Debtor carry[*]

Jonas N. Eriksen[**]
Aarhus University, DFI

Mads M. Kjær[†]
Aarhus University, DFI

This version: December 14, 2023

[*]We thank Pasquale Della Corte and seminar participants at Aarhus University for helpful comments and suggestions. Jonas N. Eriksen acknowledges support from the Danish Council of Independent Research (DFF 7024–00020B). Mads M. Kjær acknowledges support from the Danish Council of Independent Research (DFF 2033–00137B).

[**]Department of Economics and Business Economics, Aarhus University, Fuglesangs Allé 4, DK-8210 Aarhus V, Denmark, and the Danish Finance Institute. Email: jeriksen@econ.au.dk.

[†]Department of Economics and Business Economics, Aarhus University, Fuglesangs Allé 4, DK-8210 Aarhus V, Denmark, and the Danish Finance Institute. Email: mads.markvart@econ.au.dk. Corresponding author.

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Abstract

The traditional carry trade is long debtor currencies with high interest rates and short creditor currencies with low interest rates. We show that this debtor-creditor mismatch accounts for the carry trade's crash risk, but not its risk premium. We empirically demonstrate this with a novel debtor carry strategy that buys debtor currencies with high interest rates and sells debtor currencies with low interest rates. This strategy earns high expected returns that are unspanned by existing currency factors and is free from crash risk. Debtor carry is priced in the cross-section of currency returns with a risk price that remains stable across diverse cross-sections of test assets and when controlling for the currency zoo. We find that part of debtor carry returns are related to the currency composition of debt and dollar risk.

Keywords: Carry trade, debtor currencies, crash risk, currency premia

JEL Classification: F31, F34, F37, G12, G15

This version: December 14, 2023

1. Introduction

The carry trade is one of the most popular trading strategies in the foreign exchange (FX) market. The carry trade is a simple strategy designed to exploit uncovered interest parity violations by investing in currencies with high interest rates (investment currencies) and borrowing in currencies with low interest rates (funding currencies) that has remained profitable even post-publication (Bartram, Djuranovik, Garratt, and Xu, 2023). A rich literature has associated these high returns with risk-based explanations such as global crash (skewness) risk (Brunnermeier, Nagel, and Pedersen, 2008, Rafferty, 2012, Jurek, 2014, Chernov, Graveline, and Zviadadze, 2018), volatility risk (Menkhoff, Sarno, Schmeling, and Schrimpf, 2012a), liquidity risk (Karnaukh, Ranaldo, and Söderlind, 2015), and external imbalances in net foreign assets (Della Corte, Riddiough, and Sarno, 2016).

In this paper, we focus on a previously unexplored observation: the carry trade buys high interest rate debtor currencies and sells low interest rate creditor currencies. We document this property empirically in a sample of G10 currencies and highlight that interest rates and indebtedness are negatively correlated in the data. We show that this debtor-creditor mismatch accounts for the crash risk in the carry trade, but not for the risk premium. We establish this result in two steps. We first demonstrate that debtor and creditor currencies have fundamentally different risk-return properties. While debtor currencies are negatively skewed and load negatively on volatility innovations, creditor currencies are positively skewed and exposed to volatility innovations. The standard carry trade, as a result, is significantly exposed to crash risk. We then introduce the debtor carry strategy: a carry trade among debtor countries only. The debtor carry strategy buys (sells) debtor currencies with high (low) interest rates, which eliminates the mismatch. We find that debtor carry delivers average excess currency returns that are comparable to the standard carry but without crash risk. This is a puzzling observation that provides a challenge to theories of carry trade risk premia that rely on crash risk, volatility risk, and imbalances in external asset positions. However, our results echo Jurek (2014) who suggests a modest role for crash risk in rationalizing carry trade returns.

We then turn to an investigation of the risk-return properties of debtor carry to understand its risk premium and compare it to the standard carry. As a first step, we verify that debtor carry alleviates crash risk by studying its behavior across volatility regimes. The traditional carry trade is exposed to crash risk when carry trade investors unwind their positions in turbulent times (Brunnermeier et al., 2008, Chernov et al., 2018). External imbalance theory additionally suggests that carry crashes are caused by changes in creditors' risk-bearing capacity (Gabaix and Maggiori, 2015). Consistent with this idea, Menkhoff, Sarno, Schmeling, and Schrimpf (2012b) document that the carry trade suffers during periods of high FX market volatility, i.e., periods with turmoil and low risk-bearing capacity in international financial markets. The different risk-return properties of debtor and creditor currencies amplify this mechanism through the debtor-creditor mismatch embedded in the carry trade. Consequently, the debtor carry should be less sensitive to volatility shocks than the traditional carry. Standard finance theory would suggest that debtor carry should earn lower returns than standard carry in low-volatility states, but significantly higher returns in high-volatility states. We confirm this pattern empirically: debtor carry strongly outperforms the traditional carry during high volatility states, but not during low volatility states. This result is consistent with the debtor-creditor mismatch being a significant source of crash risk in the traditional carry trade.

We then address the high returns to debtor carry, which are puzzling given the lower crash risk in the strategy. To gauge the sources of debtor carry returns, we first decompose debtor carry into two component: (i) a pure mismatch strategy that buys debtor currencies with high interest rates and sells creditor currencies with low interest rate (a debtor-creditor carry) and (ii) a portfolio that tracks the difference in funding currencies between the debtor-creditor carry and the debtor carry. This decomposition allows us to reinterpret debtor carry as the sum of two long-short portfolios that both embed a debtor-creditor mismatch, but in different ways. We find that debtor carry's two components have positive dollar factor sensitivities but off-setting sensitivities towards volatility risk. The former observation points to dollar risk being a potential source of debtor carry's excess returns as the differential exposures together imply that the debtor carry loads strongly on the dollar factor of Lustig, Roussanov, and Verdelhan (2011). The latter observation explains why debtor carry is crash risk neutral, but seems puzzling when compared to the model of Gabaix and Maggiori (2015) that predicts that sensitivity to risk-bearing capacity shocks should be increasing in a currency's indebtedness. That is, we would expect debtor-creditor carry to carry a higher exposure to volatility innovations than the portfolio that tracks the difference in funding currencies. The existing literature has demonstrated that US-dollar-denominated assets are considered safe assets (Jiang, Krishnamurthy, and Lustig, 2021, 2023) and that investors "flight-to-dollar" assets during periods of market stress. Accordingly, we examine the capital flows of global investors into the bonds of low- and high-interest-rate debtors. While high interest rate debtor currencies' net capital flow is virtually unaffected by volatility innovations, debtor currencies with low interest rates experience a net outflow during periods of heightened volatility innovations. This observation is consistent with global investors' selling low interest rate debtor currencies' bonds during periods of market stress. This selling pressure implicitly sells the currency of low interest rate debtor currencies and alleviates the effect of the high interest rate debtor currencies' higher indebtedness and crash risk.

Dollar risk exposure is a potential source for debtor carry returns. We shine a light on this channel by examining the average debt composition across the debtor carry portfolios. Consistent with the original sin paradox (Eichengreen and Hausmann, 1999, Bertaut, Bruno, and Shin, 2022), low interest rate debtor currencies tend to issue debt in their local currency, whereas high interest rate debtor currencies tend to issue debt in dollars. That being the case, the debtor carry is, on average, long US dollar debtors and short local currency debtors. The long position in US dollar debtors makes the debtor carry sensitive to dollar debt risk, i.e., US dollar-denominated net external debt. Wiriadinata (2021) provide empirical evidence by showing that the real value of dollar debt increases, weakening the currencies of countries with large amounts of dollar debt when the US dollar strengthens. We explore the role of dollar debt and funding risk in the debtor carry strategy by examining its exposure to dollar, funding, liquidity, and monetary policy risk. We show that part of the high returns to detor carry can be viewed as compensation for dollar debt risk. For example, we find that the debtor carry is strongly related to dollar risk, funding risk (as measured by the TED spred), and monetary policy shocks. Consequently, the risk premium associated with debtor carry can partly, but not fully, be rationalized through the debtor carry's exposure to dollar debt and funding risk in international financial markets.

The sizable risk premium observed for debtor carry suggests that it is a priced risk factor in the cross-section of currency returns. Moreover, the puzzling observation that debtor carry delivers a risk premium of similar magnitude as the traditional carry trade while being neutral to crash risk suggests that debtor carry may be a distinct currency strategy that requires a separate risk factor. We examine the pricing ability of debtor carry in three steps. We first consider traditional regression-based mean-variance spanning tests in the spirit of Huberman and Kandel (1987) using a wide selection of risk factors from the extant literature. We follow Nucera, Sarno, and Zinna (2023) and consider a broad set of currency portfolios that are associated with popular trading strategies in FX markets including standard carry (Lustig et al., 2011, Menkhoff et al., 2012a), short- and long-term momentum (Asness, Moskowitz, and Pedersen, 2013, Menkhoff et al., 2012b), currency value (Asness et al., 2013, Menkhoff, Sarno, Schmeling, and Schrimpf, 2017), global imbalances (Della Corte et al., 2016), term spreads (Bekaert, Wei, and Xing, 2007, Lustig, Stathopoulos, and Verdelhan, 2019), long-term yields (Ang and Chen, 2010), orthogonalized carry (Barroso, Kho, Rouxelin, and Yang, 2018), and output gaps (Colacito, Riddiough, and Sarno, 2020). The results are clear: none of the existing currency factors fully span debtor carry and none can explain more than 50% of the excess returns to debtor carry, implying that debtor carry is a distinct currency strategy that is not spanned by existing currency factors.

We then turn to cross-sectional asset pricing tests to gauge the price of risk of debtor carry when controlling for existing factors. We first estimate the price of risk of debtor carry using traditional Fama and MacBeth (1973) regressions in four different cross-sections using a diverse set of currency portfolios. Using different cross-sections with diverse sets of test assets ensures that we get a better view of the price of risk (Giglio, Xiu, and Zhang, 2023). We find that debtor carry is a priced risk factor in the cross-section of currency returns in all four cross-sections with a remarkably stable price of risk estimate. Moreover, a two-factor model that includes the dollar factor and debtor carry can explain more than 50% of cross-sectional variation in the full cross-section of 45 currency portfolios.

While Fama and MacBeth (1973) have long been a standard workhorse in asset pricing and have been used to establish risk prices in the currency return literature at least since Lustig and Verdelhan (2007), it can suffer from omitted variable bias Giglio and Xiu (2021). Using a variant of this framework, Nucera et al. (2023) show that many currency risk factors do not have significant risk prices when controlling for a large set of existing currency factors. As a final component of our asset pricing tests, we turn to the three-pass approach of Giglio and Xiu (2021). We find strong evidence that debtor carry carries a positive and significant price of risk, even when controlling for the currency zoo, and that we can strongly reject the null hypothesis that debtor carry is a weak factor in the cross-section. In sum, debtor carry carries important important about cross-sectional variation in currency returns that complements that contained in existing currency factors.

Our empirical results add to a vibrant literature that investigates currency excess returns. First, our work is related to a large literature that studies risk-based explanations for carry trade returns (Lustig and Verdelhan, 2007, Burnside, Eichenbaum, Kleshchelski, and Rebelo, 2011, Lustig et al., 2011, Menkhoff et al., 2012a, Bakshi and Panayotov, 2013, Della Corte et al., 2016, Ready, Roussanov, and Ward, 2017, Zviadadze, 2017, Lustig et al., 2019). Most closely related to ours are studies that examine global crash (skewness) risk as a rationalization of carry trade returns (Brunnermeier et al., 2008, Rafferty, 2012, Jurek, 2014, Chernov et al., 2018). We contribute to this literature by documenting that the crash risk in carry trades originates from a debtor-creditor mismatch inherent to the strategy. The mismatch, however, does not explain the high returns to the carry trade as a carry trade implemented among debtor currencies is equally profitable but without crash risk. As such, our results contrast papers that attribute carry trade returns to crash risk but echo the findings of Jurek (2014) in that crash risk only accounts for a modest part of the carry trade's risk premium.

Second, our paper is also related to the literature on external imbalances and currency risk premia (Sarno and Schmeling, 2014, Gabaix and Maggiori, 2015, Della Corte et al., 2016, Barroso et al., 2018). For example, Barroso et al. (2018) also notes that average interest rates have a strong correlation with average external imbalances in the cross-section of currencies. However, our empirical results differ from theirs in that we focus on the debtor-creditor mismatch inherent to the carry trade and develop the debtor carry strategy that can be implemented in real-time, whereas they consider forward discounts that have been orthogonalized to external imbalance data and construct an orthogonalized carry trade (ORCAR) based on the orthogonalized forward discount. Although both papers address the relation between external imbalances and interest rates, we do so from different angles and debtor carry is unspanned by ORCAR.

Third, our paper is also related to a large literature that studies dollar risk in international financial markets. Bruno and Shin (2015) and Avdjiev, Du, Koch, and Shin (2019), Bruno and Shin (2023), and Niepmann and Schmidt-Eisenlohr (2023) demonstrate that the US dollar has attributes of a barometer of dollar credit conditions, with a stronger dollar associated with tighter dollar credit conditions. Jiang et al. (2021), Camanho, Hau, and Rey (2022), and Jiang et al. (2023) all point to the US dollar playing a prominent role due to demand for safe dollar-denominated assets. We add to this literature by showing that dollar debt risk can partly explain the returns to debtor carry as the strategy is long US dollar debtors and short local currency debtors. In sum, our paper provides new insights into the risk-return properties of the carry trade and offers a new strategy that provides a challenge for existing models and theories.

The remainder of the paper proceeds as follows. Section 2 heuristically motivates our work by documenting fundamental differences in the risk-return properties of debtor and creditor currencies. Section 3 describes the data used in the empirical analysis. Section 4 presents our main empirical results for debtor carry and its properties. Section 5 examines the pricing ability of debtor carry in the cross-section of currency returns. Section 6 provides concluding remarks.

2. Creditors and debtors

The currency carry trade buys high interest rate debtor currencies and sells low interest rate creditor currencies. Figure 1 illustrates this observation empirically by plotting average net foreign debt assets (scaled by GDP) for five equal-sized carry trade portfolios sorted on forward discounts. Average interest rates and external debt positions are highly correlated in the data: funding currencies are, on average, creditors with low interest rates and investment currencies are debtors with high interest rates. While this relationship seems intuitive, it is not mechanical. The carry trade is based on short-term interest rates (or forward discounts) and uncovered interest parity (UIP) violations, which is different from external debt positions. The framework proposed by Gabaix and Maggiori (2015) suggests that the carry trade exhibits a higher sensitivity to changes in the risk-bearing capacity of global financiers if creditors currencies have lower interest rates than debtors currencies, a pattern that we verify empirically in the data as illustrated in Figure 1. A shock to volatility and available liquidity that decreases the risk-bearing capacity of global financiers will, therefore, lead to creditor exchange rates appreciating against debtor exchange rates. Given the debtor-creditor mismatch inherent in the currency carry trade, this mechanism leads to a crash in the carry trade (see also Brunnermeier et al. (2008) and Chernov et al. (2018)).

[Insert Figure 1 About Here]

Figure 1 corroborates this point by including factor loadings for the five carry trade portfolios on global FX volatility risk (Menkhoff et al., 2012a) estimated from the regression

$$RX_{j,t} = a_j + b_j VOL_t^{FX} + c_j DOL_t + \varepsilon_{j,t}, \tag{1}$$

where $RX_{j,t}$ is the excess return on carry portfolio j at time t, VOL_t^{FX} denotes global FX volatility innovations, and DOL_t is the dollar factor.[1] Low interest rate currencies

[1] We estimate global FX volatility innovations from an AR(1) model for FX volatility computed as $\sigma_t^{FX} = \frac{1}{T_t}\sum_{t \in T_t}\left[\sum_{k \in K_\tau}\left(\frac{RX_{k,\tau}^2}{K_\tau}\right)\right]$, where $RX_{k,\tau}$ is the excess return on currency k at day τ, K_τ is the

have positive loadings on global FX volatility, while high interest rate currencies have negative loadings, which is consistent with a risk-based view of the carry trade. That is, the carry trade is prone to crashes in turbulent times because creditor currencies strongly outperform debtor currencies. These higher creditor currencies returns are consistent with safe-haven effects in currency markets (Ranaldo and Söderlind, 2010), whereas the negative returns to debtor currencies are consistent with the need to raise interest rates to attract funding capital, which is associated with a future depreciation of the exchange rate such that UIP holds (Brunnermeier et al., 2008).

[Insert Table 1 About Here]

These observations imply fundamentally different risk-return properties of debtor and creditor currencies. Table 1 reports descriptive statistics and factor loadings for global FX volatility risk for equal-weighted portfolios of debtor and creditor currencies from January 1985 to December 2020. The debtor portfolio has a mean annualized excess return of 2.77%, whereas the creditor portfolio has a mean annualized excess return of 1.03%. The remaining descriptive statistics demonstrate that these higher excess returns are driven by debtor currencies performing poorly in bad times. The debtor portfolio is negatively skewed and has a factor loading of -0.89 (t-stat of -7.52) for volatility risk: debtor currencies suffer in turbulent times. Creditor currencies, on the other hand, have a positive skewness and a factor loading of 1.61 (t-stat of 5.53) for volatility risk: creditor currencies act as a hedge against turbulent times. This is consistent with the debtor-creditor mismatch being a source of crash risk in the carry trade, which is corroborated by the long-short portfolio (Difference) that buys debtor currencies and sells creditor currencies. The long-short portfolio has an annualized excess return of 1.74% and a factor loading of -2.50 (t-stat of -6.44) for volatility risk. In sum, the distinct risk-return characteristics of debtor and creditor currencies, coupled with the inherent debtor-creditor mismatch in the carry trade, is a source of crash risk in the carry trade.

set of currencies available at time τ, and T_t is the number of trading days in month t. In contrast to Menkhoff et al. (2012a), we take the square daily returns instead of the absolute value as we are working with a set of liquid currencies. The results are similar if we use the original definition in Menkhoff et al. (2012a).

How does this debtor-creditor mismatch affect the pricing of the carry trade? The above results demonstrate that they may drive crash risk, but what about the risk premium? To investigate these questions, we construct a carry trade based only on debtor currencies: the debtor carry. We show that debtor carry is a highly profitable investment strategy that alleviates the crash risk tendency otherwise associated with the carry trade. Moreover, we find that debtor carry is priced in the cross-section of currency return, commands a significant price of risk in multiple tests, and survives in spanning tests using a long list of established currency risk factors. In sum, eliminating the debtor-creditor mismatch alleviates crash risk but does not eliminate the risk premium associated with the carry trade. Explaining the excess returns to debtor carry, therefore, becomes an even bigger challenge for standard asset pricing models.

3. Data and variable construction

This section provides an overview of data sources for currencies and external debt positions. We then describe the construction of currency excess returns, external debt positions, and currency portfolios.

3.1. Currency excess returns

We collect end-of-month spot and one-month forward exchange rates from Barclay's and Thomson Reuters from 1985 to 2020 for the G10 currencies: the Australian dollar (AUD), Canadian Dollar (CAD), Swiss Franch (CHF), the Euro (EUR), Japanese Yen (JPY), Norwegian Krone (NOK), Swedish Krona (SEK), New Zealand Dollar (NZD), British Pound (GBP), and US Dollar (USD). We use the Deutsche Mark (DEM) exchange rates for Germany before the introduction of the Euro in 1999. Exchange rates are defined as the US dollar (USD) price per unit of foreign currency such that an increase corresponds to an appreciation of the foreign currency. These currencies represent the most traded and liquid currencies in FX markets (Karnaukh et al., 2015, BIS, 2022).

Let $S_{k,t}$ and $F_{k,t}$ denote the spot exchange rate and one-month forward exchange rate for currency k at time t, respectively. The excess return to buying foreign currency in the forward market and selling it in the spot market at time $t+1$ is

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

which is equivalent to the spot exchange rate change less the forward premium. Under the covered interest parity (CIP), the forward premium equals interest rate differentials.

[Insert Table 2 About Here]

Panel A of Table 2 presents descriptive statistics for currency excess returns for our sample. All currencies have positive mean returns ranging from 0.11% (Euro) to 5.58 (New Zealand). The highest currency excess returns are generally observed among standard carry trade investment currencies such as New Zealand, Australia, and Norway. The majority of the currencies display negative skewness except for Japan and Switzerland, which are typical funding currencies in the carry trade and currencies often associated with safe-haven properties and creditor countries in international debt markets.

3.2. External asset and liabilities

We gauge the indebtedness of a country using *The External Wealth of Nations* (EWN) database of Lane and Milesi-Ferretti (2004, 2007, 2018), which provides annual end-of-year estimates of each country's external financial assets and liabilities.[2] For each currency, we measure indebtedness from their net external debt positions (net debt) as a percentage of GDP, which we define as end-of-year foreign debt assets minus foreign debt liabilities scaled by the nation's GDP (measured in dollars). We classify a currency as a debtor (creditor) currency if its net debt is negative (positive). For the empirical analysis, we construct monthly observations by keeping end-of-period data constant until a new observation becomes available, as in Della Corte et al. (2016). We implement a conservative lag of one year in the data that takes into account that the dataset is published with a lag (the previous year's observation is usually first available during the last quarter of this year) to

[2] Available at https://www.brookings.edu/articles/the-external-wealth-of-nations-database/.

address concerns of look-ahead bias in the portfolio construction.[3] We focus on net debt positions to capture the funding risk of a currency's external debt position. We find in unreported results that the empirical results are similar, but less strong if we consider the entire external balance sheet of the countries instead of only focusing on net debt assets (as is common in the external balance literature, e.g., Della Corte et al. (2016)).

[Insert Figure 2 About Here]

Panel B of Table 2 reports mean net debt positions from our sample of currencies and Figure 2 displays the development of debtor and creditor currencies over time. Japan and Switzerland are creditor currencies throughout our sample periods, whereas Australia, Canada, New Zealand, Sweden, and the United Kingdom are consistent debtor currencies. The remaining currencies have switched status at least once during our sample. The number of debtor (creditor) currencies has decreased (increased) during our sample period.

3.3. Currency composition of net debt

We also construct a measure of the currency composition of a country's external debt position using the end-of-year cross-border currency exposure dataset from Bénétrix, Gautam, Juvenal, and Schmitz (2019), who update (and improve) the data from Lane and Shambaugh (2010) and Bénétrix, Lane, and Shambaugh (2015).[4] Specifically, we consider the difference between net debt assets that are denominated in local currency and US dollars to distinguish local currency and dollar debtor currencies. The data is available from 1990 to 2017 and we construct monthly observations by keeping end-of-period data constant until a new observation becomes available. Panel B of Table 2 reports the mean currency composition of net debt assets for our sample of currencies. Debtor currencies such as Australia, New Zealand, and Sweden have a higher proportion of their net debt assets denominated in local currency, whereas Canada and the United Kingdom are dollar debtors. Last, we also collect the proportions of external liabilities denominated in

[3] As an example, this implies that we assume that the 2020 end-of-year observation is first available to investors in January 2022. This is a conservative choice, but since the sign of the net foreign debt position is persistent, it has no material effect on the empirical results.

[4] The data is available from the website of Agustín Bénétrix: https://agustinbenetrix.org.

local currency (lcd) from Bénétrix et al. (2019) to construct global imbalance portfolios following Della Corte et al. (2016).

3.4. Additional currency portfolios

We follow Nucera et al. (2023) and construct a broad menu of currency portfolios that are associated with popular trading strategies in FX markets from the existing literature to use as test assets in our empirical asset pricing tests. The portfolios are re-balanced every month and are equal-weighted and equal-sized, unless otherwise explicitly stated in the descriptions below.

3.4.1. Carry We construct standard carry portfolios following Lustig et al. (2011), Menkhoff et al. (2012a). At the end of each month t, we sort currencies into five equal-sized and -weighted portfolios based on their forward discount. Portfolio 1 (P1) contains currencies with the lowest forward discounts (interest rates) and Portfolio 5 (P5) contains currencies with the highest forward discounts (interest rates).

3.4.2. Momentum We construct short-term and long-term momentum portfolios following, e.g., Menkhoff et al. (2012b) and Asness et al. (2013). Specifically, at the end of each month t we sort currencies into five equal-sized and -weighted portfolios based on their past 3-months (short-term) and 12-months (long-term) returns. Portfolio 1 (P1) contains currencies with the lowest past returns and Portfolio 5 (P5) contains currencies with the highest past returns.

3.4.3. Global Imbalances We construct global imbalance portfolios following Della Corte et al. (2016). We first classify currencies into two groups based on the median net foreign asset position (nfa), defined as end-of-year foreign debt assets minus foreign debt liabilities scaled by the nation's GDP (measured in dollars). We then sort currencies within each group based on their proportion of debt denominated in their own currency (lcd). We then form six portfolios based on the two groups. We use the 40th and 80th percentiles as breakpoints for low nfa countries and the 20th and 60th percentile for high

nfa countries. The low nfa, high ldc and high nfa, low lcd portfolios are then combined into a single portfolio using equal weights.

3.4.4. Othogonalized carry We follow the description in Barroso et al. (2018) and orthogonalize the carry signals with respect to nfa and lcd. Specifically, we first regress the forward discount for each currency k on the global imbalance indicator, nfa_k and lcd_k

$$fd_{k,t} = b_{k,0} + b_{k,nfa} nfa_{k,t} + b_{k,lcd} lcd_{k,t} + \varepsilon_{k,t}, \tag{3}$$

where lcd and nfa are standardized in the cross-sectional dimension. P1 (P5) contains currencies with the lowest (highest) orthogonalized carry signals.

3.4.5. Value At the end of each month t, we follow Asness et al. (2013), Kroencke, Schindler, and Schrimpf (2014), Menkhoff et al. (2017) and allocate currencies to portfolios based on the deviations from the relative purchasing power parity (PPP) obtained from the OECD database. P1 contains overvalued currencies and P5 contains undervalued currencies.

3.4.6. Term spread and long-term yields We collect short-term (3-months) and long-term (10-year) interest rates from the OECD database. We then follow Ang and Chen (2010) and sort currencies into portfolios based on the spread between long-term and short-term interest rates (their term spread). We also form five currency portfolios based on long-term yield differentials as in Bekaert et al. (2007), which captures departures from uncovered interest rate parity at the longer end of the term structure of interest rates.

3.4.7. Output gap We follow Colacito et al. (2020) and form five portfolios based on output gaps (a measure of the relative strength of the business cycle). At the end of each month, we sort currencies on differences between the output gap of currency k and the US output gap, where the output gap is defined as the deviation of industrial production from its trend estimated using the projection method of Hamilton (2018). Industrial production data are obtained from the OECD database.

4. Debtor carry

This section introduces debtor carry, discusses its construction from double-sorted currency portfolios based on net debt positions and forward discounts, and studies its risk-return characteristics. Specifically, we examine its performance and discuss its relation to the currency decomposition of debt, capital flows, and dollar debt risk.

4.1. Portfolio formation and returns

We begin by examining the relationship between the debtor-creditor mismatch and the carry trade using a dependent portfolio sort in which we first sort currencies into debtor and creditor currencies based on the net debt positions. Debtor (creditor) currencies have negative (positive) net debt positions. We then subsequently sort debtor (creditor) currencies into three (two) equal-sized portfolios based on their forward discount. The choice of a smaller number of portfolios for creditor currencies reflects the lower number of creditor currencies throughout the sample period.

[Insert Figure 3 About Here]

Figure 3 illustrates the portfolio construction. The debtor (creditor) portfolios are denoted P1-P3 (P4-P5). The debtor carry strategy is a carry strategy implemented among debtor currencies that buys debtor currencies with high interest rates (P3) and sells debtor currencies with low interest (P1). This strategy, denoted P3–P1, eliminates the debtor-creditor mismatch in the traditional carry trade, which allows us to examine whether the traditional carry trade is driven by the mismatch or interest rates. We also construct a debitor-creditor carry trade that buys debtor currencies with high interest rates (P3) and sells creditor currencies with low interest rates (P4). This strategy, denoted P3–P4, represents a pure debitor-creditor mismatch. While it is in principle also possible to construct a creditor carry strategy (P5-P4), the lower number of creditor currencies and their special status as safe-haven currencies make it less interesting to study. Most importantly, the creditor carry strategy remains exposed to skewness and crash risk because it is short low interest rate creditor currencies.

[Insert Table 3 About Here]

Table 3 presents summary statistics for the tre debtor portfolios and two creditor portfolios sorted on forward discounts together with debtor carry (P3–P1), debtor-creditor carry (P3–P4), traditional carry, and the dollar factor. Excess returns are monotonically increasing in interest rates among debtor countries (P1 to P3). The same observation holds true, although less pronounced, for creditor countries. The debtor carry (P3–P1) has an annualized average excess return of 5.91 (t-stat of 4.20) in our sample, which is slightly larger than the debtor-creditor carry (P3–P4) that has an average excess return of 5.87 (t-stat of 2.79) and the traditional carry trade with an average excess return of 5.42 (t-stat of 2.95). Moreover, debtor carry has an annualized Sharpe ratio of 0.68 compared to 0.49 and 0.51 for debitor-creditor and traditional carry, respectively. Most strikingly, however, debtor carry has positive skewness, suggesting that crash risk is eliminated in the strategy and is not a source of debtor carry returns. Debitor-creditor carry and traditional carry, on the other hand, display highly negatively skewed excess returns. Viewed in this light, it becomes puzzling why debtor carry remains as profitable as the traditional carry trade when crash risk has been eliminated. Adding to this puzzle, we notice that debtor carry has significantly lower drawdowns compared to the competing currency strategies. For example, debtor carry has a maximum drawdown of 22.37% compared to 37.31% and 35.10% for debtor-creditor carry and traditional carry, respectively. Interestingly, the strategies are also less than perfectly correlated with each other. Debtor carry has a correlation of 0.69 with the traditional carry trade and 0.56 with the debtor-creditor carry. Debitor-creditor carry has a correlation of 0.91 with the traditional carry trade, suggesting again that the traditional carry trade is characterized by a debtor-creditor mismatch.

[Insert Figure 4 About Here]

Figure 4 plots the cumulative excess returns of the three carry strategies over time. The figure corroborates the main conclusion from the summary statistics: debtor carry is remarkably stable and does not display the same crash risk tendency as the other carry strategies. For example, the traditional carry trade experiences significant losses in the mid-to-late eighties, early nineties, and during the Great Financial Crisis. While the debtor-creditor carry trade experiences similar drawdowns, the debtor carry trade does not. The reduced crash risk in the debtor carry strategy clearly suggests that the traditional carry's crash risk behavior is related to the debtor-creditor mismatch inherent in the strategy. Next, we try to understand the differences between traditional carry and debtor carry across different states of economic turbulence.

4.2. Carry strategies and volatility

The traditional currency carry trade is sensitive to crash risk during periods of significant market stress when carry trade investors unwind their positions. One popular explanation for the high returns to the carry trade is, therefore, that investors require compensation for crash risk (Brunnermeier et al., 2008, Rafferty, 2012, Chernov et al., 2018). This observation is theoretically motivated in, for instance, the equilibrium model of Gabaix and Maggiori (2015) in which the carry trade is sensitive to risk-bearing capacity shocks of global financiers. In another framework, Brunnermeier and Pedersen (2009) show that investors can be forced to unwind their trading positions when reaching their liquidity constraints. This can generate a "liquidity spiral" that directly leads to a crash in the carry trade (Brunnermeier et al., 2008). Empirically, Menkhoff et al. (2012b) demonstrates that the carry trade suffers during periods of high FX market volatility, i.e., periods with turmoil and low risk-bearing capacity (see also Farhi, Fraiberger, Gabaix, Ranciere, and Verdelhan (2015)). On the other hand, Jurek (2014) uses out-of-the-money foreign exchange options to show that crash risk premia only account for a modest part of the excess return to currency carry trades.

[Insert Table 4 About Here]

To gauge the sensitivity of debtor carry, standard carry, and their difference to volatility shocks, Table 4 follows Menkhoff et al. (2012b) and reports average excess currency returns across four equal-sized volatility states identified using global FX volatility innovations. The first (low) regime contains the 25% of the months with the lowest volatility shocks and the fourth (high) regime contains the 25% of the months with the highest volatility shocks. If the debtor-creditor mismatch is a significant source of crash risk, then we expect debtor carry to display less sensitivity to large volatility shocks. This is precisely the pattern that we observe empirically in the data. Standard carry has positive and significant returns during the lower volatility regimes, but it suffers significantly negative returns in the high volatility regimes. The debtor carry, on the other hand, is less affected by volatility shocks. It has positive and significant mean excess returns in the three lowest volatility regimes but does not suffer as much as the standard carry during periods with large volatility shocks. The difference in the mean excess returns between debtor carry and standard carry suggests that debtor carry has lower returns than standard carry in low-volatility regimes, but significantly higher excess returns in the high-volatility regime. The results suggest that the debtor carry is not sensitive to volatility shocks, which is consistent with the debtor-creditor mismatch being a significant source of crash risk in the traditional carry trade. Moreover, this further suggests that low-interest rate countries do not necessarily provide a hedge against market turmoil as suggested by Menkhoff et al. (2012a). The hedging property of low-interest rate countries can instead be interpreted as a consequence of their typical creditor (and safe-haven) status. This deepens the puzzle for debtor carry, which has higher returns than the traditional carry trade but is less exposed to crash risk.

4.3. Where did the crash risk go?

A carry trade implemented among debtor currencies earns average excess returns that are comparable in magnitude to the traditional carry trade but are less sensitive to crash risk. This is a puzzling observation that challenges existing theories for the source of carry trade returns. This section digs deeper into the source of the debtor carry's excess returns and examines why the debtor carry is less sensitive to crash risk.

4.3.1. A debtor carry decomposition We begin by decomposing debtor carry (P3–P1) into two distinct components to shed light on the source of the debtor carry's excess returns and why its dynamics differ markedly from traditional carry, i.e.,

$$\text{Debtor carry}_t = (P3 - P4) + (P4 - P1)\,. \tag{4}$$

The first component is the debtor-creditor carry trade that buys debtor currencies with high interest rates (P3) and sells creditor currencies with low interest rates (P4). This strategy, denoted P3–P4, represents a pure debtor-creditor mismatch. The second component captures the difference in funding portfolios between the debtor-creditor carry (P1) and the debtor carry (P4). This component measures the effect of eliminating the debtor-creditor mismatch in the traditional carry trade. The components sum to the debtor carry and can therefore be used as a way to separately investigate the source of the debtor carry's excess returns.

[Insert Table 5 About Here]

Panel A of Table 5 presents factor loadings from regressing the excess returns to debtor carry and its two components on the dollar factor and global FX volatility innovations, as in (1). The regression-based results reveal a striking pattern in dollar and volatility sensitivity. First, debtor-creditor carry (P3–P4) and the difference in funding portfolios (P4–P1) have equal, but off-setting, sensitivities toward volatility innovations, implying that removing creditor currencies with low interest rates from the traditional carry trade neutralizes crash risk. Indeed, the debtor carry strategy is virtually unrelated to volatility innovations. Second, both the debtor-creditor carry and the difference in funding portfolios have positive dollar factor exposures. As a result, the debtor carry strategy realizes a large and significant loading on the dollar factor. As such, debtor carry swaps volatility risk for dollar risk. Gabaix and Maggiori (2015) predicts that the sensitivity of debtors towards shocks to global financier's risk-bearing capacity should be increasing in debtors' debt, which makes the first observation seem surprising, given that currencies in P3 are more indebted than currencies in P1.

4.3.2. Differences in debt currency denominations Debtor carry loads positive on the dollar factors through both the debtor-creditor carry and the difference in funding portfolios, whereas the debtor-creditor carry and the difference in funding portfolios have equal, but offsetting, sensitivities towards volatility innovations. To shed light on the first observation, that debtor carry is highly exposed to dollar risk, we next study the currency composition of net debt for the currencies in the debtor carry portfolios. Specifically, we consider the difference in net debt denominated in local currency and net debt denominated in US dollars (USD) using the end-of-year dataset of Bénétrix et al. (2019). We follow Della Corte et al. (2016) and construct monthly observations by keeping end-of-period data constant until a new data point becomes available and, secondly, backfill the data using the first observation and forward-fill using the last observation.[5]

[Insert Figure 5 About Here]

Figure 5 plots average differences in net debt denominated in local currency and net debt denominated in US dollars (USD) for the three debtor portfolios sorted on forward discounts. A positive (negative) bar corresponds to currencies in the portfolio being dollar (local currency) debtors on average. The figure highlights a stark pattern: low-interest rate debtors are local currency debtors, whereas high-interest debtors are dollar debtors. This observation is consistent with the original sin paradox (Eichengreen and Hausmann, 1999, Bertaut et al., 2022): high-interest rate debtor currencies tend to issue their debt in US dollars relative to their local currency. As a result, debtor carry tends to be long dollar debtors and short local currency debtors, which makes the strategy sensitive to dollar fluctuations: a dollar strengthening increases the value of a dollar debtor's debt increases (in local currency) and, thereby, corresponds to a negative economic shock for dollar debtors. Indeed, this can partially explain the debtor carry's significant dollar factor exposure, which is significantly larger than the traditional carry trade.

[5] Our conclusions remain quantitatively similar if we refrain from backfilling and forward-filling the dataset and only use data for the period for which the dataset covers. The ranking among countries is stable over time as currencies only change their debt composition gradually over time, which makes the effect of backfilling and extrapolation less pronounced.

4.3.3. Capital flows Debtor carry is long dollar debtors and short local currency debtors on average. The existing literature has demonstrated that US-dollar-denominated assets are considered safe assets (Jiang et al., 2021, 2023) and that investors "flight-to-dollar" assets during periods of market stress. This suggests that global investors' capital flow into local currency debtors' bonds should be more sensitive to risk-bearing capacity shocks. To investigate this line of inquiry, we consider capital flow data from the so-called TIC data produced by the US Treasury Department to examine whether the debtor carry's two components' equal, but off-setting, sensitivity towards global volatility shocks is related to capital flows.

The TIC data captures transactions between US residents and foreign country residents. We calculate the net flow of purchases and sales of foreign bonds for each country as "Gross sales by foreigners to US residents" minus "Gross purchases by foreigners from US residents". A positive net flow indicates that US residents have bought more foreign bonds from residents in the foreign country than residents in the foreign country have bought from US residents. A positive net flow corresponds to a positive capital inflow into the foreign country.[6] We study the sensitivity of capital flows into the long-leg and the short-leg of the debtor carry, respectively, towards changes in the risk-bearing capacity of global financiers through volatility innovations. We follow, among others, Brennan and Cao (1997) and Hau and Rey (2006) and normalize net capital flows by the 12-month past net flow to take into account that capital flows have increased during the sample period.[7]

Panel B in Table 5 presents the results from regressing the average portfolio net flow on global volatility innovations. While the net flow in high interest rate debtor currencies is virtually unaffected by volatility innovations, the net flow in low interest rate debtor currencies is highly sensitive to volatility innovations. During periods of heightened market stress, global investors flow out of low interest rate debtor currencies that have debt in local currency. Given that all debtor carry portfolios are negatively exposed to volatility innovations, the outflows from low interest rate debtor currencies that constitute the

[6] Maggiori, Neiman, and Schreger (2020) finds that debtor countries display a "home bias" in the sense that they predominantly transact in US dollar bonds and their local bonds.

[7] We arrive at identical conclusions even if we do not normalize net capital flows.

short-leg of debtor carry can help explain its resilience to crash risk in periods of market stress. Moreover, the net outflow from low interest rate debtor currencies with debt in local currency is consistent with the "flight-to-dollar" hypothesis.

4.4. Dollar debt

The debtor carry strategy buys US dollar debtors and sells local currency debtors on average. The long position in US dollar debtors should intuitively make the debtor carry more sensitive to dollar debt risk, i.e., US dollar-denominated net external debt. Wiriadinata (2021) provides empirical evidence that the real value of dollar debt increases, weakening the currencies of countries with large amounts of dollar debt when the US dollar strengthens. Moreover, she finds that dollar debtors are more sensitive towards US monetary shocks. We explore the role of dollar debt risk in the debtor carry strategy using a broad menu of indicators: the dollar factor, the TED spread (signed to represent liquidity), Pástor and Stambaugh (2003) liquidity innovations, and Fed funds expectation shocks (Nakamura and Steinsson, 2018) (defined as the 30-minute change in expectations of the Federal Funds rate from 10-minute before to 20-minute after each FOMC meeting).[8]

[Insert Table 6 About Here]

Table 6 examines the sensitivity of debtor carry returns towards dollar debt risk to understand whether debtor carry returns originate as compensation for US dollar debt funding risk. All regressions are carried out using data from January 1995 due to data availability for the time series of US monetary shocks. We set Fed funds expectations shocks equal to zero in months without a scheduled Federal Open Market Committee (FOMC) Meeting. We present results for multivariate regressions, but all signs and magnitudes are similar if we consider univariate regressions instead.

The main takeaway is straightforward: debtor carry returns are strongly related to dollar risk, funding liquidity risk, and US monetary policy shocks. Market liquidity plays a negligible role, which is consistent with Brunnermeier and Pedersen (2009), Asness et al.

[8]The time-series is updated by Acosta (2022) and made available on Miguel Acosta's website: https://www.acostamiguel.com/research.html. We are grateful to Miguel Acosta for making the data publicly available.

(2013). Interestingly, the sensitivity of P1 and P3 for changes in funding risk and Fed funds expectation shocks have opposite signs. With debtor carry being long dollar debtors and short local currency debtors, this implies that investors tend to "flight-to-dollar" debt when experiencing a positive shock to available funding liquidity. Local currency debtors, conversely, tend to depreciate at the same time. In a similar vein, a positive Fed funds expectation shock increases US interest rates. This corresponds to a negative economic shock for dollar debtors, and their currency depreciates. The debtor carry loads significantly and positively on changes in funding risk and significantly negatively on US monetary policy shocks. Market liquidity (Pástor and Stambaugh, 2003), on the other hand, is insignificant. For comparison, the traditional carry strategy has borderline significant sensitivity towards changes in funding risk and market liquidity (t-stats around 1.85), but not US monetary policy shocks which is consistent with Menkhoff et al. (2012a) and Burnside (2012) who find that the traditional carry trade is unrelated to the US business cycle.

In sum, rather than a shock to the risk-bearing capacity of global financiers, debtor carry's exposure to the dollar, funding risk, and US monetary shocks is a source of its excess returns. That is, debtor carry is partly driven by dollar debt exposures. This contrasts with the traditional carry strategy whose returns are predominantly sensitive towards risk-bearing capacity shocks. We emphasize that our results are not a complete explanation of the high returns to debtor carry, but point to feasible routes for a deeper understanding of the source of the debtor carry's excess returns.

5. Asset pricing test

This section studies the asset pricing implications of debtor carry. We first show that debtor carry is unspanned by existing currency risk factors. We then gauge its pricing ability in the cross-section of currency returns using traditional Fama and MacBeth (1973) regressions before turning to the three-pass approach of Giglio and Xiu (2021) that accounts for omitted variable bias. Debtor carry emerges as a priced risk factor in both approaches, even when controlling for the existing zoo of currency factors.

5.1. Spanning tests

The debtor carry strategy delivers average currency excess returns that rival the standard carry trade in magnitude without being exposed to crash risk. This is a puzzling observation and suggests that debtor carry may be a distinct currency strategy that requires a separate risk factor. To gauge whether debtor carry is a distinct currency strategy that provides independent information useful to investors, we examine whether it is spanned by existing currency factors. We consider a series of regression-based mean-variance spanning tests in the spirit of Huberman and Kandel (1987) using a wide selection of risk factors (see Section 3.4 for an overview) from the extant literature. The set represents a broad selection of well-established and profitable currency strategies (Nucera et al., 2023).

[Insert Table 7 About Here]

Table 7 reports the results from regressing debtor carry excess returns on the dollar factor and each of the competing factors before controlling for all factors simultaneously in a kitchen-sink regression. The main takeaway is readily evident: debtor carry is unspanned by existing factors in all tests. The debtor carry strategy delivers significant annualized alphas ranging between 2.42% and 5.27% with *t*-statistics ranging between 2.31 and 3.97. The results are robust to controlling for all factors simultaneously. The debtor carry strategy has significant positive loadings on all factors except for the value and output gap factors, which are negative but insignificant. As one would expect, debtor carry is most closely related to standard carry (Lustig et al., 2011), the global imbalance factor (Della Corte et al., 2016), orthogonalized carry (Barroso et al., 2018), long-term yields (Bekaert et al., 2007), and the slope of the yield curve (Ang and Chen, 2010). This seems natural given that the debtor carry portfolios are constructed using the same/similar datasets. Importantly, however, none can fully span debtor carry and neither can explain more than 50% of the excess returns to debtor carry. Altogether, debtor carry is not readily explained by existing currency factors and seems to be a distinct currency strategy that requires a unique explanation. We turn to cross-sectional asset pricing tests next.

5.2. Fama-MacBeth regressions

We start our cross-sectional asset pricing analysis on the pricing ability of debtor carry in the cross-section of currency returns by considering the standard Fama and MacBeth (1973) (FMB) cross-sectional regressions at the portfolio level for a broad menu of different currency strategies

$$\mathbb{E}\left[RX^j_{t+1}\right] = \boldsymbol{\lambda}'\boldsymbol{\beta}^j + \epsilon^j_{t+1}, \tag{5}$$

where $\mathbb{E}\left[RX^j_{t+1}\right]$ is the expected excess currency return to the jth currency portfolio, $\boldsymbol{\lambda}$ is a vector of risk prices, and $\boldsymbol{\beta}^j$ is a vector of factor loadings for currency portfolio j. We do not include an intercept in the cross-sectional regression, but let DOL act as a portfolio-specific intercept (Lustig et al., 2011). We consider different factor models using various combinations of the dollar factor, debtor carry, standard carry, and the global imbalance factor to gauge their relative pricing ability. We compute t-statistics using the heteroskedasticity and autocorrelation-consistent (HAC) standard errors of Newey and West (1987) with optimal truncation lag chosen as suggested by Andrews (1991).

[Insert Table 8 About Here]

Table 8 presents cross-sectional estimates for four different cross-sections of currency returns: debtor carry portfolios (Panel A), debtor carry, standard, carry, and global imbalance portfolios (Panel B), orthogonalized carry, short-term momentum, long-term momentum, currency value, output gaps, term spreads, and long-term yields (Panel C), and the full cross-section of currency portfolios (Panel D). Debtor carry is priced in all cross-sections with a price risk that ranges from 0.37 to 0.52 (t-stats between 2.51 and 4.23) depending on cross-section and control variables. The value of the estimated risk prices is close to the mean of the factor of 0.49 per month, which is an important model diagnostic (Lewellen, Nagel, and Shanken, 2010). Debtor carry is priced even when controlling for standard carry that is priced as well, suggesting that debtor carry and standard carry capture distinct features of the multifaceted risks in foreign exchange markets. Interestingly, debtor carry frequently drives out global imbalances in direct horse race tests across the different cross-sections. For each model, we also report in curly brackets the p-value from the Gibbons, Ross, and Shanken (1989) F-tests for the joint test on alphas. Remarkably, we cannot reject the null hypothesis that the alphas are zero for debtor carry in any of the cross-sections. The test, on the other hand, is frequently rejected for standard carry and global imbalances.

[Insert Figure 6 About Here]

Figure 6 plots observed mean currency excess portfolio returns against their predicted returns from (5) along with a 45° line to graphically illustrate the pricing ability of debtor carry in a two-factor model with the dollar factor. Consistent with the tabulated results, debtor carry is remarkably adept at pricing the cross-section of currency portfolio returns, even in cross-sections with strategies that are close to uncorrelated with debtor carry such as short- and long-term momentum and output gaps.

Overall, the results in Table 8 and Figure 6 suggest that debtor carry is a priced risk factor in the cross-section of currency returns. The pricing ability of debtor carry is robust to controlling for standard carry and global imbalances.

5.3. Three-pass regressions

FMB regressions have long been a standard workhorse of empirical asset pricing and have been used to establish risk prices in the currency return literature at least since Lustig and Verdelhan (2007). However, Giglio and Xiu (2021) point out that the traditional FMB regressions are potentially subject to omitted variable bias, which arises whenever the estimation of risk prices does not fully account for all priced sources of risk in the economy. Albeit that the issue is smaller here as the price of risk for a tradable factor can be directly computed as the average excess return of the factor, we still believe that it is relevant to verify that the pricing ability of debtor carry is robust to the potential omitted variable bias. Not least since Nucera et al. (2023) show that many currency risk factors do not have significant risk prices when controlling for a large set of existing currency factors.

To that end, we follow Nucera et al. (2023) and construct a large set of currency portfolios (described in Section 3.4). We have a total of 50 portfolios whose time t excess returns we collect in the vector $\mathbf{RX}_t$. We use PCA on the matrix $n^{-1}T^{-1}\left(\mathbf{RX}_t - \boldsymbol{\mu}\right)'\left(\mathbf{RX}_t - \boldsymbol{\mu}\right)$ to extract p common factors $\mathbf{f}_t$ from the excess returns of the 50 portfolios. We provide results for $p \in \{2, 3, 4, 5\}$ to show that our results are robust to the choice of the number of common factors, but note that Giglio and Xiu (2021) propose a method for choosing the optimal p, which is $\widehat{p} = 3$ in our setting. The factor loadings for the common factors are $\boldsymbol{\beta} = T^{-1}\left(\mathbf{RX}_t - \boldsymbol{\mu}\right)\mathbf{f}_t'$. We then run standard cross-sectional FMB regressions to obtain risk prices for the p common factors, i.e., $\boldsymbol{\gamma} = \left(\boldsymbol{\beta}'\boldsymbol{\beta}\right)^{-1}\boldsymbol{\beta}'\left(\mathbf{RX}_t - \boldsymbol{\mu}\right)$. Finally, we estimate a time series regression in which we regress the common factors on (demeaned) debtor carry to obtain the sensitivities $\boldsymbol{\eta}$ of the test factor on the p common factors. Finally, we estimate the robust risk price as $\gamma_{\text{Debtor carry}} = \boldsymbol{\gamma}\boldsymbol{\eta}'$. We test the strength of the test factor by testing whether the sensitivities of the test factor on the common factors are jointly equal to zero, i.e., $\boldsymbol{\eta} = 0$, using the test statistic proposed by Giglio and Xiu (2021), which we refer to as $\widehat{W}$ in our results.

[Insert Table 9 About Here]

Table 9 presents three-pass estimates of the risk premium for debtor carry for different choices of p when controlling for known currency portfolios. We also present tests for whether debtor carry is a strong factor in the cross-section. For all choices of p, debtor carry carries a significant risk premium and we can strongly reject the null that debtor carry is a weak factor. In sum, we find strong evidence that debtor carry is a priced risk factor in the cross-section of currency returns and that it is robust to controlling for a large set of existing currency factors. Our results suggest that the carry trade is not fully driven by the debtor-creditor mismatch, but that the debtor carry is a distinct source of risk in foreign exchange markets. Crash risk in the carry trade, on the other hand, seems to originate from the mismatch and difference in the fundamental properties of creditor currencies and debtor currencies.

6. Concluding remarks

We study the role of creditor and debtor currencies in the carry trade. The traditional carry trade is long debtor currencies with high interest rates and short creditor currencies with low interest rates. We show that this debtor-creditor mismatch embedded in the carry trade accounts for its crash risk, but not its risk premium. The crash risk component is driven by the fundamental differences in risk-return properties between creditor and debtor currencies. We introduce a novel carry trade implemented among debtor currencies: the debtor carry, which is long debtor currencies with high interest rates and short debtor currencies with low interest rates. Debtor carry earns a risk premium that equals that of the traditional carry trade in magnitude but without crash risk. We show that debtor carry's risk premium can be partly rationalized through the currency composition of debt and dollar debt risk. The high returns to debtor carry suggest that it is a priced risk factor in the cross-section of currency returns. We empirically show that debtor carry is unspanned by existing currency risk factors and that it commands a robust risk premium in several diverse cross-sections of currency portfolios and when controlling for the currency zoo and omitted variable bias. Interestingly, debtor carry and traditional carry are jointly priced in asset pricing tests, which implies that the two strategies require different explanations. Our empirical findings therefore have implications for existing theories for the carry risk premium and debtor carry provides a new challenge for asset pricing models.

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Table 1: Debtor and creditor portfolios

This table reports descriptive statistics for equal-weighted portfolios of debtor and creditor currencies from January 1985 to December 2020. For each portfolio, we report means, standard deviations, skewness, kurtosis, sensitivity to global FX volatility innovations, and maximum drawdowns. Newey-West t-statistics are reported in squared brackets. The sensitivity to volatility innovations is estimated using a two-factor model that includes the dollar factor and global FX volatility innovations.

	Debtor portfolio	Creditor portfolio	Difference
Mean	2.77	1.03	1.74
	[1.80]	[0.60]	[1.39]
Std	8.40	9.54	7.12
Skewness	-0.23	0.26	-0.70
Kurtosis	4.98	3.34	4.65
Volatility sensitivity	-0.89	1.61	-2.50
	[-7.52]	[5.53]	[-6.44]
MDD(%)	31.66	51.63	28.12

Table 2: Descriptive statistics

This table reports descriptive statistics for individual G10 currency returns and external data positions from January 1985 to December 2020. Panel A report means, standard deviations, skewness, and kurtosis for individual currency returns. Panel B reports mean net debt measures for currency, which we define as end-of-year foreign debt assets minus foreign debt liabilities scaled by the nation's GDP (measured in dollars), and the mean currency composition of a country's external debt position, which we define as the difference between net debt assets that are denominated in local currency and US dollars to distinguish local currency and dollar debtor currencies. The sample period is January 1985 to December 2020.

	Panel A: Currency returns				Panel B: Debt	
Currency	Mean	Std.dev.	Skewness	Kurtosis	Net debt	LC/USD
Australia	3.21	11.72	-0.44	4.80	-0.41	10.28
Canada	0.95	7.41	-0.44	6.83	-0.38	-11.78
Germany	4.58	11.55	-0.23	3.08	0.04	-13.55
Japan	0.69	11.00	0.46	4.90	0.15	-24.48
New Zealand	5.58	12.31	-0.08	4.57	-0.59	4.16
Norway	2.59	11.16	-0.25	3.70	-0.05	-20.35
Sweden	1.83	11.01	-0.23	3.89	-0.46	7.73
Switzerland	1.87	11.24	0.19	3.93	0.68	-50.08
United Kingdom	2.41	10.00	-0.04	5.40	-0.19	-38.58
Euro	0.11	9.64	-0.01	4.07		

Table 3: Debtor carry portfolios

This table reports descriptive statistics for five equal-weighted currency portfolios sorted on net debt positions and forward discounts. We first classify debtors (creditors) as currencies whose net debt, defined as end-of-year foreign debt assets minus foreign debt liabilities scaled by the nation's GDP (measured in dollars), is negative (positive). We then sort currencies based on forward discounts within each group. Portfolio P1 (P3) denotes a portfolio of debtor currencies with low (high) interest rates. Portfolio P4 (P5) denotes a portfolio of creditor currencies with low (high) interest rates. We form two long-short factors from the five portfolios sorted on net debt and forward discounts. We consider a strategy that buys P3 and sells P1, which we term debtor carry, and a strategy that buys P3 and sells P4, which is a pure debtor-creditor mismatch. We compare these strategies to the carry and dollar factors from Lustig et al. (2011). We report means, standard deviations, Sharpe ratios, skewness, kurtosis, maximum drawdown, and the pre-formation values of net debt and forward discounts for each portfolio. Newey and West (1987) t-statistics are reported in parentheses for the mean excess portfolio return. The sample period is January 1985 to December 2020.

	Debtors			Creditors		Long-short			
	P1	P2	P3	P4	P5	P3-P1	P3-P4	Carry	Dollar
Mean	-0.10	2.49	5.81	-0.05	1.52	5.91	5.87	5.42	2.33
	(-0.07)	(1.62)	(2.85)	(-0.03)	(0.79)	(4.20)	(2.79)	(2.95)	(1.60)
Std.dev.	7.98	9.10	11.30	11.00	10.31	8.75	11.95	10.59	8.02
Sharpe ratio	-0.01	0.27	0.51	-0.00	0.15	0.68	0.49	0.51	0.29
Skewness	-0.13	-0.21	-0.23	0.46	0.13	0.08	-0.82	-0.74	-0.06
Kurtosis	4.18	4.61	4.54	5.23	3.14	4.76	5.29	4.79	3.60
MDD(%)	53.44	38.35	32.12	61.75	51.20	22.37	37.31	35.10	34.25
Net debt	-0.30	-0.34	-0.45	0.30	0.40				
fd	-0.00	0.12	0.32	-0.22	-0.08				

Table 4: (Debtor) carry and volatility regimes

This table reports mean excess for debtor carry (Panel A), standard carry (Panel B), and the difference between them (Panel C), respectively, conditional on global FX volatility innovations (Menkhoff et al., 2012a) being within the lowest 25% to the highest 25% of its sample distribution. Debtor carry buys debtor currencies with high interest rates and sells debtor currencies with low interest rates. The standard carry trade buys high interest rate currencies and sells low interest rate currencies. Newey and West (1987) t-statistics are reported in parentheses for the mean excess portfolio return. The sample period is January 1985 to December 2020.

	Volatility states			
	Low	2	3	High
Panel A: Debtor carry				
Mean	7.73	7.23	8.86	-0.18
	(3.57)	(2.56)	(3.28)	(-0.05)
Std	6.65	8.39	7.89	11.28
Panel B: Standard carry				
Mean	11.86	13.03	9.64	-12.86
	(4.82)	(4.18)	(3.01)	(-2.73)
Std	7.80	8.93	9.44	13.56
Panel C: Difference				
Mean	-4.13	-5.80	-0.78	12.68
	(-2.07)	(-2.87)	(-0.34)	(3.60)
Std	6.02	6.00	7.05	10.30

Table 5: Decomposition of debtor carry

This table reports results from studying a decomposition of debtor carry into two components. The first component is the debtor-creditor carry trade that buys debtor currencies with high interest rates (P3) and sells creditor currencies with low interest rates (P4). This strategy, denoted P3–P4, represents a pure debtor-creditor mismatch. The second component captures the difference in funding portfolios between the debtor-creditor carry (P1) and the debtor carry (P4). This component measures the effect of eliminating the debtor-creditor mismatch in the traditional carry trade. Panel A reports results from regressing the components and debtor carry onto the dollar factor and global FX volatility innovations. Panel B presents the results from regressing the average portfolio net flow on global FX volatility innovations. All coefficients are multiplied by 1000 for readability in Panel B. Newey and West (1987) t-statistics are reported in parentheses for the mean excess portfolio return. The sample period is January 1985 to December 2020.

Panel A: Factor loadings			
	P3-P4	P1-P4	P3-P1
Intercept	0.41	0.01	0.42
	[2.49]	[0.04]	[3.91]
Dollar factor	0.20	0.16	0.35
	[2.01]	[1.84]	[4.79]
Volatility sensitivity	-4.30	4.09	-0.21
	[-6.18]	[6.22]	[-0.43]
R^2 (%)	17.50	16.45	10.72
Panel B: Capital flow regressions			
	P1	P3	P3-P1
Intercept	0.04	-0.02	-0.06
	[0.29]	[-0.33]	[-0.41]
Volatility sensitivity	-1.62	-0.01	1.59
	[-4.29]	[-0.09]	[3.48]

Table 6: Debtor carry, dollar, and funding risk

This table reports regression estimates of factor models that regress excess currency portfolio returns on a constant, the dollar factor, the TED spread (a measure of funding liquidity), Pástor and Stambaugh (2003) liquidity innovations (a measure of market liquidity), and federal funds rate shocks from Acosta (2022). Newey and West (1987) t-statistics are reported in parentheses. The sample period is January 1985 to December 2020.

	P1	P3	P3-P1	Carry
α	-0.15	0.23	0.38	0.35
	[-2.43]	[2.68]	[3.25]	[2.24]
DOL	0.96	1.22	0.26	0.37
	[27.05]	[22.84]	[3.43]	[3.73]
TED spread	-0.77	0.83	1.59	1.78
	[-2.52]	[1.62]	[2.81]	[1.83]
PS Liquidity	1.11	1.06	-0.05	6.66
	[0.74]	[0.61]	[-0.02]	[1.87]
FF shocks	3.17	-5.50	-8.67	-2.08
	[1.13]	[-2.44]	[-2.53]	[-0.33]
$R^2(\%)$	78.34	77.64	12.06	14.53

Table 7: Spanning regressions

This table reports traditional asset pricing tests in the form of spanning regressions in the spirit of Huberman and Kandel (1987). We regress the excess returns of the debtor carry portfolio on the excess returns of a broad menu of currency portfolios from the existing literature including the dollar and carry factors of Lustig et al. (2011), global imbalances of Della Corte et al. (2016), orthogonalized carry Barroso et al. (2018), short- and long-term momentum (Asness et al., 2013, Menkhoff et al., 2012b), currency value (Asness et al., 2013, Menkhoff et al., 2017), term spreads (Bekaert et al., 2007, Lustig et al., 2019), long-term yields (Ang and Chen, 2010), and output gaps (Colacito et al., 2020). Newey and West (1987) *t*-statistics are reported in parentheses. The sample period is January 1985 to December 2020.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
α	2.48	4.30	2.69	4.78	4.89	5.27	5.06	3.73	4.34	2.42
	(2.31)	(3.35)	(2.59)	(3.82)	(3.85)	(3.91)	(3.97)	(3.20)	(3.94)	(2.59)
DOL	0.23	0.34	0.30	0.37	0.38	0.37	0.37	0.27	0.28	0.21
	(4.35)	(4.94)	(6.62)	(5.82)	(5.81)	(5.87)	(5.79)	(4.80)	(4.52)	(5.01)
CAR	0.53									0.45
	(12.59)									(4.74)
IMB		0.31								-0.16
		(3.77)								(-1.72)
ORCAR			0.58							0.20
			(11.36)							(2.93)
STMOM				0.12						0.07
				(2.08)						(2.11)
LTMOM					0.12					0.02
					(2.08)					(0.42)
VALUE						-0.05				-0.07
						(-0.75)				(-1.50)
GAP							-0.01			-0.08
							(-0.15)			(-1.83)
LTY								0.40		0.03
								(10.96)		(0.26)
SLOPE									0.45	0.13
									(9.03)	(2.40)
R^2 (%)	51.72	20.53	44.68	13.77	13.86	11.98	11.72	38.28	40.84	64.25

Table 8: Fama-MacBeth regressions

This table reports cross-sectional Fama and MacBeth (1973) estimates for linear asset pricing models that include the dollar factor (DOL), debtor carry (DCAR), standard carry (CAR), and the global imbalance (IMB) factor in various combinations. For each model, we report risk price estimates and the corresponding Newey and West (1987) t-statistics in parentheses. We also report cross-sectional R^2 values together with the p-value from the Gibbons et al. (1989) test in curly brackets. We consider four different cross-sectional. Panel A uses five portfolios sorted on net debt and forward discounts as test assets. Panel B adds five carry portfolios and five imbalance portfolios. Panel C consider all other currency portfolios, which include five orthogonalized carry portfolios, five short-term momentum portfolio, five long-term momentum portfolios, five value portfolios, five term spread portfolios, five long-term yield portfolios, and five output gap portfolios. Panel D considers all currency portfolios in a single cross-section. The sample period is January 1985 to December 2020.

	DOL	DCAR	CAR	IMB	R^2 (%)	DOL	DCAR	CAR	IMB	R^2 (%)
	Panel A: Debtor carry portfolios					Panel B: Debtor carry, carry, and imbalance portfolios				
(1)	0.17	0.52			93.30	0.19	0.48			77.22
	(1.37)	(3.93)			{0.49}	(1.55)	(3.28)			{0.14}
(2)	0.19		0.47		83.81	0.20		0.44		77.44
	(1.49)		(2.85)		{0.07}	(1.57)		(2.67)		{0.03}
(3)	0.18			0.38	63.93	0.20			0.34	65.42
	(1.47)			(2.35)	{0.01}	(1.57)			(2.27)	{0.01}
(4)	0.18	0.48	0.50		98.58	0.19	0.41	0.46		83.58
	(1.41)	(4.14)	(3.08)		{0.50}	(1.53)	(3.63)	(2.92)		{0.15}
(5)	0.17	0.49		0.26	96.45	0.19	0.41		0.25	82.03
	(1.39)	(4.16)		(1.51)	{0.43}	(1.55)	(3.63)		(1.51)	{0.15}
(6)	0.18	0.49	0.51	0.17	99.03	0.19	0.41	0.46	0.20	83.58
	(1.40)	(4.23)	(3.05)	(0.99)	{0.40}	(1.53)	(3.69)	(2.92)	(0.99)	{0.15}
	Panel C: Other currency portfolios					Panel D: All currency portfolios				
(1)	0.20	0.40			35.96	0.20	0.44			54.33
	(1.62)	(2.60)			{0.26}	(1.60)	(3.04)			{0.09}
(2)	0.20		0.40		32.68	0.20		0.42		53.31
	(1.59)		(2.29)		{0.14}	(1.58)		(2.57)		{0.04}
(3)	0.20			0.28	20.86	0.20			0.32	41.26
	(1.59)			(1.73)	{0.11}	(1.58)			(2.11)	{0.02}
(4)	0.20	0.37	0.38		36.98	0.20	0.39	0.43		58.03
	(1.61)	(2.57)	(2.13)		{0.25}	(1.59)	(3.14)	(2.59)		{0.09}
(5)	0.20	0.39		0.16	36.28	0.20	0.40		0.23	56.77
	(1.62)	(2.65)		(1.06)	{0.27}	(1.59)	(3.18)		(1.51)	{0.10}
(6)	0.20	0.37	0.39	0.10	37.56	0.19	0.39	0.43	0.17	58.14
	(1.62)	(2.51)	(2.18)	(0.67)	{0.26}	(1.59)	(3.15)	(2.60)	(0.99)	{0.10}

Table 9: Three-pass estimates

This table presents three-pass estimates of the risk premium for debtor carry for different choices of p when controlling for known currency portfolios. We consider a broad set of 45 well-known currency portfolios: five carry portfolios, five global imbalance portfolios, five orthogonalized carry portfolios, five short-term momentum portfolios, five long-term momentum portfolios, five value portfolios, five term spread portfolios, five long-term yield portfolios, and five output gap portfolios. We also test the strength of the test factor by testing whether the sensitivities of the test factor on the common factors are jointly equal to zero, i.e., $\boldsymbol{\eta} = 0$, using the test statistic $\widehat{W}$ proposed by Giglio and Xiu (2021). The sample period is January 1985 to December 2020.

	Number of factors ($\widehat{p}$)			
	2	3	4	5
λ	0.28	0.32	0.34	0.34
	(2.93)	(2.82)	(2.88)	(2.84)
$\widehat{W}$	153.56	560.01	693.37	791.51
	[0.00]	[0.00]	[0.00]	[0.00]

Figure 1: Carry and net debt positions

This figure plots the average net debt, defined as the end-of-year foreign debt assets minus foreign debt liabilities scaled by the nation's GDP (measured in dollars), for five equal-weighted carry trade portfolios sorted on forward discounts. For each carry portfolio, we also report its sensitivity to global FX volatility innovations (Menkhoff et al., 2012a). The sample period is January 1985 to December 2020.

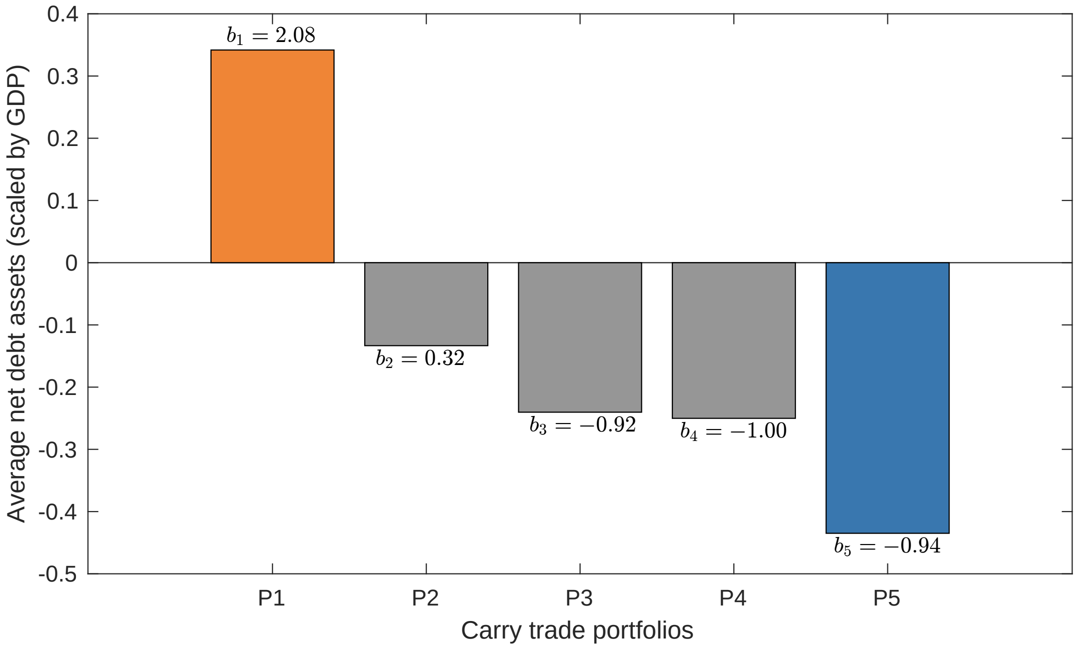

Figure 2: Debtor and creditor currencies

This figure displays the evolution of the number of debtor and creditor currencies over time. We classify debtor (creditor) currencies as currencies whose net debt, defined as end-of-year foreign debt assets minus foreign debt liabilities scaled by the nation's GDP (measured in dollars), is negative (positive). The sample period is January 1985 to December 2020.

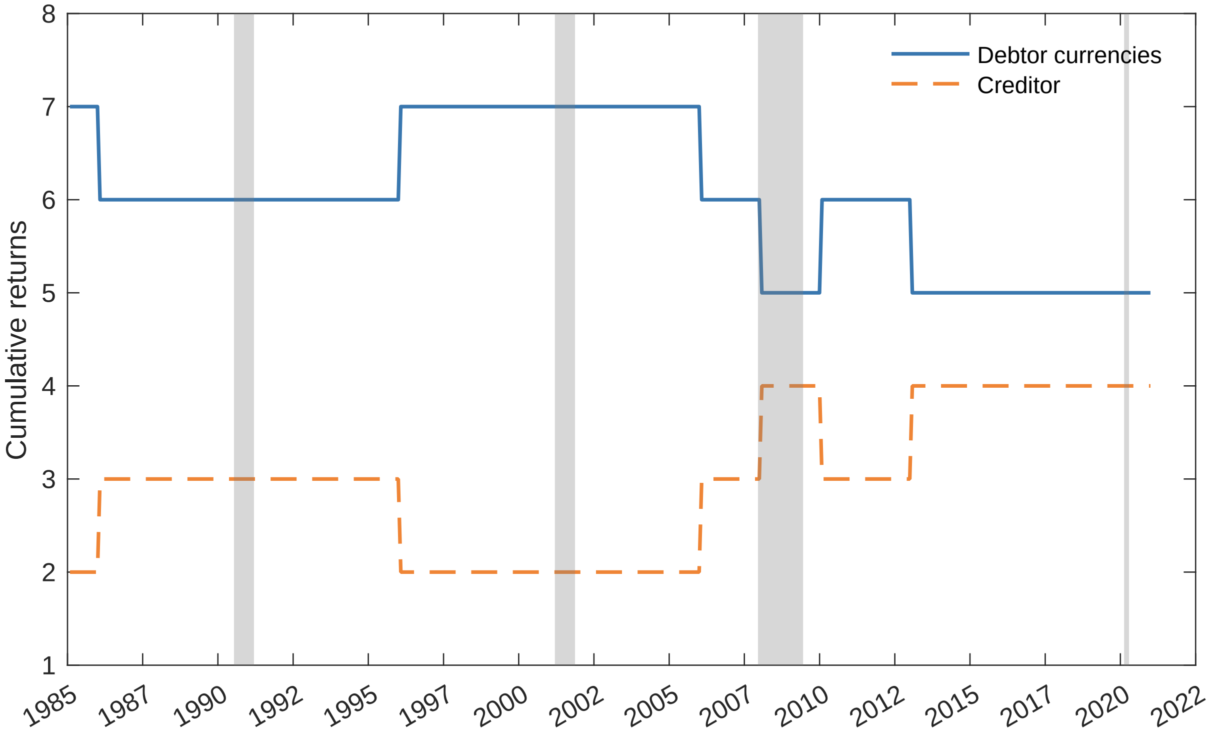

Figure 3: Portfolio construction

The figure illustrates the construction of the debtor carry risk factor. At the end of each month, currencies are first grouped into two baskets according to their net debt. We classify debtor (creditor) currencies as currencies whose net debt, defined as end-of-year foreign debt assets minus foreign debt liabilities scaled by the nation's GDP (measured in dollars), is negative (positive). We then sort currencies without each group based on forward discounts. Portfolio P1 (P3) denotes a portfolio of debtor currencies with low (high) interest rates. Portfolio P4 (P5) denotes a portfolio of creditor currencies with low (high) interest rates. The debtor carry factor is constructed as the excess returns on P3 minus the excess returns on P1. The sample period is January 1985 to December 2020.

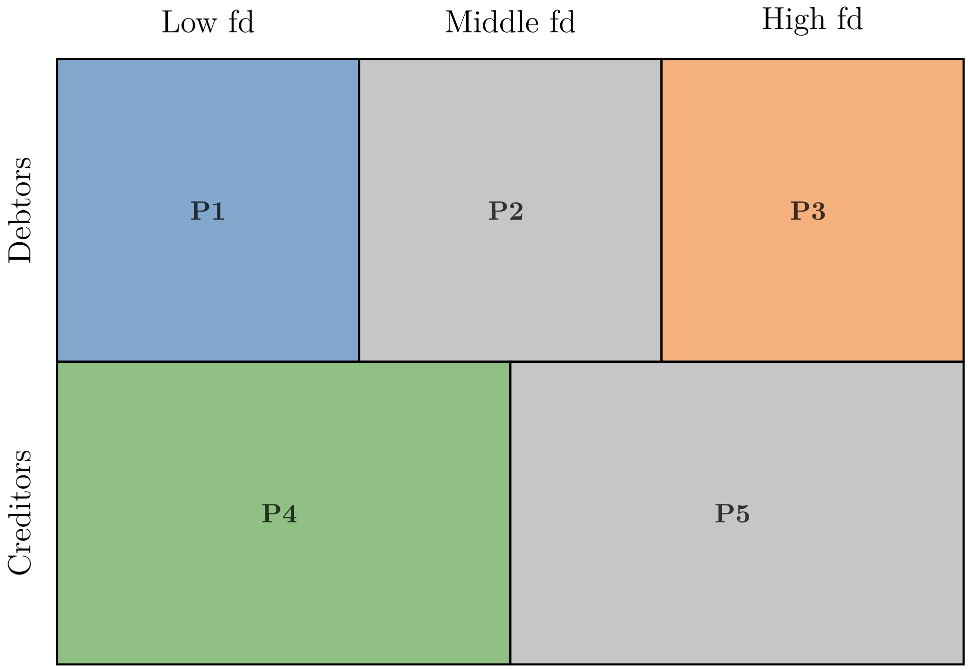

Figure 4: Cumulative portfolio returns

This figure plots the cumulative net excess returns to debtor carry, debtor-creditor carry, and standard carry. Debtor carry is a strategy that buys debtor currencies with high interest rates and sells debtor currencies with low interest rates. Debtor-creditor carry is a strategy that buys debtor currencies with high interest rates and sells creditor currencies with low interest rates. Standard carry is a strategy that buys high interest rate currencies and sells low interest rate currencies. Shaded areas correspond to NBER recession periods. The sample period is January 1985 to December 2020.

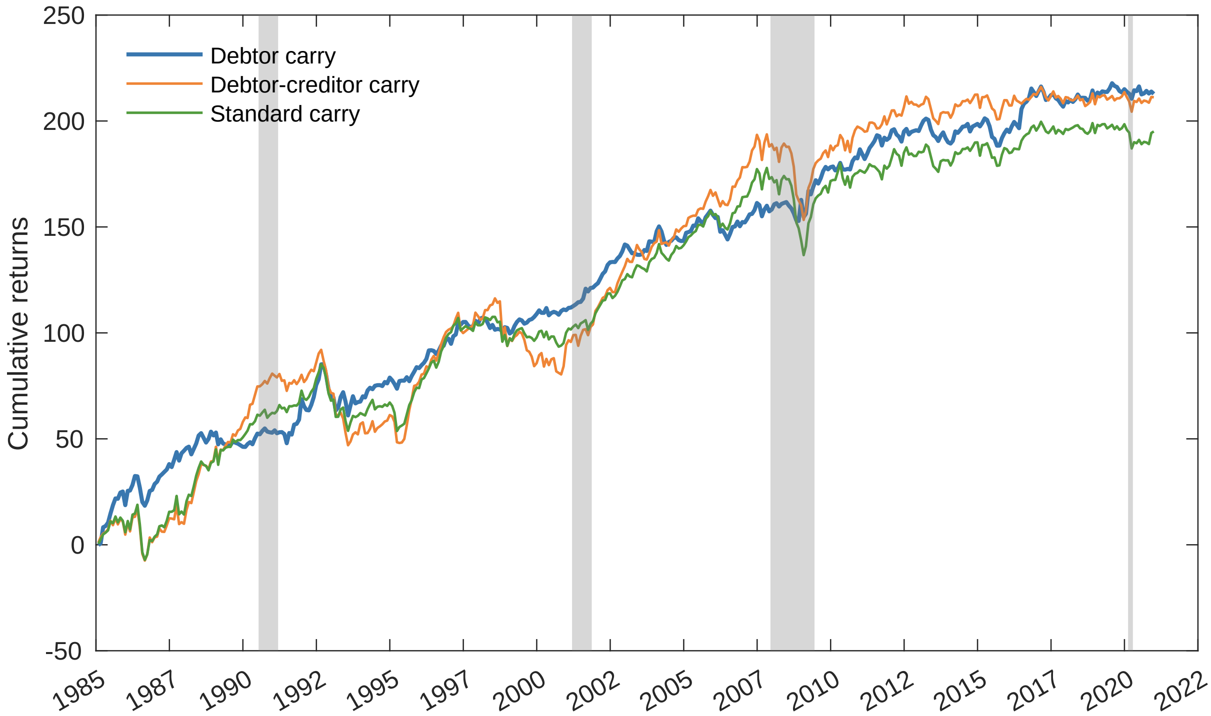

Figure 5: Debt composition

This figure displays the average currency composition of the external debt position, defined as the difference between net debt assets that are denominated in local currency and US dollars, for debtor currencies sorted on forward discounts. We identify debtor currencies as those with a negative net debt defined as end-of-year foreign debt assets minus foreign debt liabilities scaled by the nation's GDP (measured in dollars). The sample period is January 1985 to December 2020.

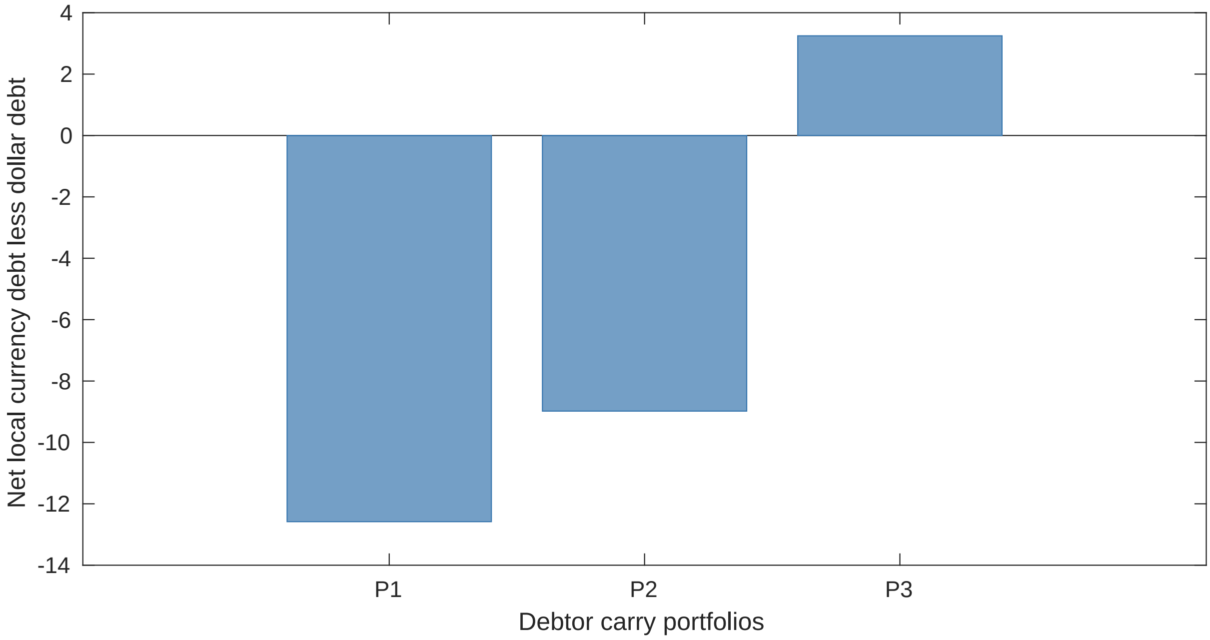

Figure 6: Pricing error plots

This figure displays pricing errors for the debtor carry factor when used as a risk together with the dollar factor in a linear asset pricing model. Risk prices are estimated using cross-sectional Fama and MacBeth (1973) regressions. Estimates are presented in Table 8. Panel A uses five portfolios sorted on net debt and forward discounts as test assets. Panel B adds five carry portfolios and five imbalance portfolios. Panel C consider all other currency portfolios, which include five orthogonalized carry portfolios, five short-term momentum portfolio, five long-term momentum portfolios, five value portfolios, five term spread portfolios, five long-term yield portfolios, and five output gap portfolios. Panel D considers all currency portfolios in a single cross-section. The sample period is January 1985 to December 2020.