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Currency Premia and Global Imbalances

Pasquale Della Corte
Imperial College London and Centre for Economic Policy Research

Steven J. Riddiough
University of Melbourne

Lucio Sarno
City University London and Centre for Economic Policy Research

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. (*JEL* F31, F37, G12, G15)

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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 this link. For example, following the U.S. Federal Reserve's announcement on May 22, 2013 that it 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 sharply sold-off. 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 June 26, 2013 attributed the large depreciation of the Indian rupee (which fell by 22% against the U.S. dollar between May and August 2013) to investors' concerns for 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.[1] 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 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, that is, 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, financiers are unwilling to intermediate currency mismatches, regardless of the excess return on offer, in the presence of risk-bearing capacity. In contrast, when

[1] The results also support a risk-based interpretation of the carry trade, a popular strategy that borrows in currencies with low-interest rates (funding currencies) and lends in currencies with high-interest rates (investment currencies). See Hansen and Hodrick (1980), Bilson (1981), Fama (1984), Lustig and Verdelhan (2007), Brunnermeier, Nagel, and Pedersen (2008), Della Corte, Sarno, and Tsiakas (2009), Burnside (2011), Burnside et al. (2011), Christiansen, Ranaldo, and Söderlind (2011), Lustig, Roussanov and Verdelhan (2011), Menkhoff et al. (2012a), Jurek (2014), Lettau, Maggiori, and Weber (2014), Bekaert and Panayotov (2015), Farhi et al. (2015), and Koijen et al. (2015).

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 minuscule. While this paper is not a direct test of the GM theory, our key results can be naturally interpreted under the description of exchange rate determination offered in this theory.

We focus the empirical analysis around two simple testable hypotheses, which we motivate in Section 1. First, currency excess returns are higher when the funding (investment) country is a net foreign creditor (debtor) and has a higher propensity to issue liabilities denominated in domestic (foreign) currency. The relation between currency excess returns and net foreign assets captures the link between external imbalances and currency risk premia in the theory of GM (2015). The currency denomination of external debt also matters for currency risk premia. One argument for this may be the case, borrowed from the "original sin" literature (e.g., Eichengreen and Hausmann 2005), is that countries that cannot issue debt in their own currency are riskier. In essence, this first testable hypothesis suggests that currency risk premia are driven by the evolution and currency denomination of net foreign assets.

Second, we test the prediction of the GM (2015) theory that, in the presence of a financial disruption (i.e., risk-bearing capacity is low and global risk aversion is high), net-debtor countries experience a currency depreciation, unlike net-creditor countries. This testable hypothesis makes clear 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.

After describing the data and portfolio construction methods in Section 2, we test and provide empirical evidence in support of the two hypotheses described above. With respect to the first testable hypothesis, we document in Section 3 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, in Section 4, we empirically test whether a global imbalance risk factor explains 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 IMB explains a large fraction of the cross-sectional variation in currency excess returns, thus supporting a risk-based view of exchange rate determination based on macroeconomic fundamentals and, specifically, on net foreign asset positions. This result holds both for a broad sample of fifty-five currencies and for a subsample of fifteen developed currencies for the period from 1983 to 2014.[2]

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 principally funded in foreign currency. For example, high-interest rate currencies positively load on the global imbalance factor, and thus deliver low returns in bad times during 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. Importantly, 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 that includes, among others, portfolio sorts on currency value, momentum, and volatility risk premia.

We also document how net foreign asset positions contain information (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 of an effect of net foreign asset positions on currency excess returns distinct from a pure interest rate channel.[3]

[2] Few attempts have been made 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). Employing a cross-sectional perspective on the role of global imbalances to help us understand currency risk premia seems quite natural.

[3] 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 that control for interest rate differentials.

In relation to the second testable hypothesis, in Section 5 we provide evidence using a battery of panel regressions where 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.

Further analysis in Section 6 provides refinements and robustness of the main results. For example, in this analysis we test the pricing power of the IMB 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. Overall, this additional analysis corroborates the core finding that global imbalance risk is a key fundamental driver of risk premia in the FX market. Finally, we briefly summarize our key findings in Section 7. A separate Internet Appendix provides further details on the data, robustness tests, and additional results.

1. 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 on 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 in which 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 (e.g., Branson, Halttunen, and Masson 1979; Branson and Henderson 1985), a combination of insufficient data on foreign bond holdings, a lack of microfoundation 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 microfounded 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: net debtor currencies are predicted to warrant an excess currency return in equilibrium and to depreciate at times when risk-bearing capacity falls. 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 it depends on conditional FX volatility.

GM (see equation (23), Proposition 6) derive the expected currency excess return as follows:

$$E(RX) = \Gamma \frac{\frac{R^*}{R} E(imp_1) - imp_0}{(R^* + \Gamma) imp_0 + \frac{R^*}{R} E(imp_1)}, \tag{1}$$

where $E(\cdot)$ is the expectation operator, and RX is the dollar excess return. The variable imp_t denotes the dollar value of U.S. imports at time t; with exports normalized to unity in Equation (1), $E(imp_1) - imp_0$ determines the evolution of net exports. In the basic Gamma model with two periods and two countries, this setting implies a positive relation between the evolution of net exports and net foreign assets since the external account must balance at the end of the last period. R and R^* are the domestic and foreign riskless interest rates. Γ captures risk-bearing capacity of financiers. When risk-bearing capacity is low (i.e., Γ is high), financial intermediaries are unwilling to absorb any imbalances, regardless of the expected 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 (Γ decreases), expected excess returns fall but do not entirely disappear, except when Γ is extremely low and financial intermediaries are prepared to absorb any currency imbalance so that uncovered interest rate parity holds. Equation (1) shows that expected excess returns will be higher when interest rate differentials are larger (carry trade) and when the funding (investment) currency is issued by a net creditor (debtor) country. Put another way, currency investors require a premium to hold the currency of debtor nations relative to creditor nations.[4]

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[4] To clarify these effects analytically in Equation (1), first consider the case in which $R^*/R > 1$; that is, the interest rate in the foreign (investment) country is higher than the one in the funding country (the U.S.). GM show that $\frac{\partial E(RX)}{\partial (R^* - R)} > 0$, which means that the

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 studied 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 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 (2015) highlight how this mechanism is consistent with the valuation channel to external adjustment studied by 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, 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.[5]

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 expected currency excess 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

expected currency excess return increases with higher interest rate differentials. Second, set $E[imp_1]-imp_0>0$ (while setting $R^*/R=1$), that is, the funding country (the U.S.) is a net foreign creditor. Given that imp is the value of U.S. imports in U.S. dollars, $E[imp_1]-imp_0>0$ implies that the U.S. is expected to become a net importer at $t=1$ to offset its positive external imbalance at $t=0$, and clearly $\frac{\partial E(RX)}{\partial(E(imp_1)-imp_0)}>0$. This establishes the result that the expected excess return is higher if the country of the funding currency is a net creditor and vice versa for net debtor countries.

[5] This is because the initial depreciation makes countries with foreign-currency-denominated liabilities poorer, not richer, by increasing their debt burden; see the portfolio balance theory in Gourinchas (2008, Section 3.2.2).

(investment) country has a higher propensity to issue liabilities denominated in domestic (foreign) currency.

This testable prediction suggests that, in addition to interest rate differentials (condition (i)) analyzed extensively in the literature, FX excess returns are driven by the evolution of external debt and its currency denomination (conditions (ii) and (iii)). In our portfolio analysis, we focus on this aspect of Hypothesis 1 and 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. 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 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 fifty-five 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: Proposition 2 of GM (2015).

Hypothesis 2. During a financial disruption (Γ increases), countries that are net external debtors experience a currency depreciation, while the opposite is true for net-creditor countries.

This prediction naturally follows 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 the empirical analysis 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, our empirical findings may be rationalized by other theories, even in a complete markets setting. In fact, Colacito et al. (2015) have recently developed a frictionless risk-sharing model of the international economy with recursive preferences and long-run risk, and it is specifically designed and able to simultaneously replicate 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, to construct testable and economically plausible empirical hypotheses. This paper then aims at providing a robust empirical assessment of these hypotheses to show novel facts about the link between global imbalances and currency risk premia.

2. 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.

2.1 Data on currency excess returns

We collect daily spot and one-month forward exchange rates vis-à-vis the U.S. dollar (USD) from Barclays and Reuters via Datastream.

Exchange rates are defined as units of USD 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 fifty-five 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 fifteen countries that 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 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

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

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

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

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 U.S. 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 United States. 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.

2.2 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 were obtained 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 Bénétrix, Lane, and Shambaugh (2015), who update the data from Lane and Shambaugh (2010), kindly provided by Philip Lane. Clearly, accurately measuring the share of external liabilities in foreign currency is a hard task, in addition to 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 for a long span of time, 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 since 1983.[6]

2.3 Global imbalance portfolios

Motivated by the considerations discussed in Section 1, we construct global imbalance portfolios as follows: at the end of each period t, we first group currencies into two baskets using our key sorting variable, that is, nfa, and 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), and 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 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

[6] This assumption makes no qualitative difference to our findings as when we examine the sample period starting in 1990 (dropping the first seven years of data altogether) our portfolio results are qualitatively identical. This is not surprising since ldc is a highly persistent variable (see Bénétrix, Lane, and Shambaugh 2015).

liabilities mainly in domestic currency), and 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 of portfolios for both samples of countries. In the Internet Appendix we show that our core results are qualitatively identical if we use four portfolios for developed countries and six portfolios for all countries; see Figure A.1 and Table A.14 in the Internet Appendix.

2.4 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 United States) are assigned to Portfolio 1, and currencies with the highest forward discounts (or highest interest rate differential relative to the United States) 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.

2.5 Momentum portfolios

Following Menkhoff et al. (2012b), at the end of each month t, we form five portfolios based on exchange rate returns for 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.

2.6 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*).

2.7 Term spread and long yields portfolios

We also construct five currency portfolios sorted on the term spread of interest rates and five currency portfolios sorted on the long-term interest rate differential relative to the United States, thus using additional information about interest rates. We collect three-month interest rates as a proxy for short-term rates, and ten-year interest rates (or five-year when ten-year are not available) to capture the long-term rates from Global Financial Data. Sorting on the term spread is motivated by the evidence in Ang and Chen (2010), and 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., Bekaert, Wei, and Xing, 2007). At the end of each month t, similar to the previous strategies, we sort currencies into five portfolios using 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.

2.8 Risk reversal portfolios

At the end of each month t, we form five currency portfolios using the one-year implied volatility of currency option risk-reversals. For this exercise, we update the implied volatility of currency options quoted over-the-counter used by Della Corte, Ramadorai, and Sarno (2016), who study the properties of this strategy to capture a skewness risk premium in FX markets. For each currency in each time period, we construct the 25-delta risk reversal, which is the implied volatility of an option strategy that buys a 25-delta out-of-the-money call and sells a 25-delta out-of-the-money put with one-year maturity. We then construct five portfolios 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*). Finally, we compute the excess return for each portfolio as an equally weighted average of the currency excess returns (based on spot and forward exchange rates) within that portfolio.

2.9 Volatility risk premium portfolios

At the end of each period t, we group currencies into five portfolios using their one-year volatility risk premium as described by Della Corte, Ramadorai, and Sarno (2016). The volatility risk premium is defined as the difference between the physical and the risk-neutral expectations of future realized volatility. Following Bollerslev, Tauchen, and Zhou

(2009), we proxy the physical expectation of future realized volatility at time t by simply using the lagged one-year realized volatility based on daily log returns. This approach requires no modeling assumptions and is consistent with the stylized fact that realized volatility is a highly persistent process. The risk-neutral expectation of the future realized volatility at time t is constructed using the model-free approach of Britten-Jones and Neuberger (2000) that employs the implied volatility of one-year currency options across five different deltas, that is, 10-delta call and put, 25-delta call and put, and at-the-money options. The volatility risk premium reflects the costs of insuring against currency volatility fluctuations and is generally negative. We construct five portfolios and allocate 20% of all currencies with the lowest volatility risk premia to Portfolio 1 (*expensive volatility insurance currencies*), and 20% of all currencies with the highest volatility risk premia to Portfolio 5 (*cheap volatility insurance currencies*). We then compute the excess return for each portfolio as an equally weighted average of the currency excess returns (based on spot and forward exchange rates) within that portfolio.

We have described nine 9 currency strategies for a total of 45 portfolios. These strategies are rebalanced monthly, and the sample runs from October 1983 to June 2014. The sample for the risk reversal and volatility risk premium portfolios, however, starts in January 1996 due to options data availability. These portfolios, for both sample periods analyzed, display a correlation ranging from slightly more than 30% to more than 90%, with the average being around 70%. This broad set of portfolios goes well beyond carry or interest rate-sorted portfolios and will form our test assets in the asset pricing analysis.

3. The Global Imbalance Strategy and the Carry Trade

3.1 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 the first portfolio (0.92% and 0.67% per annum) to the last portfolio (5.32% and 4.65% 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 Sharpe ratio at least as high as the carry trade strategy: 0.68 compared with 0.65 for all countries, and 0.59 compared with 0.43 for developed countries. This comparison suggests that the global imbalance strategy has appealing risk-adjusted returns in its own right, and, perhaps, is surprising given the information required to update the global imbalance strategy arrives only once a year.[7]

Table 1 about here

The last three rows in Table 1 report the average fd, nfa, and ldc across all portfolios. The spread in interest rate differentials is about 7% and 3.5% for all countries and developed countries. This is a large spread but is far less than the 11% and 6% 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 that is in external imbalances, but not in interest rate differentials. The last two rows reveal a sizable spread in nfa and ldc, which is monotonic for nfa in 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 1.

3.2 *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 the twelve-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 (β) estimate on CAR is positive and statistically significant, but is far and statistically different from unity (approximately 0.40). The R^2 of the contemporaneous regression of IMB on CAR is 30%. Most importantly, the constant term (α) is statistically different from zero in all specifications and economically sizable (up to 2.3% per annum), suggesting that IMB and CAR are

[7] Specifically, we construct monthly excess returns, but global imbalance portfolios are, in practice, only rebalanced 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.

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 differences 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 twelve-month lag of the dependent variable in separate regressions. The results, reported in panel B of Table 2, suggest a moderate spread in the coefficient on the CAR factor, which is often statistically significant. The α 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 for 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.

Table 2 about here

Taken together, the results reported untill now suggest that the global imbalance strategy has creditable excess returns overall and that 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), stating 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.

4. 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).

4.1 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:

$$E_t[M_{t+1}RX_{t+1}^j]=0, \tag{4}$$

with a stochastic discount factor (SDF) linear in the pricing factors f_{t+1}, given by

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

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

$$E[RX^j]=\lambda'\beta^j, \tag{6}$$

where the market price of risk $\lambda=\Sigma_f b$ can be obtained via the factor loadings b. $\Sigma_f=E\left[(f_t-\mu)(f_t-\mu)'\right]$ is the variance-covariance matrix of the risk factors, and β^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 (5) 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 λ, and statistical significance at the 10%, 5% and and 1% level, respectively, based on Newey and West (1987) standard errors 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 χ_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.[8]

4.2 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 the expected market excess return, approximated by the average excess return on a portfolio strategy 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 et al. (2012a). 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 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. Moreover, in the Internet Appendix (Table A.17), we show that using the global equity market excess return rather than DOL as the first factor does not affect our results.

4.3 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 premium 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 results in empirical work. If the risk factor has a small (but nonzero) correlation with the "true" factor, the cross-sectional R^2 could still be high, suggesting an impressive model fit. This is particularly problematic in

[8] We also calculate the χ^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 χ^2 test results are perfectly in line with the HJ distance results and therefore are not reported to conserve space.

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, that is, 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 λ, the cross-sectional R^2, and the HJ distance. Statistical significance at the 10%, 5%, and and 1% level, respectively, is based on Newey and West (1987) standard errors, with lag length determined according to Andrews (1991). 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 for two sample periods.

Starting from panel A of Table 3, we focus our interest on the sign and the statistical significance of λ_{IMB}, the market price of risk attached to the global imbalance risk factor. We find a positive and significant estimate of λ_{IMB}, in the range between 4% and 8% per annum for all countries, and between 3% and 6% per annum for developed countries.

Table 3 about here

The estimates are similar for both SDF specifications involving the IMB factor, that is, 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 positively comove with the global imbalance factor, and lower risk premia for currency portfolios exhibiting a negative covariance with the global imbalance factor. The price of risk associated with IMB is highly statistically significant in each case. We observe satisfactory cross-sectional fit in terms of R^2, which ranges from 49% to 65% 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 λ_{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 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 25 from 1983, and 35 from 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 λ_{IMB} and λ_{CAR}). The estimation results reported in panel B are qualitatively identical to the results in panel A, indicating that the pricing power of IMB earlier recorded is not driven by its ability to price global imbalance and carry portfolios, but it extends to other currency portfolios.[9]

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. A cross-sectional correlation between interest rates (typically real interest rates) and net foreign asset positions is well documented (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 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 differentials 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.[10] In short, the main point is that, even

[9] We also replace the dollar factor with the global equity factor (WEQ), which we proxy using the returns on the MSCI World Index minus the one-month U.S. interest rate, but asset pricing results remain qualitatively similar. We collect the data from Datastream and report the results in the Table A.17 in the Internet Appendix.

[10] Inflation and the output gap are the core variables in macroeconomic 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.

though the information in global imbalances is related to interest rate differentials, independent information in global imbalances matters for currency returns.

TABLE 4 ABOUT HERE

4.4 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 thirty-six-month rolling window that ends in period $t-1$ and denote this slope coefficient $\beta^i_{IMB,t}$. This exercise provides currency i exposure to IMB using only information available at time t. We then rank currencies according to $\beta^i_{IMB,t}$ 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) and 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 does 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% 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 preformation and postformation betas when moving from Portfolio 1 to Portfolio 5: they line up well with the cross-section of average excess returns in Table 1. Average preformation betas vary from -0.22 to 1.35 for all countries and from -0.94 to 0.67 for developed countries. Postformation betas are calculated by regressing the realized excess returns of beta-sorted portfolios on a constant and the global imbalance risk factor. These figures range from -0.06 to 0.69 for all countries, and from -0.29 to 0.82 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.

Table 5 about here

5. Exchange Rates and Net Foreign Assets in Bad Times

We now turn to testing Hypothesis 2, as stated in Section 1. In essence, the testable prediction from GM (2015) 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, times of large shocks to risk-bearing capacity and risk aversion (Γ is high in the model). In contrast, net external creditors experience a currency appreciation in bad times.

In GM's (2015) model, Γ 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 Γ, that is, shocks to the willingness of financiers to absorb exchange rate risk. VXY is the FX analog 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 three-month at-the-money forward options. In general, GM (2015) refer to Γ 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.[11]

We test Hypothesis 2 in two different ways. First, we estimate a panel regression in which we regress monthly exchange rate returns on a set of macroeconomic variables, allowing for fixed effects. As right-hand-side variables, we employ nfa lagged by twelve months, and the interest rate differential lagged by one 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

[11] We contemporaneously use the change in VXY (or VIX) in these regressions 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 Γ might be that it captures (changes in) the amount of capital available in financial markets to bear risk. In this case one would expect currency excess returns to decline as the amount of capital increases, and in fact evidence in the literature reveals this is the case (e.g., Jylha and Suominen 2011; Barroso and Santa-Clara 2015). However, our interpretation of Γ is, much like that of 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.

greater than one standard deviation and is zero otherwise (specifications 4-5-6).[12]

The key variable of interest in these regressions is the interaction term between nfa and the change in VXY. Given our variable definitions, Hypothesis 2 requires a positive coefficient on this variable, implying that at times when risk aversion increases (as proxied by the change in VXY) 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 U.S. dollar.[13]

Table 6 about here

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 we move from P_1 and P_5, 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 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

[12] We also add a constant and the lagged exchange rate return as a control variable. Because of the constant term and the use of fixed effects, the interpretation of the regressions relates to how currency movements are determined relative to the average currency movement in the sample.

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

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 supporting evidence for Hypothesis 2.

TABLE 7 ABOUT HERE

6. Further Analysis

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

6.1 Asset pricing tests on other cross-sections of returns

We now explore the pricing power of the IMB factor using cross-sections of equity, bond, and commodity portfolios as test assets and present our results in Table 8. In panel A, we use the twenty-five equally weighted Fama-French global equity portfolios sorted on size and book-to-market as test assets and find that the IMB factor is priced after controlling for the Fama-French global equity factors, that is, market excess return (MKT), size (SMB), and value (HML). Both λ_{IMB} and b_{IMB} are highly statistically significant, and the pricing errors are not statistically different from zero according to the HJ test. In panel B, we repeat the exercise using the twenty-five equally weighted Fama-French global equity portfolios sorted on size and momentum as test assets and the global momentum (WML) factor in substitution of the global value factor, and find similar results.[14] In panel C, we follow Menkhoff et al. (2012) and sort international bonds of different maturities (1-3, 3-5, 5-7, 7-10, and >10 years) for 20 countries (including the United States) into 5 equally weighted portfolios depending on their redemption yield. For this exercise we collect total return indices denominated in U.S. dollars from Datastream ranging from October 1983 to June 2014. We use these portfolios as test assets and then control for an international bond factor (IBO) equivalent to buying the last bond portfolio and selling the first bond portfolio. In panel D, we have obtained from Yang (2013) seven equally weighted commodity portfolios sorted on the log difference between the twelve and one-month futures prices from October 1983 to

[14] The global equity portfolios, as well as the global equity factors, are obtained from Kenneth French's Web site and are an updated version of those used in Fama and French (2012). The portfolios sorted on size and book-to-market (momentum) range from July (November) 1990 to June 2014 and are constructed using twenty-three countries (including the United States). In Table A.18 in the Internet Appendix, we also use the twenty-five equally weighted Fama-French global equity portfolios, excluding the United States, and find qualitatively similar results.

December 2008. We use these portfolios as test assets and the commodity factor as a control variable. In panels C and D, the global imbalance risk factor is priced with comparable estimates for the price of risk, and the HJ distance measure is insignificant in both cases.

TABLE 8 ABOUT HERE

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, effectively meaning that we constrain λ_{IMB} to be equal to the mean return of the IMB factor.[15] Moreover, 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.[16]

6.2 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. To address this point, we construct a factor that captures only the information arising from nfa and a factor that summarizes only the signal coming from ldc. We 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 six portfolios, except for the subset of developed countries in which we are restricted to using only four portfolios. At the end of each month, currencies are first sorted in two baskets using nfa and then into 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), and 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 procedure for the developed countries sample.

[15] Note that if we relax this restriction and do not include the global imbalance factor as an additional test asset, results remain qualitatively similar with an estimate of λ_{IMB}, which is higher and statistically significant. For instance, we find $\lambda_{IMB} = 0.16$ for the cross-section of global equity portfolios sorted on size and book-to-market. Also, the HJ test remains statistically insignificant in all cases.

[16] The asset pricing results in Table 3 suggest 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 well.

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 a SR of 0.71 (0.28) when we consider the full set of currencies.[17]

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 slightly reflect 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.

6.3 Backfilling data for *ldc*

Recall that data for *ldc* are only available from 1990 to 2012. We 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

[17] 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.

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. The asset pricing results (reported in Table A.19 in the Internet Appendix) are also qualitatively identical to the ones reported in our core analysis. In short, the results are qualitatively identical when using a sample period that does not require backfilling the *ldc* data prior to 1990.

6.4 Further analysis

In further work, we analyze a variety of other issues. We only briefly discuss some of these exercises here. For example, we show that the IMB factor does a reasonably good job at pricing the cross-section of *individual* currency excess returns (see Table A.5 in the Internet Appendix). We also run calculations using alternative base currencies, taking the viewpoint of a British, Japanese, Euro-based, and Swiss investor; these 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).[18] We find qualitatively similar and quantitatively stronger results for a sample of countries in which, using the latest *BIS Triennial Survey* (BIS 2013), we select the developed and most liquid emerging currencies (see Tables A.11 and A.12 in the Internet Appendix). We name this sample "developed and emerging countries," which is an intermediate sample (in terms of size) between the two samples analyzed in the paper until now.

7. 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 this issue by shedding light on the *macroeconomic* forces driving currency risk premia. Motivated by the theoretical

[18] This is comforting since it makes clear that the United States does not play a key role in driving our results, which are qualitatively identical, regardless of whether the currency portfolios are dollar-neutral. Indeed, the United States 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 United States, 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").

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 pervasively priced, 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

	All countries						Developed countries					
	P_1	P_2	P_3	P_4	P_5	IMB	P_1	P_2	P_3	P_4	P_5	IMB
Mean	0.92	3.50	1.40	3.57	5.32	4.40	0.68	2.45	3.06	3.45	4.65	3.97
t-stat	[0.60]	[2.18]	[1.10]	[2.39]	[2.73]	[3.51]	[0.37]	[1.31]	[1.77]	[2.00]	[2.38]	[3.26]
Med	1.20	2.69	3.52	4.24	6.79	4.94	1.24	2.73	3.66	3.87	6.90	5.27
SD	7.80	8.71	6.52	7.92	10.05	6.43	9.90	10.25	9.33	9.06	10.29	6.76
Skew	-0.16	-0.03	-0.86	-0.48	-0.27	0.17	0.05	-0.07	-0.26	-0.16	-0.28	-0.53
Kurt	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	0.21	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		0.54	0.36	0.34	0.32	0.31	
Freq	0.03	0.04	0.04	0.04	0.03		0.02	0.02	0.02	0.02	0.03	
fd	-0.54	1.21	2.02	3.50	6.79		-1.31	-0.76	1.80	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	

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 United States (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, and the sample runs from October 1983 to June 2014.

Table 2
Time-series regressions

A. $IMB_t = \alpha + \beta CAR_t + \gamma IMB_{t-12} + \varepsilon_t$										
	All countries					Developed countries				
	α	β	γ	R^2	$F_{(\alpha,\beta)}$	α	β	γ	R^2	$F_{(\alpha,\beta)}$
IMB_t	2.30	0.41		0.30	[<0.01]	1.97	0.39		0.39	[<0.01]
	(1.00)	(0.04)				(0.92)	(0.04)			
	1.98	0.41	0.07	0.30	[<0.01]	1.83	0.39	0.04	0.39	[<0.01]
IMB_t	(0.96)	(0.05)	(0.07)			(0.91)	(0.04)	(0.04)		
B. $RX_{i,t} = \alpha + \beta CAR_t + \gamma RX_{i,t-12} + \varepsilon_t$										
P_1	2.57	-0.15		0.02		2.14	-0.16	0.03		
	(1.59)	(0.07)				(1.91)	(0.07)			
P_2	4.98	-0.11		0.01		3.64	-0.09	0.01		
	(1.72)	(0.07)				(1.97)	(0.08)			
P_3	0.84	0.15		0.03		2.78	0.20	0.06		
	(1.32)	(0.05)				(1.69)	(0.06)			
P_4	3.13	0.16		0.02		2.51	0.31	0.14		
	(1.53)	(0.05)				(1.64)	(0.07)			
P_5	4.87	0.26		0.05		4.11	0.23	0.06		
	(1.91)	(0.09)				(1.91)	(0.07)			
P_1	2.59	-0.15	-0.01	0.02		2.14	-0.16	-0.01	0.03	
	(1.60)	(0.07)	(0.05)			(1.92)	(0.07)	(0.05)		
P_2	5.00	-0.11	-0.01	0.01		3.75	-0.09	-0.05	0.01	
	(1.74)	(0.07)	(0.05)			(1.96)	(0.08)	(0.05)		
P_3	0.92	0.15	-0.06	0.04		3.00	0.20	-0.07	0.06	
	(1.29)	(0.05)	(0.06)			(1.66)	(0.06)	(0.05)		
P_4	3.25	0.16	-0.03	0.02		2.70	0.31	-0.05	0.14	
	(1.48)	(0.05)	(0.05)			(1.60)	(0.07)	(0.05)		
P_5	5.23	0.26	-0.06	0.05		4.05	0.23	0.01	0.05	
	(1.92)	(0.09)	(0.06)			(1.92)	(0.07)	(0.05)		

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 $i = 1, 2, \ldots, 5$) 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, and the sample runs from October 1983 to June 2014.

Table 3
Asset pricing tests: Currency strategies

	b_{DOL}	b_{IMB}	b_{CAR}	λ_{DOL}	λ_{IMB}	λ_{CAR}	R^2	HJ	$p-value$
A. With carry trade and global imbalance portfolios as test assets									
All countries: Oct 1983-Jun 2014	0.12	0.92^b		0.02	0.05^c		0.49	0.81	[0.19]
	0.32		0.54^b	0.02		0.05^b	0.46	0.81	[0.19]
	0.19	0.59	0.22	0.02	0.04^c	0.04^b	0.50	0.81	[0.21]
All countries: Jan 1996-Jun 2014	-0.11	1.41^c		0.02	0.08^c		0.65	0.91	[0.94]
	0.14		1.12^c	0.02		0.07^c	0.63	0.91	[0.94]
	-0.02	0.81^a	0.55	0.02	0.07^c	0.07^c	0.68	0.91	[0.94]
Developed countries: Oct 1983-Jun 2014	0.19	0.74^a		0.02	0.04^b		0.58	0.65	[0.48]
	0.22		0.34	0.02		0.05^b	0.58	0.66	[0.40]
	0.20	0.44	0.15	0.02	0.03^b	0.05^a	0.60	0.65	[0.50]
Developed countries: Jan 1996-Jun 2014	-0.12	0.75^a		0.01	0.05^b		0.52	0.80	[0.99]
	-0.01		0.40	0.01		0.05^a	0.41	0.80	[0.99]
	-0.15	1.17^b	-0.28	0.01	0.06^c	0.04	0.54	0.80	[0.99]
B. Without carry trade and global imbalance portfolios as test assets									
All countries: Oct 1983Jun 2014	0.13	0.84^b		0.02	0.04^c		0.37	0.38	[0.57]
	0.30		0.54^b	0.02		0.05^c	0.36	0.41	[0.34]
	0.16	0.67^a	0.22	0.02	0.04^c	0.04^b	0.43	0.41	[0.41]
All countries: Jan 1996-Jun 2014	-0.09	1.28^c		0.02	0.07^c		0.71	0.60	[0.90]
	0.12		1.10^c	0.02		0.07^c	0.68	0.62	[0.85]
	-0.04	0.85^b	0.55	0.02	0.07^c	0.07^c	0.77	0.62	[0.83]
Developed countries: Oct 1983-Jun 2014	0.19	0.70^a		0.02	0.04^b		0.36	0.27	[0.98]
	0.21		0.31	0.02		0.05^b	0.47	0.26	[0.95]
	0.19	0.51^a	0.12	0.02	0.04^c	0.05^b	0.47	0.28	[0.96]
Developed countries: Jan 1996-Jun 2014	-0.12	0.74^b		0.01	0.05^b		0.51	0.43	[0.99]
	0.00		0.35	0.01		0.05	0.38	0.44	[0.99]
	-0.13	1.01^b	-0.20	0.01	0.06^c	0.04	0.55	0.44	[0.99]

The table presents asset pricing results for currency strategies sorted on time $t-1$ information. 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 1-year exchange rate returns), *5 value* (sorted on the past five-year 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 premium* (sorted on the difference between the one-year lagged realized volatility and model-free implied volatility) portfolios, for a total of 9 strategies and 45 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_x, the market price of risk λ_x, and the cross-sectional R^2. a, b, and c denote statistical significance at the 10%, 5%, and 1% level, respectively, based on Newey and West (1987) standard errors with Andrews (1991) optimal lag selection. 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 and the sample runs from October 1983 (from January 1996 for *risk reversal* and the *volatility risk premium* portfolios) to June 2014. Panel A employs 45 (35) portfolios as test assets when the sample runs from October 1983 (January 1996). Panel B employs 35 (25) portfolios as test assets when the sample runs from October 1983 (January 1996) as we exclude the five *carry trade* and five *global imbalance* portfolios.

Table 4
Forward discounts and global imbalances

	Forward discount			
	(1)	(2)	(3)	(4)
nfa	-0.14	-0.08	-0.13	-0.07
	(0.04)	(0.02)	(0.04)	(0.02)
ldc	-0.22	0.09	-0.30	0.06
	(0.47)	(0.17)	(0.48)	(0.17)
Inflation differential		0.97		0.96
		(0.04)		(0.05)
			0.07	0.02
			(0.03)	(0.01)
Constant	0.30	-0.21	0.35	-0.19
	(0.25)	(0.08)	(0.27)	(0.08)
R^2	0.05	0.86	0.07	0.86

The table presents results from cross-sectional regressions of the average forward discount (or interest rate differential relative to the United States) on the average net foreign asset position to gross domestic product (nfa), share of foreign liabilities in domestic currency (ldc), inflation differential relative to the United States, output gap, and a constant. Corrected standard errors are reported in parentheses. The sample runs at a monthly frequency from October 1983 to June 2014 and refers to all countries.

Table 5
Portfolios sorted on betas

	All countries						Developed countries					
	P_1	P_2	P_3	P_4	P_5	H/L	P_1	P_2	P_3	P_4	P_5	H/L
Mean	-0.54	2.18	3.85	3.10	4.67	5.21	-1.02	3.61	2.47	2.33	4.92	5.93
t-stat	[-0.38]	[1.49]	[2.39]	[1.59]	[2.38]	[2.83]	[-0.51]	[1.80]	[1.31]	[1.40]	[2.33]	[2.76]
Med	-0.29	2.47	3.53	4.53	4.27	5.79	-1.23	3.18	5.25	3.51	6.77	6.94
SD	6.62	7.62	8.18	9.10	9.61	9.11	9.74	10.29	9.25	8.51	10.59	10.79
Skew	0.17	0.13	-0.59	-0.42	-0.43	-0.30	0.01	-0.06	-0.36	-0.26	-0.32	-0.31
Kurt	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
mdd	0.49	0.35	0.18	0.30	0.26	0.20	0.65	0.36	0.30	0.27	0.33	0.42
Freq	0.10	0.14	0.15	0.14	0.07	0.17	0.10	0.15	0.13	0.10	0.04	0.14
nfa	0.45	-0.03	-0.02	-0.11	-0.41		0.47	0.28	-0.04	-0.18	-0.49	
ldc	0.53	0.50	0.48	0.46	0.41		0.57	0.49	0.47	0.46	0.46	
Pre-fd	-0.36	0.55	2.13	2.60	4.30		-1.53	-0.02	0.89	1.45	3.04	
Post-fd	-0.35	0.56	2.11	2.59	4.24		-1.51	0.00	0.84	1.43	3.04	
Pre-β	-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)	
Post-β	-0.06	0.03	0.28	0.46	0.69		-0.29	0.13	0.30	0.35	0.82	
	(0.08)	(0.09)	(0.12)	(0.15)	(0.13)		(0.09)	(0.12)	(0.10)	(0.09)	(0.10)	

The table presents descriptive statistics of β-sorted currency portfolios. Each β is obtained by regressing individual currency excess returns on the global imbalance risk factor using a thirty-six-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, and 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 postformation forward discount or interest rate differential relative to the United States (fd), the preformation βs (with standard deviations in parentheses), and the postformation βs (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 portfolios are rebalanced monthly and the sample runs from October 1983 to June 2014.

Table 6
Determinants of spot exchange rate returns

	Nominal exchange rate returns					
	(1)	(2)	(3)	(4)	(5)	(6)
nfa (lagged 12 months)	0.03	0.02	0.04	-0.09	-0.11	-0.09
	(0.09)	(0.09)	(0.09)	(0.11)	(0.10)	(0.10)
ΔVXY	-0.54	-0.54	-0.53			
	(0.07)	(0.07)	(0.09)			
$\Delta VXY \times$ nfa (lagged 12 months)	0.27	0.27	0.26			
	(0.07)	(0.07)	(0.07)			
ldc (lagged 12 months)		0.29	0.02		0.56	0.38
		(0.33)	(0.29)		(0.35)	(0.31)
fd (lagged 1 month)			-0.01			-0.01
			(0.01)			(0.01)
$\Delta VXY \times$ fd (lagged 1 month)			-0.01			
			(0.01)			
ΔVXY dummy				-1.20	-1.20	-1.11
				(0.22)	(0.22)	(0.24)
ΔVXY dummy $\times$ nfa (lagged 12 months)				0.68	0.68	0.62
				(0.19)	(0.19)	(0.18)
ΔVXY dummy $\times$ fd (lagged 1 month)						-0.01
						(0.01)
Constant and lagged exchange rate returns	YES	YES	YES	YES	YES	YES
R^2	0.06	0.06	0.06	0.02	0.02	0.03
Observations	7,568	7,568	7,568	7,568	7,568	7,568

The table presents results are 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 U.S. 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 United States (fd), the monthly change in JP Morgan's VXY index (ΔVXY), and a dummy variable that equals one if ΔVXY is greater than one standard deviation as estimated across the entire sample, and zero otherwise (ΔVXY $dummy$). The VXY tracks aggregate implied volatility in foreign exchange markets. Robust standard errors are clustered at the country level and are reported in parentheses. The sample runs at monthly frequency from June 1992 to June 2014.

Table 7
Risk-bearing capacity and global imbalance portfolios

	P_1	P_2	P_3	P_4	P_5
A. Currency excess returns					
ΔVXY	-0.09	-0.19	-0.69	-0.60	-0.71
	(0.21)	(0.19)	(0.16)	(0.23)	(0.18)
Constant	0.01	0.22	0.06	0.32	0.41
	(0.13)	(0.13)	(0.13)	(0.14)	(0.18)
R^2	0.00	0.01	0.14	0.08	0.08
B. Spot exchange rate returns					
ΔVXY	-0.07	-0.18	-0.68	-0.59	-0.71
	(0.22)	(0.19)	(0.16)	(0.22)	(0.18)
Constant	0.01	0.08	-0.10	0.03	-0.26
	(0.13)	(0.13)	(0.13)	(0.15)	(0.18)
R^2	0.00	0.01	0.14	0.08	0.08

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 at monthly frequency from June 1992 to June 2014 and refers to all countries.

Table 8
Asset pricing tests: Equity, bond, and commodity strategies

A. Size and book-to-market global portfolios								
	DOL	IMB	MKT	SMB	HML	R^2	HJ	*p-value*
b_x	0.18	0.88^c	0.16	0.60^a	0.85^c	0.62	0.63	[0.67]
λ_x	0.04^b	0.06^c	0.07^b	0.03	0.06^b			
B. Size and momentum global portfolios								
	DOL	IMB	MKT	SMB	WML	R^2	HJ	*p-value*
b_x	1.29^b	0.86^b	-0.04	0.71	0.40	0.64	0.56	[0.83]
λ_x	0.08^c	0.06^c	0.09^c	0.06^c	0.08^b			
C. International bond portfolios								
	DOL	IMB	BFA			R^2	HJ	*p-value*
b_x	0.01	0.99^c	2.46^c			0.94	0.12	[0.54]
λ_x	0.02	0.05^c	0.07^c					
D. Commodity portfolios								
	DOL	IMB	COM			R^2	HJ	*p-value*
b_x	0.53	0.85^b	0.21^b			0.69	0.08	[0.91]
λ_x	0.04	0.05^c	0.12^b					

The table presents asset pricing results for international equity, international bond, and commodity strategies. The test assets include the twenty-five equally weighted global equity portfolios formed on size and book-to-market (momentum) from Fama and French (2012) in panel A (B), the five equally weighted international bond portfolios sorted on the redemption yields from Menkhoff et al. (2012) in panel C, and the seven equally weighted commodity portfolios sorted on the log difference between the twelve-month and one-month futures prices from Yang (2013) in panel D. The risk factors include the dollar factor (DOL), global imbalance factor (IMB), the Fama-French global factors (MKT, SMB, HML, and WML), the high-minus-low international bond factor (IBO), and the high-minus-low commodity factor (COM). We report first-stage GMM estimates of the factor loadings b_x, the market price of risk λ_x, and the cross-sectional R^2. a, b, and c denote statistical significance at the 10%, 5%, and 1% level, respectively, based on Newey and West (1987) standard errors with Andrews (1991) optimal lag selection. 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 not adjusted for transaction costs (except for DOL and IMB).

Figure 1
Construction of the global imbalance risk factor

	Low 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%)

This figure describes the construction of the global imbalance (IMB) risk factor. At the end of each month, currencies are first grouped into two baskets using the median value of the net foreign asset to GDP ratio (nfa) and then into three 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), and 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.

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