneity in financial and trade linkages of countries with the US.

6 Conclusion

Does intermediary capital matter for the pricing of exchange rates? I find that the answer is yes as the risk-bearing capacity of financial intermediaries helps explain the carry trade and pattern of excess returns of the joint cross-section of a wide number of currency portfolios. Intermediary capital shocks carry a significant risk price for both, improving upon the Fama French global market return as well as durable and non-durable consumption growth, thus pointing towards the central relevance of financial intermediaries for the pricing of exchange rates and identifying a fundamental economic source of risk that drives the cross-section of foreign exchange returns. The central role of financial intermediaries and their risk-bearing capacity rationalizes the existence of the forward premium puzzle as the differential exposures of currencies to intermediary capital risk align with the pattern of carry trade returns, a result that extends to the joint cross-section of currency portfolios. My findings of a positive and significant risk price of intermediary capital shocks for the joint cross-section show that they serve as a systematic source of global risk with a meaningful economic interpretation that underlies a wide variety of exchange rate risk premia.

My comparison of the intermediary capital shocks to the HML carry factor reveals the latter ss 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 or dampens the significance of the price of intermediary capital risk. 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 all other specifications without this larger factor that subsumes it. I verify this claim by showing that intermediary capital shocks positively and significantly correlate with the HML carry factor. In addition, I explore other potential economic determinants and show that changes in the VIX and Libor-OIS spread, proxies for market volatility and risk aversion, and liquidity, respectively, are negatively correlated with carry trade returns, in line with empirical findings by previous researchers and the theoretical predictions of the macro-finance literature. I also show evidence for the relevance of real activity for the HML carry factor.

Analogously, I also explore the interaction of intermediary capital shocks with the dollar and global dollar factors identified by Verdelhan (2018) to assess their relative performance against these foreign exchange risk factors that are systematically responsible for an outsize portion of exchange rate movements. I find that intermediary capital risk is significantly priced in relation to these factors, displaying the importance of the risks emanating from fluctuations in the risk-bearing capacity of financial intermediaries for exchange rate risk premia. Intermediary capital shocks robustly price both the carry trade and joint cross-section of currency portfolios and I uncover the relevance of the global dollar factor purged of US-specific risk for the pricing of the 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 exposure to 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, despite the fact that it should be purged of US-specific information. I interpret that latter finding as either US real activity serving as a proxy for global real activity and/or heterogeneous exposure to US risk that prevents it from being fully removed.

My findings thus validate open economy models with financial intermediaries, providing empirical support for these theoretically successful class of models. I show that financial intermediaries help us better understand existing exchange rate factors as fluctuations in their risk-bearing capacity serves 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 more complete measures of intermediary capital shocks and risk-bearing capacity, perhaps constructing shocks for other participants in foreign exchange markets such as large buy-side investors, e.g. 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-based asset pricing by not utilizing their pricing kernels as an additional risk factor. Furthermore, given my findings on the central relevance of financial intermediaries, it would be of interest to fully derive an open economy intermediary-based asset pricing model to clearly outline and interpret my findings in general equilibrium. I leave these exercises open to future research.

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