

# Currency Premia and Global Imbalances<sup>\*†</sup>

Pasquale DELLA CORTE    Steven J. RIDDIOUGH    Lucio SARNO

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†Pasquale Della Corte is with Imperial College Business School, Imperial College London and CEPR, email: [p.dellacorte@imperial.ac.uk](mailto:p.dellacorte@imperial.ac.uk). Steven Riddiough is with the Faculty of Business and Economics, University of Melbourne, email: [steven.riddiough@unimelb.edu.ac](mailto:steven.riddiough@unimelb.edu.ac). Lucio Sarno is with Cass Business School, City University London and CEPR, email: [lucio.sarno@city.ac.uk](mailto:lucio.sarno@city.ac.uk).

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## **Abstract**

We show that a global imbalance risk factor that captures the spread in countries' external imbalances and their propensity to issue external liabilities in foreign currency explains the cross-sectional variation in currency excess returns. The economic intuition is simple: net debtor countries offer a currency risk premium to compensate investors willing to finance negative external imbalances because their currencies depreciate in bad times. This mechanism is consistent with exchange rate theory based on capital flows in imperfect financial markets. We also find that the global imbalance factor is priced in cross sections of other major asset markets.

*Keywords:* Currency Risk Premium; Global Imbalances; Foreign Exchange Excess Returns; Carry Trade.

*JEL Classification:* F31; F37; G12; G15.

# 1 Introduction

Imbalances in trade and capital flows have been the centerpiece of much debate surrounding the causes and consequences of the global financial crisis. Therefore it would seem natural that, given the financial crisis consisted of collapsing asset prices worldwide, global imbalances may help shed light on our fundamental understanding of asset price dynamics. The foreign exchange (FX) market provides a logical starting point for testing this hypothesis as exchange rate fluctuations and currency risk premia are theoretically linked to external imbalances, and recent events in the FX market provide a reminder of the potential importance of such a link. For example, following the US Federal Reserve’s announcement on 22 May 2013 that they would taper the size of their bond-buying programme, emerging market currencies including the Indian rupee, Brazilian real, South African rand and Turkish lira all sold-off sharply. A common characteristic among these four countries is that they are some of the world’s largest debtor nations. In fact, the Financial Times on 26 June 2013 attributed the large depreciation of the Indian rupee (which fell by 22 percent against the US dollar between May and August 2013) to investors’ concerns over India being “one of the most vulnerable emerging market currencies due to its current account deficit” (Ross, 2013).

In this paper we provide empirical evidence that exposure to countries’ external imbalances is key to understanding currency risk premia, and supports a risk-based interpretation of the carry trade, a popular strategy that involves an investor borrowing in currencies with low interest rates (funding currencies) and simultaneously lending in currencies with high interest rates (investment currencies).<sup>1</sup> Our findings are consistent with the broad implications of portfolio balance models, which emphasize the role of capital flows for exchange rate determination when assets denominated in different currencies are not perfectly substitutable. A recent notable example is the model of Gabaix and Maggiori (hereafter GM, 2015), who provide a novel theory of exchange rate determination based on capital flows in imperfect financial markets. Specifically, GM (2015) propose a two-country model in which exchange

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<sup>1</sup>The carry trade strategy builds on the violation of uncovered interest rate parity. See Hansen and Hodrick (1980), Bilson (1981), Fama (1984), Lustig and Verdelhan (2007), Brunnermeier, Nagel and Pedersen (2009), Della Corte, Sarno and Tsiakas (2009), Burnside (2011), Lustig, Roussanov and Verdelhan (2011), Burnside, Eichenbaum, Kleshchelski and Rebelo (2011), Christiansen, Rinaldo and Söderlind (2011), Colacito and Croce (2013), Kojen, Moskowitz, Pedersen and Vrugt (2013), Menkhoff, Sarno, Schmeling and Schrimpf (2012a), Farhi and Gabaix (2014), Jurek (2014), Lettau, Maggiori and Weber (2014), Bekaert and Panayotov (2015), and Farhi, Fraiberger, Gabaix, Ranciere and Verdelhan (2015).

rates are jointly determined by global imbalances and financiers' risk-bearing capacity. In their model, countries run trade imbalances and financiers absorb the resultant currency risk, i.e., financiers are long the debtor country and short the creditor country. Financiers, however, are financially constrained and this affects their ability to take positions. Intuitively, if there is little risk-bearing capacity financiers are unwilling to intermediate currency mismatches regardless of the excess return on offer. In contrast, when financiers have unlimited risk-bearing capacity they are willing to take positions in currencies whenever a positive excess return is available, and hence the currency risk premium is miniscule. While this paper is not a direct test of the GM theory, our key results can be interpreted naturally under the description of exchange rate determination offered in this theory.

We focus the empirical analysis around two simple testable hypotheses. First, currency excess returns, i.e. the returns to a carry trade strategy, are higher when (i) interest rate differentials are larger, (ii) the funding (investment) country is a net foreign creditor (debtor), and (iii) the funding (investment) country has a higher propensity to issue liabilities denominated in domestic (foreign) currency. Condition (i) is standard since on average exchange rate movements do not offset interest rate differentials due to the risk premium. Condition (ii) is novel and captures the link between external imbalances and currency risk premia in the theory of GM (2015). Condition (iii) captures the notion that the currency denomination of external debt also matters for currency risk premia. One argument why this may be the case, borrowed from the 'original sin' literature (e.g. Eichengreen and Hausmann, 2005), is that countries which cannot issue debt in their own currency are riskier. In essence, this first testable hypothesis suggests that currency risk premia are driven not only by interest rate differentials but also by the evolution and currency denomination of net foreign assets.

Second, we test the prediction of the GM (2015) theory that, when there is a financial disruption (i.e., risk-bearing capacity is very low and global risk aversion is very high), net-debtor countries experience a currency depreciation, unlike net-creditor countries. This testable hypothesis makes clearer an important part of the mechanism that generates currency risk premia: investors demand a risk premium for holding net debtor countries' currencies *because* these currencies perform poorly in bad times, which are times of large shocks to global risk aversion.

In the empirical analysis, we test and provide evidence in support of the two hypotheses

described above. In relation to the first testable hypothesis, we document that a currency strategy that sorts currencies on net foreign asset positions and a country's propensity to issue external liabilities in domestic currency – termed the ‘global imbalance’ strategy – generates a large spread in returns. Then, we empirically test whether a global imbalance risk factor can explain the cross-section of currency excess returns in a standard asset pricing framework. The global imbalance risk factor – termed the *IMB* factor, or simply *IMB* – is equivalent to the return from a high-minus-low strategy that buys the currencies of debtor nations with mainly foreign currency denominated external liabilities (the riskiest currencies) and sells the currencies of creditor nations with mainly domestic currency denominated external liabilities (the safest currencies). Our central result in this respect is that the *IMB* factor explains a large fraction of the cross-sectional variation in currency excess returns, thus supporting a risk-based view of exchange rate determination that is based on macroeconomic fundamentals and, specifically, on net foreign asset positions. This result holds both for a broad sample of 55 currencies and for a subsample of the 15 most liquid currencies over the period from 1983 to 2014.<sup>2</sup>

The economic intuition of this factor is simple: investors demand a risk premium to hold the currency of net debtor countries, especially if the debt is funded principally in foreign currency. High interest rate currencies load positively on the global imbalance factor, and thus deliver low returns in bad times when there is a spike in global risk aversion and the process of international financial adjustment requires their depreciation. Low interest rate currencies are negatively related to the global imbalance factor, and thus provide a hedge by yielding positive returns in bad times. This result suggests that returns to carry trades are compensation for time-varying fundamental risk, and thus carry traders can be viewed as taking on global imbalance risk. Moreover, the explanatory power of the global imbalance risk factor is not confined to portfolios sorted on interest rate differentials (i.e., carry trade portfolios) and other interest rate sorts but extends to a broad cross section of currency portfolios which includes, among others, portfolio sorts on currency value, momentum, and volatility risk premia.

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<sup>2</sup>There have hardly been any attempts to relate currency risk premia *cross-sectionally* to currencies' sensitivity to external imbalances, and existing evidence is confined to time series analysis (e.g. Alquist and Chinn, 2008; Della Corte, Sarno and Sestieri, 2012). It thus seems quite natural to employ a cross-sectional perspective on the role of global imbalances to help us understand currency risk premia.

We also document how net foreign asset positions contain information that is (related but) not identical to interest rate differentials in the cross section of currencies. A regression of the *IMB* factor on the carry (or ‘slope’) factor of Lustig, Roussanov and Verdelhan (2011) produces clear evidence that the two factors are significantly different from each other, although they are positively related. The main difference between sorting on interest rate differentials (carry trade strategy) and sorting on global imbalances (global imbalance strategy) is in the long portfolios of the two strategies: the riskiest countries in terms of net foreign asset positions are not necessarily the countries with the highest interest rates. Furthermore, our asset pricing tests show that the global imbalance risk factor has pricing power in the cross-section of currency excess returns even when conditioning on the carry risk factor. These findings support GM’s (2015) prediction that there is an effect of net foreign asset positions on currency excess returns that is distinct from a pure interest rate channel.<sup>3</sup>

In relation to the second testable hypothesis, we provide evidence using a battery of panel regressions that in bad times (defined as times of risk aversion shocks, proxied by the change in implied FX volatility) net-debtor countries experience a currency depreciation, unlike net-creditor countries. This result is consistent with the risk premium story of GM (2015): investors demand a risk premium for holding net debtor countries’ currencies *because* these currencies perform poorly in bad times, regardless of the interest rate differential.

Recent anecdotal evidence emphasizes the fundamental importance of net foreign assets over and above interest rates in determining currency premia: the US Federal Reserve’s announcement in May 2013 that it would scale-back its bond buying programme caused a spike in risk aversion – the VIX index rose from below 14 to over 20 during the subsequent month. In currency markets, following the Federal Reserve announcement, currencies with very similar interest rates behaved very differently, and only the currencies with large external deficit positions experienced sharp depreciations. The economic mechanism in GM (2015) and the empirical evidence in this paper make sense of this behavior, which would be hard to rationalize otherwise.<sup>4</sup>

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<sup>3</sup>This result is also consistent with the empirical work of Habib and Stracca (2012), who find that net foreign assets are particularly useful for predicting exchange rate returns in regressions which control for interest rate differentials.

<sup>4</sup>Specifically, at the point of the Federal Reserve announcement, Australia, New Zealand, and South Korea – three of the most volatile currencies in the Asia Pacific region – had almost identical interest rates (2.50 percent in New Zealand and Korea, 2.75 percent in Australia). Yet, over the May to September period, the

Further analysis provides refinements and robustness of the main results, including the following: (i) We show that sorting currencies on their beta with the global imbalance factor yields portfolios with a significant difference in returns, confirming that global imbalance information is relevant for explaining the cross section of currency excess returns. (ii) We test the pricing power of the global imbalance risk factor for cross-sections of returns in other markets, including equities, bonds and commodities. The results suggest that the *IMB* factor is also priced in these asset markets. (iii) We depart from the base scenario of a US-based investor and run calculations using alternative base currencies, taking the viewpoint of a British, Japanese, Euro-based and Swiss investor. The results indicate that the global imbalance strategy produces qualitatively identical outcomes in each case. (iv) We test the *IMB* risk factor on portfolios formed using only the most liquid developed and emerging currencies, showing that there are no qualitative changes in the results. (v) We measure the individual contribution to the currency risk premium of net foreign asset positions and the propensity to issue liabilities in domestic currency, and find that both matter. (vi) We also run cross-sectional asset pricing tests on individual currencies' excess returns, and again record that *IMB* is priced. Overall, we find that the further analysis corroborates the core finding that global imbalance risk is a key fundamental driver of risk premia in the FX market.

The remainder of the paper is organized as follows. Section 2 describes the theoretical background of our analysis and the hypotheses that we take to the data. In Section 3 we describe the data and provide details of how portfolios are constructed. In Section 4 we describe the properties of the global imbalance strategy and its returns, which we compare to the returns of the carry trade strategy. In Section 5 we report asset pricing tests and additional analysis to better understand the link between currency excess returns and global imbalances. Section 6 reports evidence on the behavior of exchange rate returns and global imbalances in bad times. In Section 7 we present a number of extensions and robustness exercises, before concluding in Section 8. A separate Internet Appendix provides further details on the data, robustness tests and additional results.

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Australian dollar depreciated by 16 percent against the US dollar, the New Zealand dollar depreciated by 10 percent, while the Korean won fell by only 1 percent. The contrasting sizes of depreciation reflect the contrast in deficit positions at the end of the first quarter of 2013, when Australia and New Zealand both had external deficit positions relative to GDP of over 60 percent, while South Korea had a far more modest 6 percent deficit.

## 2 Theoretical Motivation and Testable Hypotheses

The contribution of this paper is purely empirical, but our analysis has a clear theoretical foundation within the class of models centered around the portfolio balance theory. The seminal work in the development of this theory is often attributed to Kouri (1976), who establishes a link between the balance of payments and exchange rates in a setting where assets are imperfect substitutes, while risk averse investors are assumed to desire a diversified portfolio of risky securities. It follows that any deviation between the expected return on domestic and foreign bonds leads to a *marginal*, rather than total, transfer of wealth between assets. The risk aversion of investors, combined with the assumption that real sector adjustments are slower than for the financial sector, mean that uncovered interest rate parity fails to hold within the model. Instead, a domestic current account deficit (capital account surplus) is associated with a depreciation of the domestic currency.

Despite the early research breakthroughs relating to the portfolio balance model (see, e.g. Branson, Halttunen and Masson, 1979; Branson and Henderson, 1985), a combination of insufficient data on foreign bond holdings, a lack of micro-foundation in deriving the asset-demand functions and an early body of evidence documenting a weak relationship between the balance of payments and exchange rate returns has led to a steady and prolonged decline in the research agenda. Recently GM (2015) provide a modern micro-founded version of the portfolio balance model by incorporating an interaction between capital flows and financial intermediaries' risk-bearing capacity in imperfect financial markets.

A distinct feature of the GM model is that global imbalances are a key driver of currency risk premia, irrespective of interest rate differentials: net debtor currencies are predicted to warrant an excess currency return in equilibrium and to depreciate at times when risk-bearing capacity falls, *even* if interest rates are equal around the world. In their two-period model – termed the ‘Gamma’ model – each country borrows or lends in its own currency and global financial intermediaries absorb the exchange rate risk arising from imbalanced capital flows. Since financial intermediaries demand compensation for holding currency risk in the form of an expected currency appreciation, exchange rates are jointly determined by global capital flows and by the intermediaries' risk-bearing capacity, which GM (2015) refer to as ‘broadly defined risk aversion shocks’ and show that it depends on conditional FX volatility.



This theory has clear implications for the returns to a carry trade strategy that buys high-interest rate (“investment”) currencies and sells low-interest rate (“funding”) currencies. GM (2015, equation (23), Proposition 6) derive the excess return ( $RX$ ) arising from the carry trade strategy as follows:

$$E(RX) = \Gamma \frac{\frac{R^*}{R} E(\text{imp}_1) - \text{imp}_0}{(R^* + \Gamma) \text{imp}_0 + \frac{R^*}{R} E(\text{imp}_1)} \quad (1)$$

where the variable  $\text{imp}_t$  denotes the dollar value of US imports at time  $t$ ; with exports normalized to unity in equation (1), the evolution of imports  $E(\text{imp}_1) - \text{imp}_0$  determines net foreign asset positions in the model.  $R$  and  $R^*$  are the domestic and foreign riskless interest rates.  $\Gamma$  captures risk-bearing capacity of financiers. When risk-bearing capacity is low (i.e.,  $\Gamma$  is high in equation (1)), financial intermediaries are unwilling to absorb any imbalances, regardless of the excess return available, and hence no financial flows are necessary as trade inflows and outflows will be equal in each period. As risk-bearing capacity increases ( $\Gamma$  decreases), excess returns fall but do not entirely disappear, except when  $\Gamma$  is extremely low and financial intermediaries are prepared to absorb any currency imbalance so that uncovered interest rate parity holds. Equation (1) shows that the returns of a carry trade will be higher when interest rate differentials are larger, and when the funding (investment) currency is issued by a net creditor (debtor) country. Put another way, carry traders require a premium to hold the currency of debtor nations relative to creditor nations.<sup>5</sup>

The Gamma model makes the simplifying assumption that each country borrows or lends in its own currency, but in practice most countries do not (or cannot) issue all their debt in their own currency. This fact is the subject under study in the vast literature on the ‘original sin’ hypothesis (e.g. Eichengreen and Hausmann, 2005, and the references therein). Although GM (2015) do not provide a full analytical extension of their model that allows for currency mismatches between assets and liabilities, in Proposition 12 (point 3), they consider the impact of pre-existing stocks of debt and their currency denomination, illustrating how this generates

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<sup>5</sup>To clarify these effects analytically in equation (1), first consider the case when  $R^*/R > 1$ , i.e., the interest rate in the foreign (investment) country is higher than the one in the funding country (the US). GM show that  $\frac{\partial E(RX)}{\partial (R^* - R)} > 0$ , which means that the carry trade return increases with higher interest rate differentials. Second, set  $E[\text{imp}_1] - \text{imp}_0 > 0$  (while setting  $R^*/R = 1$ ), i.e., the funding country (the US) is a net foreign creditor. Given that  $\text{imp}$  is the value of US imports in US dollars,  $E[\text{imp}_1] - \text{imp}_0 > 0$  implies that the US is expected to become a net importer at  $t = 1$  in order to offset its positive external imbalance at  $t = 0$ , and clearly  $\frac{\partial E(RX)}{\partial (E(\text{imp}_1) - \text{imp}_0)} > 0$ . This establishes the result that the expected carry trade return is higher if the country of the funding currency is a net creditor, and viceversa for net debtor countries.

a valuation channel to the external adjustment of countries whereby the exchange rate moves in a way that facilitates the re-equilibration of external imbalances. GM highlight how this mechanism is consistent with the valuation channel to external adjustment studied by e.g. Gourinchas and Rey (2007), Gourinchas (2008), and Lane and Shambaugh (2010), and gives a role to the currency denomination of external liabilities. We note, however, that short of a full analytical description of the causal structure of foreign currency denominated debt, which is not provided by GM (2015), one cannot dismiss possible endogeneity concerns as to *why* countries issue debt in foreign currencies. Riskier countries may be forced to issue a higher proportion of foreign currency denominated debt due to, for example, political instability or inflation-induced expropriation risks. With these caveats in mind, in our empirical analysis we account for the impact of foreign currency denominated debt by considering whether currencies of countries with a higher propensity to issue liabilities in foreign currency offer a higher currency risk premium, given that such countries require much sharper depreciations to correct their external imbalances.<sup>6</sup>

The mechanism described above implies the first testable hypothesis, which is a variant of Proposition 6 in GM (2015) with the additional condition that captures the effect of the currency denomination of liabilities.

**Hypothesis 1** *The carry trade return is bigger when (i) the interest rate differential is larger, (ii) the funding (investment) country is a net foreign creditor (debtor), and (iii) the funding (investment) country has a higher propensity to issue liabilities denominated in domestic (foreign) currency.*

This testable prediction suggests that there are two drivers of FX excess returns, the first driven purely by the carry component (condition (i) above), and the second driven by the evolution of external debt and its currency denomination (conditions (ii) and (iii)). In our portfolio analysis, we combine the information in conditions (ii) and (iii) to capture both the spread in external imbalances and the propensity to issue external liabilities in foreign currency, although we also examine their separate effects in some of our tests and in the regression analysis.

We test Hypothesis 1 in several ways. Above all, we form portfolios sorted on external

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<sup>6</sup>This is because the initial depreciation makes countries with foreign-currency denominated liabilities poorer, not richer, by increasing their debt burden (see e.g. the portfolio balance theory in Gourinchas, 2008, Section 3.2.2).

imbalances (net foreign assets to GDP ratio) and the share of foreign liabilities in domestic currency to examine whether they provide predictive information for the cross-section of currency excess returns. We show that this portfolio sort generates a sizable and statistically significant spread in returns: a currency strategy that buys the extreme net debtor countries with the highest propensity to issue external liabilities in foreign currency and sells the extreme creditor countries with the lowest propensity to issue liabilities in foreign currency – which we term the ‘global imbalance’ strategy – generates Sharpe ratios of 0.59 for a universe of major countries and 0.68 for a broader set of 55 countries. This confirms the essence of Hypothesis 1, that currency excess returns are higher for net-debtor countries with higher propensity to issue liabilities in foreign currency. We also show that the returns from the global imbalance strategy are related to but different from carry trade returns, consistent with the notion that external imbalances partly capture different information from interest rate differentials.

A central mechanism in the model of GM (2015) is that during periods of financial distress, when risk-bearing capacity declines, debtor countries suffer a currency depreciation, unlike creditor countries. This is indeed the logic that rationalizes why net debtor countries must offer a currency risk premium, implying the second empirical prediction we take to the data, which is Proposition 2 of GM (2015).

**Hypothesis 2** *When there is a financial disruption ( $\Gamma$  increases), countries that are net external debtors experience a currency depreciation, while the opposite is true for net-creditor countries.*

This prediction follows naturally from the previous analysis and our empirical results provide supporting evidence on its validity through the estimation of a battery of panel regressions.

Some caveats are in order on the theoretical motivation for our empirical work. First, in our empirical work we use implied volatility indices for FX (VXY) and equity markets (VIX) to capture global risk aversion, but do not provide direct evidence that these proxies are in fact driven by the wealth of financial intermediaries. GM (2015) state that conditional volatility drives risk-bearing capacity, but we do not have a direct measure for this concept, and VXY and VIX may well be capturing many other things. Second, within the GM (2015) model, interest rates are modelled statically, as the inverse of the investor time preferences. An extended model could incorporate global imbalances as one of the financial drivers of interest rates and by doing so generate a positive albeit imperfect correlation between imbalances and

interest rates. Third, as mentioned earlier, for tractability reasons GM (2015) assume that countries can borrow and lend only in their own currencies and hence a full analytical treatment of the decision to issue debt in foreign currency is not provided. However, our empirical work does not make this assumption and we use the share of external liabilities issued in foreign currency to refine our empirical characterization of the riskiness of global imbalances. Fourth, it may be that our empirical findings can be rationalized by other theories, even in a complete markets setting. In fact, Colacito, Croce, Gavazzoni and Ready (2015) have recently developed a frictionless risk-sharing model of the international economy with recursive preferences and long-run risk, which is specifically designed and able to replicate simultaneously the properties of the carry factor of Lustig, Roussanov and Verdelhan (2011) and the global imbalance risk factor proposed in our paper.

To be clear, therefore, it is not our purpose to discriminate between alternative theories capable of rationalizing our findings or to provide a test of the theory of GM (2015); we simply use that theory as a modern example of the portfolio balance approach to exchange rate determination, in order to construct testable and economically plausible empirical hypotheses. This paper then aims at providing a robust empirical assessment of these hypotheses in order to show novel facts about the link between global imbalances and currency risk premia.

### 3 Data and Currency Portfolios

This section describes the main data employed in the empirical analysis. We also describe the construction of currency portfolios and the global imbalance risk factor.

**Currency Excess Returns.** We collect daily spot and 1-month forward exchange rates vis-à-vis the US dollar (USD) from Barclays and Reuters via Datastream. Exchange rates are defined as units of US dollars per unit of foreign currency so that an increase in the exchange rate indicates an appreciation of the foreign currency. The analysis uses monthly data obtained by sampling end-of-month rates from October 1983 to June 2014. The sample comprises 55 countries, and we call this sample ‘all countries’. Since many currencies in this broad sample are pegged or subject to capital restrictions at various points in time, we also consider a subset of 15 countries which we refer to as ‘developed countries’. The list of countries is in the Internet Appendix, which also provides further details about the FX data.

We define spot and forward exchange rates at time  $t$  as  $S_t$  and  $F_t$ , respectively, and take into account the standard value date conventions in matching the forward rate with the appropriate spot rate (see e.g., Bekaert and Hodrick, 1993). The excess return on buying a foreign currency in the forward market at time  $t$  and then selling it in the spot market at time  $t + 1$  is computed as

$$RX_{t+1} = \frac{(S_{t+1} - F_t)}{S_t}, \quad (2)$$

which is equivalent to the spot exchange rate return minus the forward premium

$$RX_{t+1} = \frac{S_{t+1} - S_t}{S_t} - \frac{F_t - S_t}{S_t}. \quad (3)$$

According to the CIP condition, the forward premium approximately equals the interest rate differential. Since CIP holds closely in the data (e.g., Akram, Rime, and Sarno, 2008), the currency excess return is approximately equal to the exchange rate return plus the differential of the foreign interest rate and the US interest rate. As a matter of convenience, throughout this paper we refer to  $fd_t = (S_t - F_t) / S_t$  as the forward discount or interest rate differential relative to the US. We construct currency excess returns adjusted for transaction costs using bid-ask quotes on spot and forward rates. We describe in the Internet Appendix the exact calculation of the net returns.

**Data on External Assets and Liabilities.** Turning to macroeconomic data, we obtain end-of-year series on foreign assets and liabilities, and gross domestic product (GDP) from Lane and Milesi-Ferretti (2004, 2007), kindly updated by Gian Maria Milesi-Ferretti. Foreign (or external) assets are measured as the dollar value of assets a country owns abroad, while foreign (or external) liabilities refer to the dollar value of domestic assets owned by foreigners. The data for all countries included in our study are until the end of 2012. For each country we measure external imbalances – the indebtedness of a country to foreigners – using the net foreign asset position (the difference between foreign assets and foreign liabilities) relative to the size of the economy (GDP), which we denote  $nfa$ . We retrieve monthly observations by keeping end-of-period data constant until a new observation becomes available.

We also use end-of-year series on the proportion of external liabilities denominated in domestic currency (denoted  $ldc$ ) from Benetrix, Lane and Shambaugh (2015), which updates the data from Lane and Shambaugh (2010), kindly provided by Philip Lane. Clearly, measuring

accurately the share of external liabilities in foreign currency is a very hard task, also because of the well-known difficulties in gathering data on derivatives positions. These data are, to the best of our knowledge, the only ones available for this purpose that cover a large sample of countries and time, spanning from 1990 to 2012. We construct monthly observations by keeping end-of-period data constant until a new observation becomes available. Note that we maintain the 1990 proportions back until 1983.<sup>7</sup>

**Global Imbalance Portfolios.** Motivated by the considerations discussed in Section 2, we construct global imbalance portfolios as follows: at the end of each period  $t$ , we first group currencies into two baskets using  $nfa$ , then reorder currencies within each basket using  $ldc$ . Hence, we allocate this set of currencies to five portfolios so that Portfolio 1 corresponds to creditor countries whose external liabilities are primarily denominated in domestic currency (safest currencies), whereas Portfolio 5 comprises debtor countries whose external liabilities are primarily denominated in foreign currency (riskiest currencies). We refer to these portfolios as the global imbalance portfolios. As for all other currency portfolios we consider, we compute the excess return for each portfolio as an equally weighted average of the currency excess returns within that portfolio and, for the purpose of computing portfolio returns net of transaction costs, we assume that investors go short foreign currencies in Portfolio 1 and long foreign currencies in the remaining portfolios. We construct the global imbalance ( $IMB$ ) risk factor as the difference between Portfolio 5 and Portfolio 1.

Figure 1 clarifies the outcome of our sequential sorting procedure. Note that the procedure does not guarantee monotonicity in both sorting variables ( $nfa$  and  $ldc$ ) because Portfolio 3 contains both low and high  $ldc$  countries. However, the corner portfolios contain the intended set of countries: specifically, Portfolio 1 contains the extreme 20% of all currencies with high  $nfa$  and high  $ldc$  (creditor nations with external liabilities mainly in domestic currency) whereas Portfolio 5 contains the top 20% of all currencies with low  $nfa$  and low  $ldc$  (debtor nations with external liabilities mainly in foreign currency). We use five portfolios rather than six, as we have a limited number of currencies in the developed countries sample and at the beginning of the all countries sample, while we also want to have the same number

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<sup>7</sup>This assumption makes no qualitative difference to our findings as when we examine the sample period starting in 1990 (dropping the first 7 years of data altogether) our portfolio results are qualitatively identical. This is not surprising since  $ldc$  is a highly persistent variable (see Benetrix, Lane and Shambaugh, 2014).

of portfolios for both samples of countries. In the Internet Appendix we show that our core results are qualitatively identical if we use 4 portfolios for developed countries and 6 portfolios for all countries; see Figure A.1 and Table A.14 in the Internet Appendix.

**Carry Trade Portfolios.** We construct five carry trade portfolios, rebalanced monthly, following the recent literature in this area (e.g. Lustig, Roussanov and Verdelhan, 2011). We use them as test assets in our empirical asset pricing analysis, alongside a number of other currency portfolios. At the end of each period  $t$ , we allocate currencies to five portfolios on the basis of their forward discounts. This exercise implies that currencies with the lowest forward discounts (or lowest interest rate differential relative to the US) are assigned to Portfolio 1, whereas currencies with the highest forward discounts (or highest interest rate differential relative to the US) are assigned to Portfolio 5. The strategy that is long Portfolio 5 and short Portfolio 1 is referred to as the *CAR* factor, or simply *CAR*.

**Momentum Portfolios.** Following Menkhoff, Sarno, Schmeling, and Schrimpf (2012b), at the end of each period  $t$  we form five portfolios based on exchange rate returns over the previous  $k$  months. We assign the 20% of all currencies with the lowest lagged exchange rate returns to Portfolio 1 (*loser currencies*), and the 20% of all currencies with the highest lagged exchange rate returns to Portfolio 5 (*winner currencies*). We construct five short-term momentum ( $k = 3$  months) and five long-term momentum ( $k = 12$  months) portfolios.

**Value Portfolios.** At the end of each period  $t$ , we form five portfolios based on the lagged five-year real exchange rate return as in Asness, Moskowitz and Pedersen (2013). We assign the 20% of all currencies with the highest lagged real exchange rate return to Portfolio 1 (*overvalued currencies*), and the 20% of all currencies with the lowest lagged real exchange rate return to Portfolio 5 (*undervalued currencies*).

**Term Spread Portfolios, and Long Yields Portfolios.** We also construct other portfolios using interest rate information, sorting on the term spread of interest rates, and on the long-term interest rate differential relative to the US, respectively. We use data from Global Financial Data: 3-month interest rates to capture the short-term rate, and 10-year interest rates (or 5-year when 10-year is not available) to capture the long-term rate. Sorting on the term spread is motivated by the evidence in Ang and Chen (2010), while sorting on long-term

interest rates is useful to capture departures from uncovered interest rate parity at the longer end of the term structure of interest rates (e.g. Chinn and Meredith, 2004; Bekaert, Wei and Xing, 2007). The portfolio construction is the same as for previous portfolios, where we form at the end of each period  $t$  five portfolios based on either the term spread or the long-term interest rate differential. We assign the 20% of all currencies with the lowest term spread (lowest long-term interest rate differential) to Portfolio 1, and the 20% of all currencies with the highest term spread (highest long-term interest rate differential) to Portfolio 5. This gives us five portfolios sorted on the term spread, and five portfolios sorted on the long-term interest rate differential.

**Risk Reversal Portfolios.** At the end of each period  $t$ , we form five portfolios sorted on 1-year out-of-the-money options. The implied volatility quotes used for this exercise are an updated sample of the data used by Della Corte, Ramadorai and Sarno (2015), to which we refer the reader for a full description of the data. We compute for each currency in each time period the risk reversal, which is the implied volatility of the 25-delta call less the implied volatility of the 25-delta put, and assign the 20% of all currencies with the highest risk reversal to Portfolio 1 (*low-skewness currencies*), and the 20% of all currencies with the lowest risk reversal to Portfolio 5 (*high-skewness currencies*).

**Volatility Risk Premia Portfolios.** At the end of each period  $t$ , we group currencies into five portfolios using the 1-year volatility risk premium, constructed as described in Della Corte, Ramadorai and Sarno (2015). The volatility risk premium is defined as the difference between expected realized volatility and a model-free measure of implied volatility obtained from currency option prices; it reflects the costs of insuring against currency volatility fluctuations. We allocate 20% of all currencies with the lowest expected volatility premia, i.e., those which are most expensive to insure, to Portfolio 1 (*expensive volatility insurance*), and 20% of all currencies with the highest expected volatility premia, i.e., those which are cheapest to insure, to Portfolio 5 (*cheap volatility insurance*).

All currency portfolios described above are constructed over the sample from October 1983 to June 2014, except for risk reversal portfolios and volatility risk premia portfolios, for which the sample starts in January 1996 due to options data availability.



## 4 The Global Imbalance Strategy and the Carry Trade

### 4.1 Portfolio Returns and the *IMB* Factor

This section describes the properties of the currency excess returns from implementing the global imbalance strategy and constructing the *IMB* factor. In Table 1 we present summary statistics for the five global imbalance portfolios sorted on *nfa* and *ldc*, as well as for the global imbalance factor *IMB*. The average excess return tends to increase from  $P_1$  (0.92 and 0.67 percent per annum) to  $P_5$  (5.32 and 4.65 percent per annum) for both samples. When we compare the Sharpe ratio (*SR*) of the global imbalance strategy to the *SR* of the carry trade strategy (see Table A.1 in the Internet Appendix), we observe that the global imbalance strategy has a higher Sharpe ratio than the carry trade strategy: 0.68 compared to 0.65 for all countries, and 0.59 compared to 0.43 for developed countries. This comparison suggests that the global imbalance strategy has appealing risk-adjusted returns in its own right, which is perhaps surprising given the information required to update the global imbalance strategy arrives only once a year.<sup>8</sup>

The last three rows in Table 1 report the average *fd*, *nfa*, and *ldc* across portfolios  $P_1$  to  $P_5$ . The spread in interest rate differentials is about 7 and 3.5 percent for all countries and developed countries, which is a large spread but far less than the 11 and 6 percent reported for the carry trade in Table A.1. This suggests that part of the return from the global imbalance strategy is clearly related to carry (interest rate information), but part of it is driven by a different source of predictability which is in external imbalances but not in interest rate differentials. The last two rows reveal that there is a sizable spread in *nfa* and *ldc*, which is monotonic for *nfa* for both samples of countries examined and is much larger than the corresponding spread for carry trade portfolios.

Overall, the currencies of net debtor countries with a relatively higher propensity to issue external liabilities in foreign currency have higher (risk-adjusted) returns than the currencies of net creditor countries with higher propensity to issue liabilities in domestic currency, consistent with Hypothesis 1 stated in Section 2.

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<sup>8</sup>Specifically, we construct monthly excess returns but global imbalance portfolios are in practice rebalanced only at the end of each year when new information on *nfa* and *ldc* becomes available. In contrast, carry trade portfolios are rebalanced every month as information on forward discounts is available monthly. The impact of this difference is confirmed by the frequency of currency portfolio switches (*Freq*), which displays less variation for the global imbalance portfolios than the carry trade portfolios.

## 4.2 *IMB* versus *CAR*

Since sorting on *nfa* and *ldc* delivers a set of portfolios with increasing interest rate differentials, one may wonder whether *IMB* captures anything more than *CAR*. To investigate this we first regress the *IMB* factor on the *CAR* factor and a constant term; in an additional regression, we also control for a 12-month lag of the dependent variable to account for potential serial correlation in the *IMB* factor (recall that the raw information about *nfa* and *ldc* is updated at the annual frequency). The results, reported in Panel A of Table 2, indicate that the slope coefficient ( $\beta$ ) estimate on *CAR* is positive and statistically significant, but it is very far and statistically significantly different from unity (approximately 0.40). The  $R^2$  of the contemporaneous regression of *IMB* on *CAR* is 30 percent. Most importantly, the constant term ( $\alpha$ ) is statistically significantly different from zero in all specifications and economically sizable (up to 2.3 percent per annum), suggesting that *IMB* and *CAR* are different from each other. Indeed, the null hypothesis that  $\alpha = 0$  and  $\beta = 1$  (i.e., the null that  $IMB = CAR$ ) is strongly rejected.

To further refine our understanding of the difference between these two portfolio sorts, we then run regressions of the five global imbalance portfolios on the *CAR* factor and a constant term, again allowing for a 12-month lag of the dependent variable in separate regressions. The results, reported in Panel B of Table 2, suggest that there is a moderate spread in the coefficient on the *CAR* factor, which is often statistically significant. The  $\alpha$  in the regression is generally statistically insignificant, except in Portfolios 4 and 5 for the sample of all countries and in Portfolio 5 for the sample of developed countries. Hence the difference between the global imbalance strategy and the carry trade strategy arises mainly from the long leg of the strategies (i.e., Portfolio 5): this means that, while sorting on global imbalances produces portfolios with increasing interest rates, the countries with the worst global imbalance positions (in terms of net foreign assets and the currency denomination of foreign debt) are not necessarily the countries with the highest interest rates. This is also apparent when examining the identity of the currencies that enter the long leg of the two strategies (see Table A.2 in the Internet Appendix), which reveals, for example, that currencies like the Danish krone or the Swedish krona are among the top six in Portfolio 5 of the global imbalance strategy due to their weak net foreign asset positions over much of the sample. Typical carry currencies like the Brazilian

real or the South African rand do not even feature among the top six most frequent currencies in the long leg of the global imbalance strategy.

Another way to assess the value added of the information in net foreign assets beyond interest rate differentials is to double sort on  $nfa$  and  $fd$ . Ideally, one would want to sort on  $nfa$ ,  $ldc$  and  $fd$ , but our cross-section is simply too small to do this. However, constructing 6 portfolios for the sample of all countries, an independent double sort on  $nfa$  and  $fd$  delivers a gross mean return per annum of 2.2 (Sharpe ratio of 0.5) for  $nfa$ , and 5.0 for  $fd$  (Sharpe ratio of 0.8). The corresponding numbers for the sample of developed countries, using 4 portfolios, are 2.0 (Sharpe ratio of 0.3) for  $nfa$  and 2.6 (Sharpe ratio of 0.8) for  $fd$ . We repeat the same analysis to assess the value added of  $ldc$  beyond  $fd$ , and thus double sort on  $ldc$  and  $fd$ . In this case, for the sample of all countries, the independent double sort delivers a gross mean return of 2.6 for  $ldc$  and 4.2 for  $fd$ , implying a Sharpe ratio of 0.7 for both  $ldc$  and  $fd$ . The corresponding numbers for the sample of developed countries, using 4 portfolios, are 3.1 (Sharpe ratio of 0.6) for  $ldc$  and 3.5 (Sharpe ratio of 0.7) for  $fd$ . In short, these results confirm that there is independent information in each of  $nfa$  and  $ldc$  that is not contained in interest rate differentials.

Taken together, the results reported till now suggest that the global imbalance strategy has creditable excess returns overall, and these returns are positively but imperfectly correlated with the returns from the carry trade. The lack of a perfect correlation is in line with Hypothesis 1 and the predictions of GM (2015), which states that global imbalances matter for the determination of currency risk premia regardless of the size of interest rate differentials. We now turn to a more rigorous investigation of the importance of global imbalance risk using formal asset pricing tests applied to a broad set of currency portfolios.

## 5 Does Global Imbalance Risk Price Currency Excess Returns?

This section presents cross-sectional asset pricing tests for currency portfolios and the global imbalance risk factor, and empirically documents that global imbalance risk is priced in a broad cross-section of currency portfolios. Also, we find that the *IMB* factor is priced even when controlling for the *CAR* factor of Lustig, Roussanov and Verdelhan (2011).

**Methodology.** We denote the discrete excess returns on portfolio  $j$  in period  $t$  as  $RX_t^j$ . In the absence of arbitrage opportunities, risk-adjusted excess returns have a price of zero and satisfy the following Euler equation:

$$E_t[M_{t+1}RX_{t+1}^j] = 0 \quad (4)$$

with a Stochastic Discount Factor (SDF),  $M_{t+1}$  linear in the pricing factors  $f_{t+1}$ , given by

$$M_{t+1} = 1 - b'(f_{t+1} - \mu) \quad (5)$$

where  $b$  is the vector of factor loadings, and  $\mu$  denotes the factor means. This specification implies a beta pricing model where the expected excess return on portfolio  $j$  is equal to the factor risk price  $\lambda$  times the risk quantities  $\beta^j$ . The beta pricing model is defined as

$$E[RX^j] = \lambda'\beta^j \quad (6)$$

where the market price of risk  $\lambda = \Sigma_f b$  can be obtained via the factor loadings  $b$ .  $\Sigma_f = E[(f_t - \mu)(f_t - \mu)']$  is the variance-covariance matrix of the risk factors, and  $\beta^j$  are the regression coefficients of each portfolio's excess return  $RX_{t+1}^j$  on the risk factors  $f_{t+1}$ .

The factor loadings  $b$  entering equation (4) are estimated via the Generalized Method of Moments (*GMM*) of Hansen (1982). To implement *GMM*, we use the pricing errors as a set of moments and a prespecified weighting matrix. Since the objective is to test whether the model can explain the cross-section of expected currency excess returns, we only rely on unconditional moments and do not employ instruments other than a constant and a vector of ones. The first-stage *GMM* estimation used here employs an identity weighting matrix, which tells us how much attention to pay to each moment condition. With an identity matrix, *GMM* attempts to price all currency portfolios equally well. The tables report estimates of  $b$  and  $\lambda$ , and standard errors based on Newey and West (1987) with optimal lag length selection set according to Andrews (1991). The model's performance is then evaluated using the cross-sectional  $R^2$  and the *HJ* distance measure of Hansen and Jagannathan (1997), which quantifies the mean-squared distance between the SDF of a proposed model and the set of admissible SDFs. To test whether the *HJ* distance is statistically significant, we simulate  $p$ -values using a weighted sum of  $\chi_1^2$ -distributed random variables (see Jagannathan and Wang, 1996; Ren and Shimotsu, 2009).

The estimation of equation (6) is also undertaken using a two-pass ordinary least squares regression following Fama and MacBeth (1973), and a two-step GMM estimation. Our results, however, are virtually identical and therefore we only present one-step GMM estimates below.<sup>9</sup>

**Risk Factors and Pricing Kernel.** The most recent literature on cross-sectional asset pricing in currency markets has considered a two-factor SDF. The first risk factor is typically the expected market excess return, approximated by the average excess return on a portfolio strategy that is long in all foreign currencies with equal weights and short in the domestic currency – the *DOL* factor. For the second risk factor, the literature has employed several return-based factors such as the slope factor (essentially *CAR*) of Lustig, Roussanov, and Verdelhan (2011) or the global volatility factor of Menkhoff, Sarno, Schmeling and Schrimpf (2012a). Regardless of its parsimony and the likely omission of other potential factors, this simple empirical model has delivered important insights on the relation between global risk and expected currency returns. Following this literature, we consider a two-factor SDF with *DOL* and *IMB* as risk factors to assess the validity of the theoretical prediction in Hypothesis 1 that carry trade returns are linked to external imbalances, and that currencies more exposed to global imbalance risk offer a higher risk premium. We also employ the two-factor SDF with *DOL* and *CAR* as in Lustig, Roussanov and Verdelhan (2011), and a three-factor SDF with *DOL*, *CAR* and *IMB*. The latter, three-factor SDF allows us to assess whether *IMB* has any independent pricing power beyond *CAR* or simply mimicks information already embedded in *CAR*.

**Cross-Sectional Regressions.** Table 3 presents the cross-sectional asset pricing results. The test assets include the following 35 currency portfolios for the sample from October 1983 to June 2014: 5 carry trade, 5 global imbalance, 5 short-term momentum and 5 long-term momentum, 5 value, 5 term spread, and 5 long yields portfolios. For the sample from January 1996 to June 2014, we augment the above set of test assets with 5 risk reversal and 5 volatility risk premia portfolios, yielding a total of 45 currency portfolios. Lewellen, Nagel and Shanken (2010) show that a strong factor structure in test asset returns can give rise to misleading

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<sup>9</sup>We also calculate the  $\chi^2$  test statistic for the null hypothesis that all cross-sectional pricing errors (i.e., the difference between actual and predicted excess returns) are jointly equal to zero. The  $\chi^2$  test results are perfectly in line with the *HJ* distance results, and therefore are not reported to conserve space.

results in empirical work. If the risk factor has a small (but non-zero) correlation with the ‘true’ factor, the cross-sectional  $R^2$  could still be high suggesting an impressive model fit. This is particularly problematic in small cross sections, and it is a key reason why we employ such a broad set of currency portfolios rather than just focusing, for example, on the 5 carry portfolios.

Since  $IMB$  is a tradable risk factor, its price of risk must equal its expected return, i.e. the price of global imbalance risk cannot be a free parameter in estimation. When the test assets include the global imbalance portfolios, this problem does not arise. However, when the test assets do not include the global imbalance portfolios (such as the asset pricing tests conducted later in the paper on cross-sections of equity, bond and commodity portfolios) we follow the suggestion of Lewellen, Nagel and Shanken (2010) and include the global imbalance factor as one of the test assets. This effectively means that we constrain the price of risk for  $IMB$  to be equal to the mean return of the traded global imbalance portfolio. The same logic applies to  $CAR$ .

The results from implementing asset pricing tests on the above cross sections of currency portfolios as test assets are presented in Table 3, which reports estimates of factor loadings  $b$ , the market prices of risk  $\lambda$ , the cross-sectional  $R^2$ , and the  $HJ$  distance. Newey and West (1987) corrected standard errors with lag length determined according to Andrews (1991) are reported in parentheses. The  $p$ -values of the  $HJ$  distance measure is reported in brackets. The results are reported for all three SDF specifications described above, both for all countries and for developed countries, and over two sample periods.

Starting from Panel A of Table 3, we focus our interest on the sign and the statistical significance of  $\lambda_{IMB}$ , the market price of risk attached to the global imbalance risk factor. We find a positive and significant estimate of  $\lambda_{IMB}$ , in the range between 4 and 8 percent per annum for all countries, and 3-6 percent per annum for developed countries. The estimates are very similar for both SDF specifications involving the  $IMB$  factor, i.e. also when the SDF includes  $CAR$ . A positive estimate of the factor price of global imbalance risk implies higher risk premia for currency portfolios whose returns comove positively with the global imbalance factor, and lower risk premia for currency portfolios exhibiting a negative covariance with the global imbalance factor. The standard errors of the risk prices are approximately equal to 1 percent for all estimations carried out. The price of risk associated with  $IMB$  is more than

two standard deviations from zero, and thus highly statistically significant in each case. We observe satisfactory cross-sectional fit in terms of  $R^2$ , which ranges from 49 to 65 percent for the two-factor SDF that includes  $DOL$  and  $IMB$ . Further support in favor of the pricing power of  $IMB$  comes from the fact that the  $HJ$  distance is insignificant. It is also worth noting that the SDF specification with  $DOL$  and  $CAR$  (hence not including  $IMB$ ), does well in pricing the test assets, as  $\lambda_{CAR}$  is statistically significant, the  $R^2$  is satisfactory (albeit lower than the SDF specifications involving  $IMB$ ), and the  $HJ$  distance is not significant. However, the bottom line for our purposes is that a simple two-factor model that includes  $IMB$  performs well in pricing the cross-section of currency excess returns, and global imbalance risk is priced whether or not  $CAR$  is included as a risk factor in the model. In turn, the latter point corroborates the results in the previous section, suggesting that there is some differential information embedded in  $IMB$  versus  $CAR$ .

Panel B of Table 3 reports the same information as Panel A for asset pricing tests conducted on test assets that now exclude both carry trade and global imbalance portfolios; hence the number of test assets is now 25 since 1983, and 35 since 1996. This exercise is an interesting out-of-sample test since we attempt to price currency portfolios that do not include the portfolios from which  $IMB$  and  $CAR$  are constructed (although we do include the  $IMB$  and  $CAR$  factors as test assets to ensure arbitrage-free estimates of  $\lambda_{IMB}$  and  $\lambda_{CAR}$ ). The estimation results reported in Panel B are qualitatively identical to the results in Panel A, indicating that the pricing power of  $IMB$  recorded earlier is not driven simply by its ability to price global imbalance and carry portfolios, but it clearly extends to other currency portfolios.

Note that we do not argue that these two determinants of currency risk premia (global imbalances and interest rate differentials) are unrelated, only that they are imperfectly correlated. It is well-documented that there is a cross-sectional correlation between interest rates (typically real interest rates) and net foreign asset positions (e.g. Rose, 2010). In Table 4, we present results from a cross-sectional regression of the nominal interest rate differentials used in our study on net foreign assets and the share of liabilities denominated in domestic currency. These results show clearly that net foreign assets enter the regression with a strongly statistically significant coefficient and with the expected sign: higher  $nfa$  is associated with lower interest rates. The  $R^2$  is lower than one might expect, however, suggesting that there may be important omitted variables in the regression. Indeed, when we add inflation differen-

tials and output gap differentials to the regression, net foreign asset positions remain strongly significant, but the  $R^2$  increases dramatically, mainly due to inflation differentials.<sup>10</sup> In short, the main point is that, even though the information in global imbalances is related to interest rate differentials, there is some independent information in global imbalances that matters for exchange rate returns.

**Portfolios based on *IMB* Betas.** We provide evidence of the explanatory power of the *IMB* factor for currency excess returns from a different viewpoint. We form portfolios based on an individual currency’s exposure to global imbalance risk, and investigate whether these portfolios have similar return distributions to the global imbalance portfolios. If global imbalance risk is a priced factor, then currencies sorted according to their exposure to global imbalance risk should yield a cross section of portfolios with a significant spread in average currency returns.

We regress individual currency excess returns at time  $t$  on a constant and the global imbalance risk factor using a 36-month rolling window that ends in period  $t - 1$ , and denote this slope coefficient as  $\beta_{IMB,t}^i$ . This exercise provides currency  $i$  exposure to *IMB* only using information available at time  $t$ . We then rank currencies according to  $\beta_{IMB,t}^i$  and allocate them to five portfolios at time  $t$ . Portfolio 1 contains the currencies with the largest negative exposure to the global imbalance factor (lowest betas), while Portfolio 5 contains the most positively exposed currencies (highest betas). Table 5 summarizes the descriptive statistics for these portfolios. We find that buying currencies with a low beta (i.e., insurance against global imbalance risk) yields a significantly lower return than buying currencies with a high beta (i.e., high exposure to global imbalance risk). The spread between the last portfolio and the first portfolio is in excess of 5 percent per annum for both sets of countries. Average excess returns generally increase, albeit not always monotonically, when moving from the first to the last portfolio. Moreover, we also find a clear monotonic increase in both average *pre*-formation and *post*-formation betas when moving from Portfolio 1 to Portfolio 5: they line up perfectly well with the cross-section of average excess returns in Table 1. Average *pre*-formation betas vary from  $-0.22$  to  $1.35$  for all countries, and from  $-0.94$  to  $0.67$  for developed countries. *Post*-

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<sup>10</sup>Inflation and the output gap are the core variables in macro models of the short-term interest rate, commonly used in the ‘Taylor rule’ literature. Note that the regressions in Table 4 are run for 53, rather than 55, countries due to difficulties in obtaining reliable data for the full sample for Greece and Venezuela.



formation betas are calculated by regressing realized excess returns of beta-sorted portfolio  $j$  on  $DOL$  and  $IMB$ . These figures range from  $-0.30$  to  $0.31$  for all countries, and from  $-0.57$  to  $0.59$  for developed countries. Overall, these results confirm that global imbalance risk is important for understanding the cross-section of currency excess returns, providing further support to Hypothesis 1.

## 6 Exchange Rates and Net Foreign Assets in Bad Times

We now turn to testing Hypothesis 2, as stated in Section 2. In essence, the testable prediction from GM (2015) that we take to the data is that exchange rates are jointly determined by global imbalances and financiers' risk-bearing capacity so that net external debtors experience a currency depreciation in bad times, which are times of large shocks to risk bearing capacity and risk aversion ( $\Gamma$  is high in the model). In contrast, net external creditors experience a currency appreciation in bad times.

In the model of GM (2015),  $\Gamma$  is driven by shocks to conditional FX volatility. We use the change in the VXY index as a proxy for conditional FX volatility risk to proxy  $\Gamma$ , i.e. shocks to the willingness of financiers to absorb exchange rate risk. VXY is the FX analogue of the VIX index, and is a tradable volatility index designed by JP Morgan. It measures aggregate volatility in currencies through a simple, turnover-weighted index of G7 volatility based on 3-month at-the-money forward options. In general, GM (2015) refer to  $\Gamma$  as loosely proxying for global risk aversion shocks, and therefore we also show in the Internet Appendix (Tables A.6, A.7 and A.9) the robustness of our results using the change in VIX, a commonly used proxy for global risk aversion in the empirical finance literature.<sup>11</sup>

We test Hypothesis 2 in two different ways. First, we estimate a panel regression where we regress monthly exchange rate returns on a set of macro variables, allowing for fixed effects. As

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<sup>11</sup>We use the change in VXY (or VIX) contemporaneously in these regressions in order to capture the effect of the shock on exchange rate returns predicted by Hypothesis 2, which states that net debtor countries' currencies depreciate on impact when risk aversion increases. An alternative interpretation of  $\Gamma$  might be that it captures (changes in) the amount of capital available in financial markets to bear risk. In this case one would expect the returns of the carry trade strategy to decline as the amount of capital increases, and in fact there is evidence in the literature that this is the case (e.g. Jylha and Suominen, 2011; Barroso and Santa-Clara, 2014). However, our interpretation of  $\Gamma$  is, much like GM (2015), that it reflects shocks to risk aversion and hence the change in VXY seems a reasonable proxy, as does the VIX. Indeed, Bekaert, Hoerova and Lo Duca (2013) find that a large component of the VIX index is driven by factors associated with time-varying risk aversion; see also Ang, Hodrick, Xing and Zhang (2006).

right-hand-side variables, we employ *nfa* lagged by 12 months, and the interest rate differential lagged by 1 month. In some specifications we also include *ldc*, and the change in VXY on its own. Importantly, we also allow for an interaction term between *nfa* as well as the interest rate differential and the change in the VXY index (specification 1-2-3), or the change in VXY times a dummy that is equal to unity when the change in VXY is greater than one standard deviation and is zero otherwise (specifications 4-5-6).<sup>12</sup>

The key variable of interest in these regressions is the interaction term between *nfa* and the VXY change. Given our variable definitions, Hypothesis 2 requires a positive coefficient on this variable, which would imply that at times when risk aversion increases (as proxied by the VXY change) countries with larger net foreign asset positions to GDP experience a currency appreciation, whereas the currencies of countries with larger net debtor positions depreciate. The results, reported in Table 6, indicate that this is the case as the interaction term is positive and strongly statistically significant in all regression specifications, even when controlling for the interest rate differential, the change in VXY and the other control variables described above. It is instructive to note that the change in VXY also enters significantly and with the expected sign, meaning that increases in risk aversion are associated with appreciation of the US dollar.<sup>13</sup>

Our second test of Hypothesis 2 involves estimating time-series regressions of the returns from the five global imbalance portfolios on the change in VXY. Remember that the long (short) portfolio comprises the currencies with highest (lowest) net foreign liabilities and a higher (lower) propensity to issue external liabilities in foreign currency. Hence Hypothesis 2 requires that the return on the long portfolio is negatively related to conditional FX volatility, proxied by the change in VXY; by contrast the return on the short portfolio should be positively related to the change in VXY. The results from estimating these regressions are reported in Table 7 (both for excess returns and just the spot exchange rate component), and show a decline (which is almost monotonic) in the coefficients on the change in VXY, as one would expect. However, the coefficients for  $P_1$  and  $P_2$  are not statistically different from zero, implying that the currencies of net creditors do not respond to shocks to conditional volatility. The coefficients for portfolios  $P_3$ ,  $P_4$  and  $P_5$  are negative and statistically significant, and they

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<sup>12</sup>We also add a constant, and the lagged exchange rate return as a control variable.

<sup>13</sup>We also run similar panel regressions for excess returns rather than exchange rate returns, reported in Table A.8 of the Internet Appendix, and find consistent results.

are largest for  $P_5$ , implying that the currencies in the long portfolio of the global imbalance strategy depreciate the most in bad times. Overall, the currencies issued by the extreme net debtor countries with the highest propensity to issue liabilities in foreign currency depreciate sharply in bad times relative to the currencies issued by the extreme net creditor countries with the lowest propensity to issue liabilities in foreign currency. This result constitutes further supportive evidence for Hypothesis 2.

## 7 Further Analysis

In this section, we present a battery of additional exercises that further refine and corroborate the results reported earlier.

**Asset Pricing Tests on Other Cross-Sections of Returns.** In our empirical asset pricing analysis, the pricing power of the global imbalance factor was tested using cross sections of currency portfolios (up to 45 portfolios). We now explore the pricing power of the global imbalance factor on cross-sections of portfolios of other assets, without including currency portfolios as test assets. Specifically, in Table 8, we apply asset pricing tests to 25 equity portfolio returns (sorted either by size and book-to-market, or by size and momentum), 5 international bond portfolio returns, and 7 commodity portfolio returns.<sup>14</sup>

Starting from Panels A and B, which report the results for the cross-sections of equity portfolios, we find that the global imbalance risk factor is priced in these cross-sections of returns, even controlling for Fama-French factors.<sup>15</sup> The *IMB* risk price estimate is 0.07 and highly statistically significant, the  $R^2$  is reasonably high (0.57 in Panel A, and 0.70 in Panel B), and the *HJ* test is statistically insignificant. Similarly, Panel C reports the results when we price 5 international bond portfolio returns, and we control for an international bond factor. In Panel D, we consider 7 commodity portfolio returns, and in this case we control for

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<sup>14</sup>The size and book-to-market (momentum) portfolios are from Kenneth French's website and range from July 1990 (November 1990) to June 2014. We use equally weighted portfolios that do not include the US to be consistent with the dollar-neutral equally-weighted currency portfolios. The commodity portfolios, sorted on the log difference between the 12-month and the one-month futures prices, are from Yang (2013) and range from October 1983 to December 2008. For international bonds, we sort bonds of different maturities (1-3y, 3-5y, 5-7y, 7-10y, >10y) for 19 countries into five portfolios depending on their redemption yield. We use total return indices denominated in US dollars from Datastream.

<sup>15</sup>We use 3 Fama-French factors in each regression. In Panel A, they are the excess return on the market, Small Minus Big and High Minus Low, while in Panel B High Minus Low is replaced by Winners Minus Losers (momentum). Overall, we estimate 5 risk prices in both Panels A and B.

a commodity factor. Both in Panels C and D, the global imbalance risk factor is priced with comparable estimates of the risk price, the  $R^2$  is high, and the  $HJ$  distance is not significant.

Since  $IMB$  is a tradable risk factor, its price of risk must equal its expected return. Thus, in the above asset pricing tests we include the global imbalance factor as one of the test assets, which effectively means we constrain the price of risk for  $IMB$  to be equal to the mean return of the traded global imbalance portfolio. Note, however, that if we do not include the global imbalance factor as a test asset the results are qualitatively identical, with a slightly higher  $R^2$ , and a slightly higher estimate of the price of imbalance risk around 0.08 for the equity cross sections. Also, the estimation results are qualitatively identical when using the Fama-MacBeth procedure or two-stage GMM rather than first-stage GMM.

Overall, these results suggest that global imbalance risk is priced in some of the most common cross-sections of equities, international bonds and commodities.<sup>16</sup>

**Independent Contribution of  $nfa$  and  $ldc$ .** The global imbalance factor is constructed by sequentially sorting currencies first with respect to  $nfa$ , and then with respect to  $ldc$ . A natural question to ask is whether the information in the global imbalance factor is driven by  $nfa$  or  $ldc$ , or both. Earlier we reported results from independent double sorts to show that each of  $nfa$  and  $ldc$  contains information for excess returns that is not embedded in interest rate differentials. To address this point further, we construct a factor that captures only the information arising from  $nfa$  and a factor that summarizes only the signal coming from  $ldc$ . We will refer to these factors as  $NFA$  and  $LDC$ , respectively. Figure A.1 in the Internet Appendix reports a visual description of how we construct these factors. We use 6 portfolios, except for the subset of developed countries where we are restricted to using only 4 portfolios. At the end of each month, currencies are first sorted in two baskets using  $nfa$ , and then in three baskets using  $ldc$ . The  $NFA$  factor is computed as the average return on the low  $nfa$  portfolios ( $P_4$ ,  $P_5$  and  $P_6$ ) minus the average return on the high  $nfa$  portfolios ( $P_1$ ,  $P_2$  and  $P_3$ ), whereas the  $LDC$  factor is computed as the average return on the low  $ldc$  portfolios ( $P_3$  and  $P_6$ ) minus the average return on the high  $ldc$  portfolios ( $P_1$  and  $P_4$ ). We use a similar

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<sup>16</sup>The asset pricing results in Table 3 suggested that the  $IMB$  factor prices the cross-section of currency excess returns. However, we also execute asset pricing tests using only the five carry portfolios as test assets. The results, reported in Tables A.3 and Table A.4 in the Internet Appendix (with and without imposing the constraint on the price of global imbalance risk), confirm that the  $IMB$  factor prices this cross section very well.

procedure for the developed countries sample.

We report the summary statistics of these portfolios' excess returns along with the *NFA* and *LDC* factors in Table A.15 in the Internet Appendix. The excess return per unit of volatility risk on both factors tends to be comparable when we inspect the subset of developed countries (the *SR* equals 0.34 for *NFA* and 0.38 for *LDC*). When we move away from developed countries, the *LDC* factor tends to outperform the *NFA* factor: the *LDC* (*NFA*) factor displays an *SR* of 0.78 (0.59) when we add the most liquid emerging market currencies to the set of developed countries, and an *SR* of 0.71 (0.28) when we consider the full set of currencies.<sup>17</sup>

Table A.16 in the Internet Appendix presents asset pricing tests based on a linear three-factor model that includes the *DOL*, *NFA* and *LDC* factors. As test assets, we use the same cross sections of currency portfolios used for the core asset pricing results in Table 3. The results in Table A.16 show that the market price of risk is positive and statistically significant for both *NFA* and *LDC* when we focus on the broadest sample of all countries and the intermediate sample of developed and emerging countries. Results for the subset of developed countries suggest that the market price of risk is positive and statistically significant for *NFA*, but is not statistically significant for *LDC*. This may be because the share of external liabilities denominated in domestic currency is more homogenous across major economies, but shows more cross-sectional variation as one expands the sample of countries to include emerging markets. These results are the same for cross-sections that include the global imbalance portfolios and the carry portfolios (Panel A) as well as for cross sections that do not (Panel B). The  $R^2$  is reasonably high, and the *HJ* distance is not significant.

Overall, the evidence in this section confirms that both sorting variables used in our global imbalance strategy contribute to the price of global imbalance risk, and reflect slightly different aspects of risk. The sorting procedure used in the core analysis allows us to combine the information in *nfa* and *ldc* in a simple fashion, and to construct a single risk factor that captures these two different aspects of the evolution of global imbalances across countries.

**Backfilling data for *ldc*.** Recall that data for *ldc* are only available since 1990 and we

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<sup>17</sup>Note that here we report summary statistics for portfolios gross of transaction costs. Otherwise, we would need to report both long and short net positions for the same portfolio as *NFA* and *LDC* require different combinations of long and short portfolios.

backfill the data to 1983 by keeping them constant at their 1990 values for all countries. One may be concerned about the impact of this choice, and therefore we check the robustness of this decision by starting the sample in January 1991 (given that *ldc* is available at the end of Dec 1990). We then construct the global imbalance portfolios and the *IMB* factor. For the developed sample, we find that the *IMB* factor has a mean return of 3.91 ( $t$ -stat = 2.54), and  $SR = 0.53$ . For the sample of all countries, the mean return is 4.73 ( $t$ -stat = 2.84), and  $SR = 0.69$ . In short, the results are qualitatively identical when using a sample period that does not require backfilling the *ldc* data prior to 1990.

**Individual Currencies.** Ang, Liu and Schwarz (2010) argue that forming portfolios may potentially destroy information by shrinking the dispersion of betas. In Table A.5 we deal with this concern and present cross-sectional asset pricing tests with individual currency excess returns as test assets. Since the set of currencies is now unbalanced, we only report estimates of market prices of risk obtained via Fama-MacBeth regressions. Also, since country-level excess returns, especially for currencies with limited trading activity, may be contaminated by outliers, least square estimates can be severely distorted and fail to deliver unbiased estimates. We deal with this problem by using the least absolute deviation (LAD) estimator which is robust to thick-tailed errors and is not sensitive to atypical data points (Bassett and Koenker, 1978; Koenker and Bassett, 1982). We report bootstrapped standard errors in parentheses.<sup>18</sup>

In Panel A the test assets are excess returns constructed as long positions in foreign currencies irrespective of the level of interest rates. Note that these individual currency excess returns are not adjusted for transaction costs as ex-ante we ignore whether an investor should buy or sell the foreign currency. We refer to these excess returns as unconditional excess returns. The SDF includes *DOL* and *IMB* as risk factors. The market price of global imbalance risk is positive and statistically significant, and the estimate is very close to the estimates obtained in Table 3 (0.05 and 0.06 for our two samples of countries). The cross-sectional  $R^2$  is reasonably high, 34 percent for all countries and 64 percent for developed countries, especially considering that individual excess returns are far more noisy than portfolio returns.

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<sup>18</sup>To calculate bootstrapped standard errors, we simulate  $y_{i,t} = \alpha_i + \beta_i f_t + \varepsilon_{i,t}$  and  $f_t = \mu + \sum_{i=1}^p A_i f_{t-i} + u_t$ , where  $y_{i,t}$  is the excess return on the  $i$ -th currency,  $\alpha_i$  is the constant,  $\beta_i$  is the vector of factor loadings,  $f_t$  denotes the risk factors following a  $p$ -order VAR process,  $\varepsilon_{i,t}$  are idiosyncratic residuals, and  $u_t \sim N(0, \Sigma)$ . We estimate this system, and use the parameter estimates to generate 1000 time-series by jointly resampling  $\varepsilon_{i,t}$  and  $u_t$ .

In Panel B we use as test assets excess returns managed on the basis of interest rate differentials: the US investor buys the foreign currency and sells the US dollar when the forward discount is positive (i.e., the foreign currency interest rate is higher than the US interest rate), and vice versa. Results remain largely comparable to the previous panel. In short, these results suggest that the global imbalance risk factor does a reasonably good job at pricing the cross-section of individual currency excess returns.

**Alternative base currencies.** We depart from the base scenario of a US-based investor and run calculations using alternative base currencies, taking the viewpoint of a British, Japanese, Euro-based and Swiss investor. The results indicate that, in each case, the global imbalance portfolio has similar return characteristics to the ones reported in Table 1 (see Table A.10 in the Internet Appendix). This is comforting since it makes clear that the US does not play a key role in driving our results, which are qualitatively identical regardless of whether the currency portfolios are dollar-neutral or not. Indeed, the US may be seen as an interesting exception to our story in this paper, especially during the recent crisis, because it is one of the largest external debtors in the world and yet it appreciated strongly during the crisis. Part of the explanation may be that the US, which has a substantial currency mismatch on its balance sheet, borrows in domestic currency and is generally considered a safe reserve currency (see Maggiori, 2013 for a theoretical discussion of this ‘reserve currency paradox’). In any event, we find it comforting that our results hold when using four alternative base currencies.

**Removing Illiquid Currencies.** Tables A.11 and A.12 display the results from building the global imbalance portfolio (and running asset pricing tests) using a sample where currencies with limited liquidity are removed. Specifically, using the latest *BIS Triennial Survey*, we select the most liquid currencies and name this sample ‘developed and emerging countries,’ which is an intermediate sample (in terms of size) between the two samples analyzed in the paper till now. We hypothesize that while forward rates may be available for a large number of currencies, there would have been low liquidity in many of them. Additionally, the imposition of capital controls in a number of the emerging market nations might have made it impossible to engage in a currency strategy at some points in time.

Table A.11 shows that there are no qualitative changes to the properties of the global imbalance strategy as reported in Table 1, but the performance of the strategy is enhanced,

reaching a Sharpe ratio of 0.95. Table A.12 reports cross-sectional asset pricing results, which are highly comparable to the results in Table 3. Finally, Table A.13 shows that the time series regressions reported in Table 2 (showing the differences between *IMB* and *CAR*) are very similar when using this sample of countries.

## 8 Conclusions

The large and sudden depreciation of high-interest currencies in the aftermath of the Lehman Brothers' collapse has revived interest in the risk-return profile of the foreign exchange market. While the recent empirical literature has established that currency excess returns can be understood as compensation for time-varying risk, it is silent about the economic determinants underlying currency premia.

This paper tackles exactly this issue by shedding light on the *macroeconomic* forces driving currency risk premia. Motivated by the theoretical insights of portfolio balance models of exchange rate determination in incomplete financial markets, we show that sorting currencies on net foreign asset positions and a country's propensity to issue external liabilities in domestic currency generates a large spread in returns. In fact, a risk factor that captures exposure to global imbalances and the currency denomination of external liabilities explains the bulk of currency excess returns in a standard asset pricing model. The economic intuition for this risk factor is simply that net debtor countries offer a currency risk premium to compensate investors willing to finance negative external imbalances. This means that currency risk premia are actually determined by two different, albeit related, channels: the first is related to the familiar interest rate differential, and the second is related to the evolution of net foreign asset positions and their currency of denomination.

We also show that, when global risk aversion spikes, net debtor nations experience a sharp currency depreciation. Moreover, global imbalance risk appears to be priced pervasively, not just in carry trade portfolios, but also in other cross-sections of currency returns as well as in cross-sections of returns from other major asset markets.

Overall, we provide empirical support for the existence of a meaningful link between exchange rate returns and macroeconomic fluctuations, uncovering a fundamental and theoretically motivated source of risk driving currency returns.



**Table 1. Descriptive Statistics: Global Imbalance Portfolios**

The table presents descriptive statistics of currency portfolios sorted on the time  $t - 1$  net foreign asset position to gross domestic product ( $nfa$ ), and the share of foreign liabilities in domestic currency ( $ldc$ ). The first portfolio ( $P_1$ ) contains the top 20% of all currencies with high  $nfa$  and high  $ldc$  (creditor nations with external liabilities mainly in domestic currency) whereas the last portfolio ( $P_5$ ) contains the top 20% of all currencies with low  $nfa$  and low  $ldc$  (debtor nations with external liabilities mainly in foreign currency).  $IMB$  is a long-short strategy that buys  $P_5$  and sells  $P_1$ . The table also reports the first order autocorrelation coefficient ( $ac_1$ ), the annualized Sharpe ratio ( $SR$ ), the maximum drawdown ( $mdd$ ), the frequency of portfolio switches ( $freq$ ), the average forward discount or interest rate differential relative to the US ( $fd$ ), the average  $nfa$ , and the average  $ldc$ .  $t$ -statistics based on Newey and West (1987) standard errors with Andrews (1991) optimal lag selection are reported in brackets. Excess returns are expressed in percentage per annum and adjusted for transaction costs. The portfolios are rebalanced monthly from October 1983 to June 2014.

	$P_1$	$P_2$	$P_3$	$P_4$	$P_5$	$IMB$	$P_1$	$P_2$	$P_3$	$P_4$	$P_5$	$IMB$
	<i>All Countries</i>						<i>Developed Countries</i>					
<i>mean</i>	0.92	3.51	1.40	3.57	5.32	4.40	0.67	2.45	3.06	3.46	4.65	3.98
<i>t-stat</i>	[0.60]	[2.18]	[1.10]	[2.39]	[2.73]	[3.51]	[0.37]	[1.31]	[1.77]	[2.00]	[2.38]	[3.26]
<i>med</i>	1.20	2.69	3.52	4.24	6.79	4.94	1.24	2.73	3.66	3.87	6.90	5.27
<i>sdev</i>	7.80	8.71	6.52	7.92	10.05	6.43	9.90	10.25	9.33	9.06	10.29	6.76
<i>skew</i>	-0.16	-0.03	-0.86	-0.48	-0.27	0.17	0.05	-0.07	-0.26	-0.16	-0.28	-0.53
<i>kurt</i>	3.56	3.95	6.42	5.49	4.36	6.17	3.56	3.27	3.90	6.08	3.66	5.17
$ac_1$	0.08	0.05	0.09	0.06	0.08	0.09	0.06	0.02	0.05	0.08	0.06	-0.01
$SR$	0.12	0.40	0.22	0.45	0.53	0.68	0.07	0.24	0.33	0.38	0.45	0.59
$mdd$	0.46	0.29	0.33	0.26	0.30	0.20	0.54	0.36	0.34	0.32	0.31	0.26
$freq$	0.03	0.04	0.04	0.04	0.03		0.02	0.02	0.02	0.02	0.03	
$fd$	-0.54	1.20	2.02	3.50	6.80		-1.32	-0.76	1.81	2.15	2.23	
$nfa$	0.43	0.14	0.10	-0.46	-0.56		0.41	0.31	0.04	-0.37	-0.37	
$ldc$	0.63	0.47	0.44	0.47	0.28		0.61	0.46	0.48	0.49	0.34	

**Table 2. Time-Series Regressions**

The table presents time-series regression estimates. In Panel A, we regress the global imbalance factor's excess returns ( $IMB_t$ ) on the carry trade factor's excess returns ( $CAR_t$ ). In Panel B, we regress the excess returns of the global imbalance portfolios ( $RX_{i,t}$  for  $i = 1, 2, \dots, 5$ ) on the carry trade factor's excess returns. We also control for the lagged one-year dependent variable as external imbalance information is gathered once a year. The global imbalance portfolios are sorted on the time  $t - 1$  net foreign asset position to gross domestic product ( $nfa$ ), and the share of foreign liabilities in domestic currency ( $ldc$ ). The first portfolio ( $P_1$ ) contains the top 20% of all currencies with high  $nfa$  and high  $ldc$  (creditor nations with external liabilities mainly in domestic currency) whereas the last portfolio ( $P_5$ ) contains the top 20% of all currencies with low  $nfa$  and low  $ldc$  (debtor nations with external liabilities mainly in foreign currency).  $IMB$  is a long-short strategy that buys  $P_5$  and sells  $P_1$ .  $CAR$  denotes a long-short strategy that buys high yielding currencies and sells low yielding currencies. Newey and West (1987) standard errors with Andrews (1991) optimal lag selection are reported in parentheses.  $F_{(\alpha,\beta)}$  denotes the F-test for the null hypothesis that  $\alpha = 0$  and  $\beta = 1$  (with  $p$ -values in brackets). Excess returns are expressed in percentage per annum, and adjusted for transaction costs. The portfolios are rebalanced monthly from October 1983 to June 2014.

Panel A: $IMB_t = \alpha + \beta CAR_t + \gamma IMB_{t-12} + \varepsilon_t$									
$RX_t$	$\alpha$	$\beta$	$R^2$	$F_{(\alpha,\beta)}$	$\alpha$	$\beta$	$\gamma$	$R^2$	$F_{(\alpha,\beta)}$
<i>All Countries</i>									
$IMB_t$	2.30 (1.00)	0.41 (0.05)	0.30	< .01]	1.98 (0.96)	0.41 (0.05)	0.07 (0.07)	0.30	< .01]
<i>Developed Countries</i>									
$IMB_t$	1.97 (0.92)	0.39 (0.04)	0.39	< .01]	1.83 (0.91)	0.39 (0.04)	0.04 (0.04)	0.39	< .01]
Panel B: $RX_{i,t} = \alpha + \beta CAR_t + \gamma RX_{i,t-12} + \varepsilon_t$									
	$\alpha$	$\beta$	$R^2$		$\alpha$	$\beta$	$\gamma$	$R^2$	
<i>All Countries</i>									
$RX_{1,t}$	2.57 (1.59)	-0.15 (0.07)	0.02		2.59 (1.60)	-0.15 (0.07)	-0.01 (0.05)	0.02	
$RX_{2,t}$	4.98 (1.72)	-0.11 (0.07)	0.01		5.00 (1.74)	-0.11 (0.07)	-0.01 (0.05)	0.01	
$RX_{3,t}$	0.84 (1.32)	0.15 (0.05)	0.03		0.92 (1.29)	0.15 (0.05)	-0.06 (0.06)	0.04	
$RX_{4,t}$	3.13 (1.53)	0.16 (0.05)	0.02		3.25 (1.48)	0.16 (0.05)	-0.03 (0.05)	0.02	
$RX_{5,t}$	4.87 (1.91)	0.26 (0.09)	0.05		5.23 (1.92)	0.26 (0.09)	-0.06 (0.06)	0.05	
<i>Developed Countries</i>									
$RX_{1,t}$	2.14 (1.91)	-0.16 (0.07)	0.03		2.14 (1.92)	-0.16 (0.07)	-0.01 (0.05)	0.03	
$RX_{2,t}$	3.64 (1.97)	-0.09 (0.08)	0.01		3.75 (1.96)	-0.09 (0.08)	-0.05 (0.05)	0.01	
$RX_{3,t}$	2.78 (1.69)	0.20 (0.06)	0.06		3.00 (1.66)	0.20 (0.06)	-0.07 (0.05)	0.06	
$RX_{4,t}$	2.51 (1.64)	0.31 (0.07)	0.14		2.70 (1.60)	0.31 (0.07)	-0.05 (0.05)	0.14	
$RX_{5,t}$	4.11 (1.91)	0.23 (0.07)	0.06		4.05 (1.92)	0.23 (0.07)	0.01 (0.05)	0.05	

**Table 3. Asset Pricing Tests: Currency Strategies**

The table presents asset pricing results for currency strategies. The test assets include *5 carry trade* (sorted on the one-month forward discounts), *5 global imbalance* (sorted on the net foreign asset position and the share of foreign liabilities in domestic currency), *5 short-term momentum* (sorted on the past three-month exchange rate returns), *5 long-term momentum* (sorted on the past one-year exchange rate returns), *5 value* (sorted on the past five-years real exchange rate returns), *5 slope* (sorted on the term spread of interest rates), *5 long yields* (sorted on long-term interest rate differentials), *5 risk reversal* (sorted on the 25-delta one-year currency risk reversal), and *5 volatility risk premia* (sorted on the difference between the one-year lagged realized volatility and model-free implied volatility) portfolios. The set of pricing factors includes the dollar (*DOL*), the global imbalance (*IMB*) and carry trade (*CAR*) factors. We report first-stage GMM estimates of the factor loadings  $b$ , the market price of risk  $\lambda$ , and the cross-sectional  $R^2$ . Newey and West (1987) standard errors with Andrews (1991) optimal lag selection are reported in parentheses. *HJ* denotes the Hansen and Jagannathan (1997) distance (with simulated  $p$ -value in brackets) for the null hypothesis that the *HJ* distance is equal to zero. Excess returns are in annual terms and adjusted for transaction costs. The portfolios are rebalanced monthly from October 1983 (except *risk reversal* and *volatility risk premium* which start from January 1996) to June 2014. In *Panel A*, we use 35 (45) portfolios as test assets when starting from October 1983 (January 1996). In *Panel B*, we use 25 (35) portfolios as test assets when starting from October 1983 (January 1996) as we remove the *carry trade* and *global imbalance* portfolios from the set of test assets.

Panel A: with carry trade and global imbalance portfolios as test assets													
$b_{DOL}$		$b_{IMB}$		$b_{CAR}$		$\lambda_{DOL}$		$\lambda_{IMB}$		$\lambda_{CAR}$		$R^2$	$HJ$
<i>All Countries: 10/1983 – 06/2014</i>													
0.12	(0.27)	0.92	(0.40)			0.02	(0.01)	0.05	(0.01)			0.49	0.81 [0.19]
0.32	(0.29)			0.54	(0.26)	0.02	(0.01)			0.05	(0.01)	0.46	0.81 [0.19]
0.19	(0.27)	0.59	(0.41)	0.22	(0.32)	0.02	(0.01)	0.04	(0.01)	0.04	(0.01)	0.50	0.81 [0.21]
<i>All Countries: 01/1996 – 06/2014</i>													
-0.11	(0.43)	1.41	(0.44)			0.02	(0.01)	0.08	(0.01)			0.65	0.91 [0.94]
0.14	(0.41)			1.12	(0.40)	0.02	(0.01)			0.07	(0.01)	0.63	0.91 [0.94]
-0.02	(0.43)	0.81	(0.46)	0.55	(0.54)	0.02	(0.01)	0.07	(0.01)	0.07	(0.01)	0.68	0.91 [0.94]
<i>Developed Countries: 10/1983 – 06/2014</i>													
0.19	(0.23)	0.74	(0.42)			0.02	(0.02)	0.04	(0.01)			0.58	0.65 [0.48]
0.22	(0.23)			0.34	(0.21)	0.02	(0.02)			0.05	(0.02)	0.58	0.66 [0.40]
0.20	(0.23)	0.44	(0.32)	0.15	(0.23)	0.02	(0.02)	0.03	(0.01)	0.05	(0.02)	0.60	0.65 [0.50]
<i>Developed Countries: 01/1996 – 06/2014</i>													
-0.12	(0.33)	0.75	(0.42)			0.01	(0.02)	0.05	(0.01)			0.52	0.80 [0.99]
-0.01	(0.31)			0.40	(0.28)	0.01	(0.02)			0.05	(0.02)	0.41	0.80 [0.99]
-0.15	(0.35)	1.17	(0.48)	-0.28	(0.33)	0.01	(0.02)	0.06	(0.01)	0.04	(0.02)	0.54	0.80 [0.99]

*Continued*

**Table 3. Asset Pricing Tests: Currency Strategies** (*continued*)

Panel B: without carry trade and global imbalance portfolios as test assets														
$b_{DOL}$		$b_{IMB}$		$b_{CAR}$		$\lambda_{DOL}$		$\lambda_{IMB}$		$\lambda_{CAR}$		$R^2$	$HJ$	
<i>All Countries: 10/1983 – 06/2014</i>														
0.13	(0.27)	0.84	(0.34)			0.02	(0.01)	0.04	(0.01)			0.37	0.38	[0.57]
0.30	(0.28)			0.54	(0.25)	0.02	(0.01)			0.05	(0.01)	0.36	0.41	[0.34]
0.16	(0.27)	0.67	(0.34)	0.22	(0.29)	0.02	(0.01)	0.04	(0.01)	0.04	(0.02)	0.43	0.41	[0.41]
<i>All Countries: 01/1996 – 06/2014</i>														
-0.09	(0.41)	1.28	(0.36)			0.02	(0.01)	0.07	(0.01)			0.71	0.60	[0.90]
0.12	(0.40)			1.10	(0.37)	0.02	(0.01)			0.07	(0.01)	0.68	0.62	[0.85]
-0.04	(0.41)	0.85	(0.40)	0.55	(0.48)	0.02	(0.01)	0.07	(0.01)	0.07	(0.01)	0.77	0.62	[0.83]
<i>Developed Countries: 10/1983 – 06/2014</i>														
0.19	(0.23)	0.70	(0.36)			0.02	(0.02)	0.04	(0.01)			0.36	0.27	[0.97]
0.21	(0.22)			0.31	(0.19)	0.02	(0.02)			0.05	(0.02)	0.47	0.26	[0.95]
0.19	(0.22)	0.51	(0.30)	0.12	(0.20)	0.02	(0.02)	0.04	(0.01)	0.05	(0.02)	0.47	0.28	[0.96]
<i>Developed Countries: 01/1996 – 06/2014</i>														
-0.12	(0.33)	0.74	(0.37)			0.01	(0.02)	0.05	(0.01)			0.51	0.43	[0.99]
0.01	(0.30)			0.35	(0.27)	0.01	(0.02)			0.05	(0.02)	0.38	0.44	[0.99]
-0.13	(0.34)	1.01	(0.43)	-0.20	(0.31)	0.01	(0.02)	0.06	(0.01)	0.04	(0.02)	0.55	0.44	[0.99]

**Table 4. Forward Discounts and Global Imbalances**

The table presents results from cross-sectional regressions of the average forward discount (or interest rate differential relative to the US) on the average (i) net foreign asset position to gross domestic product (*nfa*), (ii) share of foreign liabilities in domestic currency (*ldc*), (iii) inflation differential relative to the US, (iv) output gap, and (v) a constant. White (1980) corrected standard errors are reported in parentheses.

	<i>Dependent variable: forward discount</i>			
	(1)	(2)	(3)	(4)
<i>nfa</i>	-0.141 (0.036)	-0.075 (0.017)	-0.127 (0.037)	-0.072 (0.017)
<i>ldc</i>	-0.221 (0.465)	0.089 (0.169)	-0.302 (0.482)	0.064 (0.169)
<i>inflation differential</i>		0.969 (0.043)		0.959 (0.045)
<i>output gap</i>			0.074 (0.033)	0.021 (0.009)
<i>constant</i>	0.298 (0.253)	-0.209 (0.082)	0.349 (0.265)	-0.190 (0.083)
<i>Adjusted R<sup>2</sup></i>	0.05	0.86	0.07	0.86

**Table 5. Portfolios Sorted on Betas**

The table presents descriptive statistics of  $\beta$ -sorted currency portfolios. Each  $\beta$  is obtained by regressing individual currency excess returns on the global imbalance risk factor using a 36-month moving window that ends in period  $t - 1$ . The first portfolio ( $P_1$ ) contains the top 20% of all currencies with the lowest betas whereas the last portfolio ( $P_5$ ) contains the top 20% of all currencies with the highest betas.  $H/L$  denotes a long-short strategy that buys  $P_5$  and sells  $P_1$ . Excess returns are expressed in percentage per annum. The table also reports the first order autocorrelation coefficient ( $ac_1$ ), the annualized Sharpe ratio ( $SR$ ), the maximum drawdown ( $mdd$ ), the frequency of portfolio switches ( $freq$ ), the average net foreign asset position to gross domestic product ( $nfa$ ), the share of foreign liabilities in domestic currency ( $ldc$ ), the *pre*- and *post*-formation forward discount or interest rate differential relative to the US ( $fd$ ), the *pre*-formation  $\beta$ s (with standard deviations in parentheses) and the *post*-formation  $\beta$ s (with standard errors in parentheses).  $t$ -statistics based on Newey and West (1987) standard errors with Andrews (1991) optimal lag selection are reported in brackets. The sample runs from October 1983 to June 2014.

	$P_1$	$P_2$	$P_3$	$P_4$	$P_5$	$H/L$	$P_1$	$P_2$	$P_3$	$P_4$	$P_5$	$H/L$
	<i>All Countries</i>						<i>Developed Countries</i>					
<i>mean</i>	-0.54	2.18	3.85	3.10	4.67	5.21	-1.02	3.61	2.47	2.33	4.92	5.93
<i>t-stat</i>	[-0.38]	[1.49]	[2.39]	[1.59]	[2.38]	[2.83]	[-0.51]	[1.80]	[1.31]	[1.40]	[2.33]	[2.76]
<i>med</i>	-0.29	2.47	3.53	4.53	4.27	5.79	-1.23	3.18	5.25	3.51	6.77	6.94
<i>sdev</i>	6.62	7.62	8.18	9.10	9.61	9.11	9.74	10.29	9.25	8.51	10.59	10.79
<i>skew</i>	0.17	0.13	-0.59	-0.42	-0.43	-0.30	0.01	-0.06	-0.36	-0.26	-0.32	-0.31
<i>kurt</i>	3.90	3.98	5.56	4.18	4.77	3.55	3.65	3.98	3.71	4.07	5.28	4.37
$ac_1$	0.13	0.03	0.09	0.15	0.12	0.11	0.11	0.05	0.11	0.06	0.09	0.07
$SR$	-0.08	0.29	0.47	0.34	0.49	0.57	-0.10	0.35	0.27	0.27	0.46	0.55
<i>mdd</i>	0.49	0.35	0.18	0.30	0.26	0.20	0.65	0.36	0.30	0.27	0.33	0.42
<i>freq</i>	0.10	0.14	0.15	0.14	0.07	0.17	0.10	0.15	0.13	0.10	0.04	0.14
<i>nfa</i>	0.45	-0.03	-0.02	-0.11	-0.41		0.47	0.28	-0.04	-0.18	-0.49	
<i>ldc</i>	0.53	0.50	0.48	0.46	0.41		0.57	0.49	0.47	0.46	0.46	
<i>pre-fd</i>	-0.36	0.55	2.13	2.60	4.30		-1.53	-0.02	0.89	1.45	3.04	
<i>post-fd</i>	-0.35	0.56	2.11	2.59	4.24		-1.51	0.00	0.84	1.43	3.04	
<i>pre-<math>\beta</math></i>	-0.22	0.14	0.51	0.78	1.35		-0.94	-0.50	-0.28	0.05	0.67	
	(0.35)	(0.47)	(0.66)	(0.76)	(0.76)		(0.97)	(0.96)	(0.88)	(0.67)	(0.57)	
<i>post-<math>\beta</math></i>	-0.30	-0.31	-0.09	0.07	0.31		-0.57	-0.19	0.03	0.12	0.59	
	(0.05)	(0.04)	(0.04)	(0.05)	(0.06)		(0.05)	(0.03)	(0.04)	(0.04)	(0.05)	

**Table 6. Determinants of Spot Exchange Rate Returns**

The table presents results from fixed-effects panel regressions. We use discrete exchange rate returns at monthly frequency as the dependent variable. Exchange rates are defined as units of US dollars per unit of foreign currency such that a positive return denotes a foreign currency appreciation. The set of independent variables includes the net foreign asset position to gross domestic product (*nfa*), the share of foreign liabilities in domestic currency (*ldc*), the forward discount or interest rate differential relative to the US (*fd*), the monthly change in JP Morgan's VXY index ( $\Delta VXY$ ), and a dummy variable that equals one if  $\Delta VXY$  is greater than one standard deviation as estimated across the entire sample, and zero otherwise ( $\Delta VXY$  *dummy*). The VXY tracks aggregate implied volatility in foreign exchange markets. Robust standard errors are clustered at country level and are reported in parentheses. The superscripts *a*, *b* and *c* denote statistical significance at the 10%, 5% and 1% level, respectively. The sample runs from June 1992 to June 2014.

	Dependent variable: nominal exchange rate returns					
	(1)	(2)	(3)	(4)	(5)	(6)
<i>nfa</i> (lagged 12 months)	0.026 (0.090)	0.015 (0.090)	0.038 (0.093)	-0.092 (0.105)	-0.113 (0.104)	-0.088 (0.104)
$\Delta VXY$	-0.544 <sup>c</sup> (0.074)	-0.544 <sup>c</sup> (0.074)	-0.527 <sup>c</sup> (0.085)			
$\Delta VXY \times nfa$ (lagged 12 months)	0.269 <sup>c</sup> (0.073)	0.269 <sup>c</sup> (0.073)	0.258 <sup>c</sup> (0.070)			
<i>ldc</i> (lagged 12 months)		0.285 (0.325)	0.019 (0.292)		0.562 (0.347)	0.380 (0.308)
<i>fd</i> (lagged 1 month)			-0.003 (0.002)			-0.002 (0.003)
$\Delta VXY \times fd$ (lagged 1 month)			-0.001 (0.001)			
$\Delta VXY$ <i>dummy</i>				-1.199 <sup>c</sup> (0.216)	-1.204 <sup>c</sup> (0.217)	-1.108 <sup>c</sup> (0.241)
$\Delta VXY$ <i>dummy</i> $\times nfa$ (lagged 12 months)				0.678 <sup>c</sup> (0.190)	0.678 <sup>c</sup> (0.190)	0.622 <sup>c</sup> (0.183)
$\Delta VXY$ <i>dummy</i> $\times fd$ (lagged 1 month)						-0.005 (0.004)
Additional Variables: Constant and lagged exchange rate returns	<i>YES</i>	<i>YES</i>	<i>YES</i>	<i>YES</i>	<i>YES</i>	<i>YES</i>
<i>Adjusted R</i> <sup>2</sup>	0.06	0.06	0.06	0.02	0.02	0.03
Observations	7568	7568	7568	7568	7568	7568

**Table 7. Risk Bearing Capacity and Global Imbalance Portfolios**

This table presents results from time-series regressions. In *Panel A*, we regress monthly currency excess returns to the *global imbalance portfolios* (see Table 1) on a constant and the monthly changes in the *VXY* index. In *Panel B*, we regress the exchange rate return component to the *global imbalance portfolios* on a constant and the monthly changes in the *VXY* index. Newey and West (1987) standard errors with Andrews (1991) optimal lag selection are reported in parentheses. The sample runs from June 1992 to June 2014.

Panel A: Currency Excess Returns					
	$P_1$	$P_2$	$P_3$	$P_4$	$P_5$
$\Delta VXY$	-0.091 (0.211)	-0.193 (0.190)	-0.689 <sup>c</sup> (0.158)	-0.600 <sup>c</sup> (0.226)	-0.714 <sup>c</sup> (0.181)
Constant	0.011 (0.130)	0.217 <sup>a</sup> (0.128)	0.058 (0.128)	0.320 <sup>b</sup> (0.143)	0.406 <sup>b</sup> (0.176)
<i>Adjusted R</i> <sup>2</sup>	-0.00	0.01	0.14	0.08	0.08
Panel B: Spot Exchange Rate Returns					
	$P_1$	$P_2$	$P_3$	$P_4$	$P_5$
$\Delta VXY$	-0.074 (0.216)	-0.180 (0.190)	-0.684 <sup>c</sup> (0.160)	-0.585 <sup>c</sup> (0.224)	-0.706 <sup>c</sup> (0.181)
Constant	0.009 (0.127)	0.080 (0.129)	-0.099 (0.130)	0.033 (0.146)	-0.258 (0.178)
<i>Adjusted R</i> <sup>2</sup>	-0.00	0.01	0.14	0.08	0.08



**Table 8. Asset Pricing Tests: Equity, Bond, and Commodity Strategies**

The table presents asset pricing results for equity, bond and commodity strategies. The test assets include the global equity portfolios sorted on size and book-to-market (momentum) from Fama and French (2012) in *Panel A* (*Panel B*), 5 international bond portfolios sorted on the redemption yields in *Panel C*, and 7 commodity portfolios sorted on the log difference between the 12-month and the one-month futures prices from Yang (2013) in *Panel D*. The set of risk factors include the dollar factor (*DOL*), global imbalance factor (*IMB*), Fama and French (2012) global factors (*MKT*, *SMB*, *HML*, and *WML*), high-minus-low international bond factor (*IBO*), and high-minus-low commodity factor (*COM*). We report first-stage GMM estimates of the factor loadings  $b$ , the market price of risk  $\lambda$ , and the cross-sectional  $R^2$ . Newey and West (1987) standard errors with Andrews (1991) optimal lag selection are reported in parentheses.  $HJ$  denotes the Hansen and Jagannathan (1997) distance (with simulated  $p$ -value in brackets) for the null hypothesis that the  $HJ$  distance is equal to zero. Excess returns are in annual terms.

Panel A: Size and Book-to-Market Global Portfolios							
	<i>DOL</i>	<i>IMB</i>	<i>MKT</i>	<i>SMB</i>	<i>HML</i>	$R^2$	$HJ$
$b$	0.52 (0.45)	0.98 (0.36)	0.01 (0.17)	0.39 (0.35)	0.93 (0.41)	0.57	0.60 [0.33]
$\lambda$	0.05 (0.01)	0.07 (0.01)	0.06 (0.03)	0.02 (0.01)	0.07 (0.02)		
Panel B: Size and Momentum Global Portfolios							
	<i>DOL</i>	<i>IMB</i>	<i>MKT</i>	<i>SMB</i>	<i>WML</i>	$R^2$	$HJ$
$b$	0.72 (0.66)	1.07 (0.36)	0.13 (0.26)	0.67 (0.39)	0.61 (0.29)	0.70	0.54 [0.70]
$\lambda$	0.06 (0.01)	0.07 (0.01)	0.09 (0.03)	0.04 (0.01)	0.10 (0.02)		
Panel C: International Bond Portfolios							
	<i>DOL</i>	<i>IMB</i>	<i>IBO</i>			$R^2$	$HJ$
$b$	-0.13 (0.31)	1.17 (0.36)	2.48 (0.42)			0.98	0.05 [0.84]
$\lambda$	0.02 (0.02)	0.07 (0.02)	0.07 (0.01)				
Panel D: Commodity Portfolios							
	<i>DOL</i>	<i>IMB</i>	<i>COM</i>			$R^2$	0.06
$b$	0.78 (1.53)	0.77 (0.43)	0.20 (0.09)			0.75	[0.94]
$\lambda$	0.06 (0.05)	0.05 (0.02)	0.11 (0.04)				

	low ldc	medium ldc	high ldc
high nfa	$P'_3$ (10%)	$P_2$ (20%)	$P_1$ (20%)
low nfa	$P_5$ (20%)	$P_4$ (20%)	$P''_3$ (10%)

**Figure 1. Construction of the Global Imbalance Risk Factor**

This figure describes the construction of the global imbalance (*IMB*) risk factor. At the end of each month, currencies are first grouped into 2 baskets using the median value of the net foreign asset to GDP ratio (*nfa*), and then into 3 baskets using the share of foreign liabilities in domestic currency (*ldc*). The *ldc* breakpoints are the 20th and 60th (40th and 80th) percentiles for the high (low) *nfa* portfolios. The first portfolio ( $P_1$ ) contains the top 20% of all currencies with high *nfa* and high *ldc* (creditor nations with external liabilities denominated mainly in domestic currency) whereas the last portfolio ( $P_5$ ) contains the top 20% of all currencies with low *nfa* and low *ldc* (debtor nations with external liabilities denominated mainly in foreign currency). The portfolios  $P'_3$  and  $P''_3$  are intermediate portfolios each containing 10% of all currencies which are then aggregated into Portfolio  $P_3$ . The global imbalance factor (*IMB*) is constructed as the excess return on  $P_5$  minus the excess return on  $P_1$ . We use 5 portfolios due to a limited number of currencies. Figure A.1 in the Internet Appendix describes the construction of the *IMB* factor based on 6 (4) portfolios for *All Countries* (*Developed Countries*).

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Internet Appendix to  
“Currency Premia and Global Imbalances”

(not for publication)

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**Abstract**

This appendix presents the description of the data as well as supplementary results not included in the main body of the paper.

# A Exchange Rate Data and Excess Returns

**Data on Spot and Forward Exchange Rates.** We collect daily spot and 1-month forward exchange rates vis-à-vis the US dollar (USD) from Barclays and Reuters via Datastream. The empirical analysis uses monthly data obtained by sampling end-of-month rates from October 1983 to June 2014. Our sample comprises 55 countries: Argentina, Australia, Austria, Belgium, Brazil, Canada, Chile, China, Colombia, Croatia, Czech Republic, Denmark, Egypt, Estonia, Euro Area, Finland, France, Germany, Greece, Hong Kong, Hungary, Iceland, India, Indonesia, Ireland, Israel, Italy, Japan, Kazakhstan, Latvia, Lithuania, Malaysia, Mexico, Morocco, Netherlands, New Zealand, Norway, Philippines, Poland, Portugal, Russia, Singapore, Slovakia, Slovenia, South Africa, South Korea, Spain, Sweden, Switzerland, Thailand, Tunisia, Turkey, Ukraine, United Kingdom, and Venezuela. We call this sample ‘all countries’.

A number of currencies in this sample are pegged or subject to capital restrictions. In reality, the top 10 currencies account for 90 percent of the average daily turnover in FX markets (Bank for International Settlements, 2013), and investors may not easily trade some of the minor currencies in large amounts even though quotes on forward contracts (deliverable or non-deliverable) are available. Hence, we also consider a subset of 15 countries which we refer to as ‘developed countries’. This sample includes: Australia, Belgium, Canada, Denmark, Euro Area, France, Germany, Italy, Japan, Netherlands, New Zealand, Norway, Sweden, Switzerland, and the United Kingdom. After the introduction of the euro in January 1999, we remove the Eurozone countries and replace them with the euro.<sup>1</sup> As in Lustig, Roussanov, and Verdelhan (2011) and many subsequent studies, we remove data when we observe large deviations from the covered interest rate parity (CIP) condition.<sup>2</sup>

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<sup>1</sup>We also consider a set of countries comprising the most liquid currencies (termed ‘developed & emerging’ sample). Qualitatively, the results remain the same; see e.g. Tables A.8 and A.9 of the Internet Appendix.

<sup>2</sup>On the one hand, one may be concerned that times when CIP deviations occur are likely to be times of distress in the FX market that can be particularly informative about risk premia. On the other hand, some of those times can be characterized by extreme illiquidity and lack of tradability, so that prices are essentially uninformative. Moreover, the GM theory assumes no riskless arbitrage. We filtered the data as follows: for the Developed sample of 15 countries, we do not remove any observations. For the broader sample, we eliminate the following observations: Argentina from September 2008 to April 2009, and from May 2012 to June 2014; Egypt from November 2011 to August 2013; Indonesia from December 1997 to July 1998, and from February 2001 to May 2005; Malaysia from May 1998 to June 2005; Turkey from November 2000 to November 2001; South Africa for August 1985, and from January 2002 to May 2005; Russia from December 2008 to January 2009; Kazakhstan from November 2008 to February 2009. These are episodes where CIP deviations were very large (generally in excess of 25 percent) and likely not tradable. Note that the removal of CIP deviations

**Currency Excess Returns.** Recall from Section 3 the definition of the excess return on buying a foreign currency in the forward market at time  $t$  and then selling it in the spot market at time  $t + 1$

$$RX_{t+1} = \frac{(S_{t+1} - F_t)}{S_t} \quad (1)$$

which is equivalent to the spot exchange rate return minus the forward premium, i.e.,  $RX_{t+1} = ((S_{t+1} - S_t)/S_t) - ((F_t - S_t)/S_t)$ . We construct currency excess returns adjusted for transaction costs using bid-ask quotes on spot and forward rates. The net excess return for holding foreign currency for a month is computed as  $RX_{t+1}^l \simeq (S_{t+1}^b - F_t^a)/S_t^a$ , where  $a$  indicates the ask price,  $b$  the bid price, and  $l$  a long position in a foreign currency. The net excess return accounts for the full round-trip transaction cost occurring when the foreign currency is purchased at time  $t$  and sold at time  $t + 1$ . If the investor buys foreign currency at time  $t$  but decides to maintain the position at time  $t + 1$ , the net excess return is computed as  $RX_{t+1}^l \simeq (S_{t+1} - F_t^a)/S_t^a$ . Similarly, if the investor closes the position in foreign currency at time  $t + 1$  already existing at time  $t$ , the net excess return is defined as  $RX_{t+1}^l \simeq (S_{t+1}^b - F_t)/S_t^b$ . The net excess return for holding domestic currency for a month is computed as  $RX_{t+1}^s \simeq (F_t^b - S_{t+1}^a)/S_t^b$ , where  $s$  stands for a short position on a foreign currency. In this case, the investor sells foreign currency at time  $t$  in the forward market at the bid price  $F_t^b$  and offsets the position in the spot market at time  $t + 1$  using the ask price  $S_{t+1}^a$ . If the foreign currency leaves the strategy at time  $t$  and the short position is rolled over at time  $t + 1$ , the net excess return is computed as  $RX_{t+1}^s \simeq (F_t^b - S_{t+1}^b)/S_t^b$ . Similarly, if the investor closes a short position on the foreign currency at time  $t + 1$  already existing at time  $t$ , the net excess return is computed as  $RX_{t+1}^s \simeq (F_t - S_{t+1}^a)/S_t^b$ . In short, excess returns are adjusted for the full round-trip transaction cost in the first and last month of the sample. The total number of currencies in our portfolios changes over time, and we only include currencies for which we have bid and ask quotes on forward and spot exchange rates in the current and subsequent period. When we construct portfolio returns, we compute an equally weighted average of the currency excess returns within that portfolio, and assume that investors go short foreign currencies in Portfolio 1 and long foreign currencies in the remaining portfolios.

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does not affect any of our results in this paper with two exceptions: Turkey for the period around the 2001 devaluation, and Malaysia for the 1998-2005 period of capital controls.

**Table A.1. Descriptive Statistics: Carry Trade Portfolios**

The table presents descriptive statistics of currency portfolios sorted on the time  $t - 1$  one-month forward discount or interest rate differential relative to the US ( $fd$ ). The first portfolio ( $P_1$ ) contains the top 20% of all currencies with low  $fd$  (low-yielding currencies) whereas the last portfolio ( $P_5$ ) contains the top 20% of all currencies with high  $fd$  (high-yielding currencies).  $CAR$  is a long-short strategy that buys  $P_5$  and sells  $P_1$ . The table also reports the first order autocorrelation coefficient ( $ac_1$ ), the annualized Sharpe ratio ( $SR$ ), the maximum drawdown ( $mdd$ ), the frequency of portfolio switches ( $freq$ ), the average  $fd$ , the average net foreign asset position to gross domestic product ( $nfa$ ), and the average share of foreign liabilities in domestic currency ( $ldc$ ).  $t$ -statistics based on Newey and West (1987) standard errors with Andrews (1991) optimal lag selection are reported in brackets. Excess returns are expressed in percentage per annum and adjusted for transaction costs. The portfolios are rebalanced monthly from October 1983 to June 2014.

	$P_1$	$P_2$	$P_3$	$P_4$	$P_5$	$CAR$	$P_1$	$P_2$	$P_3$	$P_4$	$P_5$	$CAR$
	<i>All Countries</i>						<i>Developed Countries</i>					
<i>mean</i>	0.47	0.05	2.38	2.27	5.91	5.44	0.65	0.93	1.93	2.59	5.31	4.67
<i>t-stat</i>	[0.33]	[0.04]	[1.55]	[1.34]	[3.10]	[3.20]	[0.36]	[0.49]	[1.11]	[1.47]	[2.41]	[2.24]
<i>median</i>	0.82	1.53	2.87	2.98	8.53	7.67	-0.67	1.91	3.55	3.33	5.30	7.48
<i>sdev</i>	7.79	7.66	8.10	8.67	9.28	8.39	9.98	9.64	9.12	9.51	11.39	10.90
<i>skew</i>	0.16	-0.16	-0.30	-0.59	-0.42	-0.86	0.33	0.01	-0.07	-0.42	-0.19	-0.95
<i>kurt</i>	4.22	3.73	4.12	5.66	4.67	5.02	3.76	3.60	3.86	4.69	4.28	5.38
$ac_1$	0.01	0.03	0.07	0.10	0.13	0.13	0.00	0.07	0.08	0.04	0.11	0.07
$SR$	0.06	0.01	0.29	0.26	0.64	0.65	0.06	0.10	0.21	0.27	0.47	0.43
<i>mdd</i>	0.42	0.37	0.37	0.35	0.31	0.33	0.55	0.45	0.38	0.29	0.37	0.38
<i>freq</i>	0.19	0.28	0.31	0.33	0.17		0.13	0.26	0.32	0.24	0.13	
<i>fd</i>	-1.69	-0.86	0.93	3.30	9.28		-2.05	-1.01	0.31	1.61	4.04	
<i>nfa</i>	0.53	0.06	-0.15	-0.35	-0.39		0.60	0.00	-0.10	-0.08	-0.39	
<i>ldc</i>	0.52	0.50	0.43	0.43	0.40		0.54	0.55	0.44	0.43	0.41	

**Table A.2 Portfolio Composition**

The table presents the composition of the five carry trade (*Panel A*) and global imbalance (*Panel B*) portfolios. We report the top six currencies (with the frequency in brackets) entering each portfolio. The portfolios are rebalanced monthly from October 1983 to June 2014.

<i>All Countries</i>					<i>Developed Countries</i>				
$P_1$	$P_2$	$P_3$	$P_4$	$P_5$	$P_1$	$P_2$	$P_3$	$P_4$	$P_5$
Panel A: Carry Trade Portfolios									
JPY [0.18]	CAD [0.08]	GBP [0.08]	AUD [0.07]	ZAR [0.13]	CHF [0.42]	NLG [0.14]	DKK [0.20]	GBP [0.17]	NZD [0.35]
CHF [0.16]	DKK [0.08]	NOK [0.06]	NZD [0.06]	TRY [0.10]	JPY [0.40]	EUR [0.14]	CAD [0.15]	NOK [0.16]	AUD [0.25]
SGD [0.12]	SGD [0.06]	CAD [0.05]	MXN [0.05]	BRL [0.06]	DEM [0.06]	CAD [0.10]	GBP [0.14]	SEK [0.15]	ITL [0.12]
HKD [0.09]	EUR [0.06]	KRW [0.05]	HUF [0.05]	MXN [0.05]	DKK [0.03]	DEM [0.10]	SEK [0.11]	AUD [0.14]	NOK [0.10]
CNY [0.05]	SEK [0.05]	HKD [0.05]	GBP [0.05]	HUF [0.05]	CAD [0.03]	SEK [0.08]	NOK [0.10]	CAD [0.12]	GBP [0.08]
MYR [0.04]	NLG [0.04]	NZD [0.05]	PHP [0.04]	NZD [0.05]	NLG [0.02]	DKK [0.07]	FRF [0.07]	DKK [0.08]	SEK [0.06]
Panel B: Global Imbalance Portfolios									
CHF [0.11]	GBP [0.10]	AUD [0.11]	HUF [0.09]	TRY [0.11]	CHF [0.26]	CHF [0.20]	NOK [0.29]	CAD [0.28]	DKK [0.30]
HKD [0.10]	JPY [0.09]	NOK [0.10]	NZD [0.09]	PHP [0.09]	JPY [0.26]	JPY [0.19]	AUD [0.25]	SEK [0.22]	NZD [0.22]
EUR [0.10]	CHF [0.08]	SGD [0.08]	PLN [0.07]	DKK [0.09]	DEM [0.16]	NLG [0.16]	GBP [0.17]	NZD [0.22]	SEK [0.19]
JPY [0.09]	NLG [0.07]	GBP [0.07]	MXN [0.06]	SEK [0.08]	EUR [0.12]	FRF [0.13]	EUR [0.11]	AUD [0.11]	GBP [0.18]
SGD [0.09]	FRF [0.06]	HKD [0.07]	TND [0.06]	NZD [0.08]	CAD [0.10]	DKK [0.13]	ITL [0.11]	NOK [0.09]	ITL [0.06]
CNY [0.08]	ILS [0.06]	CAD [0.06]	MYR [0.06]	ISK [0.07]	FRF [0.07]	GBP [0.09]	BEF [0.03]	ITL [0.04]	AUD [0.04]

**Table A.3. Asset Pricing Tests: Global Imbalance Risk**

The table presents cross-sectional asset pricing results for the linear factor model based on the dollar (*DOL*) and the global imbalance (*IMB*) risk factors. The test assets are excess returns to five carry trade portfolios sorted on the one-month forward discount. *IMB* is a long-short strategy that buys the currencies (top 20%) of debtor nations with external liabilities mainly in foreign currency, and sells the currencies (top 20%) of creditor nations with external liabilities mainly in domestic currency. *Panel A* reports first-stage GMM estimates of the factor loadings  $b$ , the market price of risk  $\lambda$ , and the cross-sectional  $R^2$ . Newey and West (1987) standard errors with Andrews (1991) optimal lag selection are reported in parentheses. *HJ* refers to the Hansen and Jagannathan (1997) distance (with simulated  $p$ -value in brackets) for the null hypothesis that the *HJ* distance is equal to zero. *Panel B* reports least-squares estimates of time series regressions with Newey and West (1987) and Andrews (1991) standard errors in parentheses. Excess returns are in annual terms and adjusted for transaction costs. The portfolios are rebalanced monthly from October 1983 to June 2014.

Panel A: Factor Prices												
	$b_{DOL}$	$b_{IMB}$	$\lambda_{DOL}$	$\lambda_{IMB}$	$R^2$	<i>HJ</i>	$b_{DOL}$	$b_{IMB}$	$\lambda_{DOL}$	$\lambda_{IMB}$	$R^2$	<i>HJ</i>
	<i>All Countries</i>				<i>Developed Countries</i>							
	-0.07	1.53	0.02	0.07	0.87	0.14	0.16	0.85	0.02	0.05	0.91	0.06
	(0.29)	(0.54)	(0.01)	(0.02)		[0.16]	(0.22)	(0.47)	(0.02)	(0.02)		[0.80]
Panel B: Factor Betas												
	$\alpha$	$\beta_{DOL}$	$\beta_{IMB}$	$R^2$		$\alpha$	$\beta_{DOL}$	$\beta_{IMB}$	$R^2$			
$P_1$	-0.01	1.00	-0.33	0.80		0.01	0.97	-0.46	0.74			
	(0.01)	(0.05)	(0.04)			(0.01)	(0.04)	(0.06)				
$P_2$	-0.02	0.99	-0.17	0.83		-0.01	1.01	-0.16	0.82			
	(0.01)	(0.04)	(0.03)			(0.01)	(0.04)	(0.04)				
$P_3$	0.01	1.05	-0.10	0.85		-0.01	0.97	0.01	0.86			
	(0.01)	(0.03)	(0.02)			(0.01)	(0.03)	(0.03)				
$P_4$	-0.01	1.04	0.12	0.82		-0.01	0.97	0.14	0.83			
	(0.01)	(0.04)	(0.05)			(0.01)	(0.03)	(0.04)				
$P_5$	0.01	0.90	0.46	0.74		0.01	1.02	0.52	0.77			
	(0.01)	(0.05)	(0.08)			(0.01)	(0.04)	(0.06)				

**Table A.4. Asset Pricing: Global Imbalance Risk with Constraints**

This table re-estimates the linear factor model of Table A.3 while including the global imbalance factor as one of the test assets as suggested by Lewellen, Nagel and Shanken (2010). We report first-stage GMM estimates of factor loadings  $b$ , market price of risk  $\lambda$ , and cross-sectional  $R^2$ . Newey and West (1987) standard errors with Andrews (1991) optimal lag selection are reported in parentheses.  $HJ$  refers to the Hansen and Jagannathan (1997) distance (with simulated  $p$ -value in brackets) for the null hypothesis that the  $HJ$  distance is equal to zero. Excess returns are in annual terms and adjusted for transaction costs. The portfolios are rebalanced monthly from October 1983 to June 2014.

$b_{DOL}$	$b_{IMB}$	$\lambda_{DOL}$	$\lambda_{IMB}$	$R^2$	$HJ$	$b_{DOL}$	$b_{IMB}$	$\lambda_{DOL}$	$\lambda_{IMB}$	$R^2$	$HJ$
<i>All Countries</i>						<i>Developed Countries</i>					
0.06	1.03	0.02	0.05	0.79	0.17	0.17	0.75	0.02	0.04	0.91	0.07
(0.27)	(0.31)	(0.01)	(0.01)		[0.10]	(0.21)	(0.33)	(0.02)	(0.01)		[0.85]

**Table A.5. Country-Level Asset Pricing Tests: Global Imbalance Risk**

This table presents cross-sectional asset pricing results for individual currency excess returns. The linear factor model includes the dollar (*DOL*) and the global imbalance (*IMB*) risk factors. *IMB* is a long-short strategy that buys the currencies (top 20%) of debtor nations with external liabilities mainly in foreign currency and sells the currencies (top 20%) of creditor nations with external liabilities mainly in domestic currency. The test assets are country-level unconditional and conditional excess returns. The unconditional excess return for each currency pair is computed as  $RX_{t+1} = (S_{t+1} - F_t) / S_t$ , where  $S_t$  denotes the spot exchange rate and  $F_t$  is the one-month forward rate. The conditional excess return is calculated as  $RX_{t+1} = \gamma \times (S_{t+1} - F_t) / S_t$ , where  $\gamma = 1$  ( $\gamma = -1$ ) when the foreign interest rate is higher (lower) than the US interest rate. The table reports estimates of the market price of risk  $\lambda$ , the cross-sectional  $R^2$  and the root mean squared error (*RMSE*) obtained via the Fama-MacBeth procedure with robust regressions in the first and second step to account for outliers in individual currency excess returns. Bootstrapped standard errors based on a block-bootstrap algorithm with 1,000 repetitions are reported in parentheses. Excess returns are in annual terms and run at the monthly frequency from October 1983 to June 2014.

Unconditional Excess Returns				Conditional Excess Returns			
$\lambda_{DOL}$	$\lambda_{IMB}$	$R^2$	<i>RMSE</i>	$\lambda_{DOL}$	$\lambda_{IMB}$	$R^2$	<i>RMSE</i>
<i>All Countries</i>							
0.04	0.06	0.34	28.4	0.04	0.07	0.25	35.9
(0.02)	(0.02)			(0.02)	(0.02)		
<i>Developed Countries</i>							
0.03	0.05	0.64	4.6	0.05	0.08	0.32	7.4
(0.02)	(0.02)			(0.03)	(0.02)		



**Table A.6. Determinants of Spot Exchange Rate Returns**

The table presents results from fixed-effects panel regressions. We use discrete exchange rate returns at the monthly frequency as the dependent variable. Exchange rates are defined as units of US dollars per unit of foreign currency such that a positive return denotes a foreign currency appreciation. The set of independent variables includes the net foreign asset position to gross domestic product (*nfa*), the share of foreign liabilities in domestic currency (*ldc*), the forward discount or interest rate differential relative to the US (*fd*), the monthly change in the VIX index ( $\Delta VIX$ ), and a dummy variable that equals one if  $\Delta VIX$  is greater than one standard deviation as estimated across the entire sample, and zero otherwise ( $\Delta VIX$  dummy). Robust standard errors are clustered at country level and reported in parentheses. The superscripts *a*, *b* and *c* denote statistical significance at the 10%, 5% and 1% level, respectively. The sample runs from January 1986 to June 2014.

	Dependent variable: nominal exchange rate returns					
	(1)	(2)	(3)	(4)	(5)	(6)
<i>nfa</i> (lagged 12 months)	-0.043 (0.069)	-0.040 (0.072)	-0.015 (0.076)	-0.129 <sup>a</sup> (0.075)	-0.137 <sup>a</sup> (0.076)	-0.106 (0.073)
$\Delta VIX$	-0.143 <sup>c</sup> (0.017)	-0.143 <sup>c</sup> (0.017)	-0.126 <sup>c</sup> (0.019)			
$\Delta VIX \times nfa$ (lagged 12 months)	0.069 <sup>c</sup> (0.018)	0.069 <sup>c</sup> (0.018)	0.058 <sup>c</sup> (0.017)			
<i>ldc</i> (lagged 12 months)		-0.092 (0.226)	-0.327 (0.203)		0.193 (0.254)	-0.073 (0.209)
<i>fd</i> (lagged 1 month)			-0.004 <sup>b</sup> (0.002)			-0.001 (0.003)
$\Delta VIX \times fd$ (lagged 1 month)			-0.001 ( $< .001$ )			
$\Delta VIX$ dummy				-1.400 <sup>c</sup> (0.217)	-1.403 <sup>c</sup> (0.219)	-1.207 <sup>c</sup> (0.252)
$\Delta VIX$ dummy $\times nfa$ (lagged 12 months)				0.646 <sup>c</sup> (0.239)	0.646 <sup>c</sup> (0.239)	0.525 <sup>b</sup> (0.229)
$\Delta VIX$ dummy $\times fd$ (lagged 1 month)						-0.010 (0.006)
Additional Variables: Constant and lagged exchange rate returns	<i>YES</i>	<i>YES</i>	<i>YES</i>	<i>YES</i>	<i>YES</i>	<i>YES</i>
<i>Adjusted R</i> <sup>2</sup>	0.08	0.08	0.08	0.03	0.03	0.03
Observations	8960	8960	8960	8960	8960	8960

**Table A.7. Risk Bearing Capacity and Global Imbalance Portfolios**

This table presents results from time-series regressions. In *Panel A*, we regress monthly currency excess returns to the *global imbalance portfolios* (see Table 1) on a constant and the monthly changes in the VIX index. In *Panel B*, we regress the exchange rate return component to the *global imbalance portfolios* on a constant and the monthly changes in the VIX index. Newey and West (1987) standard errors with Andrews (1991) optimal lag selection are reported in parentheses. The superscripts *a*, *b* and *c* denote statistical significance at the 10%, 5% and 1% level, respectively. The sample runs from January 1986 to June 2014.

Panel A: Currency Excess Returns					
	$P_1$	$P_2$	$P_3$	$P_4$	$P_5$
$\Delta VIX$	-0.037 (0.037)	-0.059 (0.051)	-0.144 <sup>c</sup> (0.038)	-0.146 <sup>c</sup> (0.041)	-0.148 <sup>b</sup> (0.061)
Constant	0.102 (0.128)	0.312 (0.132)	0.157 (0.111)	0.326 <sup>b</sup> (0.128)	0.493 <sup>c</sup> (0.162)
<i>Adjusted R</i> <sup>2</sup>	0.00	0.01	0.15	0.11	0.07
Panel B: Spot Exchange Rate Returns					
	$P_1$	$P_2$	$P_3$	$P_4$	$P_5$
$\Delta VIX$	-0.035 (0.037)	-0.057 (0.051)	-0.143 <sup>c</sup> (0.038)	-0.143 <sup>c</sup> (0.041)	-0.143 <sup>c</sup> (0.060)
Constant	0.127 (0.125)	0.187 (0.131)	-0.027 (0.111)	0.027 (0.129)	-0.092 (0.168)
<i>Adjusted R</i> <sup>2</sup>	0.00	0.01	0.15	0.10	0.06

## A.8. Determinants of Excess Currency Returns

The table presents results from fixed-effects panel regressions. We use discrete currency excess returns at the monthly frequency as the dependent variable. The set of independent variables includes the net foreign asset position to gross domestic product ( $nfa$ ), the share of foreign liabilities in domestic currency ( $ldc$ ), the monthly change in the VXY index ( $\Delta VXY$ ), and a dummy variable that equals one if  $\Delta VXY$  is greater than one standard deviation as estimated across the entire sample, and zero otherwise ( $\Delta VXY$  dummy). Robust standard errors are clustered at country level and reported in parentheses. The superscripts  $a$ ,  $b$  and  $c$  denote statistical significance at the 10%, 5% and 1% level, respectively. The sample runs from June 1992 to June 2014.

	Dependent variable: currency excess returns			
	(1)	(2)	(3)	(4)
$nfa$ (lagged 12 months)	0.059 (0.092)	0.080 (0.102)	-0.059 (0.102)	-0.049 (0.108)
$\Delta VXY$	-0.556 <sup>c</sup> (0.073)	-0.557 <sup>c</sup> (0.073)		
$\Delta VXY \times nfa$ (lagged 12 months)	0.270 <sup>c</sup> (0.072)	0.270 <sup>c</sup> (0.073)		
$ldc$ (lagged 12 months)		-0.540 (0.359)		-0.271 (0.342)
$\Delta VXY$ dummy			-1.185 <sup>c</sup> (0.213)	-1.183 <sup>c</sup> (0.213)
$\Delta VXY$ dummy $\times nfa$ (lagged 12 months)			0.671 <sup>c</sup> (0.187)	0.671 <sup>c</sup> (0.187)
Additional Variables: Constant and lagged excess currency return	<i>YES</i>	<i>YES</i>	<i>YES</i>	<i>YES</i>
<i>Adjusted R</i> <sup>2</sup>	0.06	0.06	0.02	0.02
Observations	7652	7652	7652	7652

## A.9. Determinants of Excess Currency Returns

The table presents results from fixed-effects panel regressions. We use discrete currency excess returns at the monthly frequency as the dependent variable. The set of independent variables includes the net foreign asset position to gross domestic product ( $nfa$ ), the share of foreign liabilities in domestic currency ( $ldc$ ), the monthly change in the VIX index ( $\Delta VIX$ ), and a dummy variable that equals one if  $\Delta VIX$  is greater than one standard deviation as estimated across the entire sample, and zero otherwise ( $\Delta VIX$  dummy). Robust standard errors are clustered at country level and reported in parentheses. The superscripts  $a$ ,  $b$  and  $c$  denote statistical significance at the 10%, 5% and 1% level, respectively. The sample runs from January 1986 to June 2014.

	Dependent variable: currency excess returns			
	(1)	(2)	(3)	(4)
$nfa$ (lagged 12 months)	0.001 (0.071)	0.031 (0.088)	-0.084 (0.073)	-0.066 (0.079)
$\Delta VIX$	-0.145 <sup>c</sup> (0.017)	-0.145 <sup>c</sup> (0.017)		
$\Delta VIX \times nfa$ (lagged 12 months)	0.069 <sup>c</sup> (0.018)	0.069 <sup>c</sup> (0.018)		
$ldc$ (lagged 12 months)		-0.751 <sup>b</sup> (0.291)		-0.470 <sup>a</sup> (0.275)
$\Delta VIX$ dummy			-1.413 <sup>c</sup> (0.219)	-1.404 <sup>c</sup> (0.219)
$\Delta VIX$ dummy $\times nfa$ (lagged 12 months)			0.641 <sup>c</sup> (0.238)	0.643 <sup>c</sup> (0.239)
Additional Variables: Constant and lagged excess currency return	<i>YES</i>	<i>YES</i>	<i>YES</i>	<i>YES</i>
<i>Adjusted R</i> <sup>2</sup>	0.08	0.08	0.03	0.03
Observations	8960	8960	8960	8960

**Table A.10. Global Imbalance Portfolios and Other Pricing Currencies**

The table presents descriptive statistics of currency portfolios sorted on the time  $t - 1$  net foreign asset position to gross domestic product ( $nfa$ ), and the share of foreign liabilities in domestic currency ( $ldc$ ) when the pricing currency is not the US dollar. The first portfolio ( $P_1$ ) contains the top 20% of all currencies with high  $nfa$  and high  $ldc$  (creditor nations with external liabilities mainly in domestic currency) whereas the last portfolio ( $P_5$ ) contains the top 20% of all currencies with low  $nfa$  and low  $ldc$  (debtor nations with external liabilities mainly in foreign currency).  $IMB$  is a long-short strategy that buys  $P_5$  and sells  $P_1$ . The table also reports the first order autocorrelation coefficient ( $ac_1$ ), the annualized Sharpe ratio ( $SR$ ), the maximum drawdown ( $mdd$ ), the frequency of portfolio switches ( $freq$ ), the average forward discount ( $fd$ ), the average  $nfa$ , and the average  $ldc$ .  $t$ -statistics based on Newey and West (1987) standard errors with Andrews (1991) optimal lag selection are reported in brackets. Excess returns are expressed in percentage per annum and adjusted for transaction costs. The portfolios are rebalanced monthly from October 1983 to June 2014.

	$P_1$	$P_2$	$P_3$	$P_4$	$P_5$	$IMB$	$P_1$	$P_2$	$P_3$	$P_4$	$P_5$	$IMB$
	<i>CHF as pricing currency</i>						<i>DEM-EUR as pricing currency</i>					
<i>mean</i>	0.48	1.73	0.38	2.45	4.34	3.85	-0.29	1.39	-0.14	1.92	3.91	4.20
<i>t-stat</i>	[0.40]	[1.47]	[0.19]	[1.50]	[2.65]	[3.04]	[-0.25]	[1.55]	[-0.08]	[1.40]	[2.82]	[3.06]
<i>median</i>	0.28	2.23	2.58	2.80	5.63	3.14	-1.83	1.50	1.68	1.72	2.66	4.38
<i>sdev</i>	6.75	6.65	10.24	9.03	8.52	6.11	6.31	4.95	8.88	7.60	6.92	6.56
<i>skew</i>	-0.06	-0.15	-0.19	-0.44	0.17	0.53	0.29	0.34	-0.02	-0.41	0.82	0.41
<i>kurt</i>	4.48	4.03	4.36	3.84	4.78	7.45	5.22	3.87	4.92	4.06	7.60	6.61
$ac_1$	-0.05	-0.04	0.07	0.01	0.07	0.15	0.01	-0.01	0.07	-0.01	0.13	0.14
$SR$	0.07	0.26	0.04	0.27	0.51	0.63	-0.05	0.28	-0.02	0.25	0.57	0.64
$mdd$	0.30	0.23	0.44	0.31	0.27	0.23	0.42	0.16	0.43	0.37	0.22	0.24
$freq$	0.02	0.03	0.03	0.04	0.03		0.02	0.03	0.04	0.04	0.03	
$fd$	1.95	3.31	3.77	5.36	8.33		0.55	2.04	2.56	4.18	7.17	
$nfa$	0.26	0.07	0.09	-0.47	-0.57		0.43	0.15	0.09	-0.47	-0.56	
$ldc$	0.62	0.45	0.44	0.47	0.28		0.61	0.45	0.44	0.47	0.28	

*continued*

**Table A.10. Global Imbalance Portfolios and Other Pricing Currencies** (*continued*)

	$P_1$	$P_2$	$P_3$	$P_4$	$P_5$	$IMB$	$P_1$	$P_2$	$P_3$	$P_4$	$P_5$	$IMB$
	<i>GBP as pricing currency</i>						<i>JPY as pricing currency</i>					
<i>mean</i>	-1.24	0.60	-0.80	1.25	3.17	4.41	1.27	3.41	1.41	3.61	5.64	4.37
<i>t-stat</i>	[-0.82]	[0.41]	[-0.46]	[0.80]	[2.09]	[3.38]	[0.69]	[1.69]	[0.60]	[1.65]	[2.38]	[3.43]
<i>median</i>	-2.25	-1.44	0.24	1.86	3.00	4.38	2.58	5.96	5.11	7.14	7.27	4.29
<i>sdev</i>	7.48	7.76	9.35	8.89	8.41	6.26	9.92	10.38	11.86	11.77	11.70	6.18
<i>skew</i>	0.57	0.87	0.13	0.28	0.91	0.39	-0.44	-0.50	-0.57	-0.68	-0.43	0.78
<i>kurt</i>	6.27	6.02	6.09	5.21	7.88	6.74	5.32	4.60	4.52	5.06	4.08	8.20
$ac_1$	0.12	0.08	0.05	-0.05	0.02	0.15	0.05	0.09	0.08	0.06	0.12	0.14
<i>SR</i>	-0.17	0.08	-0.09	0.14	0.38	0.70	0.13	0.33	0.12	0.31	0.48	0.71
<i>mdd</i>	0.56	0.39	0.55	0.43	0.30	0.24	0.37	0.29	0.49	0.48	0.38	0.23
<i>freq</i>	0.02	0.03	0.03	0.04	0.03		0.02	0.03	0.03	0.04	0.03	
<i>fd</i>	-2.30	-0.71	0.21	1.74	4.74		2.53	4.39	4.45	6.32	9.14	
<i>nfa</i>	0.39	0.15	0.12	-0.47	-0.57		0.41	0.13	0.09	-0.47	-0.57	
<i>ldc</i>	0.63	0.47	0.44	0.47	0.28		0.62	0.45	0.45	0.47	0.28	

**Table A.11. Descriptive Statistics of Global Imbalance Portfolios: Subset of Currencies**

The table presents descriptive statistics for the sample of *Developed & Emerging Countries* which comprises the currencies of developed economies as well as the most liquid emerging market currencies. The currency portfolios sorted on the time  $t - 1$  net foreign asset position to gross domestic product ( $nfa$ ), and the share of foreign liabilities in domestic currency ( $ldc$ ). The first portfolio ( $P_1$ ) contains the top 20% of all currencies with high  $nfa$  and high  $ldc$  (creditor nations with external liabilities mainly in domestic currency) whereas the last portfolio ( $P_5$ ) contains the top 20% of all currencies with low  $nfa$  and low  $ldc$  (debtor nations with external liabilities mainly in foreign currency). *IMB* is a long-short strategy that buys  $P_5$  and sells  $P_1$ . The table also reports the first order autocorrelation coefficient ( $ac_1$ ), the annualized Sharpe ratio ( $SR$ ), the maximum drawdown ( $mdd$ ), the frequency of portfolio switches ( $freq$ ), the average forward discount ( $fd$ ), the average  $nfa$ , and the average  $ldc$ .  $t$ -statistics based on Newey and West (1987) standard errors with Andrews (1991) optimal lag selection are reported in brackets. Excess returns are expressed in percentage per annum and adjusted for transaction costs. The portfolios are rebalanced monthly from October 1983 to June 2014.

	$P_1$	$P_2$	$P_3$	$P_4$	$P_5$	<i>IMB</i>
	<i>Developed &amp; Emerging Countries</i>					
<i>mean</i>	1.18	2.58	2.08	3.49	7.62	6.45
<i>t-stat</i>	[0.69]	[1.46]	[1.36]	[2.01]	[3.89]	[4.21]
<i>median</i>	1.13	1.99	2.59	4.23	8.85	7.85
<i>sdev</i>	9.14	9.63	8.33	9.05	10.55	6.76
<i>skew</i>	0.04	-0.09	-0.40	-0.50	-0.71	-0.60
<i>kurt</i>	3.11	3.69	4.73	5.91	5.09	6.41
$ac_1$	0.05	0.04	0.04	0.08	0.06	0.18
<i>SR</i>	0.13	0.27	0.25	0.39	0.72	0.95
<i>mdd</i>	0.51	0.37	0.32	0.32	0.31	0.28
<i>freq</i>	0.02	0.03	0.03	0.03	0.02	
<i>fd</i>	-0.66	0.06	2.06	4.05	7.74	
<i>nfa</i>	0.26	0.26	0.10	-0.42	-0.41	
<i>ldc</i>	0.64	0.48	0.44	0.50	0.33	

**Table A.12. Asset Pricing Tests: Currency Strategies**

The table presents asset pricing results for the sample of *Developed & Emerging Countries* which comprises the currencies of developed economies as well as the most liquid emerging market currencies. The test assets include *5 carry trade* (sorted on the one-month forward discount), *5 global imbalance* (sorted on the net foreign asset position and the share of foreign liabilities in domestic currency), *5 short-term momentum* (sorted on the past three-month exchange rate returns), *5 long-term momentum* (sorted on the past one-year exchange rate returns), *5 value* (sorted on the past five-years exchange rate returns), *5 slope* (sorted on the term spread of interest rates), *5 long yields* (sorted on long-term interest rate differential), *5 risk reversal* (sorted on the 25-delta one-year currency risk reversal), and *5 volatility risk premia* (sorted on the difference between the one-year lagged realized volatility and model-free implied volatility). The set of pricing factors includes the dollar (*DOL*), the global imbalance (*IMB*) and carry trade (*CAR*) factors. We report first-stage GMM estimates of the factor loadings  $b$ , the market price of risk  $\lambda$ , and the cross-sectional  $R^2$ . Newey and West (1987) standard errors with Andrews (1991) optimal lag selection are reported in parentheses. *HJ* denotes the Hansen and Jagannathan (1997) distance (with simulated  $p$ -value in brackets) for the null hypothesis that the *HJ* distance is equal to zero. Excess returns are in annual terms and adjusted for transaction costs. The portfolios are rebalanced monthly from October 1983 (except for the *risk reversal* and the *volatility risk premia* portfolios which start from January 1996) to June 2014. In *Panel A*, we use 35 (45) portfolios as test assets when starting from October 1983 (January 1996). In *Panel B*, we use 25 (35) portfolios as test assets when starting from October 1983 (January 1996) as we remove the *carry trade* and *global imbalance* portfolios from the set of test assets.

Panel A: with carry trade and global imbalance portfolios as test assets														
$b_{DOL}$	$b_{IMB}$	$b_{CAR}$	$\lambda_{DOL}$	$\lambda_{IMB}$	$\lambda_{CAR}$	$R^2$	$HJ$							
<i>Developed &amp; Emerging Countries: 10/1983 – 06/2014</i>														
0.12	(0.25)	1.08	(0.47)	0.03	(0.01)	0.06	(0.01)					0.56	0.69	[0.66]
0.27	(0.25)			0.45	(0.22)	0.03	(0.01)			0.06	(0.02)	0.49	0.70	[0.29]
0.14	(0.25)	0.89	(0.50)	0.10	(0.24)	0.03	(0.01)	0.06	(0.01)	0.06	(0.02)	0.56	0.69	[0.66]
<i>Developed &amp; Emerging Countries: 01/1996 – 06/2014</i>														
-0.07	(0.40)	1.24	(0.50)			0.02	(0.01)	0.09	(0.02)			0.57	0.81	[0.99]
0.10	(0.34)			0.76	(0.33)	0.02	(0.01)			0.09	(0.02)	0.53	0.82	[0.98]
-0.04	(0.38)	0.93	(0.54)	0.21	(0.38)	0.02	(0.02)	0.08	(0.02)	0.08	(0.02)	0.58	0.81	[0.99]
Panel B: without carry trade and global imbalance portfolios as test assets														
<i>Developed &amp; Emerging Countries: 10/1983 – 06/2014</i>														
0.10	(0.25)	1.12	(0.42)			0.03	(0.01)	0.06	(0.01)			0.47	0.39	[0.91]
0.26	(0.24)			0.40	(0.21)	0.03	(0.02)			0.05	(0.02)	0.41	0.37	[0.51]
0.11	(0.25)	1.02	(0.43)	0.03	(0.21)	0.03	(0.01)	0.06	(0.01)	0.05	(0.02)	0.51	0.39	[0.77]
<i>Developed &amp; Emerging Countries: 01/1996 – 06/2014</i>														
-0.09	(0.39)	1.24	(0.45)			0.02	(0.02)	0.09	(0.02)			0.61	0.49	[0.99]
0.09	(0.33)			0.68	(0.31)	0.02	(0.02)			0.08	(0.02)	0.55	0.50	[0.99]
-0.08	(0.38)	1.17	(0.52)	0.06	(0.36)	0.02	(0.02)	0.09	(0.02)	0.08	(0.02)	0.68	0.50	[0.99]



**Table A.13. Time-Series Regressions**

The table presents time-series regression estimates for the sample of *Developed & Emerging Countries* which comprises the currencies of developed economies as well as the most liquid emerging market currencies. In *Panel A*, we regress the global imbalance factor's excess returns ( $IMB_t$ ) on the carry trade factor's excess returns ( $CAR_t$ ). In *Panel B*, we regress the excess returns of global imbalance portfolios ( $RX_{i,t}$  for  $i = 1, 2, \dots, 5$ ) on the carry trade factor's excess returns. We also control for the lagged one-year dependent variable as external imbalance information is gathered once a year. The global imbalance portfolios are sorted on the time  $t - 1$  net foreign asset position to gross domestic product ( $nfa$ ), and the share of foreign liabilities in domestic currency ( $ldc$ ). The first portfolio ( $P_1$ ) contains the top 20% of all currencies with high  $nfa$  and high  $ldc$  (creditor nations with external liabilities mainly in domestic currency) whereas the last portfolio ( $P_5$ ) contains the top 20% of all currencies with low  $nfa$  and low  $ldc$  (debtor nations with external liabilities mainly in foreign currency).  $IMB$  is a long-short strategy that buys  $P_5$  and sells  $P_1$ .  $CAR$  denotes a long-short strategy that buys high-yielding currencies and sells low-yielding currencies. Newey and West (1987) standard errors with Andrews (1991) optimal lag selection are reported in parentheses.  $F_{(\alpha,\beta)}$  denotes the F-test for the null hypothesis that  $\alpha = 0$  and  $\beta = 1$  (with  $p$ -values in brackets). Excess returns are expressed in percentage per annum, and adjusted for transaction costs. The portfolios are rebalanced monthly from October 1983 to June 2014.

Panel A: $IMB_t = \alpha + \beta CAR_t + \gamma IMB_{t-12} + \varepsilon_t$									
$RX_t$	$\alpha$	$\beta$	$R^2$	$F_{(\alpha,\beta)}$	$\alpha$	$\beta$	$\gamma$	$R^2$	$F_{(\alpha,\beta)}$
<i>Developed and Emerging Countries</i>									
$IMB_t$	4.04 (1.05)	0.43 (0.04)	0.38	[< .01]	3.50 (1.07)	0.43 (0.04)	0.08 (0.04)	0.39	[< .01]
Panel B: $RX_{i,t} = \alpha + \beta CAR_t + \gamma RX_{i,t-12} + \varepsilon_t$									
	$\alpha$	$\beta$	$R^2$		$\alpha$	$\beta$	$\gamma$	$R^2$	
<i>Developed and Emerging Countries</i>									
$RX_{1,t}$	2.92 (1.73)	-0.18 (0.07)	0.04		2.94 (1.73)	-0.18 (0.07)	-0.02 (0.05)	0.04	
$RX_{2,t}$	4.29 (1.94)	-0.16 (0.08)	0.03		4.33 (1.92)	-0.16 (0.08)	-0.02 (0.05)	0.03	
$RX_{3,t}$	2.05 (1.62)	0.11 (0.06)	0.02		2.13 (1.60)	0.11 (0.06)	-0.04 (0.06)	0.01	
$RX_{4,t}$	2.72 (1.69)	0.27 (0.07)	0.09		2.83 (1.62)	0.27 (0.07)	-0.03 (0.06)	0.09	
$RX_{5,t}$	6.96 (2.06)	0.24 (0.08)	0.05		7.21 (2.03)	0.24 (0.08)	-0.03 (0.05)	0.05	

**Table A.14. Descriptive Statistics: Even Number of Global Imbalance Portfolios**

The table presents descriptive statistics of currency portfolios sorted on the time  $t-1$  net foreign asset position to gross domestic product ( $nfa$ ), and the share of foreign liabilities in domestic currency ( $ldc$ ). The first portfolio contains the top 20% of all currencies with high  $nfa$  and high  $ldc$  (creditor nations with external liabilities mainly in domestic currency) whereas the last portfolio contains the top 20% of all currencies with low  $nfa$  and low  $ldc$  (debtor nations with external liabilities mainly in foreign currency).  $IMB$  is a long-short strategy that buys the last portfolio and sells the first portfolio. The table also reports the first order autocorrelation coefficient ( $ac_1$ ), the annualized Sharpe ratio ( $SR$ ), the maximum drawdown ( $mdd$ ), the frequency of portfolio switches ( $freq$ ), the average forward discount ( $fd$ ), the average  $nfa$ , and the average  $ldc$ .  $t$ -statistics based on Newey and West (1987) standard errors with Andrews (1991) optimal lag selection are reported in brackets. Excess returns are expressed in percentage per annum and adjusted for transaction costs. The portfolios are rebalanced monthly from October 1983 to June 2014.

	$P_1$	$P_2$	$P_3$	$P_4$	$P_5$	$P_6$	$IMB$	$P_1$	$P_2$	$P_3$	$P_4$	$IMB$
	<i>All Countries</i>							<i>Developed Countries</i>				
<i>mean</i>	0.61	2.84	3.44	1.76	3.08	5.74	5.12	0.75	2.83	3.02	4.36	3.61
<i>t-stat</i>	[0.43]	[1.67]	[2.27]	[1.29]	[1.83]	[3.00]	[3.82]	[0.40]	[1.55]	[1.83]	[2.24]	[2.90]
<i>median</i>	0.88	2.33	3.70	4.71	4.64	6.39	6.04	0.67	3.34	4.54	5.58	4.30
<i>sdev</i>	7.38	9.18	8.16	7.17	9.31	9.82	6.54	9.75	9.98	8.91	10.18	6.90
<i>skew</i>	-0.13	-0.05	-0.21	-0.48	-1.33	-0.03	0.50	0.05	-0.17	-0.22	-0.26	-0.57
<i>kurt</i>	3.36	4.38	4.14	5.45	10.38	4.68	6.77	3.68	3.24	5.32	3.70	5.25
$ac_1$	0.08	0.05	0.06	0.07	0.01	0.10	0.13	0.07	0.03	0.05	0.07	0.01
$SR$	0.08	0.31	0.42	0.25	0.33	0.58	0.78	0.08	0.28	0.34	0.43	0.52
$mdd$	0.49	0.31	0.24	0.34	0.36	0.29	0.22	0.56	0.27	0.32	0.34	0.26
$freq$	0.03	0.04	0.04	0.04	0.04	0.03	0.06	0.02	0.02	0.02	0.03	0.05
$fd$	-0.71	0.79	1.73	2.47	3.97	6.89		-1.04	0.19	2.09	2.29	
$nfa$	0.42	0.19	0.26	-0.23	-0.45	-0.59		0.35	0.31	-0.38	-0.35	
$ldc$	0.64	0.51	0.37	0.52	0.44	0.27		0.60	0.40	0.55	0.35	

**Table A.15. Descriptive Statistics: Global Imbalance Factor Decomposition**

The table presents descriptive statistics of currency portfolios sorted on time  $t - 1$  information. In *All Countries* and *Developed & Emerging Countries (Developed Countries)*, currencies are first grouped into two baskets using the net foreign asset position to GDP ratio (*nfa*), and then into three (two) baskets using the share of foreign liabilities in domestic currency (*ldc*). The *NFA* factor is constructed as the average return on the low *nfa* portfolios  $P_4$ ,  $P_5$  and  $P_6$  ( $P_3$  and  $P_4$ ) minus the average return on the high *nfa* portfolios  $P_1$ ,  $P_2$  and  $P_3$  ( $P_1$  and  $P_2$ ). The *LDC* factor is computed as the average return on the low *ldc* portfolios  $P_3$  and  $P_6$  ( $P_2$ , and  $P_4$ ) minus the average return on the high *ldc* portfolios  $P_1$  and  $P_4$  ( $P_1$  and  $P_3$ ). The table also reports the first order autocorrelation coefficient ( $ac_1$ ), the annualized Sharpe ratio (*SR*), the maximum drawdown in percent (*MDD*), the frequency of portfolio switches (*freq*), the average forward discount (*fd*), the average *nfa*, and the average *ldc*. *t*-statistics based on Newey and West (1987) standard errors with Andrews (1991) optimal lag selection are reported in brackets. Excess returns are expressed in percentage per annum. The portfolios are rebalanced monthly from October 1983 to June 2014.

	$P_1$	$P_2$	$P_3$	$P_4$	$P_5$	$P_6$	<i>NFA</i>	<i>LDC</i>
<i>All Countries</i>								
<i>mean</i>	0.55	2.92	3.52	1.85	3.21	5.90	1.32	3.51
<i>t-stat</i>	[0.38]	[1.71]	[2.33]	[1.35]	[1.91]	[3.09]	[1.46]	[3.82]
<i>sdev</i>	7.37	9.18	8.17	7.17	9.31	9.82	4.80	4.96
<i>skew</i>	-0.13	-0.05	-0.21	-0.47	-1.33	-0.04	-0.44	0.10
<i>kurt</i>	3.36	4.38	4.15	5.45	10.41	4.69	3.88	4.58
$ac_1$	0.09	0.05	0.05	0.07	0.01	0.09	0.06	0.05
<i>SR</i>	0.07	0.32	0.43	0.26	0.34	0.60	0.28	0.71
<i>mdd</i>	0.49	0.30	0.24	0.33	0.36	0.29	0.27	0.15
<i>freq</i>	0.03	0.04	0.04	0.04	0.04	0.03		
<i>fd</i>	-0.76	0.84	1.80	2.53	4.07	7.03		
<i>nfa</i>	0.42	0.19	0.26	-0.23	-0.45	-0.59		
<i>ldc</i>	0.64	0.51	0.37	0.52	0.44	0.27		
<i>Developed &amp; Emerging Countries</i>								
<i>mean</i>	0.91	2.22	2.54	2.15	4.17	8.59	3.08	4.03
<i>t-stat</i>	[0.54]	[1.18]	[1.57]	[1.30]	[1.95]	[4.34]	[3.04]	[4.03]
<i>sdev</i>	8.82	10.17	8.81	8.58	11.55	10.67	5.22	5.16
<i>skew</i>	0.08	-0.06	-0.18	-0.61	-0.84	-0.68	-0.52	0.02
<i>kurt</i>	3.31	3.80	3.91	6.55	6.39	4.93	4.03	3.96
$ac_1$	0.06	0.05	0.04	0.08	0.05	0.05	0.09	0.10
<i>SR</i>	0.10	0.22	0.29	0.25	0.36	0.81	0.59	0.78
<i>mdd</i>	0.56	0.39	0.26	0.32	0.42	0.33	0.18	0.16
<i>freq</i>	0.03	0.03	0.03	0.03	0.03	0.02		
<i>fd</i>	-0.68	-0.28	1.21	2.86	5.25	8.32		
<i>nfa</i>	0.22	0.32	0.35	-0.36	-0.39	-0.42		
<i>ldc</i>	0.65	0.51	0.36	0.55	0.44	0.30		
<i>Developed Countries</i>								
<i>mean</i>	0.70	2.90	3.09	4.43	1.96	1.77		
<i>t-stat</i>	[0.37]	[1.58]	[1.87]	[2.27]	[1.86]	[2.11]		
<i>sdev</i>	9.75	9.98	8.91	10.19	5.83	4.63		
<i>skew</i>	0.05	-0.17	-0.22	-0.26	-0.40	-0.05		
<i>kurt</i>	3.68	3.25	5.32	3.71	3.88	3.39		
$ac_1$	0.07	0.03	0.05	0.07	-0.01	-0.01		
<i>SR</i>	0.07	0.29	0.35	0.43	0.34	0.38		
<i>mdd</i>	0.56	0.27	0.31	0.34	0.20	0.14		
<i>freq</i>	0.02	0.02	0.02	0.03				
<i>fd</i>	-1.09	0.24	2.15	2.34				
<i>nfa</i>	0.35	0.31	-0.38	-0.35				
<i>ldc</i>	0.60	0.40	0.55	0.35				

**Table A.16. Asset Pricing Tests: Global Imbalance Factor Decomposition**

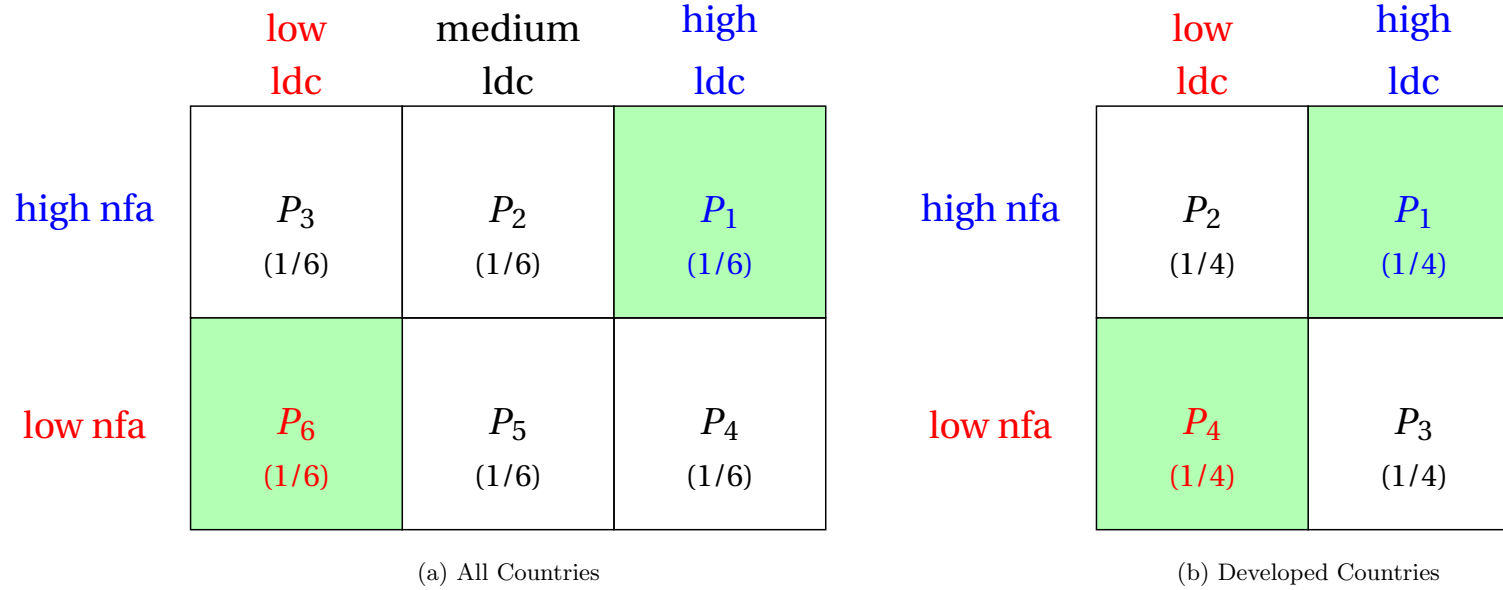
The table presents asset pricing results for currency strategies. The test assets include *5 carry trade* (sorted on the one-month forward discounts), *5 global imbalance* (sorted on the net foreign asset position and the share of foreign liabilities in domestic currency), *5 short-term momentum* (sorted on the past three-month exchange rate returns), *5 long-term momentum* (sorted on the past one-year exchange rate returns), *5 value* (sorted on the past five-years exchange rate returns), *5 slope* (sorted on the term spread of interest rates), *5 long yields* (sorted on long-term interest rate differentials), *5 risk reversal* (sorted on the 25-delta one-year currency risk reversal), and *5 volatility risk premium* (sorted on the difference between the one-year lagged realized volatility and model-free implied volatility). The set of pricing factors includes the dollar (*DOL*), net foreign asset (*NFA*) and share of foreign liabilities denominated in domestic currency (*LDC*) factors. We report first-stage GMM estimates of the factor loadings  $b$ , the market price of risk  $\lambda$ , and the cross-sectional  $R^2$ . The superscripts  $a$ ,  $b$ , and  $c$  indicate statistical significance at the 10%, 5% and 1% level, respectively, using Newey and West (1987) standard errors with Andrews (1991) optimal lag selection.  $HJ$  denotes the Hansen and Jagannathan (1997) distance for the null hypothesis that the  $HJ$  distance is equal to zero. We bold the statistic when failing to reject the null hypothesis at the 5% significance level. Excess returns are in annual terms and adjusted for transaction costs. The portfolios are rebalanced monthly from October 1983 (except for the *risk reversal* and the *volatility risk premia* portfolios which start from January 1996) to June 2014. In *Panel A*, we use 35 (45) portfolios as test assets when starting from October 1983 (January 1996). In *Panel B*, we use 25 (35) portfolios as test assets when starting from October 1983 (January 1996) as we remove the *carry trade* and *global imbalance* portfolios from the set of test assets.

Panel A: with carry trade and global imbalance portfolios as test assets															
$b_{DOL}$	$b_{NFA}$	$b_{LDC}$	$\lambda_{DOL}$	$\lambda_{NFA}$	$\lambda_{LDC}$	$R^2$	$HJ$	$b_{DOL}$	$b_{NFA}$	$b_{LDC}$	$\lambda_{DOL}$	$\lambda_{NFA}$	$\lambda_{LDC}$	$R^2$	$HJ$
<i>All Countries: 10/1983 – 06/2014</i>								<i>All Countries: 01/1996 – 06/2014</i>							
0.41	0.91 <sup>b</sup>		0.02 <sup>a</sup>	0.02 <sup>c</sup>		0.37	<b>0.81</b>	-0.37	2.57 <sup>c</sup>		0.02 <sup>a</sup>	0.05 <sup>c</sup>		0.59	<b>0.91</b>
0.00		1.30 <sup>c</sup>	0.02 <sup>a</sup>		0.04 <sup>c</sup>	0.14	<b>0.81</b>	0.23		2.81 <sup>c</sup>	0.02 <sup>a</sup>		0.05 <sup>c</sup>	0.58	<b>0.91</b>
-0.01	0.97 <sup>b</sup>	1.50 <sup>c</sup>	0.02 <sup>a</sup>	0.02 <sup>b</sup>	0.04 <sup>c</sup>	0.54	<b>0.80</b>	-0.13	1.50 <sup>a</sup>	1.50 <sup>b</sup>	0.02 <sup>a</sup>	0.04 <sup>c</sup>	0.04 <sup>c</sup>	0.65	<b>0.90</b>
<i>Developed and Emerging: 10/1983 – 06/2014</i>								<i>Developed and Emerging: 01/1996 – 06/2014</i>							
0.30	0.94 <sup>b</sup>		0.03 <sup>a</sup>	0.03 <sup>c</sup>		0.49	<b>0.70</b>	-0.12	1.69 <sup>c</sup>		0.02	0.05 <sup>c</sup>		0.55	<b>0.81</b>
0.28		0.18	0.03 <sup>a</sup>		0.01	0.01	<b>0.70</b>	0.22		3.24 <sup>c</sup>	0.02		0.07 <sup>c</sup>	0.47	<b>0.82</b>
0.06	1.05 <sup>c</sup>	1.11 <sup>b</sup>	0.03 <sup>a</sup>	0.03 <sup>c</sup>	0.03 <sup>c</sup>	0.57	<b>0.69</b>	-0.04	1.29 <sup>a</sup>	1.01	0.02	0.05 <sup>c</sup>	0.04 <sup>c</sup>	0.57	<b>0.81</b>
<i>Developed Countries: 10/1983 – 06/2014</i>								<i>Developed Countries: 01/1996 – 06/2014</i>							
0.35	0.73 <sup>a</sup>		0.02	0.03 <sup>c</sup>		0.65	<b>0.66</b>	-0.02	0.96 <sup>a</sup>		0.01	0.03 <sup>c</sup>		0.55	<b>0.80</b>
0.37		-0.46	0.02		0.01	0.01	<b>0.66</b>	-0.08		1.37	0.01		0.03 <sup>c</sup>	0.24	<b>0.80</b>
0.37	0.73 <sup>a</sup>	-0.06	0.02	0.03 <sup>c</sup>	0.01	0.65	<b>0.65</b>	-0.02	0.97 <sup>a</sup>	-0.02	0.01	0.03 <sup>c</sup>	0.01	0.55	<b>0.80</b>

*Continued*

**Table A.16. Asset Pricing Tests: Imbalance Factor Decomposition** (*continued*)

Panel B: without carry trade and global imbalance portfolios as test assets															
$b_{DOL}$	$b_{NFA}$	$b_{LDC}$	$\lambda_{DOL}$	$\lambda_{NFA}$	$\lambda_{LDC}$	$R^2$	$HJ$	$b_{DOL}$	$b_{NFA}$	$b_{LDC}$	$\lambda_{DOL}$	$\lambda_{NFA}$	$\lambda_{LDC}$	$R^2$	$HJ$
<i>All Countries: 10/1983 – 06/2014</i>							<i>All Countries: 01/1996 – 06/2014</i>								
0.38	0.74 <sup>a</sup>		0.02 <sup>a</sup>	0.02 <sup>b</sup>		0.27	<b>0.40</b>	-0.33	2.34 <sup>b</sup>		0.02	0.04 <sup>c</sup>		0.56	<b>0.60</b>
0.02		1.17 <sup>c</sup>	0.02 <sup>a</sup>		0.03 <sup>c</sup>	0.01	<b>0.39</b>	0.23		2.60 <sup>c</sup>	0.02 <sup>a</sup>		0.05 <sup>c</sup>	0.62	<b>0.59</b>
-0.02	0.88 <sup>b</sup>	1.48 <sup>c</sup>	0.02 <sup>a</sup>	0.01 <sup>a</sup>	0.04 <sup>c</sup>	0.42	<b>0.37</b>	-0.06	1.20	1.75 <sup>c</sup>	0.02	0.04 <sup>c</sup>	0.04 <sup>c</sup>	0.70	<b>0.59</b>
<i>Developed and Emerging: 10/1983 – 06/2014</i>							<i>Developed and Emerging: 01/1996 – 06/2014</i>								
0.28	0.93 <sup>b</sup>		0.03 <sup>a</sup>	0.03 <sup>c</sup>		0.39	<b>0.37</b>	-0.11	1.55 <sup>c</sup>		0.02	0.05 <sup>c</sup>		0.48	<b>0.50</b>
0.23		0.33	0.03 <sup>a</sup>		0.01	0.01	<b>0.40</b>	0.20		2.52 <sup>c</sup>	0.02		0.06 <sup>c</sup>	0.33	<b>0.49</b>
0.06	1.09 <sup>c</sup>	1.03 <sup>c</sup>	0.03 <sup>a</sup>	0.03 <sup>c</sup>	0.03 <sup>c</sup>	0.34	<b>0.39</b>	-0.03	1.15 <sup>b</sup>	1.25	0.02	0.05 <sup>c</sup>	0.04 <sup>c</sup>	0.50	<b>0.49</b>
<i>Developed Countries: 10/1983 – 06/2014</i>							<i>Developed Countries: 01/1996 – 06/2014</i>								
0.34	0.67 <sup>a</sup>		0.02	0.02 <sup>c</sup>		0.49	<b>0.25</b>	-0.03	0.96 <sup>b</sup>		0.01	0.03 <sup>c</sup>		0.48	<b>0.43</b>
0.35		-0.40	0.02		0.01	0.01	<b>0.30</b>	-0.02		0.98	0.01		0.02 <sup>c</sup>	0.13	<b>0.45</b>
0.34	0.66 <sup>a</sup>	-0.03	0.02	0.02 <sup>c</sup>	0.01	0.44	<b>0.28</b>	-0.03	0.97 <sup>b</sup>	0.01	0.01	0.03 <sup>c</sup>	0.01	0.47	<b>0.44</b>



**Figure A.1. Decomposition of the Global Imbalance Risk Factor**

This figure describes the construction of the global imbalance (*IMB*) risk factor and its decomposition. For *All Countries*, currencies are sorted at the end of each month into 2 baskets using the median value of the net foreign asset to GDP ratio (*nfa*) and then, within each basket, into a further 3 baskets using the share of foreign liabilities in domestic currency (*ldc*). The *ldc* breakpoints are the 33rd and 67th percentiles. The *IMB* factor is constructed as the excess return on the lowest *nfa* and *ldc* portfolio ( $P_6$ ) minus the excess return on the highest *nfa* and *ldc* portfolio ( $P_1$ ). This is equivalent to buying the currencies of debtor nations with external liabilities denominated mainly in foreign currency and selling the currencies of creditor nations with external liabilities denominated mainly in domestic currency. The global imbalance risk factor is then decomposed into the *NFA* factor, computed as the average excess return on the low *nfa* portfolios ( $P_4$ ,  $P_5$  and  $P_6$ ) minus the average excess return on the high *nfa* portfolios ( $P_1$ ,  $P_2$  and  $P_3$ ), and the *LDC* factor, constructed as the average excess return on the low *ldc* portfolios ( $P_3$  and  $P_6$ ) minus the average excess return on the high *ldc* portfolios ( $P_1$  and  $P_4$ ). For *Developed Countries*, currencies are double sorted into 4 portfolios using the median values of *nfa* and *ldc*. The *IMB* factor is constructed as the excess return on  $P_4$  minus the excess return on  $P_1$ . The *NFA* factor is constructed as the average excess return on  $P_3$  and  $P_4$  minus the average excess return on  $P_1$  and  $P_2$  whereas the *LDC* factor is the average excess return on  $P_2$  and  $P_4$  minus the average excess return on  $P_1$  and  $P_3$ .