## MAURICE OBSTFELD University of California, Berkeley

HAONAN ZHOU Princeton University

# The Global Dollar Cycle

**ABSTRACT** The US dollar's nominal effective exchange rate closely tracks global financial conditions, which themselves show a cyclical pattern. Over that cycle, world asset prices, leverage, and capital flows move in concert with global growth, especially influencing the fortunes of emerging markets and developing economies (EMDEs). This paper documents that dollar appreciation shocks predict economic downturns in EMDEs and highlights policies countries could implement to dampen the effects of dollar fluctuations. Dollar appreciation shocks themselves are highly correlated not just with tighter US monetary policies but also with measures of US domestic and international dollar funding stress that themselves reflect global investors' risk appetite. After the initial market panic and upward dollar spike at the start of the COVID-19 pandemic, the dollar fell as global financial conditions eased; but the higher inflation that followed has induced central banks everywhere to tighten monetary policies more recently. The dollar has strengthened considerably since mid-2021 and a contractionary phase of the global financial cycle is now underway. Owing to increases in public- and business-sector debts during the pandemic, a strong dollar, higher interest rates, and slower economic growth will be challenging for EMDEs.

Since the late 1970s, cycles of US dollar appreciation have been accompanied by slower global economic growth, with the negative correlation most pronounced for emerging markets and developing economies (EMDEs). This time is no different. It may be surprising that this correlation

*Conflict of Interest Disclosure*: The authors did not receive financial support from any firm or person for this paper or from any firm or person with a financial or political interest in this paper. The authors are not currently an officer, director, or board member of any organization with an interest in this paper.

Brookings Papers on Economic Activity, Fall 2022: 361–427 © 2023 The Brookings Institution.

has not weakened over the decades in light of the secularly declining economic weight of the United States on the production side of the world economy and the rising weight of the EMDEs. In 1992, the United States accounted for 19.6 percent of world GDP measured at purchasing power parity, versus a 42.3 percent share for EMDEs; by 2021 the US share had shrunk to 15.7 percent, whereas EMDEs had reached a 57.9 percent share of world output.<sup>1</sup> Nonetheless, fluctuations in the US dollar continue to play a key role worldwide and an especially powerful role in the fortunes of the less advanced economies. A fundamental reason is the explosive growth of global financial markets since the early 1990s and the dominant position of the US currency in those markets.

In this paper, we document the channels of the dollar's impact on EMDEs, building on recent research that seeks to trace and understand the international propagation of financial shocks. We emphasize how newer models of international finance have grown from earlier approaches in the face of the occasionally turbulent evolution of world capital markets. We also explore empirically the implications of those models for the US dollar's exchange rate. The paper is in four sections.

Section I makes three main points. First, in the fifty years since the emergence of the floating exchange rate system, the volume of international financial transactions has exploded compared with directly trade-related transactions. That expansion has brought a global financial cycle in world asset prices, leverage, and financial capital flows to the fore as a correlate of synchronized growth movements across countries. Second, as global financial markets have expanded in importance and scope, open-economy macro models have evolved to feature a more-detailed focus on financial markets along with the roles of risk aversion, market frictions, and investor sentiment. These models have yielded important insights on the international transmission of government policies and the factors behind exchange rate volatility. Third, even a half century after the advent of floating, the US dollar remains the world's dominant currency for asset markets as well as trade, making the nominal dollar exchange rate a reliably powerful concomitant of the global financial cycle. We document the dollar's strong negative correlation with key global real and financial variables, as well as its particular

1. IMF, "World Economic Outlook Database," for April 2022, https://www.imf.org/en/ Publications/WEO/weo-database/2022/April, accessed August 15, 2022. The changes differ in magnitude but go in the same direction when market exchange rates are used to compare GDP shares. Using that metric, the US share drops from 25.7 percent to 23.8 percent between 1992 and 2021 while the EMDE share rises from 16.5 percent to 41.7 percent. importance for emerging economies, and list features of EMDEs that help to explain this correlation.<sup>2</sup>

In section II, we illustrate the pervasive influence of dollar shocks on EMDEs by tracking their dynamic relation to a range of quantity, price, and financial variables. We argue that with appropriate econometric controls, the dollar's weighted nominal exchange rate against other advanced economies can be viewed as an external predictor of macro developments in EMDEs. Using a panel local projections (LP) framework applied to a set of twenty-six EMDEs over 1999–2019, we document that dollar appreciation shocks predict declines in output, consumption, investment, and government spending. Accompanying these developments are a decline in the traded-goods sector, a depreciation of the local currency against the dollar, a fall in the terms of trade (that is, a rise in the price of imports relative to exports), a decline in domestic credit, losses in equity markets, and a widening of the sovereign borrowing spread for foreign currency loans. These adverse correlates of dollar appreciation shocks are more pronounced for countries that peg their exchange rates, that have not adopted inflation-targeting monetary frameworks, and that have high levels of external liabilities denominated in US dollars. One policy inference consistent with these findings is that more-flexible exchange rate regimes do not shut out the global financial cycle, but they are indeed helpful in buffering external financial shocks and can do so most effectively when supported by relatively high inflation credibility at the central bank and relatively low external dollarization.

To understand better the US dollar's powerful influence over EMDEs' macroeconomic and financial conditions, we next seek to identify factors that drive the shock variable in our local projections, the dollar's exchange rate against other advanced economies. Section III reports the results of that investigation over the 1999–2021 sample period. US monetary policy (proxied by the change in short-term US Treasury rates) is an influential correlate of dollar movements; so are long-term Treasury rates, which have played an especially important role during the Federal Reserve's large-scale asset purchases of the zero lower bound period, but not just then.

Recent literature on exchange rate determination, surveyed below, has also found an important role for investors' perceptions of the safety and

<sup>2.</sup> We follow the literature in our focus on the nominal dollar exchange rate because it is that variable that adjusts in the short run to financial shocks. The real exchange rate is more relevant for resource allocation, but in environments with moderate inflation, changes in real and nominal rates are highly correlated.

liquidity of US Treasury assets, proxied by deviations from covered interest arbitrage in government bond markets. This factor creates a potent interaction between the global financial cycle and the dollar, because in "risk-off" episodes where global risk appetite declines, investors' flight to safe assets simultaneously raises the foreign currency price of dollars and constrains the lending of financial intermediaries. Like other recent authors, we find a prominent role for the relative US Treasury "convenience yield" in section III, and we make a case that this attribute of Treasury obligations depends in large part on the perceived safety and liquidity conferred by their dollar denomination. A direct indicator of low investor risk appetite, the excess bond premium (EBP) proposed by Gilchrist and Zakrajšek (2012), turns out to be the most reliably influential correlate of dollar movements in our estimates. An examination of the EBP's influence on EMDEs in the LP framework of section II implies that dollar movements driven primarily by changes in the EBP predict especially large and persistent negative effects.

Our concluding section IV places the current troubled global economic landscape in the context of the global dollar cycle. High inflation driven in part by a sharp recovery from the COVID-19 recession sparked a monetary tightening cycle across major central banks. In response, the world economy moved from an expansionary phase of the global dollar cycle following the initial COVID-19 shock in the first half of 2020 to a contractionary phase now. The Federal Reserve has been among the most aggressive (if not early) tighteners, and the dollar has appreciated sharply since mid-2021. Determined disinflation by the Federal Reserve and continued dollar appreciation could lead to more intense debt troubles for a range of EMDEs. Indeed, danger signals are flashing. On the other hand, if the Federal Reserve fails to get a handle on US inflation, that would be disruptive in the longer term. Among the consequences, the dollar's status as the premier global currency could come under threat, reinforcing other disintegrative trends and risks.

# I. The Dollar and the World Economy: Evolving Linkages and Models

The modern system of floating exchange rates was born in March 1973, just short of fifty years ago. Having faced a long period of intense speculative pressure in foreign exchange markets, Japan and a large group of European countries suspended nearly three decades of postwar practice in that month and announced they would no longer peg their currencies to the US dollar. In the subsequent half century, what initially looked like a temporary retreat from the dollar-centric Bretton Woods system became permanent, and by the turn of the millennium, many EMDEs had embraced considerable exchange rate flexibility as well. These developments took place in a global environment of supply shocks and high inflation and were in part motivated by countries' desire to sever links with the dollar that made it hard to manage domestic macroeconomic policy independently. Yet, despite that intention, the dollar has remained central to the functioning of the international monetary and financial system, as has US monetary policy. The system has evolved considerably, however, and with it, the ways in which US policies and the dollar have an impact on the rest of the world.

The most notable change has been a spectacular growth in international financial positions and flows, facilitated by the rapid deepening of national financial markets and their cross-border linkages. Due to this growth, the way economic shocks are propagated through the world economy has changed. One important change following the initial years of floating is that US macro-economic policies have increasingly come to affect other countries through financial channels, even countries with exchange rates that are flexible against the dollar. Another change is the greater scope for global financial market shocks to buffet the dollar, with spillback effects outside the United States, particularly in EMDEs. In this section we survey key indicators of the changes in global capital markets, important co-movements between global macro-variables and the dollar, and ways in which open-economy theories have progressed to address these facts.

### I.A. Trends in Global Capital Markets

The end of the industrial countries' fixed exchange rates in the early 1970s set off a process of wide-ranging financial account liberalization. Without some degree of restriction on cross-border financial flows, the Bretton Woods system would likely have fallen victim to speculation even before the early 1970s. The adoption of floating, however, eased balance of payments constraints and allowed countries to direct monetary policy toward domestic rather than external goals, while simultaneously freeing up cross-border payments. That countries suddenly had the option to liberalize international financial flows does not fully explain why they chose that path. The political and economic factors pushing in that direction were sufficiently powerful and widespread, however, that by the mid-1990s the richer economies were approaching an unprecedented degree of financial integration while many



Figure 1. External Asset and Liability Ratios to GDP across Country Groups, 1970–2020

Source: Data from Lane and Milesi-Ferretti (2018), updated through 2020, https://www.brookings.edu/ research/the-external-wealth-of-nations-database/.

Note: Income groupings for this figure are based on the 2019 World Bank classification. These data exclude small offshore financial centers in the Caribbean and Channel Islands.

emerging markets embarked on more limited, but still substantial, liberalization programs.<sup>3</sup>

One indicator of a country's global financial integration is the level of external assets and liabilities that it holds, measured as a ratio to GDP. Figure 1 plots these data for the world economy as a whole, as well as for three groups of countries: high-income, upper-middle income, and lower-middle plus low-income economies. These ratios increased markedly after the early 1970s, accelerating upward around the mid-1990s before continuing their advance at a slower rate after the global financial crisis of 2007–2009.

3. For historical perspectives on the evolution of the global capital market emphasizing economic and political drivers, see Obstfeld and Taylor (2017) and Obstfeld (2021).

Several facts stand out. For the advanced, high-income economies, external positions now exceed three times GDP on a weighted-average basis. In some cases, such as that of the United States, external positions are levered and subject to substantial currency mismatch, meaning that movements in equity prices, bond prices, and exchange rates—sometimes driven by waves in global investor sentiment—can effect sizable transfers of wealth from or to foreigners.

The two EMDE income groups hold broadly similar levels of external assets and liabilities, but lower-income countries hold fewer external assets and more liabilities, making many of them substantial net foreign debtors. If we measure average financial integration by external asset ratios, EMDEs are now where the high-income countries were around the late 1980s. Given more market and institutional fragility in many of these countries, however, increasing financial openness has brought greater vulnerability to capital market disturbances—as Calvo, Leiderman, and Reinhart (1996) highlighted and as we discuss further below. Much debt of low-income countries is owed to official creditors, of which China is now the biggest, and some official debts carry concessional terms.<sup>4</sup> But lower-income "frontier markets" are quite exposed to global financial shifts.

Short-term movements in exchange rates are driven by asset demand and supply changes that are reflected in financial account balance of payments flows. The greater importance of the financial account for exchange rate determination today owes to the huge volume of two-way traffic through foreign exchange markets to finance asset transactions, compared with the much more modest flows that would be the minimum necessary to finance current account imbalances alone.

Figure 2 offers one way to visualize the evolution in the external financing landscape. For the same groupings as in figure 1, figure 2 shows separately the sum of the included countries' current plus capital account surpluses and deficits—preponderantly balances of trade in goods, services, and investment income. The figure also shows separately global financial (often called capital) inflows, which are national residents' net incurrence of liabilities to foreign residents, and financial (or capital) outflows, which are national residents in the acquisition of claims on foreign residents. In principle, countries could finance their current account deficits with financial inflows just equal to those deficits (assuming no financial outflows) and dispose of their current

<sup>4.</sup> See Horn, Reinhart, and Trebesch (2019), whose estimates suggest that the size of China's official lending surpasses that of important multilateral institutions such as the World Bank and the IMF.



Figure 2. Global Current Account Imbalances and Financial Flows across Country Groups, 1980–2020

Source: International Monetary Fund, Balance of Payments Statistics.

Note: Income groupings for this figure are based on the 2019 World Bank classification. These data exclude small offshore financial centers in the Caribbean and Channel Islands.

account surpluses via financial outflows just equal to those surpluses.<sup>5</sup> As the figure shows, however, the volumes of two-way capital flows are much higher than that. Over the past decade, global capital inflows and outflows have been around \$5 trillion annually, while global current account imbalances have been a small fraction of that. The same pattern holds even for the richer EMDEs.<sup>6</sup> Financial flows ballooned to extreme levels everywhere before the global financial crisis, receding sharply as the crisis unfolded.

These high volumes of financial flows provide a potent channel for external disturbances to have an impact on domestic asset markets as well as the real economy. A rise in world demand for a country's assets, for example, will result in financial inflows as well as currency appreciation and higher asset prices. These price changes will reduce the current account balance over time, but more quickly, they act to moderate the initial incipient financial inflow and induce a financial outflow owing to the lower expected return on domestic assets. In the process, those whose appetite for the target country's assets has risen end up holding more of them, while those domestic or foreign residents who part with those assets end up holding more foreign bonds, loans, and equities. Notwithstanding ex post financial account credits and debits that are largely offsetting, the process is far from neutral, as it has an impact on net exports, domestic aggregate demand, inflation, and financial conditions.

#### I.B. Global Cycles and the Dollar

Research following the global financial crisis has documented that the world economy is subject to synchronized cycles in asset prices, leverage, and capital flows. Financial cycles are driven in part by US developments, including Federal Reserve monetary policy, but also have an important global component that channels actions by major non-US central banks.

5. In principle, global current account surpluses should equal global deficits and global financial inflows should equal global outflows. Errors and omissions in balance of payments data, sometimes large, mean that these equalities do not hold exactly in practice. Financial flows to upper-middle-income countries were supported during the early 2010s by advanced economy central banks' large-scale asset purchases, but fell sharply in 2015–2016 in the face of turmoil in China's equity and currency markets.

6. In addition, while financial inflows and outflows as reported in balance of payments statistics are often referred to as gross capital flows (the net balance of financial outflows less inflows being the current account balance), they are net measures. Financial inflows are foreign residents' purchases less sales of domestic assets, while financial outflows are domestic residents' purchases less sales of foreign assets. The true gross transaction levels are big multiples even of the gross flows shown in figure 2. For example, see the discussion of the United States' international financial transactions in Obstfeld (2022).

The nominal exchange rate of the dollar is a prominent correlate of global financial conditions, with a stronger dollar implying increased financial stringency globally.7 In EMDEs where there are significant private or public dollar liabilities, a stronger dollar tends to raise those liabilities' values, immediately impairing balance sheets and tightening financial and fiscal conditions. More than 80 percent of emerging markets' overall external debt liabilities are denominated in foreign currency, mostly US dollars (Financial Stability Board 2022), and in some countries, internal currency mismatch creates another potential fault line.8 Not only does a stronger dollar itself lead to tighter financial conditions by weakening debtor balance sheets, heightened risk aversion in world markets tends to appreciate the dollar as investors everywhere seek safety, implying another channel of negative correlation between dollar strength and EMDE macroeconomic performance. Episodes of high global liquidity are associated with a weak dollar and lead to capital inflows and credit expansion in EMDEs, but a prior buildup of vulnerabilities can crystallize abruptly when the global financial cycle turns and the dollar strengthens.<sup>9</sup>

Figure 3 shows the relationship between monthly levels of the nominal effective US dollar exchange rate and the global financial cycle index constructed by Miranda-Agrippino and Rey (2020), as extended and updated by Miranda-Agrippino, Nenova and Rey (2020). Their index is defined as the common global factor from a dynamic factor model of equity, corporate bond, and commodity prices from markets in North America, Latin America,

7. On the global financial cycle, see Rey (2013) and the recent survey by Miranda-Agrippino and Rey (2022). Both the cycle and the dollar's central role were highlighted by Bruno and Shin (2015a, 2015b) and Shin (2020), and have been explored in subsequent work by these authors along with others. Important contributions by Reinhart and Reinhart (2009) and Forbes and Warnock (2012) documented the cyclical behavior of international capital flows, which is also evident in figure 2. Jordà and others (2019) offer evidence of a global financial cycle among seventeen advanced economies over the past century and a half. They document that its intensity has been historically high since around 1990.

8. The Financial Stability Board estimate of external foreign currency debt liabilities does not cover China. However, the net external US dollar debt exposures of China's banks and nonfinancial firms are large and growing, as the Committee on the Global Financial System (2020) and Kodres, Shen, and Duffie (2022) document.

9. The procyclicality of capital flows to EMDEs has risen in recent years as nonbank lenders, notably investment funds, have come to play a bigger role compared with banks (Financial Stability Board 2022). While more sovereign issuance in domestic currencies has mitigated the classic "original sin" fiscal vulnerability due to dollar issuance, it can promote capital flow volatility because advanced country investors in sovereign bonds are exposed to currency risk in addition to duration risk when advanced country interest rates rise and induce rises in EMDE rates. Carstens and Shin (2019) characterize this interplay as "original sin redux." EMDE corporates continue to borrow extensively in US dollars.

**Figure 3.** Broad Nominal Dollar Index and Miranda-Agrippino and Rey Global Financial Cycle Index



Sources: Miranda-Agrippino, Nenova, and Rey (2020); Federal Reserve H.10 release (FRED ticker DTWEXBGS).

Note: The underlying currency weights are based on goods and services trade and are available at https://www.federalreserve.gov/releases/h10/weights/default.htm. The dollar index prior to 2006 is provided by von Beschwitz, Collins, and Datta (2019), the currency weights of which incorporate estimated services trade data.

Europe, and the Asia-Pacific region, including Australia. The correlation over the period since 2000 is quite negative, at –0.54. In the present millennium, tighter financial conditions have accompanied a stronger dollar.<sup>10</sup> Davis, Valente, and van Wincoop (2021) and Miranda-Agrippino and Rey (2022) show that common global factors in gross capital flows move closely with asset price factors.

Part of the mechanism underlying the negative correlation in figure 3 is a strong negative relationship between the dollar and global commodity prices, illustrated in figure 4. The correlation coefficient between the monthly

10. This levels relationship appears to be a medium-frequency one: the correlations between monthly changes are close to zero over the entire period in both the pre- and post-2000 subsamples. Over the entire sample period starting in 1980, the simple correlation coefficient between the levels of the two monthly series is positive at 0.47; and over the subperiod ending in 2000, it rises to a very high 0.79. These estimates could be misleading, however, because the coverage of the Miranda-Agrippino, Nenova, and Rey (2020) update in terms of both countries and assets is more limited before the late 1990s.



Figure 4. The Dollar and Dollar Commodity Prices

Sources: International Monetary Fund, Primary Commodity Prices; Federal Reserve H.10 release (FRED ticker DTWEXBGS).

Note: The underlying currency weights are based on goods and services trade and are available at https://www.federalreserve.gov/releases/h10/weights/default.htm. The dollar index prior to 2006 is provided by von Beschwitz, Collins, and Datta (2019), the currency weights of which incorporate estimated services trade data.

changes is –0.57 over the period from February 2003 to April 2022. Observe the difference in scales between the left-hand vertical axis measuring dollar movements and the right-hand axis measuring commodity price movements. A 1 percent appreciation of the dollar is associated with a much larger percentage fall in average global commodity prices. Thus, dollar commodity prices fall in real terms when the dollar strengthens. In itself, this change generally hurts commodity exporters among the EMDEs while benefiting importers, but it is not the only implication for these countries of a stronger dollar.<sup>11</sup>

One implication, as figure 5 shows, is that the growth in world trade volume is strongly negatively correlated with changes in the dollar's strength.

11. Obstfeld (2022) discusses the dollar–commodity price link in more detail. See also Druck, Magud, and Mariscal (2018). The IMF index in figure 4 is an average over many commodities that can move idiosyncratically. For example, dollar appreciation in 2022 has been driven partly by high oil and agricultural prices that have pushed up inflation and elicited contractionary central bank responses. Yet, as expectations of a recession have risen, other commodity prices (such as industrial metal prices) have fallen.



Figure 5. Dollar Appreciation and Growth in World Trade in Goods and Services

Sources: International Monetary Fund; Federal Reserve H.10 release (FRED ticker DTWEXBGS). Note: The underlying currency weights are based on goods and services trade and are available at https://www.federalreserve.gov/releases/h10/weights/default.htm. The dollar index prior to 2006 is provided by von Beschwitz, Collins, and Datta (2019), the currency weights of which incorporate estimated services trade data.

Partly this results simply from the importance of commodities in world trade—when their real prices fall, measured world trade volume contracts but there are several other important channels at work, including financial channels. One is the key importance of trade in investment goods, with world investment being strongly negatively correlated with the dollar.<sup>12</sup> Table 1 documents the negative year-by-year correlations of the dollar with world trade and investment—and their increased absolute size—after the year 2000. Given these patterns in the data, it is not surprising that dollar strength is also negatively correlated with growth in advanced economies and in EMDEs, as table 1 and figure 6 show. EMDE economic fortunes are even more tightly linked to the dollar than are those of the advanced economies. Financial as well as trade channels are at work for both sets of

<sup>12.</sup> The International Monetary Fund (2016) documents the link between global trade volume and investment. For further discussion of dollar-trade causation channels, see Bruno, Kim, and Shin (2018), Bruno and Shin (2021), and Obstfeld (2022).

Correlation with	1980–2021	1980–2000	2001–2021
World trade volume growth	-0.32	-0.39	-0.61
Growth in world investment/GDP share	-0.45	-0.32	-0.58
Advanced economy output growth	-0.05	-0.24	-0.36
EMDE output growth	-0.63	-0.56	-0.59

Table 1. Dollar Appreciation and Global Aggregates

Sources: World Economic Outlook Database, April 2022; Federal Reserve H.10 release.

Note: Exchange rates are year averages of the broad dollar nominal exchange rate from the Federal Reserve H.10 release. The underlying currency weights are based on goods and services trade and are available at https://www.federalreserve.gov/releases/h10/weights/default.htm. Pre-2006 currency weights incorporate estimated services trade data; see von Beschwitz, Collins, and Datta (2019) for details. The data series for the change in world investment begins in 1981. The numbers reported are simple correlation coefficients of percentage changes in the exchange rate index and a global aggregate growth rate.

Figure 6. The Dollar and GDP Growth in Advanced Economies and EMDEs



Sources: International Monetary Fund; Federal Reserve H.10 release (FRED ticker DTWEXBGS). Note: The underlying currency weights are based on goods and services trade and are available at https://www.federalreserve.gov/releases/h10/weights/default.htm. The dollar index prior to 2006 is provided by von Beschwitz, Collins, and Datta (2019), the currency weights of which incorporate estimated services trade data. countries, and the relative importance of these channels has changed over time with the growth, scope, and reach of international financial markets.

#### I.C. Financial Market Experience and Exchange Rates

Early macroeconomic models of policy transmission under floating exchange rates focused on induced changes in the current account balance, which largely determined whether policies would be transmitted positively or negatively abroad. An expansionary monetary policy, for example, would raise output and therefore spending on imports, imparting a positive stimulus abroad, whereas the accompanying currency depreciation might shift domestic demand away from imports while raising exports, imparting a negative impulse. In these models, the net effect on foreign aggregate demand would be positive if the expanding country suffered a reduction in its current account balance, but negative if the current account balance improved. Capital flows played an entirely supporting role, passively financing any current account imbalance at a global interest rate equalized to the domestic rate (when reckoned in a common currency) through a risk-neutral uncovered interest rate parity (UIP) condition. To the extent that policies by the United States played any unique role, it was due to the country's size-its share of global GDP-which gave its policies the power to affect foreign rates of interest.

While the preceding channels have remained important, they offer an increasingly incomplete picture of either policy transmission or exchangerate determination today. A half century after the move to floating, gross capital flows have expanded far beyond the needs of trade finance, and exchange rates must equilibrate these financial flows in the face of potentially large shifts in investor preferences and global asset supplies. Attention has therefore shifted to more-detailed accounts of the structure of international financial markets and the determinants of capital flows, along with the possibility that financial account drivers of exchange rates could appear dominant over short- and even medium-term horizons. The need to update exchange rate theories became more apparent after the global financial crisis. Since the crisis, frictions have become more salient in a range of financial markets, including international money markets, due to new financial regulations and changing business models.<sup>13</sup> The implications are especially

13. Early on, Dornbusch (1976) highlighted how exchange rates could react disproportionately to money supply shocks in models with sticky output prices, "overshooting" long-run positions even when investors have rational expectations and UIP holds. More recent models posit a role for possibly hard-to-observe financial market shocks, amplified by market frictions (Itskhoki and Mukhin 2021). important for EMDEs, where the shocks to global financial markets collide with shallower and more brittle financial systems, institutions, and policy frameworks.

An important strand of theorizing from the 1970s and 1980s, recently revived, is the portfolio balance approach to capital flows and exchange rate determination. This approach views demands in international asset markets as reflecting optimizing choices by risk-averse investors, following the work of James Tobin.14 UIP does not generally hold in these models, and uncovered interest arbitrage among currencies can offer positive or negative expected returns that depend on the covariance of returns with an appropriate stochastic discount factor (a risk premium). More recent models combine riskaverse investors with segmented financial markets where specialized traders operate. As in the main model of Gabaix and Maggiori (2015), departures from UIP can emerge even under risk neutrality if incentive constraints limit financial intermediaries' balance sheet sizes and thereby create limits to risk-neutral arbitrage. However, these models become even richer with risk-averse investors (Gabaix and Maggiori 2015; Itskhoki and Mukhin 2021). Another rationale for departures from UIP is based on the idea that bonds denominated in different currencies, and issued by different borrowers, may offer different degrees of liquidity. That additional "convenience yield" can compensate holders to some degree for a lower pecuniary return on the bond. Several studies have argued that US Treasury liabilities offer especially high convenience yields.15

A common theme in these models is that asset-demand functions are downward sloping: wealth owners will willingly absorb more of a particular bond onto their balance sheets only if its price falls, that is, if its expected yield rises. Downward sloping demand can be motivated by risk aversion, by the need for a bond's excess return to rise to compete for scarce balance sheet space, or by marginal convenience yields that diminish as the supply of a particular bond rises. Unlike in the UIP world, where bond demands are infinitely elastic, however, these models open the door to a

14. The approach was discussed in the pages of *Brookings Papers on Economic Activity* by Branson (1970), Kouri and Braga de Macedo (1978), and Dornbusch (1980), among others.

15. See, for example, Canzoneri and others (2008), Krishnamurthy and Vissing-Jorgensen (2012), Nagel (2016), and Del Negro and others (2017). Du and Schreger (2022) and Maggiori (2022) provide recent surveys of models with financial market imperfections. In these models, global risk-off episodes propagate through various channels, for example, increasing demand for asset safety and liquidity or, even in models where investors are risk neutral, constricting leverage due to tighter value-at-risk constraints (Adrian and Shin 2014). These different mechanisms may call for different policy responses to economic or financial shocks.

rich array of additional asset market shocks: to investors' risk aversion, to their appetite for safe assets or liquidity, to the stringency of financial constraints, to relative supplies of bonds in different currencies, or simply to non-optimizing behavior. Some of these shocks are driven by monetary policy, but they can arise independently of monetary policy or other central bank actions, and importantly, some appear to be major drivers of exchange rates.<sup>16</sup> A challenge for empirical work is to find measurable counterparts of these financial shocks.

Although financial shocks need not be driven by monetary policy, monetary policy can affect financial conditions in ways that propagate internationally. Ammer and others (2016) find that US monetary policy tightening transmits abroad primarily through a financial channel—long-term US interest rates rise with direct spillover effects on foreign long-term rates. The resulting contractionary impact on foreign activity is the main net effect of US policy, as the impact on the US current account balance is minimal.<sup>17</sup> Monetary policies may also spill abroad by other effects on financial conditions, for example, through interrelated effects on investor expectations, balance sheet constraints, leverage, and risk aversion. US monetary policy is especially powerful in this regard, as documented by Miranda-Agrippino and Rey (2022), among others. Kalemli-Özcan (2019) argues that hikes in the federal funds rate lower the risk tolerance of global investors (the risk-taking channel of monetary policy), with particularly strong effects on capital flows, credit spreads, and sovereign borrowing premia in EMDEs.

The special importance for the world of US policies and financial conditions is hard to rationalize in traditional models, other than through the United States' global GDP weight, an attribute broadly shared by the euro area and China. However, the US footprint in financial markets is proportionally much larger than its GDP weight, and its financial markets are the deepest anywhere. As of 2021, for example, US equity markets accounted for over 40 percent of global market cap, nearly four times larger than the second-place contender, China (SIFMA 2022). Outstanding US debt securities at the end of 2021, at \$49.3 trillion, were more than double those of

16. Among recent studies are Linnemann and Schabert (2015), Engel (2016), Krishnamurthy and Lustig (2019), Valchev (2020), Jiang, Krishnamurthy, and Lustig (2021), Engel and Wu (forthcoming), and Lilley and others (2022). Relative "outside" bond supplies in global markets may change in the absence of monetary policy changes through balance sheet operations by government entities (including sterilized foreign exchange interventions) or through government fiscal imbalances.

17. Obstfeld (2015) documents the strong co-movement of global nominal long-term interest rates.

40

60

80



Figure 7. The US Dollar's Disproportionate Share in Global Assets and Transactions

Source: Adapted from Committee on the Global Financial System (2020) with some updated data.

20

US share of world trade

US share of world GDP at market exchange rates

the euro area or China.<sup>18</sup> Moreover, the US dollar's roles in world portfolios and transactions are unrivaled and go far beyond the United States' shares in world output or trade, as illustrated in figure 7.<sup>19</sup> By large margins, the dollar is the world's premier funding, reserve, invoice, anchor, and vehicle currency, an important reason for the outsized impact of US monetary and financial conditions on global activity. That impact is especially intense for EMDEs, which generally are more vulnerable to foreign financial shocks owing to shallower and less developed foreign exchange and capital markets, weaker financial regulatory frameworks, balance sheet weaknesses, and shorter track records of credible macro policies.<sup>20</sup>

18. Bank for International Settlements, "Debt Securities Statistics," https://www.bis.org/ statistics/secstats.htm, accessed November 4, 2022.

19. An alternative source for recent data on the dollar's dominance is Bertaut, von Beschwitz, and Curcuru (2021). They analyze newer invoicing data assembled by Boz and others (2022) and find that the dollar's share in export invoicing is 96.3 percent in the Americas, 74.0 percent in the Asia-Pacific region, 23.1 percent in Europe, and 79.1 percent in the rest of the world. On the dollar's central and growing role in international bond markets, see Maggiori, Neiman, and Schreger (2020).

20. Gourinchas (2021) presents a comprehensive survey of the dollar's global roles. Models of the multiple network effects that underlie the dollar's unique position include Gopinath and Stein (2021), Chahrour and Valchev (2022), and Mukhin (2022). These types of models can also rationalize the dollar's exceptional liquidity or convenience yield. Bianchi, Bigio, and Engel (2021) model how the dollar's central role in international banking leads to a convenience premium and to dollar appreciation during global risk-off events. For theoretical models of US monetary policy transmission focusing on global safe dollar asset demand, see Canzoneri and others (2013), Jiang, Krishnamurthy, and Lustig (2020), and Kekre and Lenel (2021).

# II. Emerging Markets and the Dollar

In this section we estimate the response to nominal US dollar appreciation for a sample of twenty-six EMDEs spanning multiple regions. The results indicate that dollar appreciation shocks are broadly contractionary, predicting prolonged downturns with the severity of the negative effects dependent on country characteristics.

#### II.A. Methodology and Initial Findings

Our core econometric exercise investigates how emerging market economies respond to changes in the nominal foreign exchange value of the US dollar. We proceed through a set of panel local projections (Jordà 2005):

(1) 
$$y_{i,t+h} - y_{i,t-1} = \mu_{i,h} + \beta_h \Delta s_t + \gamma'_h \Delta z_t + \sum_{l=1}^p \delta'_{h,l} \Delta w_{i,t-l} + \varepsilon_{i,h,l}$$

We unpack equation (1) term by term. The dependent variable is the cumulative change in country *i*'s economic or financial variable *y* from quarter t - 1 to t + h, h = 0, ..., H. To understand the dollar's potentially pervasive influence on EMDEs more fully, we consider a wide range of economic indicators. To that end, we compile quarterly data for twenty-six EMDEs spanning the period from the late 1990s to 2019. While the makeup of our sample is largely dictated by data availability, it nonetheless covers about 90 percent of total 2021 EMDE GDP at market exchange rates and a time period that is reasonably uniform in terms of its high degree of global financial activity and integration. The data set includes information on national accounts, bilateral dollar exchange rates, related price indexes, terms of trade, domestic credit, equity prices, and interest rates. Here we report impulse responses for real GDP, investment, GDP deflator inflation, the bilateral exchange rate against the dollar, local currency equity prices, and the monetary policy interest rate. Online appendix A presents the full set of impulse response functions. Online appendix B provides a detailed report on the data sources for each country.

On the right-hand side of equation (1), a country- and horizon-specific intercept  $\mu_{i,h}$  accounts for unobserved country heterogeneity as well as for linear trends in *y*. Our choice of shock variables and controls merits a detailed discussion. To measure shocks to the dollar exchange rate,  $\Delta s_i$ , we consider innovations to the trade-weighted dollar index against a basket of advanced economy (AE) currencies, obtained from the Federal Reserve H.10

release.<sup>21</sup> Typical emerging market economies will have little direct influence over the bilateral exchange rates among AE currency pairs, making the nominal AE dollar index plausibly external to EMDEs once appropriate controls have been imposed to account for common shocks to the aggregate of EMDEs that could feed back into the dollar's broad exchange rate against other AEs. The impulse response function of *y* is represented by the set of coefficients  $\{\beta_k\}_{k=0}^{H}$ .<sup>22</sup>

As we demonstrate further in section III and as a large body of literature has affirmed, dollar movements are highly responsive to various global and US-specific factors. Shifts in US monetary policy and financial conditions, as well as changes in investors' risk perceptions, can drive the dollar. At the same time, some of these factors are also endogenous and could respond to common shocks that hit the United States and foreign economies, including EMDEs. By including a vector of additional global controls  $\Delta z$ , in equation (1), we get closer to a dollar shock component that is external to EMDE developments while allowing that other potential determinants of EMDE dynamics simultaneously have effects. Within  $z_{i}$ , we include US monetary policy as represented by the effective federal funds rate when the latter is positive and the Wu and Xia (2016) shadow rate during the zero lower bound period. As a way to control for US financial conditions, we adopt a factor-augmented approach by including in z, the Federal Reserve Bank of Chicago's Adjusted National Financial Conditions Index (ANFCI). The index is constructed from a dynamic factor model of more than one hundred measures of financial activity in the United States and filters out the influence of overall economic activity and inflation.<sup>23</sup> In section III, we take a broader view and show that the dollar correlations reported in section I reflect the dollar's dependence on a range of shocks that potentially affect EMDEs.

Taken as a group, EMDEs are large enough that common EMDE shocks could potentially move the dollar exchange rate relative to other AEs. To reduce feedback from individual country outcomes to the dollar exchange

21. The currencies included in the Nominal Major Currencies U.S. Dollar Index (FRED ticker DTWEXM) are the euro, Japanese yen, Canadian dollar, UK pound sterling, Swiss franc, Australian dollar, and Swedish krona. We use quarter-end observations of the index with merchandise trade weights. We also check that our results are robust if we use quarterly averages of the index instead.

22. Using the terminology in Stock and Watson (2018),  $\{\beta_h\}_{h=0}^H$  measures the cumulative impulse responses for first differences of the dependent variable.

23. For details on the ANFCI, see Brave and Kelley (2017). Our estimates are robust to alternative timing assumptions, in particular, if we control only for the lagged values of the US policy rate and financial conditions index.

rate through this channel, we control for aggregate economic activity in the EMDE bloc. Using a dynamic factor model like the one that underlies the ANFCI, we extract a common dynamic real GDP factor from an unbalanced quarterly panel of more than sixty EMDE countries. The intent of this additional global control, also included in  $\Delta z_p$  is to capture EMDE business cycle fluctuations at a reasonably high frequency.<sup>24</sup>

Equation (1) also includes the vector of lagged controls  $\Delta w_{i,t-l} \equiv (\Delta s_{t-l}, \Delta z_{t-l}, \Delta q_{i,t-l})'$ , l = 1, ..., p, where the country-specific local controls  $\Delta q_{i,t-l}$  comprise lags of  $y_{i,t}$  as well as lags of additional country-specific economic indicators.<sup>25</sup> By lagging the local controls by one period, we implicitly make an ordering assumption: global controls and dollar shocks have instantaneous impacts on emerging economy variables, but the effects of EMDE economic and financial variables, including the policy responses to the dollar shock, themselves arrive with a lag.<sup>26</sup>

Our LP approach builds on several earlier contributions, all of which are informative but narrower than our analysis in various ways. Liu, Spiegel, and Tai (2017) explicitly apply a factor-augmented vector autoregressive (FAVAR) analysis to Korea, Japan, and China, but they display impulse responses based on a Cholesky ordering that precludes impact effects of dollar movements. Avdjiev, Bruno, and others (2019) include the nominal effective dollar in a panel vector autoregression (VAR) but examine a limited set of variables with no controls for global demand. Eguren Martin, Mukhopadhyay, and van Hombeeck (2017) and Hofmann and Park (2020) come closer to our suggested method but examine a limited range of response variables. Eguren Martin, Mukhopadhyay, and van Hombeeck (2017) focus on growth outcomes only, while Hofmann and Park (2020) are largely concerned with the dollar's connection with expected distributions of future investment and exports. The closest precursor to our approach is Shousha (2022), who investigates the EMDE response to dollar shocks through a

24. Online appendix B provides an overview of the model and estimation method. Figure A7 plots our estimated dynamic emerging market demand factor.

25. Specifically, we include lagged quarterly changes in real GDP, the bilateral exchange rate against the US dollar, and the policy interest rate. As these controls have long data series often extending back to the 1980s, we ensure that our LP procedure utilizes as much data as possible, while avoiding over-parameterizing the model by including too many controls. Our estimate corresponds to the "lag-augmented" LP estimator of a VAR(p) model for the data (y, q, s, z)' (Montiel Olea and Plagborg-Møller 2021). The lag-augmented approach allows us to compute Eicker-Huber-White standard errors for robust inference over potentially nonstationary data. We choose a conservative VAR lag by setting p equal to four quarters.

26. Plagborg-Møller and Wolf (2021) discuss the implementation of structural vector autoregressive (SVAR) restrictions in local projections.

VAR model. While our findings in this section are broadly similar and complementary, we push our analysis further in several ways. We use a flexible yet robust LP approach on a larger country sample and examine a wider range of EMDE outcome variables. By focusing on the dollar's exchange rate against AEs only and adding factor-augmented controls, we obtain a sharper identification of dollar shocks that are external to developments in EMDEs. Like Shousha (2022), we also consider potential country-level heterogeneity in the transmission of dollar shocks. As will be clear in section II.B, our state-dependent LP estimation is more flexible in explicitly accommodating time variation in policy regimes and balance sheet exposures.

Figure 8 shows the average response to a 10 percent dollar appreciation in our EMDE sample. We report impulse response functions as well as 68 percent and 90 percent confidence bands. In response to the dollar shock, real GDP falls, reaching a trough of about -1.5 percent relative to trend after about eight quarters. In line with this output response, investment also falls. Year-over-year inflation in the GDP deflator falls over four quarters before starting to recover. The domestic currency depreciates immediately against the dollar. This bilateral depreciation continues subsequently, reversing partially only after output bottoms out. In online appendix A.1, we show that in line with a contraction in global trade, export and import prices both decline. However, export prices lose more ground than import prices, so the terms of trade deteriorate and reinforce other contractionary forces on spending. For indicators of financial market responses, the central bank policy rate is estimated to rise marginally on impact and subsequently it rises further for about two years. While this estimate is not statistically significant until several quarters have passed, there are additional financial repercussions through a sharp fall in equity prices, as well as a rise in the emerging markets bond index (EMBI) spread on sovereign dollar borrowing and a decline in nominal domestic credit (both shown in online appendix A.1). These all contribute to the overall contractionary impact of the dollar shock.27

27. Adopting the Gorodnichenko and Lee (2020) methodology for variance decompositions in LPs, we find an important role for dollar shocks in explaining the dynamics of macro aggregates in our sample of emerging market economies. For consumption, exports, and aggregate output, the shares explained by dollar shocks reach 25 to 30 percent after two quarters. On the financial side, dollar appreciation explains around 20 percent of equity price variance after eight quarters.

Figure 8. Impulse Response: 10 Percent Appreciation of Advanced Economies' Dollar Index





Note: The impulse response functions of EMDE economic and financial variables to a 10 percent appreciation of the dollar exchange rate against a basket of advanced economy currencies, based on the local projection, equation (1). For regressions involving the GDP deflator, country-quarter observations with a year-over-year change greater than 50 percent are dropped. Equity prices are local currency stock market indexes. Heteroskedasticity-robust 90 percent and 68 percent confidence bands are reported.

#### II.B. Dollar Shocks and Country Heterogeneity

Following a series of studies starting with Ramey and Zubairy (2018), we extend our LP framework to allow the impact of dollar shocks to differ based on predetermined characteristics or "states" of EMDEs. Formally, we estimate the following panel LP with state dependence:

(2) 
$$y_{j,t+h} - y_{j,t-1} = I_{j,t-1} \times \left[ \mu_{A,j,h} + \beta_{A,h} \Delta s_t + \gamma'_{A,h} \Delta z_t + \sum_{l=1}^{p} \delta'_{A,h,l} \Delta w_{j,t-l} \right] + \left( 1 - I_{j,t-1} \right) \times \left[ \mu_{B,j,h} + \beta_{B,h} \Delta s_t + \gamma'_{B,h} \Delta z_t + \sum_{l=1}^{p} \delta'_{B,h,l} \Delta w_{j,t-l} \right] + \varepsilon_{j,h,t}.$$

The indicator function  $I_{j,t-1}$  takes the value 1 if country *j*'s economy is in state *A* on date t - 1 (that is, prior to the shock realization  $\Delta s_t$ ) and 0 if it is in state *B*.<sup>28</sup> The slope coefficients associated with  $I_{j,t-1} \cdot \Delta s_t$  in state *A*,  $\{\beta_{A,h}\}_{h=0}^H$ , can be interpreted as the impulse response function conditional on the economy being in that state and similarly for  $\{\beta_{B,h}\}_{h=0}^H$  and state *B*.

Ex ante policy regimes and external balance sheet exposure to dollar movements define states of the economy prominent in policy discussions of EMDEs' vulnerability to dollar shocks. We consider three dimensions of country heterogeneity: flexibility of the exchange rate, whether the central bank is an inflation targeter (as a proxy for monetary policy credibility), and the degree of dollar denomination of liabilities to foreigners.

The findings in this section should be interpreted with caution because countries are not allocated randomly among policy or financial regimes. Perhaps countries with different degrees of foreign dollar liability exposure also differ in other respects. For example, if countries with more dollar exposure also trade more with the United States, their trade might be affected more strongly by dollar shocks for reasons unconnected with financial structure. Another potential bias comes from the endogeneity of policy regimes. Some countries might choose their exchange rate regime with an eye toward minimizing impacts from the external shocks that they face. In that case, we might underestimate the contrasts between more and less flexible exchange rate regimes. Countries that adopt inflation targeting

28. In the international macro literature, Ben Zeev (2019) uses a state-dependent LP framework to study the interaction between international credit supply shocks and the exchange rate regime. Recent work by Gonçalves and others (2022) establishes the validity of the state-dependent LP approach, in particular if the state indicators depend only on lagged endogenous variables. As our discussion suggests, our choices of states are likely to satisfy that requirement. might simply be those endowed with a range of other institutional features that would enhance macro stability even without a formal inflation target.

EXCHANGE RATE FLEXIBILITY Countries with more exchange rate flexibility have an extra degree of freedom to respond to global shocks. The exchange rate itself is to some extent a two-edged weapon: depreciation in the face of a negative external impulse can raise aggregate demand for domestic goods through the net export channel and also raise trade-oriented firms' demand for labor and new capital, but it may damage balance sheets with contractionary effects.<sup>29</sup> However, a flexible exchange rate frees the central bank to move policy interest rates independently of foreign rates so as to stabilize the economy, and it removes the need for measures to defend a pegged exchange rate against speculative attacks.<sup>30</sup>

Rey (2013) argued that the global financial cycle to some degree renders the choice of exchange rate regime for EMDEs moot, since even a floating rate cannot repel financial shocks coming from advanced financial markets. However, a number of empirical studies suggest that even for EMDEs, more flexible regimes mitigate the adverse effects of various global shocks like the dollar shock responses we documented above, even if they do not fully offset them. We will add support to that view.<sup>31</sup>

We define countries as having exchange rate pegs according to Ilzetzki, Reinhart, and Rogoff's (2019) classification. In our application, we consider an exchange rate as pegged when it is either a fixed peg or a crawling peg with narrow bands in the final month of a quarter.<sup>32</sup> Other countries, either

29. Even when exports are invoiced in dollars, so that domestic currency depreciation does not immediately lower export prices for foreigners and thereby spur higher foreign demand, exporter profits rise, encouraging hiring, consumption, and investment.

30. Kalemli-Özcan (2019) makes a related argument. She shows that a contractionary US monetary shock raises the required excess return on EMDE bonds, a contractionary effect. Under a flexible exchange rate, this risk premium increase is achieved in part through an immediate currency depreciation. Under a pegged exchange rate, however, a sharper domestic monetary contraction would be needed to achieve the same risk premium rise, with even more damage to the economy.

31. For example, Obstfeld, Ostry, and Qureshi (2019) consider shocks to the CBOE S&P 100 Volatility Index (VXO, the precursor of the VIX); Loipersberger and Matschke (2022) consider shocks to the CBOE Volatility Index (VIX); Ben Zeev (2019) considers shocks to the EBP; and Degasperi, Hong, and Ricco (2021) consider shocks to US monetary policy. Gourinchas (2018) estimates a model of the Chilean economy incorporating potential expansionary and contractionary channels of peso depreciation and concludes that, on balance, exchange rate flexibility supports the central bank's stabilization efforts.

32. That is, our pegs have coarse classification codes 1 and 2 (Ilzetzki, Reinhart, and Rogoff 2019). Loipersberger and Matschke (2022) also adopt this definition of a pegged rate. Emerging European economies whose currencies are anchored or pegged to the euro are regarded as having a flexible exchange rate against the dollar. Observations designated as a "free-falling" or "dual-market" exchange rate regime are dropped from our analysis.

freely floating their currencies or having relatively more flexible currency managements, are labeled as floaters.

Figure 9 shows the response to a 10 percent dollar appreciation according to the flexibility of the exchange rate regime. GDP and investment fall more sharply for countries with exchange rate pegs, consistent with the idea that exchange rate flexibility helps buffer dollar shocks. There is a significant fall in the GDP deflator for pegs. The stock market also drops more sharply in pegs. Countries with exchange rate pegs are more likely to raise their policy interest rates in the short run and over time to maintain their exchange rates, possibly contributing to the deflationary force of the dollar shock. In contrast, countries with floats do not tighten monetary policy in response to contractionary dollar shocks.<sup>33</sup> Countries with pegs display a smaller currency depreciation over the first year or so (as one would expect) and bigger falls in export prices and the terms of trade (see online appendix A.1).<sup>34</sup>

The general picture that emerges is one in which countries with more exchange rate flexibility do better in coping with the external shock of dollar appreciation.

MONETARY POLICY CREDIBILITY Flexible exchange rates can also promote macroeconomic stability by enhancing monetary autonomy and thereby allowing the adoption of a credible inflation-targeting regime. Moreover, when monetary policy is credible, a central bank can allow exchange rate fluctuations to buffer the economy against foreign shocks with less worry about de-anchoring inflation expectations or rapid exchange rate pass-through to domestic prices (Bems and others 2021). Thus, we expect that inflationtargeting EMDEs may fare better in the face of dollar shocks from abroad. In defining the inflation-targeting state indicator for our estimates, we adopt

33. De Leo, Gopinath, and Kalemli-Özcan (2022) document that EMDE central banks with more flexible exchange rates cut their policy interest rates in response to instrumented US monetary policy shocks (Gertler and Karadi 2015) and argue that EMDE monetary responses have therefore tended to be countercyclical, consistent with the findings on sudden capital inflow stops in Eichengreen and Gupta (2018). However, our notion of dollar shocks is broader than that of Gertler and Karadi (2015), which accounts for only a small share of dollar variability, or sudden stops.

34. As the online appendix also shows, domestic credit rises initially in countries with pegs, which could reflect a countercyclical policy attempt under the constraint of a peg. Remember that our definition of "peg" includes crawling bands, which therefore may respond to shocks over time. Export prices would fall less for floaters if, as the data in Boz and others (2022) suggest is true for many EMDEs, exports are invoiced in dollars, so that a depreciation of the domestic currency against the dollar pulls their domestic-currency prices up relative to the case of pegs.





Source: Authors' calculations.

Note: The impulse responses of EMDE economic and financial variables to a 10 percent dollar appreciation against a basket of advanced economy currencies, conditional on the exchange rate regime. Estimates are derived from the state-dependent local projection, equation (2). The state indicator  $I_{t-1}$  is defined based on the IIzetzki, Reinhart, and Rogoff (2019) (IRR) exchange rate regime one quarter prior to the current quarter *t*. A country is considered to have a floating exchange rate ( $I_t = 1$ ) if it is assigned an IRR coarse regime code of 3 or 4 in quarter *t*. Countries with a pegged exchange rate have an IRR coarse regime code of 1 or 2. The figure plots 68 percent robust standard error bands. For regressions involving the GDP deflator, country-quarter observations with year-over-year change greater than 50 percent are dropped. Equity prices are local currency stock market indexes.

the classification of Ha, Kose, and Ohnsorge (2021), which is based on the IMF's *Annual Report on Exchange Arrangements and Exchange Restrictions* database.<sup>35</sup>

Figure 10 shows how the impulse responses differ depending on the monetary regime. For macro aggregates such as real GDP and investment, the results are broadly similar to the pegged/float comparison in figure 9. In non-targeters, however, there is more deflation over time, the bilateral currency depreciation against the dollar is greater over time, and the stock market slump is deeper. Non-targeters raise their policy interest rates, which is consistent with a stronger deflationary response. In online appendix A.1, we show that the terms of trade evolve similarly for the two groups. In addition, non-targeters see a bigger contraction in domestic credit and soon see rises in their EMBI spreads.

DOLLAR LIABILITIES Finally, EMDEs with large dollar-denominated liabilities are potentially vulnerable to unexpected domestic currency depreciation against the dollar that increases real debt burdens. Less dollarization of external liabilities should mitigate the procyclical effects of dollar movements on domestic balance sheets and financial conditions (especially when the exchange rate is more flexible).

We use Bénétrix and others' (2019) estimates of the currency composition of external positions to gauge the role of external balance sheet exposure to adverse dollar appreciation. The indicator  $I_{j,t-1}$  takes the value 1 if during year t - 1, country *j*'s dollar-denominated portfolio liabilities as a share of GDP exceed the median over all country-time observations in our twenty-six-country sample.

Figure 11 shows that when the dollar appreciates, countries with higher external dollar exposure suffer bigger declines in GDP after about four quarters. Incongruously, investment is predicted to rise initially and remain higher in high-exposure countries. High-exposure countries eventually experience greater depreciation against the dollar and see steeper equity-price declines and bigger hikes in policy rates. Online appendix A.1 reports that high-exposure countries suffer a significantly larger adverse terms of trade change, and also display slower domestic credit growth after about four quarters. Finally, high-exposure countries experience persistently higher EMBI sovereign spreads.

<sup>35.</sup> Our data on monetary regimes and dollar liabilities (see the next subsection) run until the end of 2017.

Figure 10. Impulse Response: 10 Percent Appreciation of Advanced Economies' Dollar Index, by Monetary Regime



Source: Authors' calculations.

Note: The impulse responses of EMDE economic and financial variables to a 10 percent dollar appreciation against a basket of advanced economy currencies, conditional on the monetary policy regime. Estimates are derived from the state-dependent local projection, equation (2). The state indicator  $I_{t-1}$  is defined based on the classification of Ha, Kose, and Ohnsorge (2021). A country is in state  $I_{t-1} = 1$  only if it practices inflation targeting in the previous year. The figure plots 68 percent robust standard error bands. For regressions involving the GDP deflator, country-quarter observations with year-over-year change greater than 50 percent are dropped. Equity prices are local currency stock market indexes.



Figure 11. Impulse Response: 10 Percent Appreciation of Advanced Economies' Dollar Index, by Dollar Liability to GDP

Source: Authors' calculations.

Note: The impulse responses of EMDE economic and financial variables to a 10 percent dollar appreciation against a basket of advanced economy currencies, conditional on the degree of balance sheet exposure to the dollar. Estimates are derived from the local projection, equation (2). The state indicator  $I_{I-1}$  is based on the cross-border currency exposure data set of Bénétrix and others (2019). A country is in state  $I_{I-1} = 1$  if its external dollar liabilities as a share of GDP in the previous year exceed the median of all country-quarter observations. The figure plots 68 percent robust standard error bands. For regressions involving the GDP deflator, country-quarter observations with year-over-year change greater than 50 percent are dropped. Equity prices are local currency stock market indexes.

SUMMARY More exchange rate flexibility, an inflation-targeting monetary framework, and lower dollar liabilities to foreigners all generally strengthen an emerging economy's defenses against a dollar appreciation shock. Other features of an economy can be important as well. Shousha's (2022) findings suggest that lower dollar invoicing of exports and greater integration into global value chains enhance macro stability. He reports similar results to ours concerning exchange rate flexibility and monetary policy credibility.

We have also examined the role of openness to cross-border financial flows, asking whether restrictions on capital flows enhance resilience to external dollar shocks. Using the Chinn and Ito (2006) de jure measure of financial openness, we examined the response to a dollar shock in EMDEs with relatively open and closed financial accounts.<sup>36</sup> Capital flow restrictions appear to make little difference for the effects on real variables or the exchange rate, but countries with higher openness experience bigger rises in short-term interest rates and EMBI spreads, along with a significantly bigger fall in domestic credit. This evidence needs to be interpreted with caution, but it suggests that the stabilization benefits from capital controls may be smaller than those from exchange rate flexibility, credible monetary policy, and avoidance of external dollar liabilities.<sup>37</sup>

# III. Financial Determinants of the Dollar Exchange Rate

Movements in the US dollar's effective nominal exchange rate against advanced economies clearly have an impact on EMDEs. The dollar's influence appears stronger in countries with more rigid exchange rate regimes, less credible monetary frameworks, and more foreign currency external debt. Those findings give a partial insight into the correlations of EMDE

36. We classify a country as relatively open if its normalized Chinn-Ito score, ranging from 0 (most closed) to 1 (most open), exceeds 0.5. For example, Indonesian measures pushed the country from a score of 0.70 in 2010 to 0.42 in 2011; Brazil moved from 0.48 in 2005 to 0.54 during 2006–2009 and as far down as 0.16 by 2015.

37. Even for China, which maintains a relatively high level of capital flow controls but manages its exchange rate, the annual correlation between real output growth and nominal dollar appreciation is -0.50 over 1999–2021. Over the same period, the correlation of China's growth rate with that of EMDEs other than China (based on the IMF's PPP-weighted growth measure) is about -0.8. A more granular treatment of controls would differentiate between inflow and outflow controls. Consistent with our findings, Klein and Shambaugh (2015) find that capital controls, unless extensive, do little to enhance the efficacy of monetary policy. Loipersberger and Matschke (2022) conclude that capital controls can yield stabilization benefits for EMDEs with pegged, but not floating, exchange rate regimes.

activity with the dollar reported in section I. Insight into the channels of dollar influence comes from identifying shocks that drive the broad nominal dollar.

## III.A. Modeling the Dollar's Exchange Rate against Advanced Economies

To model the dollar's exchange rate against advanced economies, we follow Engel and Wu (forthcoming) and start with a modified interest parity relationship.<sup>38</sup> Let *s* denote the log dollar exchange rate, defined as the foreign currency price of the dollar, so that a rise in *s* is an appreciation of the dollar. Let  $i_t^L$  denote the interest rate per period on a short-term market dollar instrument, for example, the London Interbank Offered Rate (LIBOR), and  $i_t^{L*}$  the interest rate per period on a comparable foreign currency instrument. The classic UIP condition, based on risk neutrality, full arbitrage, and rational expectations, is written:

(3) 
$$i_{t}^{L*} - \left(i_{t}^{L} + \mathbb{E}_{s_{t+1}} - s_{t}\right) = 0.$$

There is extensive evidence against this simple form of interest parity. We modify it by introducing two additional factors. Let  $\rho_t$  denote an equilibrium excess return on the trade in which one borrows dollars and invests in interest-bearing foreign currency assets. As noted above, the excess return may result simply from optimization under risk aversion, in which case it might reflect the covariance of the dollar's value with a stochastic discount factor, but it could alternatively be a required net return on investment determined by incentive constraints (Gabaix and Maggiori 2015) or a combination of these elements (Gabaix and Maggiori 2015; Itskhoki and Mukhin 2021). Also in play might be heterogeneous expectations that diverge from well-informed rational expectations. We denote by  $\lambda_t^s$  an additional liquidity or convenience yield on the dollar instrument (relative to foreign currency instruments) owing to the dollar's unique global role. The modified UIP condition would then read:

$$i_{\iota}^{L*}-\left(i_{\iota}^{L}+\mathbb{E}_{\iota}s_{\iota+1}-s_{\iota}\right)=\rho_{\iota}+\lambda_{\iota}^{s}.$$

38. Exchange rate models of the 1970s, such as Dornbusch (1976), also started from interest parity but, in monetarist fashion, emphasized relative money supplies as an ultimate driver of relative interest rates and thereby of exchange rates. More recent models recognize interest rates as instruments of monetary policy and therefore as direct drivers of exchange rates. We take that approach here.

This equation can be solved forward to express the exchange rate's current level in terms of expected future interest rate differences, excess returns, dollar liquidity shocks, and a terminal exchange rate:

(4) 
$$s_{t} = \sum_{s=0}^{k-1} \mathbb{E}_{t} \left( i_{t+s}^{L} - i_{t+s}^{L*} \right) + \sum_{s=0}^{k-1} \mathbb{E}_{t} \left( \rho_{t+s} - \lambda_{t+s}^{s} \right) + \mathbb{E}_{t} \left( s_{t+k}^{L} \right).$$

A skeptical view of equation (4) would be that the composite term  $\rho_t + \lambda_t^s$  is "dark matter" that tautologically gives an interest parity–based theory of the exchange rate empirical validity. The theory acquires content from measurable correlates of  $\rho_t$  and  $\lambda_t^s$  that can be justified by empirically persuasive models. In general, it is challenging to identify effects of the two shocks individually, as they surely are driven by common factors. For example, a rise in global safe asset demand due to higher risk aversion could be associated with a simultaneous tightening of balance sheet constraints and rise in the marginal convenience value of dollars, leading to positive co-movement in  $\rho_t$  and  $\lambda_t^{s, 39}$ 

Further insights into the determinants of exchange rates come from considering the liquidity advantages of safer government-issued bonds compared with privately issued market instruments. We denote by  $i_t(i_t^*)$  the US (foreign) short-term central government bond yield. If  $i_t^L - i_t(i_t^{L*} - i_t^*)$  is taken to measure the marginal liquidity yield on the US Treasury (foreign government) liability, then we may take:

$$\gamma_t \equiv i_t^L - i_t - \left(i_t^{L*} - i_t^*\right)$$

as a measure of relative Treasury liquidity, as suggested by Engel and Wu (forthcoming). Importantly,  $\gamma_t$  differences out the pure relative liquidity value of dollar denomination captured by  $\lambda_t^s$ . The last definition, together with equation (4), allows us to express the exchange rate in terms of relative government bond yields as:

(5) 
$$s_{t} = \sum_{s=0}^{k-1} \mathbb{E}_{t} (i_{t+s} - i_{t+s}^{*}) + \sum_{i=0}^{k-1} \mathbb{E}_{i} (\rho_{t+s} + \lambda_{t+s}^{s} + \gamma_{t+s}) + \mathbb{E}_{i} (s_{t+k}).$$

Equation (5) will provide one basis for our empirical study of correlates of the dollar's exchange rate, but there are two other versions of the exchange

<sup>39.</sup> As Krishnamurthy and Lustig (2019) put it, convenience yields are relevant even when intermediaries are unconstrained, but "innovations to the convenience yield are certainly correlated with shocks to the financial sector" (456).

rate equation that provide complementary perspectives. Let  $i_i^{(k)}(i_i^{(k)*})$  be the *k*-period long-term Treasury (foreign government bond) zero coupon yield. According to a standard approximation,  $i_i^{(k)}$  is related to the path of expected future short rates by:

$$i_{t}^{(k)} = \frac{1}{k} \sum_{s=0}^{k-1} \mathbb{E}_{t}(i_{t+s}) + \tau_{t}^{(k)},$$

where  $\tau_t^{(k)}$  is the term premium on a *k*-period US government bond. A corresponding equation involving the foreign term premium  $\tau_t^{(k)*}$  holds for the foreign government bond. Using the term structure relationships, we express equation (5) as:

(6) 
$$s_{t} = k \left( i_{t}^{(k)} - i_{t}^{(k)*} \right) - k \left( \tau_{t}^{(k)} - \tau_{t}^{(k)*} \right) + \sum_{t=0}^{k-1} \mathbb{E}_{t} \left( \rho_{t+s} + \lambda_{t+s}^{s} + \gamma_{t+s} \right) \\ + \mathbb{E}_{t} \left( s_{t+k} \right).$$

A final relationship comes from explicitly considering cross-currency arbitrage in long-term bonds. Denoting the annualized excess return and liquidity factors on *k*-period long-term government bonds by  $\rho_{t+s}^{(k)}$ ,  $\lambda_{t+s}^{(k)s}$ , and  $\gamma_{t+s}^{(k)}$ , we translate the longer-term interest parity relationship into an expression for the current spot exchange rate:

(7) 
$$s_{t} = k \left( i_{t}^{(k)} - i_{t}^{(k)*} + \rho_{t}^{(k)} + \lambda_{t}^{(k)*} + \gamma_{t}^{(k)} \right) + \mathbb{E}_{t} \left( s_{t+k} \right).$$

Equations (5), (6), and (7) lead to different (but related) estimation specifications, given empirical stand-ins for the deviations from strict UIP.<sup>40</sup> For example, let  $\Delta$  denote a first difference (which in practice will be a three-month or one-year first difference resulting in overlapping monthly observations).<sup>41</sup> Equation (5) suggests the specification:

(8) 
$$\Delta s_{t} = \alpha + \beta_{1} \Delta (i_{t} - i_{t}^{*}) + \beta_{2} \Delta \rho_{t} + \beta_{3} \Delta \lambda_{t}^{s} + \beta_{4} \Delta \gamma_{t} + X_{t-1} \delta + \varepsilon_{t},$$

where  $X_{t-1}$  contains lagged (by three or twelve months) levels of the included variables, as well as lagged variables useful in predicting the

40. We will not attempt to explore the constraint implied by equations (6) and (7), that  $\rho_{t}^{(k)} + \lambda_{t}^{(k)s} + \gamma_{t}^{(k)} = \frac{1}{k} \sum_{s=0}^{k-1} \mathbb{E}_{t} (\rho_{t+s} + \lambda_{t+s}^{s} + \gamma_{t+s}) - (\tau_{t}^{(k)} - \tau_{t}^{(k)*}).$ 

41. This practice is also adopted by Hansen and Hodrick (1980), Greenwood and others (2020), and Dahlquist and Söderlind (2022), among others. We further ensure consistency with theory by matching the tenors of interest rates and currency bases wherever possible.

included first differences. The error term  $\varepsilon_t$  contains the expectations innovation  $\mathbb{E}_{t}s_{t+k} - \mathbb{E}_{t-1}s_{t+k}$ , likely to be small for large *k*, as well as any omitted date *t* shocks explaining revisions to the right-hand side of equation (5). While equation (8) therefore cannot be viewed as a structural relationship, it still yields useful information on the empirical correlates of dollar movements. One variable we include in the matrix  $X_{t-1}$  is the lagged log real exchange rate, which Eichenbaum, Johannsen, and Rebelo (2021) find to be a powerful predictor of future changes in the nominal exchange rate.<sup>42</sup> Using equation (6) and an approximation suggested by Du, Pflueger, and Schreger (2020), we derive an alternative regression equation:<sup>43</sup>

(9) 
$$\Delta s_{t} = \alpha + \beta_{1}k\Delta(i_{t}^{(k)} - i_{t}^{(k)*}) + \beta_{2}k(\tau_{t}^{(k)} - \tau_{t}^{(k)*}) + \beta_{3}\Delta\rho + \beta_{4}\Delta\lambda_{t}^{s} + \beta_{5}\Delta\gamma_{t} + X_{t-1}\delta + \varepsilon_{t},$$

where we replace the short-term government yield differential in the lagged control  $X_{t-1}$  by the long-term government yield differential and the term premium differential.

Finally, equation (7) suggests the formulation:

(10) 
$$\Delta s_{t} = \alpha + \beta_{1}k\Delta(i_{t}^{(k)} - i_{t}^{(k)*}) + \beta_{2}k\Delta\rho_{t}^{(k)} + \beta_{3}k\Delta\lambda_{t}^{(k)*} + \beta_{4}k\Delta\gamma_{t}^{(k)} + X_{t-1}\delta + \varepsilon_{t}.$$

Empirical exchange rate studies have generally focused on short-term interest rates as in equation (8), but large-scale central bank purchases of long-term bonds since the global financial crisis have rekindled interest in the role of long-term rates, as captured in equations (9) and (10). Models by Greenwood and others (2020) and Gourinchas, Ray, and Vayanos (2022), for example, argue that increases in a country's supply of long-term government bonds will push long-term interest rates up and appreciate its currency,

43. In particular, we approximate  $i_i^{(k+1)}$  by  $i_i^{(k)}$  and  $\tau_i^{(k+1)}$  by  $\tau_i^{(k)}$  at quarterly and yearly horizons. Intuitively, the yield curve at long tenors is relatively flat.

<sup>42.</sup> We take no stand on whether the nominal exchange rate log level is a stationary or nonstationary random variable. Jiang, Krishnamurthy, and Lustig (2021) assume it is stationary, whereas Engel and Wu (forthcoming) assume it is not, and both agree that the real exchange rate is stationary, if highly persistent. Itskhoki (2021), on the other hand, argues that real exchange rates are nonstationary. Mindful that our exchange rate equations are not structural, we would nonetheless assume that revisions to nominal exchange rate expectations far in the future have minimal correlation with current financial variables, for which stationarity is sufficient but not necessary.

whereas central bank purchases (which withdraw bonds from the market) will result in lower long-term rates and depreciation. In contrast, the analyses in Krishnamurthy and Lustig (2019) and Jiang, Krishnamurthy, and Lustig (2021) suggest that increases in US long-term bond supplies could push the currency down by reducing the marginal convenience yields represented by  $\gamma_t^{(k)}$  and  $\lambda_t^{(k)s}$  in equation (7).

We will not try to resolve the general equilibrium effects of long-term bond purchases here but will simply document the correlations of the dollar exchange rate with proxies for the main determining factors. Chief among these are long-term interest rates themselves, which we derive from estimated zero coupon yield curves from Bloomberg. We also use the zero coupon yield curves to extract term premia, based on Adrian, Crump, and Moench's (2013) term structure model.<sup>44</sup> Figure A8 in the online appendix plots our estimated term premium series for each country and compares them with other term premium estimates in the literature.

In estimating equations (8)–(10), we use two proxy variables to capture potential variation in the excess return terms, the Chicago Board Options Exchange Volatility Index (VIX) and the EBP of Gilchrist and Zakrajšek (2012). The VIX appears in many studies to capture generalized shifts in global risk aversion.<sup>45</sup> As Gilchrist and Zakrajšek (2012) explain, the EBP is built up from individual US corporation bond spreads, adjusted to remove estimates of firm-specific default risk and thus reflecting risk appetite or market sentiment rather than expected cash flows. Lilley and others (2022) find roles for related variables in explaining the variation of the dollar exchange rate after the global financial crisis, and all of them arguably are indicators of financial stresses that could have an impact on required excess returns, as well as liquidity convenience yields. Figure 12

44. Greenwood and others (2020) argue that foreign assets and long-term US government bonds are portfolio substitutes because they are similarly exposed to US short-term interest rate risk, which generally will move foreign exchange asset values and US bond prices in the same direction. Thus, when the supply of US long-term bonds rises, investors will want to sell foreign long-term assets as they rebalance their portfolios, making the dollar appreciate. The "original sin redux" argument of Carstens and Shin (2019) suggests there would be especially high substitutability between US long-term Treasuries and long-term sovereign EMDE bonds. In contrast, short-maturity US bonds and foreign assets are more complementary in portfolios owing to the diversification motive. One challenge in determining empirically the exchange rate effects of bond operations like quantitative easing (QE) is that they also can signal central bank targets for the price level path, with effects on future expectations of inflation and nominal interest rates.

45. Examples include Forbes and Warnock (2012), Rey (2013), Obstfeld, Ostry, and Qureshi (2019), Kalemli-Özcan (2019), Kalemli-Özcan and Varela (2021), and Loipersberger and Matschke (2022).


Figure 12. Key Proxy Drivers of Excess Returns: Quarterly Averages



Sources: Gilchrist and Zakrajšek (2012); FRED; Federal Reserve H.10 release.

Note: Panel A plots the evolution of the Gilchrist and Zakrajšek (2012) EBP (left-hand y axis, extracted from US nonfinancial firms' borrowing spreads) and the CBOE VIX (right-hand y axis). Panel B plots the Federal Reserve H.10 nominal dollar index against advanced economy currencies along with EBP. Shaded areas correspond to US recession episodes as dated by the National Bureau of Economic Research (FRED ticker USRECM).

plots the VIX and EBP measures and compares them with the broad dollar index.

For  $\gamma_t$  we use alternative measures of low- or no-risk private sector borrowing spreads over government bond rates. At the three-month horizon we use the difference between the TED spread (of LIBOR over the US Treasury bill rate) and its foreign counterpart. At the one-year horizon, we instead use the LIBOR interest-rate swap spread over the US Treasury note yield.<sup>46</sup>

# III.B. Covered Interest Parity and the US Dollar Liquidity Premium

The primary variable we will use to capture the dollar premium,  $\lambda_{r,s}^{s}$ , will be the LIBOR cross-currency basis—the deviation from covered interest parity among advanced country interbank borrowing rates—as we now explain.

Unlike UIP, covered interest parity (CIP) refers to a comparison of returns on debt instruments where exchange rate uncertainty is eliminated through the sale of one instrument's gross proceeds in the forward exchange market. An investment in a foreign currency debt instrument can effectively be transformed into a synthetic dollar investment if coupled with a forward exchange market sale of the foreign currency payoff, in which a counterparty agrees to exchange dollars for the foreign currency on the payoff date at a pre-agreed price (the forward exchange rate). CIP holds when synthetic dollar loans carry the same return or cost as comparable direct dollar loans. If  $f_t$  denotes the forward foreign currency price of dollars on date t, then in terms of our earlier notation, CIP holds when  $i_t^L = i_t^{L*} + s_t - f_t$ , or when:

(11) 
$$i_t^{L*} = i_t^L + f_t - s_t.$$

Comparing equation (11) to equation (3) shows that UIP and CIP are equivalent if and only if  $f_t = \mathbb{E}_t s_{t+1}$ , but long-standing evidence firmly rejects that equality.

Indeed, CIP itself has failed to hold among different classes of low-risk or riskless bonds due to factors that are closely linked to exchange rate fluctuations. For market interest rates such as LIBOR, CIP deviations were small up through 2007–2008, but big and fairly persistent deviations from CIP have emerged since. Relative to the US dollar as the home currency,

<sup>46.</sup> Many empirical studies analyze LIBOR CIP, even though LIBORs are indicative and may not be perceived as absolutely risk-free in all circumstances. However, analysis based on even less risky rates such as the overnight indexed swap (OIS) rate yields similar conclusions (Du and Schreger 2022).

the gap  $x_t^L \equiv i_t^{L*} - (i_t^L + f_t - s_t)$ —called the LIBOR dollar basis—has generally been positive for most Group of Ten (G10) currencies since the global financial crisis, implying that  $i_t^L < i_t^{L*} + s_t - f_t$ : the cost of borrowing dollars directly is below that of synthetic dollar borrowing (for example, borrowing euros and selling them spot for dollars while simultaneously entering a forward contract to sell the dollars for euros upon maturity of the original euro loan).<sup>47</sup> In contrast, the Treasury basis, defined with respect to government bond rates (and with  $i_t$  denoting the US Treasury rate and  $i_t^*$  the foreign government bond rate) is  $x_t \equiv i_t^* - (i_t + f_t - s_t)$ . The condition  $x_t = 0$ did not hold closely even before the financial crisis. It has not held afterward either, but  $x_t$  has become more closely correlated with  $x_t^L$ , which had a much smaller variance than  $x_t$  before the crisis but has had a generally similar variance since. Figure 13 illustrates the behavior of the two bases, for both the three-month and one-year investment horizons.

Du, Im, and Schreger (2018) have highlighted the Treasury premium as a measure of the relative convenience yield from holding US Treasury securities. Krishnamurthy and Lustig (2019), Jiang, Krishnamurthy, and Lustig (2021), and Engel and Wu (forthcoming) posit that Treasury basis fluctuations have a causal impact on dollar exchange rates. In those analyses, the advantage of US Treasury obligations arises from two (likely related) sources: the greater liquidity of Treasuries relative to privately issued bonds and the greater liquidity of dollar bonds relative to non-dollar bonds. But it is not straightforward to identify separately the two components of the convenience yield.

We have taken the relative spread  $\gamma_t \equiv i_t^L - i_t - (i_t^{L*} - i_t^*)$  between private and central government issuers as a measure of the relative liquidity of US Treasuries. This measure, however, should bear little connection to the dollar's special international role, as the spreads it compares are for bonds of like currency denomination. Notice, however, that:

$$\begin{aligned} \gamma_{i} &= i_{i}^{L} - i_{i} - \left[i_{i}^{L*} + s_{i} - f_{i} - \left(i_{i}^{*} + s_{i} - f_{i}\right)\right] \\ &= i_{i}^{L} - \left(i_{i}^{L*} + s_{i} - f_{i}\right) - \left[i_{i} - \left(i_{i}^{*} + s_{i} - f_{i}\right)\right] \\ &= x_{i} - x_{i}^{L}, \end{aligned}$$

47. The US dollar basis has generally been negative for the Australian and New Zealand dollars, for reasons elucidated by Borio and others (2016) and Liao and Zhang (2020). For a broad discussion of the literature on deviations from CIP, see Du and Schreger (2022). Note that the literature generally defines the US dollar basis with a sign opposite to our convention. Given the wider scope of our discussion in this paper, however, we judged the definition in the text to be less confusing for readers.



Figure 13. LIBOR and Treasury Basis, 1999–2021

Sources: Bloomberg; Refinitiv.

Note: Ten-day moving average of daily deviations from CIP for three-month LIBOR rates and Treasury yields. Cross-sectional average is taken over CAD, CHF, DKK, EUR, GBP, JPY, NOK, and SEK. Vertical line marks September 2008. Pairwise correlations between the level of the average Treasury basis and the average LIBOR basis are computed and reported. One-year LIBOR bases are calculated based on LIBOR interest rate swaps.

which implies that:

(12) 
$$x_t = x_t^L + \gamma_t$$

Equation (1) is the key to our rationale for proxying  $\lambda_t^s$  by the LIBOR basis. As a first step, consider the thought experiment of a world with no financial frictions, in which markets would conduct full and efficient arbitrage between currencies in interbank markets. Because the assets involved in that arbitrage have identical liquidity characteristics apart from their currencies of denomination, any observed nonnegative dollar basis would have to reflect  $\lambda_t^s$ . In that idealized world, equation (12) cleanly allocates the total Treasury premium between a component related dollar denomination per se and a component entirely due to the inherent comparative liquidity of Treasury obligations versus market-issued obligations. The main drivers of both  $\lambda_t^s$  and  $\gamma_t$  would be factors like global safe asset demand, risk aversion, and bond supplies that alter marginal convenience yields even with unconstrained intermediaries.<sup>48</sup>

Real-world financial markets are beset by trading constraints, however, and the LIBOR dollar basis therefore reflects not only the dollar's marginal liquidity value but also market frictions.<sup>49</sup> A range of evidence supports the link between intermediaries' balance sheet capacity and deviations from CIP, as discussed by Du (2019) and Du and Schreger (2022). Conversely, Federal Reserve swaps of dollars with foreign central banks, which lend the dollars to domestic banks with constrained alternative dollar access, have limited basis spreads by effectively filling in for scarce private balance sheet space (Bahaj and Reis 2022; Goldberg and Ravazzolo 2022). Notwith-standing the strong influence of market frictions on the dollar LIBOR basis, it still can serve as a stand-in for dollar liquidity in a regression equation for the dollar exchange rate that also controls for direct indicators of financial stress as well as the Treasury relative liquidity factor,  $\gamma_r$ .

48. In the interest arbitrage comparison, the combination of a cash position in a foreign asset and a forward purchase of dollars might inherit some fraction of the dollar convenience yield  $\lambda_s^s$ , but as Jiang, Krishnamurthy, and Lustig (2021) argue, that fraction would most likely be strictly less than 1.

49. As we observed earlier, the convenience yields themselves are likely to depend partly on market frictions. Especially in the presence of frictions, the separability of US Treasury attributes one might be tempted to infer from the idealized version of equation (12) is implausible. For example, the depth of the US Treasury market surely enhances the value of "dollarness" for many other dollar-denominated assets.

Below, we will also consider the Treasury basis  $x_t$  as a single regressor in place of the LIBOR basis and  $\gamma_t$ , as Krishnamurthy and Lustig (2019), Jiang, Krishnamurthy, and Lustig (2021), and Engel and Wu (forthcoming) do. According to equation (12), the Treasury basis is the sum of the LIBOR dollar basis and  $\gamma_t$ , so in principle it could serve as an indicator of both those convenience yields if they are weighted equally by investors. However, there is no reason to assume that equal weighting holds, and our baseline specification with both  $x_t^L$  and  $\gamma_t$  does not do so. The data support that approach.<sup>50</sup>

It is well known that the LIBOR basis (like the Treasury basis) is closely associated with the dollar: dollar appreciations correspond to a wider basis.<sup>51</sup> This correlation admits different channels of causation. It may be that the basis-dollar link mainly reflects shifts in global investor preferences or asset supplies that drive the dollar, perhaps through a convenience yield channel. But a complementary account holds that dollar movements reflect shifts in global financial conditions that simultaneously alter financial intermediaries' balance sheet space and thereby their propensities to arbitrage return gaps via the forward exchange market.<sup>52</sup> The relationship between global balance sheet capacity and the dollar owes to more than just common risk aversion or safe asset demand shocks. Through an additional feedback loop, dollar appreciation, whatever its cause, itself impairs the balance sheets of unhedged dollar debtors, tightening financial conditions and widening US dollar bases. These possibilities all dictate caution in interpreting the exchange rate regressions that we present next. At best, they capture key correlations that are potentially indicative of alternative causal mechanisms

50. In unreported estimates, we find that when we enter both the Treasury basis  $x_i$  and  $\gamma_i$  in the regression, the estimated coefficient of  $\gamma_i$  is negative and smaller in absolute value than the estimated coefficient of  $x_i$ , which itself is the same as the estimated coefficient of  $x_t^T$  in our baseline regressions. On the other hand, as our findings below show, the estimated coefficient of  $x_i$ , when entered alone without  $\gamma_i$  is biased downward owing to omitted variable bias from leaving out  $\gamma_i$ . These patterns are consistent with the assumption that  $x_t^T$  and  $\gamma_i$  indeed capture different components of the Treasury liquidity yield, but with the pure dollar effect  $\lambda_t^s$  quantitatively more important to investors on average over the entire sample period.

51. See, for example, Avdjiev, Du and others (2019) and Cerutti, Obstfeld, and Zhou (2021).

52. Du (2019) makes this argument, also documenting the closer co-movement between the LIBOR and Treasury bases after the global financial crisis (see figure 13). That co-movement suggests a relatively larger role for  $\lambda_i^s$  after the crisis and for  $\gamma_t$  before. The substantial correlation coefficient of the two bases before the crisis, however, suggests a significant role for  $\lambda_i^s$  even then.

### III.C. Empirical Exchange Rate Equations

We next present and discuss the results of estimating equations (8)–(10) by ordinary least squares, using a monthly panel of G10 currencies starting in 1999. As discussed in the previous sections, for each specification, we present estimates for three-month and one-year changes in the log nominal end-of-period bilateral exchange rate of G10 currencies against the dollar, including currency fixed effects throughout. As overlapping samples are used, we report heteroskedasticity-robust and autocorrelation-robust standard errors (Driscoll and Kraay 1998). Three-month log changes are measured at an annual rate. Further details on the data are in online appendix B.

In each of tables 2–4, the first two columns estimate over 1999–2021 and the second two estimate over the post-crisis period 2010–2021. Odd-numbered columns report equations with the LIBOR basis  $x_t^L$  and  $\gamma_t$  both included, while even-numbered columns instead include the Treasury basis  $x_t$  as the sole convenience yield proxy. In the estimation, all interest rates regardless of tenor are expressed as annualized rates.

Panels A and B of table 2 report estimates of equation (8). The two panels are based, respectively, on three-month and one-year exchange rate changes, and three-month and one-year changes in three-month and one-year interest rates. Over all specifications and samples, the change in the three-month US Treasury interest rate relative to the foreign bond rate is highly economically and statistically significant. For example, column 1 in panel A implies that a 10 basis point increase in the annualized three-month Treasury differential over a quarter appreciates the dollar by 125.08/4 = 31.3 basis point rise in the one-year Treasury differential over a year appreciates the dollar by 40.7 basis points.

In all regressions the lagged real exchange rate is also highly significant, with real appreciation predicting nominal depreciation over the following period. This mean reversion, though estimated fairly precisely over the entire sample, is rather gradual (generally around 2–4 basis points depreciation of the foreign currency per year for a 10 basis point real appreciation of the dollar), in line with the copious evidence of slow mean reversion in real exchange rates (Itskhoki 2021). Estimated mean reversion is higher over the post-crisis sample.

Turning to indicators associated with the convenience yield of dollar Treasuries, in odd-numbered columns of both panels of table 2, the  $\gamma_t$  variable measuring the relative liquidity of Treasuries (apart from their

	$\Delta = three months; fc quarter-over-quarter depreciation$			
Variables	(1) 1999–2021	(2) 1999–2021	(3) 2010–2021	(4) 2010–2021
Panel A: Three-month horizon				
$\Delta(i^{US}_{3m,t}-i^*_{3m,t})$	12.508***	13.313***	15.749***	17.340***
$\Delta \gamma_{3m,t}$	(2.772) 2.990 (3.214)	(2.751)	(4.641) 4.706 (5.756)	(3.989)
basis (pp)	(2.776)		(4.797)	
$\Delta$ three-month Treasury basis (pp)		6.274*** (2.402)		8.877** (3.445)
$\Delta \log \text{VIX}$	0.052 (0.034)	0.052 (0.034)	0.085** (0.041)	0.086** (0.041)
$\Delta$ excess bond premium	17.701*** (3.454)	17.400*** (3.382)	15.058*** (4.610)	14.263*** (4.457)
Lag RER	-0.198*** (0.070)	-0.211*** (0.072)	-0.448*** (0.078)	-0.447*** (0.079)
Observations	2,757	2,757	1,440	1,440
Adjusted R <sup>2</sup>	0.252	0.250	0.220	0.219
Currency FE	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$
Lagged controls	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$
Driscoll and Kraay (1998) lags	3	3	3	3

 Table 2. Exchange Rate Equations: Short-Term Rates

currency denomination) is correctly signed but statistically insignificant. The LIBOR basis has the theoretically correct sign and is quite significant for three-month changes. The estimated coefficient of the Treasury basis is smaller than that of the LIBOR basis over both estimation samples, owing to the former's conflation of the dollar effect  $\lambda_t^s$  with the weaker effect  $\gamma_t$ . In panel B for one-year exchange rate changes, both dollar bases have correct signs but generally lower statistical significance than in panel A. Only for the post-crisis sample do we find statistically significant coefficients (at the 5 percent level) associated with both bases. The coefficients of the LIBOR basis are comparable to those of interest rates, if usually somewhat smaller.

Next consider the two regressors meant to capture financial market stresses. At the three-month horizon (panel A), the influence of the VIX has the expected sign but is very small, with a 10 basis point increase in the index corresponding to a minuscule 0.5/4 = 0.125 basis point appreciation of the dollar over the quarter for the entire sample and just below 0.9/4 = 0.225 basis point post-crisis. Neither estimate is significant at the 5 percent level. However, the EBP variable is highly statistically significant

#### **OBSTFELD** and ZHOU

Variables	$\Delta$ = one year; fc year-over-year depreciation				
	(1) 1999–2021	(2) 1999–2021	(3) 2010–2021	(4) 2010–2021	
Panel B: One-year horizon					
$\Delta(i_{1yd}^{US} - i_{1yd}^*)$	4.069***	4.043***	4.069***	4.062***	
Λν.	(1.060) 2.252	(1.063)	(1.103) 4.080	(1.168)	
$\rightarrow$ 1 ly, t	(1.917)		(3.067)		
$\Delta$ one-year LIBOR basis (pp)	2.807 (2.604)		8.102** (3.392)		
$\Delta$ one-year Treasury basis (pp)		2.621 (1.794)	· · · ·	5.595** (2.738)	
$\Delta \log \text{VIX}$	-0.024 (0.019)	-0.023 (0.020)	-0.003 (0.023)	-0.003 (0.024)	
$\Delta$ excess bond premium	7.534***	7.490***	6.143***	6.301***	
Lag RER	(1.200) $-0.205^{***}$ (0.044)	(1.220) -0.200*** (0.044)	(0.049)	$-0.383^{***}$ (0.052)	
Observations	2,725	2,742	1,440	1,440	
Adjusted <i>R</i> <sup>2</sup>	0.449	0.447	0.489	0.476	
Currency FE	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	
Lagged controls	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	
Driscoll and Kraay (1998) lags	12	12	12	12	

Table 2. Exchange Rate Equations: Short-Term Rates (Continued)

Source: Authors' calculations.

Note: Table reports the results of estimating equation (8) on a monthly sample for bilateral exchange rates of G10 currencies against the US dollar. Spot exchange rates are expressed in units of foreign currency per US dollar. The variables  $\Delta \gamma_{5m,i}$  and  $\Delta \gamma_{1j,i}$  are the relative spread difference between US and foreign three-month LIBOR rates and one-year LIBOR swap rates, respectively, against yields on government securities of like tenor. The Treasury basis at tenor *j* is defined as  $i_{j,i}^{t} - (i_{j,i}^{US} + f_{j,i} - s_i)$ , where *f* and *s* are forward and spot exchange rates. For panel A, overlapping quarterly changes along with interest rates and bases at three-month tenors are used. The dependent variable is the *annualized* quarter-over-quarter depreciation rate. For panel B, overlapping yearly changes and depreciation rates are used. All variables are expressed in percentages (or in 100 times log terms). The table reports standard errors per Driscoll and Kraay (1998).

\*\*\* p < 0.01, \*\* p < 0.05, \* p < 0.1.

with a large coefficient. In column 1 of panel A, a 10 basis point rise in the EBP is associated with a currency appreciation over the quarter of  $177/4 \approx 44$  basis points, with a slightly smaller correlation in column 3. The estimated coefficient of EBP is only slightly lower post-crisis, and it remains statistically significant at the 1 percent level.<sup>53</sup>

53. In standard deviation terms, a one standard deviation increase in  $100 \times \log VIX$  translates into a 4.4 basis point dollar appreciation over the same quarter, based on estimation over the entire 1999–2021 sample. A one standard deviation increase in EBP is associated with a 31 basis point dollar appreciation over the same horizon and sample. The corresponding numbers post-crisis are 7.2 basis points (for the VIX) and 11.8 basis points (for EBP).

	$\Delta = three$ n	$\Delta = three months; fc quarter-over-quarter depreciation$				
Variables	(1) 1999–2021	(2) 1999–2021	(3) 2010–2021	(4) 2010–2021		
Panel A: Three-month horizon						
$\Delta(i_{10y,t}^{US} - i_{10y,t}^{*})$	38.975*** (4.190)	39.928*** (4.112)	42.666*** (5.579)	44.166*** (5.233)		
$\Delta(tp_{10y,t}^{US} - tp_{10y,t}^{*})$	-23.773*** (3.882)	-24.609*** (3.762)	-25.408*** (5.334)	-26.635*** (5.134)		
$\Delta \gamma_{3m,t}$	-1.933 (2.804)		-0.189 (4.687)			
$\Delta$ three-month LIBOR basis (pp)	5.325** (2.382)		9.792** (4.313)			
$\Delta$ three-month Treasury basis (pp)		1.307 (1.875)		5.914* (3.046)		
$\Delta \log \text{VIX}$	0.074**	0.074**	0.113*** (0.043)	0.112*** (0.042)		
$\Delta$ excess bond premium	20.091*** (2.795)	19.729*** (2.683)	16.956*** (4.072)	15.770*** (3.755)		
Lag RER	-0.177*** (0.060)	-0.188*** (0.061)	-0.422*** (0.072)	-0.421*** (0.072)		
Observations	2,757	2,757	1,440	1,440		
Adjusted R <sup>2</sup>	0.350	0.348	0.338	0.334		
Currency FE	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$		
Lagged controls	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$		
Driscoll and Kraay (1998) lags	3	3	3	3		

Table 3. Exchange Rate Equations: Long-Term Rates, Short-Term Liquidity Premium

Panel B of table 2 indicates that the VIX has the wrong sign (but is insignificant) for one-year exchange rate changes. The excess bond premium is sizable and significant in panel B in all specifications, with an even stronger influence than in panel A. In every column of panel B, a 10 basis point rise in EBP is estimated to appreciate the currency by more than 60 basis points over the year—at least 1.5 times the association with a 10 basis point rise in the interest differential.

Finally, the  $R^2$  coefficients are notable. In the equation estimates that panel A reports, all  $R^2$ s are between 0.2 and 0.3. In panel B, however,  $R^2$ s fall between 0.4 and 0.5. Taken together, the variables in the regressions have considerable explanatory power for contemporaneous year-to-year exchange rate changes.

Table 3 reports estimates of equation (9). As expected, estimated coefficients for changes in long-term interest differentials are much larger than for short-term differentials, which in equation (8) stand in for news about

	$\Delta$ = one year; fc year-over-year depreciation				
Variables	(1) 1999–2021	(2) 1999–2021	(3) 2010–2021	(4) 2010–2021	
Panel B: One-year horizon	l				
$\Delta(i_{10y,t}^{US} - i_{10y,t}^{*})$	9.614*** (2.138)	9.625*** (2.144)	9.341*** (1.812)	9.470*** (2.042)	
$\Delta(tp_{10y,t}^{US} - tp_{10y,t}^{*})$	-6.034*** (2.007)	-6.014*** (2.024)	-6.744*** (2.073)	-5.782*** (2.042)	
$\Delta \gamma_{1_{y,t}}$	0.886 (2.184)		3.390 (3.598)		
$\Delta$ three-month LIBOR basis (pp)	0.148 (3.001)		9.694*** (3.593)		
$\Delta$ three-month Treasury basis (pp)		0.778 (1.994)		5.636* (3.042)	
$\Delta \log \text{VIX}$	-0.013 (0.019)	-0.012 (0.020)	0.004 (0.021)	0.008 (0.020)	
$\Delta$ excess bond premium	7.866*** (1.349)	7.844*** (1.382)	6.655*** (1.583)	6.848 <sup>***</sup> (1.706)	
Lag RER	-0.192*** (0.043)	-0.185*** (0.044)	-0.366*** (0.052)	-0.362*** (0.055)	
Observations	2,725	2,742	1,440	1,440	
Adjusted R <sup>2</sup>	0.462	0.461	0.554	0.533	
Currency FE	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	
Lagged controls	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	
Driscoll and Kraay (1998) lags	12	12	12	12	

**Table 3.** Exchange Rate Equations: Long-Term Rates, Short-Term Liquidity Premium (Continued)

Source: Authors' calculations.

Note: Table reports the results of estimating equation (9) on a monthly sample for bilateral exchange rates of G10 currencies against the US dollar. Spot exchange rates are expressed in units of foreign currency per US dollar. The term premium differential,  $tp_{10\mu}^{(S)} - tp_{10\mu}^*$  is estimated based on zero-coupon government bond yield curves from Bloomberg and national central banks, using the model of Adrian, Crump, and Moench (2013) with four principal components of yields as the state variables. The variables  $\Delta \gamma_{3\mu\nu}$  and  $\Delta \gamma_{1\mu\nu}$  are the relative spread difference between US and foreign three-month LIBOR rates and one-year LIBOR swap rates, respectively, against yields on government scurities of like tenor. The Treasury basis at tenor *j* is defined as  $i_{j,\ell}^* - (i_{j,\ell}^{(S)} + f_{j,\ell} - s_i)$ , where *f* and *s* are forward and spot exchange rates. For panel A, overlapping quarterly changes along with interest rates and bases at three-month tenors are used. The dependent variable is the annualized quarter-over-quarter depreciation rate. For panel B, overlapping yearly changes and depreciation are used. All variables are expressed in percentages (or in 100 times log terms). The table reports standard errors per Driscoll and Kraay (1998).

\*\*\* p < 0.01, \*\* p < 0.05, \* p < 0.1.

future short-term interest rates. In panel A, column 1, a 10 basis point rise in the ten-year yield differential in favor of Treasuries is associated with a  $389.75/4 \approx 97$  basis point appreciation of the dollar over the same quarter. The association is somewhat stronger in the quantitative easing (QE) era following the financial crisis. In panel B, column 1, a 10 basis point rise in the ten-year Treasury yield differential is associated with a 96 basis point dollar appreciation over the same year. The coefficient is roughly stable across specifications and periods in panel B. In all table 3 estimates, the term premium differential has the negative sign that equation (9) implies, but the absolute sizes of its coefficients are smaller than those for long-term interest differentials, contrary to the theory. This pattern may reflect that the term premium variables are estimated, and therefore measured with error. Throughout table 3, the estimated role of the lagged real exchange rate conforms to the pattern in table 2.

The change in  $\gamma_i$  is statistically insignificant in all cases, but the coefficients for the LIBOR basis are of correct sign and statistically significant at the 5 percent level or better, except in column 1 of panel B. In column 3 of panel B, covering post-crisis data, the variable's estimated coefficient is similar to that of the long-term interest differential. On the other hand, EBP is statistically significant and sizable for all specifications and time periods. The VIX index is now statistically significant in panel A for three-month changes, but its coefficient remains small in magnitude and is not ever statistically significant for the longer horizon (one-year, panel B). The  $R^2$  coefficients are higher across the board than in table 2, reaching the range of 0.46–0.56 in panel B.

The strong estimated relationship of long-term interest differentials with exchange rates and the impressive in-sample fit of exchange rate equations based on long-term rates is consistent with recent theories of debt-driven exchange rate movements such as Greenwood and others (2020) and Gourinchas, Ray, and Vayanos (2022), as well as with several econometric studies on the effects of QE by major central banks, such as Dedola and others (2021). In equation (9), however, long-term rate differentials are entered jointly with the term premium, their difference standing in for the expected sum of future short-term rate differentials. Furthermore, the term premium is measured with error. A better sense of the impact of long-term rates follows directly from potential arbitrage among long-term government yields.

Table 4 presents estimates of that equation. The regressions in this table construct  $\gamma_t$  and cross-currency bases using ten-year LIBOR interest rate

	$\Delta = three months; fc quarter-over-quarter depreciation$			
Variables	(1) 1999–2021	(2) 1999–2021	(3) 2010–2021	(4) 2010–2021
Panel A: Three-month horizon				
$\Delta(i_{10yt}^{US} - i_{10yt}^{*})$	26.918***	24.342***	24.332***	24.108***
$\Delta \gamma_{10y,t}$	(3.337) 32.875*** (4.382)	(3.310)	(3.296) 19.870** (9.511)	(3.375)
$\Delta$ ten-year LIBOR basis (pp)	(4.382) 53.786*** (10.316)		(9.511) 49.961*** (14.653)	
$\Delta$ ten-year Treasury basis (pp)		33.648***	(	23.271**
		(5.188)		(9.085)
$\Delta \log VIX$	0.063*	0.071*	0.097**	0.106**
-	(0.037)	(0.038)	(0.045)	(0.048)
$\Delta$ excess bond premium	16.411***	16.598***	14.430***	15.390***
	(2.947)	(2.869)	(3.994)	(4.063)
Lag RER	-0.154 **	-0.154 **	-0.334***	-0.335***
	(0.072)	(0.066)	(0.066)	(0.069)
Observations	2,695	2,727	1.440	1.440
Adjusted $R^2$	0.312	0.294	0.289	0.273
Currency FE	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$
Lagged controls	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$
Driscoll and Kraay (1998) lags	3	3	3	3

Table 4. Exchange Rate Equations: Long-Term Rates, Long-Term Liquidity Premium

swaps (based on three-month float-to-float exchanges), as in Du, Tepper, and Verdelhan (2018). All four columns of panel A suggest that a 10 basis point rise in the ten-year Treasury yield differential correlates with a substantial dollar appreciation over the same quarter of about 250/4 = 62.5 basis points. For one-year changes (panel B), the association is higher over the entire sample (around a 94 basis point appreciation for a 10 basis point yield difference) but closer to panel A over the post-crisis sample (roughly a 75 basis point effect).

Liquidity differences between long-term government bond  $\gamma_t$  are influential on exchange rate movements. All estimates are significant at least at the 10 percent level in table 4. The statistical significance is weakest during the post-crisis subperiod for one-year exchange rate changes. The LIBOR basis is again statistically and economically extremely significant, with estimated coefficients well in excess of long-term interest gaps. Treasury bases have similar significance, as in all the tables, but with downward-biased coefficients. The VIX roughly follows the pattern of table 3, relevant for three-month exchange rate changes but small in magnitude and unimportant

Variables	$\Delta$ = one year; fc year-over-year depreciation			
	(1) 1999–2021	(2) 1999–2021	<i>(3)</i> 2010–2021	<i>(4)</i> 2010–2021
	1777 2021	1777 2021	2010 2021	2010 2021
Panel B: One-year horizon				
$\Delta(i_{10y,t}^{US} - i_{10y,t}^{*})$	9.421***	8.153***	7.486***	7.589***
	(1.601)	(1.616)	(1.316)	(1.438)
$\Delta \gamma_{10vI}$	10.159***		4.846*	
• • • • • • • • • • • • • • • • • • • •	(2.571)		(2.813)	
$\Delta$ ten-vear LIBOR basis (pp)	16.031***		17.810***	
	(4.879)		(5.018)	
$\Delta$ ten-vear Treasury basis (pp)	()	10.952***	()	8.227**
)		(2.566)		(3.305)
A log VIX	0.002	-0.006	0.018	0.018
	(0.019)	(0.018)	(0.017)	(0.017)
A excess bond premium	6 721***	6 918***	5 846***	7 625***
Z excess bond premium	(1.173)	(1, 243)	(1.416)	(1.655)
Lag RER	0 107***	(1.2+3) 0 202***	0 271***	0.271***
Lag KEK	-0.197	(0.042)	-0.371	-0.3/1
	(0.048)	(0.042)	(0.030)	(0.000)
Observations	2.624	2.673	1.440	1.440
Adjusted $R^2$	0.472	0.446	0.510	0.485
Currency FE	✓	$\checkmark$	$\checkmark$	$\checkmark$
Lagged controls	1	1	1	1
Driscoll and Kroov (1009) lags	12	12	12	12
Discon and Kraay (1998) lags	12	12	12	12

**Table 4.** Exchange Rate Equations: Long-Term Rates, Long-Term Liquidity Premium (Continued)

Source: Authors' calculations.

Note: Table reports the results of estimating equation (10) on a monthly sample for bilateral exchange rates of G10 currencies against the US dollar. Spot exchange rates are expressed in units of foreign currency per US dollar. The variable  $\Delta \gamma_{10,xi}$  is the relative spread difference between US and foreign ten-year LIBOR swap rates against yields on government securities of like tenor. For panel A, overlapping quarterly changes along with interest rates and bases at three-month tenors are used. The dependent variable is the annualized quarter-over-quarter depreciation rate. For panel B, overlapping yearly changes and depreciation are used. All variables are expressed in percentages (or in 100 times log terms). The table reports standard errors per Driscoll and Kraay (1998).

\*\*\* p < 0.01, \*\* p < 0.05, \* p < 0.1.

for one-year changes. Also consistent with the other tables, EBP remains highly significant and strongly associated with both one-quarter and one-year exchange rate movements. The  $R^2$ s are slightly lower than in table 3, albeit still sizable.

To summarize the results of tables 2–4, US Treasury interest rate differentials are important correlates of dollar exchange rate changes, but long-term yield differentials are especially powerful over our entire sample period and since the global financial crisis. These correlations indicate the importance of monetary and debt management policies. Other factors, however, play important roles, in line with the recent literature on exchange

rate determination. One such factor is the cross-currency dollar basis-LIBOR or Treasury-with the former being a more direct measure of the specific liquidity value of the US dollar to global investors. While both bases reflect the marginal liquidity advantage of US Treasury obligations as seen by market participants, and therefore also monetary and debt policies, they also reflect global safe asset demand and related financial market frictions. In risk-off market episodes, the demand for safe dollar assets rises while financial intermediary constraints simultaneously tighten. One widely monitored index of risk sentiment, the VIX, has some contemporaneous correlation with the dollar exchange rate in the short term (over three months) but nothing detectable at longer term (over a year). While we find the LIBOR basis to have a strong and highly statistically significant correlation with the dollar, the most consistently influential correlate (aside from interest rates themselves) is the EBP (Gilchrist and Zakrajšek 2012)-an indicator of credit market sentiment. This finding provides strong evidence that US financial conditions, alongside monetary policies, are key factors influencing the dollar and potentially the global financial cycle.

# III.D. EBP Shocks and Emerging Markets

The exchange rate equations we estimated in the previous section illustrate the important connection between dollar movements and US financial conditions. The high and consistent correlation of EBP movements with dollar shocks invites a direct look at how EBP shocks themselves affect emerging market economies. The EBP is based on US data and is a strong predictor of US recessions, but it could also capture broader global movements in risk appetite and financial conditions. In this section we return to the LP framework of section II and show that EBP shocks predict sharp contractions in emerging market economies. Section II reported the average results of "generic" dollar shocks, possibly driven by a range of factors including the EBP, but here we home in on the specific role of EBP shocks, as have a number of other recent studies.<sup>54</sup> To that end, we replace the

54. Ben Zeev (2019) conducts an exercise similar to ours but focusing on the statedependent response of EMDEs to EBP shocks according to whether the exchange rate is fixed. Cesa-Bianchi and Sokol (2022) study the transmission of EBP shocks from the United States to the United Kingdom. Gilchrist and others (2022) study how several proxies for global risk affect sovereign spreads on dollar-denominated bonds. They find that the EBP has the strongest influence on spreads. Georgiadis, Müller, and Schumann's (2021) counterfactual analysis based on a Bayesian vector autoregression framework suggests that dollar appreciation significantly amplifies the contractionary effect of global risk shocks, mostly through a financial channel. contemporaneous dollar appreciation shock in equation (1) with quarterly EBP changes, while keeping the lagged change in the nominal AE dollar index in the same forecasting equation to control for any lagged dollar impact on EMDE variables not captured by the EBP.

Figure 14 plots selected impulse responses of EMDE economic and financial variables to a 250 basis point increase in EBP. We find an overwhelmingly contractionary impact as in section II, but the slump seems to gather strength more slowly and then becomes deeper and more persistent than the one caused by a general dollar shock. Real output contracts below trend by a cumulative 5 percentage points after ten quarters, driven by steep declines in consumption and investment that more than offset a rise in net exports (see online appendix A.3 for impulse responses not included in the figure). The peak exchange rate depreciation against the dollar exceeds 10 percent, accompanied by worsening terms of trade and an overall contraction in trade volumes. The shock also has a deflationary impact on both domestic and trade-related prices. Looking at financial variables, nominal credit shrinks. The policy rate jumps upward by nearly 5 percentage points on impact (and peaks at 10 percentage points) while dollar borrowing costs, proxied by the EMBI spread, rise on impact and the domestic equity prices enter a prolonged decline. While US dollar appreciation is generally negative for EMDEs' economic health, dollar movements associated with the risk appetite shifts that EBP captures have especially severe impacts.

# IV. The Dollar's Unsettled Future

The start of the COVID-19 pandemic in the first quarter of 2020 saw panic in global financial markets, large financial capital outflows from EMDEs, and a sharp rise in the dollar. The US Treasury market itself became illiquid as a "dash for cash" developed in March. The global dollar cycle went sharply into contraction.

Central banks around the world made deep cuts to interest rates, and governments deployed aggressive fiscal support of their economies. Given the central role of US financial markets and the dollar, Federal Reserve actions were especially important in stabilizing world financial markets. Expansion of Federal Reserve swap lines and establishment of the Foreign and International Monetary Authorities (FIMA) Repo Facility—which ensured a buyer of last resort for foreign central banks desiring to sell US Treasury reserves—were central to the turnaround (Goldberg and Ravazzolo 2022). So were the Federal Reserve's renewed large-scale asset purchases and lending to the private sector, unprecedented in volume and scope.



Figure 14. Impulse Response: 2.5 Percent Increase of Excess Bond Premium

Source: Authors' calculations.

Note: The impulse response functions of EMDE economic and financial variables to a 2.5 percent increase in the EBP (Gilchrist and Zakrajšek 2012). Estimates are derived from the local projection, equation (1), but with the change in the dollar index against AE currencies replaced by quarterly changes in EBP. For regressions involving the GDP deflator, country-quarter observations with a year-over-year change greater than 50 percent are dropped. Equity prices are local currency stock market indexes. Heteroskedasticity-robust 90 percent and 68 percent confidence bands are reported.

Capital flowed back into EMDEs, the dollar retreated, and a new expansive stage of the global dollar cycle began (see figure 15).

As the world economy reopened from pandemic lockdowns, demand pressures collided with supply constraints to generate a worldwide upsurge in inflation. The contribution of aggregate demand to inflation has been particularly high in the United States. Yet, while many EMDE central banks and a small number of AE central banks began raising policy interest rates in 2021 (panels A and B of figure 15), the Federal Reserve has been late to the game, raising the federal funds target by 25 basis points in March 2022 before scrambling to add another 50 basis points in May, 75 in June, 75 in July, and 75 more in September as US core inflation continued to rise.55 As of this writing, two more 75 basis point hikes seem very possible in 2022. The result has been a sharp dollar appreciation, starting in mid-2021 when it became evident that faster US inflation would force the Federal Reserve to tighten earlier than markets had expected (panels C and D of figure 15). Now, a renewed contractionary phase of the global dollar cycle is underway. The effects will be economically harmful for many EMDEs, where both public- and business-sector debt loads rose significantly due to the pandemic. EMDEs will suffer as depreciation of their currencies raises the real value of dollar debts, as higher interest rates raise debt servicing burdens, and as slower growth erodes government tax receipts and business profits.

Indeed, EMDEs are facing a twofold challenge under current macroeconomic conditions. After making impressive progress to contain inflation over recent decades, they are raising domestic interest rates to prevent inflation from again becoming entrenched in the face of domestic currency depreciation and higher global commodity prices. At the same time, tighter financial conditions are having a contractionary effect, impairing balance sheets and worsening debt burdens.

An important research priority is to study exactly how EMDEs use their policy tools to cope with external financial shocks and whether these responses successfully reduce negative domestic repercussions. The macro tools deployed comprise monetary policy, foreign exchange intervention, fiscal policy, macroprudential policy, and direct measures to limit capital inflows and outflows. In particular, what is the role of the exchange rate does it enable a more countercyclical response and otherwise buffer foreign shocks, as the results of this paper and others suggest, or is it a net shock

<sup>55.</sup> Board of Governors of the Federal Reserve System, "Policy Tools: Open Market Operations," https://www.federalreserve.gov/monetarypolicy/openmarket.htm.

**Figure 15.** Monetary Policies, Global Inflation, and the US Dollar Exchange Rate, 2020–2022



Panel B: EMDE policy rate changes



Percentage points



**Figure 15.** Monetary Policies, Global Inflation, and the US Dollar Exchange Rate, 2020–2022 (*Continued*)

Panel D: Broad nominal dollar index (2016 = 100)



Sources: Bank for International Settlements; IMF International Financial Statistics (via Haver); Refinitiv; Federal Reserve H.10 release.

Note: Panels A and B plot year-over-year and year-to-date for 2022 changes in policy interest rates for a set of AEs and emerging market economies. For 2022, the latest observations on policy rates were retrieved on October 20, 2022. EA in panel A refers to euro area (European Central Bank main refinancing rate). Panel C shows monthly values of year-over-year CPI inflation at an annual rate for both the G10 AEs and fifty-one EMDEs. Inflation rates are group weighted averages with 2015 nominal GDP weights.

amplifier? What are the transmission channels of currency changes and how important are they quantitatively in different countries? In a recent survey of emerging market central banks by the Committee on the Global Financial System (2021, 71), only seven of eighteen agreed that local currency depreciation is expansionary, while two believed it was contractionary and nine simply did not respond to the question. Perhaps the nonresponses reflected the question's failure to specify the shock driving local depreciation a critical consideration. The results of this paper support the proposition that regimes with some exchange rate flexibility, central bank credibility, and lower foreign currency liabilities are helpful as platforms for effective EMDE policy responses to shocks. The current dollar cycle will retest the resilience of EMDE policy frameworks that in general were effective in coping with the COVID-19 shock early in 2020. This time, the test occurs in an environment of elevated inflation and rising, not falling, global interest rates.

What policy options do EMDEs have in their current situation? Those that are available may have limited effectiveness and come with significant trade-offs, though some EMDEs are already pursuing them. One option is foreign exchange intervention, that is, sales of hard currency reserves (mostly dollars) for the domestic currency, aimed at resisting its depreciation. This approach could in principle allow somewhat stronger currencies and lower policy interest rates consistent with less imported inflation. However, many EMDEs rely on sizable reserve war chests to inspire market confidence, and they could burn through large volumes of their holdings in prolonged battles against a strong dollar. If advanced country central banks were to extend their swap line offerings, that would effectively bolster EMDE foreign exchange reserves.

A second approach would be to moderate currency depreciation through tighter controls on financial capital outflows. However, this route also comes with costs. EMDEs that tighten nonresident outflows will face reputational damage that would worsen their future access to international capital markets (Clayton and others 2022). Prohibitions exclusively targeting resident outflows might yield limited benefits while inflicting considerable domestic administrative and political costs. Supportive fiscal responses are largely off the table owing to higher sovereign debt levels.

The modern floating exchange rate system emerged fifty years ago amid conditions superficially much like today's: high inflation pressures, severe commodity price shocks, geopolitical tensions, and an inward turn by the United States from perceived burdens of global leadership. Inflation persisted in AEs until the early 1980s. But global disinflation, led by a strong dollar, threw many developing countries into a prolonged debt crisis and nearly a decade of lost growth during the 1980s. The restoration of price stability in the United States, coupled with the growth of US and world capital markets and deepening global trade links, eventually solidified the US dollar's de facto position as the dominant global currency, notwithstanding the scrapping of the de jure Bretton Woods arrangements that had centered on the dollar. The dollar's primacy was boosted further by US sponsorship of worldwide economic integration and opening after the collapse of the Soviet empire.

Strong contractionary measures by the world's central banks, acting with the relative independence they achieved largely as a result of past unpleasant inflation experiences, are likely to tame inflation this time. Indeed, there is a danger that central banks jointly create an unnecessarily sharp global recession through uncoordinated policies that effectively export inflation to trading partners through actions that strengthen their own currencies, as modeled by Oudiz and Sachs (1984) in this journal. In the present environment, central bankers need to be even more than usually attentive to the actions and reactions of their counterparts abroad.

The US macroeconomic outlook is once again central. Were it to remain unchecked, persistently high inflation in the United States could undermine the dollar's key global status as the inflation of the 1970s threatened to do. That would only add to a current trend toward global market fragmentation powered by nationalist political movements and international tensions. All countries would suffer.

As in the early 1970s, the reliability of US support for multilateralism in international relations will be crucial in determining the dollar's future. Reinforced by the United States' still dominant economic and geopolitical position, the substantial positive network externalities from worldwide dollar use mean that competitors such as the euro and yuan are unlikely to dislodge the dollar in the near term. Despite China's global ambitions for its currency, this is especially true for the yuan as long as China's financial markets remain relatively closed to foreign investors. But the case for the yuan becomes more plausible as China's economy grows relative to global output and as it gradually pursues targeted financial opening.<sup>56</sup> Sharper

56. On China's financial opening strategy and the prospects for the yuan as a global currency, see Clayton and others (2022) and Gourinchas (2021). Arslanalp, Eichengreen, and Simpson-Bell (2022) examine the much discussed recent decline of the dollar in international reserves (from more than 70 percent in 1999 to 59 percent in the last quarter of 2021) and show that only about a fourth of the decline reflects higher yuan holdings, the rest being diversification by reserve managers into nontraditional currencies.

political tensions between country blocs punctuated by further weaponization of trade and financial relations would accelerate the process. A world with multiple key currencies and the factors that bring it about could well change the positions of EMDEs in global markets and the policy regimes they adopt in response.

Going forward, global shocks associated with health emergencies, extreme weather, and cyber security breaches will likely add to the strains on world financial markets. Today's vast and interconnected dollar-centric world capital market looks strikingly different from its shape fifty years ago, but it may look very different still fifty years hence.

**ACKNOWLEDGMENTS** We are grateful to Fernando Eguren Martin, Zhengyang Jiang, Gian Maria Milesi-Ferretti, Emi Nakamura, Mikkel Plagborg-Møller, Hyun Song Shin, Jón Steinsson, and Mark Watson for helpful discussion; to Victoria de Quadros for outstanding research assistance; and to Egemen Eren, Gordon Liao, Friederike Niepmann, and Jianlin Wang for help obtaining data. Janice Eberly and our discussants, Şebnem Kalemli-Özcan and Matteo Maggiori, provided helpful detailed comments. We also had the benefit of reactions from *BPEA* conference participants. Obstfeld acknowledges with thanks financial support from the Class of 1958 chair and the Clausen Center at UC Berkeley. Zhou acknowledges generous financial support from the International Economics Section and the Griswold Center for Economic Policy Studies at Princeton University.

# References

- Adrian, Tobias, Richard K. Crump, and Emanuel Moench. 2013. "Pricing the Term Structure with Linear Regressions." *Journal of Financial Economics* 110, no. 1: 110–38.
- Adrian, Tobias, and Hyun Song Shin. 2014. "Procyclical Leverage and Value-at-Risk." *Review of Financial Studies* 27, no. 2: 373–403.
- Ammer, John, Michiel De Pooter, Christopher Erceg, and Steve Kamin. 2016. "International Spillovers of Monetary Policy." IFDP Notes. Washington: Board of Governors of the Federal Reserve System.
- Arslanalp, Serkan, Barry J. Eichengreen, and Chima Simpson-Bell. 2022. "The Stealth Erosion of Dollar Dominance and the Rise of Nontraditional Reserve Currencies." *Journal of International Economics* 138:103656.
- Avdjiev, Stefan, Valentina Bruno, Catherine Koch, and Hyun Song Shin. 2019. "The Dollar Exchange Rate as a Global Risk Factor: Evidence from Investment." *IMF Economic Review* 67, no. 1: 151–73.
- Avdjiev, Stefan, Wenxin Du, Catherine Koch, and Hyun Song Shin. 2019. "The Dollar, Bank Leverage, and Deviations from Covered Interest Parity." *American Economic Review: Insights* 1, no. 2: 193–208.
- Bahaj, Saleem, and Ricardo Reis. 2022. "Central Bank Swap Lines: Evidence on the Effects of the Lender of Last Resort." *Review of Economic Studies* 89, no. 4: 1654–93.
- Bems, Rudolfs, Francesca Caselli, Francesco Grigoli, and Bertrand Gruss. 2021. "Expectations' Anchoring and Inflation Persistence." *Journal of International Economics* 132:103516.
- Ben Zeev, Nadav. 2019. "Global Credit Supply Shocks and Exchange Rate Regimes." Journal of International Economics 116:1–32.
- Bénétrix, Agustin, Deepali Gautam, Luciana Juvenal, and Martin Schmitz. 2019. "Cross-Border Currency Exposures." Working Paper 19/299. Washington: International Monetary Fund. https://www.imf.org/en/Publications/WP/Issues/2019/ 12/27/Cross-Border-Currency-Exposures-48876.
- Bertaut, Carol, Bastian von Beschwitz, and Stephanie Curcuru. 2021. "The International Role of the U.S. Dollar." FEDS Notes. Washington: Board of Governors of the Federal Reserve System.
- Bianchi, Javier, Saki Bigio, and Charles Engel. 2021. "Scrambling for Dollars: International Liquidity, Banks and Exchange Rates." Working Paper 29457. Cambridge, Mass.: National Bureau of Economic Research. https://www.nber. org/papers/w29457.
- Borio, Claudio, Robert N. McCauley, Patrick McGuire, and Vladyslav Sushko. 2016. "Covered Interest Parity Lost: Understanding the Cross-Currency Basis." *BIS Quarterly Review*, 45–64.
- Boz, Emine, Camila Casas, Georgios Georgiadis, Gita Gopinath, Helena Le Mezo, Arnaud Mehl, and Tra Nguyen. 2022. "Patterns of Invoicing Currency in Global Trade: New Evidence." *Journal of International Economics* 136:103604.

- Branson, William H. 1970. "Monetary Policy and the New View of International Capital Movements." *Brookings Papers on Economic Activity*, no. 2: 235–62.
- Brave, Scott A., and David Kelley. 2017. "Introducing the Chicago Fed's New Adjusted National Financial Conditions Index." *Chicago Fed Letter*, no. 386. https://www.chicagofed.org/~/media/publications/chicago-fed-letter/2017/cfl386pdf.pdf.
- Bruno, Valentina, Se-Jik Kim, and Hyun Song Shin. 2018. "Exchange Rates and the Working Capital Channel of Trade Fluctuations." *American Economic Association Papers and Proceedings* 108:531–36.
- Bruno, Valentina, and Hyun Song Shin. 2015a. "Capital Flows and the Risk-Taking Channel of Monetary Policy." *Journal of Monetary Economics* 71:119–32.
- Bruno, Valentina, and Hyun Song Shin. 2015b. "Cross-Border Banking and Global Liquidity." *Review of Economic Studies* 82, no. 2: 535–64.
- Bruno, Valentina, and Hyun Song Shin. 2021. "Dollar and Exports." Working Paper 819. Basel: Bank for International Settlements. https://www.bis.org/publ/ work819.pdf.
- Calvo, Guillermo A., Leonardo Leiderman, and Carmen M. Reinhart. 1996. "Inflows of Capital to Developing Countries in the 1990s." *Journal of Economic Perspectives* 10, no. 2: 123–39.
- Canzoneri, Matthew, Robert Cumby, Behzad Diba, and David López-Salido. 2008. "Monetary Aggregates and Liquidity in a Neo-Wicksellian Framework." *Journal of Money, Credit and Banking* 40, no. 8: 1667–98.
- Canzoneri, Matthew, Robert Cumby, Behzad Diba, and David López-Salido. 2013. "Key Currency Status: An Exorbitant Privilege and an Extraordinary Risk." *Journal of International Money and Finance* 37:371–93.
- Carstens, Agustin, and Hyun Song Shin. 2019. "Emerging Markets Aren't Out of the Woods Yet." *Foreign Affairs*, March 15. https://www.foreignaffairs.com/ world/emerging-markets-arent-out-woods-yet.
- Cerutti, Eugenio M., Maurice Obstfeld, and Haonan Zhou. 2021. "Covered Interest Parity Deviations: Macrofinancial Determinants." *Journal of International Economics* 130:103447.
- Cesa-Bianchi, Ambrogio, and Andrej Sokol. 2022. "Financial Shocks, Credit Spreads, and the International Credit Channel." *Journal of International Economics* 135:103543.
- Chahrour, Ryan, and Rosen Valchev. 2022. "Trade Finance and the Durability of the Dollar." *Review of Economic Studies* 89, no. 4: 1873–910. https://academic.oup.com/restud/article-abstract/89/4/1873/6414211?redirectedFrom=fulltext.
- Chinn, Menzie D., and Hiro Ito. 2006. "What Matters for Financial Development? Capital Controls, Institutions, and Interactions." *Journal of Development Economics* 81, no. 1: 163–92.
- Clayton, Christopher, Amanda Dos Santos, Matteo Maggiori, and Jesse Schreger. 2022. "Internationalizing Like China." Working Paper 30336. Cambridge, Mass.: National Bureau of Economic Research. https://www.nber.org/papers/w30336.

- Committee on the Global Financial System. 2020. "US Dollar Funding: An International Perspective." CGFS Paper 65. Basel: Bank for International Settlements.
- Committee on the Global Financial System. 2021. "Changing Patterns of Capital Flows." CGFS Paper 66. Basel: Bank for International Settlements.
- Dahlquist, Magnus, and Paul Söderlind. 2022. "Individual Forecasts of Exchange Rates." Research Paper 22-06. Stockholm: Swedish House of Finance.
- Davis, J. Scott, Giorgio Valente, and Eric van Wincoop. 2021. "Global Drivers of Gross and Net Capital Flows." Journal of International Economics 128:103397.
- Degasperi, Riccardo, Seokki Simon Hong, and Giovanni Ricco. 2021. "The Global Transmission of U.S. Monetary Policy." Working Paper. https://www.aeaweb.org/ conference/2022/preliminary/paper/irQaY589.
- De Leo, Pierre, Gita Gopinath, and Şebnem Kalemli-Özcan. 2022. "Monetary Policy Cyclicality in Emerging Economies." Working Paper 30458. Cambridge, Mass.: National Bureau of Economic Research. https://www.nber.org/papers/ w30458.
- Del Negro, Marci, Domenico Giannone, Marc P. Giannoni, and Andrea Tambalotti. 2017. "Safety, Liquidity, and the Natural Rate of Interest." *Brookings Papers on Economic Activity*, Spring, 235–94.
- Dornbusch, Rudiger. 1976. "Expectations and Exchange Rate Dynamics." *Journal* of *Political Economy* 84, no. 6: 1161–76.
- Dornbusch, Rudiger. 1980. "Exchange Rate Economics: Where Do We Stand?" Brookings Papers on Economic Activity, no. 1: 143–85.
- Driscoll, John C., and Aart C. Kraay. 1998. "Consistent Covariance Matrix Estimation with Spatially Dependent Panel Data." *Review of Economics and Statistics* 80, no. 4: 549–60.
- Druck, Pablo, Nicholas E. Magud, and Rodrigo Mariscal. 2018. "Collateral Damage: Dollar Strength and Emerging 'Markets' Growth." North American Journal of Economics and Finance 43:97–117.
- Du, Wenxin. 2019. Commentary on "Mind the Gap in Sovereign Debt Markets: The U.S. Treasury Basis and the Dollar Risk Factor," by Arvind Krishnamurthy and Hanno Lustig. In *Economic Policy Symposium Proceedings: Challenges for Monetary Policy*. Jackson Hole, Wyo.: Federal Reserve Bank of Kansas.
- Du, Wenxin, Joanne Im, and Jesse Schreger. 2018. "The U.S. Treasury Premium." Journal of International Economics 112:167–81.
- Du, Wenxin, Carolin E. Pflueger, and Jesse Schreger. 2020. "Sovereign Debt Portfolios, Bond Risks, and the Credibility of Monetary Policy." *Journal of Finance* 75, no. 6: 3097–138.
- Du, Wenxin, and Jesse Schreger. 2022. "CIP Deviations, the Dollar, and Frictions in International Capital Markets." In *Handbook of International Economics, Volume 6*, edited by Gita Gopinath, Elhanan Helpman, and Kenneth Rogoff. Amsterdam: North Holland.

- Du, Wenxin, Alexander Tepper, and Adrien Verdelhan. 2018. "Deviations from Covered Interest Rate Parity." *Journal of Finance* 73, no. 3: 915–57.
- Eguren Martin, Fernando, Mayukh Mukhopadhyay, and Carlos van Hombeeck. 2017. "The Global Role of the US Dollar and Its Consequences." *Bank of England Quarterly Bulletin* Q4.
- Eichenbaum, Martin, Benjamin K. Johannsen, and Sergio Rebelo. 2021. "Monetary Policy and the Predictability of Nominal Exchange Rates." *Review of Economic Studies* 88, no. 1: 192–228.
- Eichengreen, Barry, and Poonam Gupta. 2018. "Managing Sudden Stops." In *Monetary Policy and Global Spillovers: Mechanisms, Effects, and Policy Measures*, edited by Enrique G. Mendoza, Ernesto Pastén, and Diego Saravia. Santiago: Central Bank of Chile.
- Engel, Charles. 2016. "Exchange Rates, Interest Rates, and the Risk Premium." American Economic Review 106, no. 2: 436–74.
- Engel, Charles, and Steve Pak Yeung Wu. Forthcoming. "Liquidity and Exchange Rates: An Empirical Investigation." *Review of Economic Studies*.
- Financial Stability Board. 2022. US Dollar Funding and Emerging Market Economy Vulnerabilities. https://www.fsb.org/2022/04/us-dollar-funding-and-emergingmarket-economy-vulnerabilities/.
- Forbes, Kristin J., and Francis E. Warnock. 2012. "Capital Flow Waves: Surges, Stops, Flight, and Retrenchment." *Journal of International Economics* 88, no. 2: 235–51.
- Gabaix, Xavier, and Matteo Maggiori. 2015. "International Liquidity and Exchange Rate Dynamics." *Quarterly Journal of Economics* 130, no. 3: 1369–420.
- Georgiadis, Georgios, Gernot J. Müller, and Ben Schumann. 2021. "Global Risk and the Dollar." Discussion Paper 16245. London: Centre for Economic Policy Research.
- Gertler, Mark, and Peter Karadi. 2015. "Monetary Policy Surprises, Credit Costs, and Economic Activity." *American Economic Journal: Macroeconomics* 7, no. 1: 44–76.
- Gilchrist, Simon, Bin Wei, Vivian Z. Yue, and Egon Zakrajšek. 2022. "Sovereign Risk and Financial Risk." *Journal of International Economics* 136:103603.
- Gilchrist, Simon, and Egon Zakrajšek. 2012. "Credit Spreads and Business Cycle Fluctuations." *American Economic Review* 102, no. 4: 1692–720.
- Goldberg, Linda S., and Fabiola Ravazzolo. 2022. "The Fed's International Dollar Liquidity Facilities: New Evidence on Effects." Working Paper 29982. Cambridge, Mass.: National Bureau of Economic Research. https://www.nber.org/papers/ w29982.
- Gonçalves, Sílvia, Ana Maria Herrera, Lutz Kilian, and Elena Pesavento. 2022. "When Do State-Dependent Local Projections Work?" Working Paper 2205. Federal Reserve Bank of Dallas. https://www.dallasfed.org/research/papers/ 2022/wp2205.
- Gopinath, Gita, and Jeremy C. Stein. 2021. "Banking, Trade, and the Making of a Dominant Currency." *Quarterly Journal of Economics* 136, no. 2: 783–830.

- Gorodnichenko, Yuriy, and Byoungchan Lee. 2020. "Forecast Error Variance Decompositions with Local Projections." *Journal of Business and Economic Statistics* 38:921–33.
- Gourinchas, Pierre-Olivier. 2018. "Monetary Policy Transmission in Emerging Markets: An Application to Chile." In *Monetary Policy and Global Spillovers: Mechanisms, Effects, and Policy Measures*, edited by Enrique G. Mendoza, Ernesto Pastén, and Diego Saravia. Santiago: Central Bank of Chile.
- Gourinchas, Pierre-Olivier. 2021. "The Dollar Hegemon? Evidence and Implications for Policymakers." In *The Asian Monetary Policy Forum: Insights for Central Banking*, edited by Steven J. Davis, Edward S. Robinson, and Bernard Yeung. Singapore: World Scientific Publishing.
- Gourinchas, Pierre-Olivier, Walker D. Ray, and Dimitri Vayanos. 2022. "A Preferred-Habitat Model of Term Premia, Exchange Rates, and Monetary Policy Spillovers." Working Paper 29875. Cambridge, Mass.: National Bureau of Economic Research. https://www.nber.org/papers/w29875.
- Greenwood, Robin, Samuel G. Hanson, Jeremy C. Stein, and Adi Sunderam. 2020. "A Quantity-Driven Theory of Term Premia and Exchange Rates." Working Paper 27615. Cambridge, Mass.: National Bureau of Economic Research. https:// www.nber.org/papers/w27615.
- Ha, Jongrim, M. Ayhan Kose, and Franziska Ohnsorge. 2021. "One-Stop Source: A Global Database of Inflation." Working Paper 9737. Washington: World Bank. https://elibrary.worldbank.org/doi/abs/10.1596/1813-9450-9737.
- Hansen, Lars Peter, and Robert J. Hodrick. 1980. "Forward Exchange Rates as Optimal Predictors of Future Spot Rates: An Econometric Analysis." *Journal of Political Economy* 88, no. 5: 829–53.
- Hofmann, Boris, and Taejin Park. 2020. "The Broad Dollar Exchange Rate as an EME Risk Factor." *BIS Quarterly Review*, December.
- Horn, Sebastian, Carmen M. Reinhart, and Christoph Trebesch. 2019. "China's Overseas Lending." Working Paper 26050. Cambridge, Mass.: National Bureau of Economic Research.
- Ilzetzki, Ethan, Carmen M. Reinhart, and Kenneth S. Rogoff. 2019. "Exchange Arrangements Entering the Twenty-First Century: Which Anchor Will Hold?" *Quarterly Journal of Economics* 134, no. 2: 599–646.
- International Monetary Fund (IMF). 2016. "Global Trade: What's Behind the Slowdown?" In *World Economic Outlook: Subdued Demand: Symptoms and Remedies*. Washington: Author.
- Itskhoki, Oleg. 2021. "The Story of the Real Exchange Rate." *Annual Review of Economics* 13, no. 1: 423–55.
- Itskhoki, Oleg, and Dmitry Mukhin. 2021. "Exchange Rate Disconnect in General Equilibrium." *Journal of Political Economy* 129, no. 8: 2183–232.
- Jiang, Zhengyang, Arvind Krishnamurthy, and Hanno Lustig. 2020. "Dollar Safety and the Global Financial Cycle." Working Paper 27682. Cambridge, Mass.: National Bureau of Economic Research. https://www.nber.org/papers/w27682.

- Jiang, Zhengyang, Arvind Krishnamurthy, and Hanno Lustig. 2021. "Foreign Safe Asset Demand and the Dollar Exchange Rate." *Journal of Finance* 76, no. 3: 1049–89.
- Jordà, Òscar. 2005. "Estimation and Inference of Impulse Responses by Local Projections." *American Economic Review* 95, no. 1: 161–82.
- Jordà, Oscar, Moritz Schularick, Alan M. Taylor, and Felix Ward. 2019. "Global Financial Cycles and Risk Premiums." *IMF Economic Review* 67, no. 1: 109–50.
- Kalemli-Özcan, Şebnem. 2019. "U.S. Monetary Policy and International Risk Spillovers." In *Economic Policy Symposium Proceedings: Challenges for Monetary Policy*. Jackson Hole, Wyo.: Federal Reserve Bank of Kansas.
- Kalemli-Özcan, Şebnem, and Liliana Varela. 2021. "Five Facts about the UIP Premium." Working Paper 28923. Cambridge, Mass.: National Bureau of Economic Research. https://www.nber.org/papers/w28923.
- Kekre, Rohan, and Moritz Lenel. 2021. "The Flight to Safety and International Risk Sharing." Working Paper 29238. Cambridge, Mass.: National Bureau of Economic Research. https://www.nber.org/papers/w29238.
- Klein, Michael W., and Jay C. Shambaugh. 2015. "Rounding the Corners of the Policy Trilemma: Sources of Monetary Policy Autonomy." *American Economic Journal: Macroeconomics* 7, no. 4: 33–66.
- Kodres, Laura, Leslie Sheng Shen, and Darrell Duffie. 2022. "Dollar Funding Stresses in China." Working Paper. Social Science Research Network, May 25. https://papers.ssrn.com/sol3/papers.cfm?abstract\_id=4099944.
- Kouri, Pentti J. K., and Jorge Braga de Macedo. 1978. "Exchange Rates and the International Adjustment Process." *Brookings Papers on Economic Activity*, no. 1: 111–57.
- Krishnamurthy, Arvind, and Hanno Lustig. 2019. "Mind the Gap in Sovereign Debt Markets: The U.S. Treasury Basis and the Dollar Risk Factor." In *Economic Policy Symposium Proceedings: Challenges for Monetary Policy*. Jackson Hole, Wyo.: Federal Reserve Bank of Kansas.
- Krishnamurthy, Arvind, and Annette Vissing-Jorgensen. 2012. "The Aggregate Demand for Treasury Debt." *Journal of Political Economy* 120, no. 2: 233–67.
- Lane, Philip R., and Gian Maria Milesi-Ferretti. 2018. "The External Wealth of Nations Revisited: International Financial Integration in the Aftermath of the Global Financial Crisis." *IMF Economic Review* 66, no. 1: 189–222.
- Liao, Gordon, and Tony Zhang. 2020. "The Hedging Channel of Exchange Rate Determination." Discussion Paper 1283. Washington: Board of Governors of the Federal Reserve System.
- Lilley, Andrew, Matteo Maggiori, Brent Neiman, and Jesse Schreger. 2022. "Exchange Rate Reconnect." *Review of Economics and Statistics* 104, no. 4: 845–55.
- Linnemann, Ludger, and Andreas Schabert. 2015. "Liquidity Premia and Interest Rate Parity." *Journal of International Economics* 97, no. 1: 178–92.

- Liu, Zheng, Mark M. Spiegel, and Andrew Tai. 2017. "Measuring the Effects of Dollar Appreciation on Asia: A FAVAR Approach." *Journal of International Money and Finance* 74:353–70.
- Loipersberger, Florian, and Johannes Matschke. 2022. "Financial Cycles and Domestic Policy Choices." *European Economic Review* 143:104034.
- Maggiori, Matteo. 2022. "International Macroeconomics with Imperfect Financial Markets." In *Handbook of International Economics, Volume 6*, edited by Gita Gopinath, Elhanan Helpman, and Kenneth Rogoff. Amsterdam: North Holland.
- Maggiori, Matteo, Brent Neiman, and Jesse Schreger. 2020. "International Currencies and Capital Allocation." *Journal of Political Economy* 128, no. 6: 2019–66.
- Miranda-Agrippino, Silvia, Tsvetelina Nenova, and Hélène Rey. 2020. "Global Footprints of Monetary Policies." Working Paper. http://www.helenerey.eu/ AjaxRequestHandler.ashx?Function=GetSecuredDOC&DOCUrl=App\_Data/ helenerey\_eu/Working-Papers\_en-GB/\_Documents\_2019-20/291828257\_ 67186463733\_MirandaAgrippinoNenovaRey.pdf.
- Miranda-Agrippino, Silvia, and Hélène Rey. 2020. "U.S. Monetary Policy and the Global Financial Cycle." *Review of Economic Studies* 87, no. 6: 2754–76.
- Miranda-Agrippino, Silvia, and Hélène Rey. 2022. "The Global Financial Cycle." In *Handbook of International Economics, Volume 6*, edited by Gita Gopinath, Elhanan Helpman, and Kenneth Rogoff. Amsterdam: North Holland.
- Montiel Olea, José Luis, and Mikkel Plagborg-Møller. 2021. "Local Projection Inference Is Simpler and More Robust Than You Think." *Econometrica* 89, no. 4: 1789–823.
- Mukhin, Dmitry. 2022. "An Equilibrium Model of the International Price System." American Economic Review 112, no. 2: 650–88.
- Nagel, Stefan. 2016. "The Liquidity Premium of Near-Money Assets." *Quarterly Journal of Economics* 131, no. 4: 1927–71.
- Obstfeld, Maurice. 2015. "Trilemmas and Trade-offs: Living with Financial Globalisation." Working Paper 480. Basel: Bank for International Settlements. https://www.bis.org/publ/work480.pdf.
- Obstfeld, Maurice. 2021. "The Global Capital Market Reconsidered." Oxford Review of Economic Policy 37, no. 4: 690–706.
- Obstfeld, Maurice. 2022. "The International Financial System after Covid-19." In *Prospects of the Global Economy after Covid-19*, edited by Thorsten Beck and Yung Chul Park. London: CEPR Press.
- Obstfeld, Maurice, Jonathan D. Ostry, and Mahvash S. Qureshi. 2019. "A Tie That Binds: Revisiting the Trilemma in Emerging Market Economies." *Review of Economics and Statistics* 101, no. 2: 279–93.
- Obstfeld, Maurice, and Alan M. Taylor. 2017. "International Monetary Relations: Taking Finance Seriously." *Journal of Economic Perspectives* 31, no. 3: 3–28.
- Oudiz, Gilles, and Jeffrey Sachs. 1984. "Macroeconomic Policy Coordination among the Industrial Economies." *Brookings Papers on Economic Activity*, no. 1: 1–75.

- Plagborg-Møller, Mikkel, and Christian K. Wolf. 2021. "Local Projections and VARs Estimate the Same Impulse Responses." *Econometrica* 89, no. 2: 955–80.
- Ramey, Valerie A., and Sarah Zubairy. 2018. "Government Spending Multipliers in Good Times and in Bad: Evidence from US Historical Data." *Journal of Political Economy* 126, no. 2: 850–901.
- Reinhart, Carmen M., and Vincent R. Reinhart. 2009. "Capital Flow Bonanzas: An Encompassing View of the Past and Present." In *NBER International Seminar* on Macroeconomics 2008, edited by Jeffrey Frankel and Christopher Pissarides. Chicago: University of Chicago Press.
- Rey, Hélène. 2013. "Dilemma not Trilemma: The Global Financial Cycle and Monetary Policy Independence." In *Economic Policy Symposium Proceedings: Global Dimensions of Unconventional Monetary Policy*. Jackson Hole, Wyo.: Federal Reserve Bank of Kansas.
- Securities Industry and Financial Markets Association (SIFMA). 2022. SIFMA Research Quarterly—4Q21. https://www.sifma.org/wp-content/uploads/2022/01/ US-Research-Quarterly-Equity-2022-01-26-SIFMA.pdf.
- Shin, Hyun Song. 2020. "Global Liquidity and Procyclicality." In *The State of Economics, the State of the World*, edited by Kaushik Basu, David Rosenblatt, and Claudia Sepúlveda. Cambridge, Mass.: MIT Press.
- Shousha, Samer. 2022. "The Dollar and Emerging Market Economies: Channels and Impacts." Working Paper. https://www.dropbox.com/s/wc8vwjsngp5sj0e/ Shousha\_USDEME\_Last.pdf?dl=0.
- Stock, James H., and Mark W. Watson. 2018. "Identification and Estimation of Dynamic Causal Effects in Macroeconomics Using External Instruments." *Economic Journal* 128, no. 610: 917–48.
- Valchev, Rosen. 2020. "Bond Convenience Yields and Exchange Rate Dynamics." American Economic Journal: Macroeconomics 12, no. 2: 124–66.
- von Beschwitz, Bastian, Christopher G. Collins, and Deepa D. Datta. 2019. "Revisions to the Federal Reserve Dollar Indexes." FEDS Notes. Washington: Board of Governors of the Federal Reserve System.
- Wu, Jing Cynthia, and Fan Dora Xia. 2016. "Measuring the Macroeconomic Impact of Monetary Policy at the Zero Lower Bound." *Journal of Money, Credit* and Banking 48, no. 2-3: 253–91.

# Comments and Discussion

#### COMMENT BY

**ŞEBNEM KALEMLI-ÖZCAN** A central issue in international macroeconomics regards the transmission of shocks between countries. As laid bare by the 2008 global financial crisis, the COVID-19 global pandemic, and the recent monetary policy tightening of central banks around the world, it is getting extremely difficult for policymakers to pursue domestic stabilization mandates in an increasingly interconnected global economy. Since a combination of financial and trade linkages ties domestic outcomes to global shocks, policies driven by domestic mandates will also have international spillover effects.

In this world, US monetary policy developments retain a major influence. A large body of literature shows that fluctuations in US monetary policy affect global investors' risk sentiments and, in turn, global financial conditions. The link between US monetary policy and global financial conditions forms the global financial cycle (GFC), as originally shown by Rey (2013). GFC is defined as the co-movement of risky asset prices, capital flows, financial intermediary leverage, and global growth. One common factor summarizing GFC is investors' risk sentiments measured by the CBOE Volatility Index (VIX), capturing global risk aversion and uncertainty.

The paper by Obstfeld and Zhou documents the same cycle, but instead of having it driven by US monetary policy or a measure of global risk aversion such as the VIX, they argue that the US dollar is in the driver's seat. They call it the global dollar cycle. As all these variables are endogenous and correlated with each other, the global dollar cycle is also correlated with the risk sentiments of global investors and with US monetary policy. The

Brookings Papers on Economic Activity, Fall 2022: 428-447 © 2023 The Brookings Institution.

approach by Obstfeld and Zhou has a fundamental advantage in terms of documenting the quantitative importance of the financial channel of international spillovers over the standard trade channel. Since their key variable for the global dollar cycle is the US dollar's nominal exchange rate, they can account for tighter global financial conditions linked to a strong dollar simultaneously with the competitiveness of other countries' currencies that are depreciating against the US dollar when the cycle turns. As countries suffer from the global dollar cycle when the US dollar appreciates, experiencing slower growth in spite of higher net exports, it is clear that the financial channel dominates over the trade channel in the data.<sup>1</sup>

This is a very nice and timely contribution to Brookings Papers on Economic Activity. Showing the quantitative importance of the financial channel for international transmission of shocks and policies over the trade channel is especially important in a world where the share in trade and world output for emerging markets and developing economies (EMDEs) is larger than that of the United States, as documented by the authors. The trade channel tells us that if the US dollar is strong, EMDE currencies are weak, and this is good for their net exports, improving their current accounts.<sup>2</sup> By highlighting the quantitative importance of the financial channel, the paper sheds light on the perverse fact that EMDEs do worse when their currencies depreciate against the dollar. This fact has been documented by extensive literature focusing on contractionary depreciations in EMDEs. However, in this literature authors have had a hard time differentiating between the shocks driving the currency depreciations vis-à-vis the US dollar in EMDEs, since currency depreciations and financial crises go hand in hand: EMDE currencies tank at the same time those countries experience banking and sovereign crises. The "dollar shock" of the current paper is also not exogenous in a pure sense. Since the authors define the dollar shock to be an appreciation of the US dollar against advanced economies' (AEs)-Group of Ten (G10)-currencies, it can at least be taken as an external shock to EMDEs. When the US dollar appreciates against AEs, it also appreciates against EMDE currencies via a global appreciation of the US dollar.

<sup>1.</sup> An early contribution highlighting the role of the US dollar in bilateral nominal exchange rates for negative financial spillovers for other countries instead of positive trade spillovers is Bruno and Shin (2015).

<sup>2.</sup> In a world where export prices are sticky in dollars, this channel might be muted; see Gopinath and others (2020).

The key result of the paper is how EMDEs got hurt from the dollar shock over quite a long horizon and from the global dollar cycle in general, whereas AEs, whose currencies are also depreciating against the US dollar, can get by. The authors document that dollar appreciation shocks predict declines in output, consumption, and investment, together with declines in domestic credit, terms of trade (higher import prices than export prices), and higher sovereign borrowing spreads on foreign currency debt in a sample of twenty-six EMDEs during 1999–2019. They also show that this result is more pronounced in EMDEs who peg their exchange rate, who did not adopt an inflation-targeting monetary policy framework, and who have high levels of external debt denominated in dollars.

The key policy questions then become: Why are EMDEs different? And what type of policies can EMDEs employ to deal with the global dollar cycle? Before getting into the answers given to these questions by the authors, let me briefly summarize what the standard international macro theory teaches us in terms of external shocks and EMDEs. For any small open economy, EMDE or not, standard theory postulates that countries should let their exchange rate carry the burden of adjustment when financial conditions change in the rest of the world. The intuition goes back to what I called the trade channel above. Monetary policy tightening slows down economic activity in the United States, which decreases US external demand. However, the associated appreciation of the dollar (depreciation in the rest of the world) helps other countries increase their exports to the United States and cut back their imports from the United States. If these countries are also net borrowers and experience capital outflows due to tightening of monetary policy in the United States, then a depreciating currency is the only force available to combat reduced activity by switching external demand to their goods. This channel, known as the expenditure switching channel of the Mundell-Fleming model, highlights the virtue of flexible exchange rates. It has been challenged in the academic literature and by the policymakers on the basis of the negative effects of excessive exchange rate volatility on countries with extensive debt denominated in the US dollars, dubbed as "fear of floating" by Calvo and Reinhart (2002). Hence, policies in support of limiting the exchange rate volatility have been used extensively by policymakers as foreign exchange interventions. There are also papers that show the optimality of such intervention policies depending on modeling of financial frictions (Itskhoki and Mukhin 2021).

If the main channel of international spillovers is the financial channel, the above reasoning changes. I argue (Kalemli-Özcan 2019) that exchange rate flexibility helps countries to smooth out the effects of financial cycles





Source: Kalemli-Özcan (2019); reproduced with permission from Federal Reserve Bank of Kansas City.

driven by US monetary policy and a strong US dollar, such as the GFC and the global dollar cycle. My reasoning is not based on the standard expenditure switching channel but rather the strength of the primary channel of spillovers of these financial cycles in the data—changes in global investors' risk sentiments. I document that US monetary policy tightening leading to a strong US dollar increases the required excess return on EMDE bonds, which leads to contractionary outcomes in EMDEs, as also documented here by Obstfeld and Zhou. If EMDEs have flexible exchange rates, the risk premium increases are achieved in part through a currency depreciation. Under a pegged exchange rate, however, a sharper domestic monetary contraction would be needed to achieve the same risk premium rise with more damage to the economy. I show that free-floating EMDEs are much more insulated from risk premia shocks driven by US monetary policy than EMDEs with managed floats, in terms of their output.

Figure 1 is at the heart of my argument (Kalemli-Özcan 2019). The figure shows local projections, similar to Obstfeld and Zhou, but uses Gertler and Karadi's (2015) instrumented exogenous US monetary policy tightening between 1996 and 2018, instead of Obstfeld and Zhou's dollar shock.<sup>3</sup> As shown in panel A, EMDE government bond spreads vis-à-vis

<sup>3.</sup> A similar result is shown by Di Giovanni and others (2022) using the VIX instead of exogenous US monetary policy tightening.

US Treasuries, for less than twelve-month bonds, goes up more than oneto-one when the United States tightens, but for AEs, these spreads go down, as shown in panel B.

The reasoning is as follows. When the US monetary policy is tighter and the US dollar is stronger, global investors go to a risk-off mode and de-lever by shedding risk assets worldwide, not only domestically in the US stock markets. Since EMDEs are a riskier asset class as a whole than AEs, regardless of the type of investment (bonds, loans, equities) global investors make, EMDEs are affected much more, not only via de-leveraging but also via higher risk premia. The risk-averse financial intermediaries and the associated risk premia have a key role in this argument as the US financial intermediaries are pricing the risky assets worldwide. When the US dollar is stronger, global financial intermediaries get out of non-dollar assets and retrench to the US Treasuries. The fact that this happens by getting more out of EMDE assets (sudden stops) at the higher risk premia charged to EMDE assets highlights the key role of endogenously risk-averse global financial intermediaries as modeled by Akinci, Kalemli-Özcan, and Queralto (2022).<sup>4</sup> As a result, flexible exchange rates will help to smooth out this risk premia.

What other policy options are available to EMDEs, in addition to flexible exchange rates, to deal with the contractionary effects of the global dollar cycle and GFC? Using monetary policy to defend a currency against the US dollar can be counterproductive. As shown in Kalemli-Özcan (2019), EMDEs who try to prevent depreciations against a strong US dollar using monetary policy end up having larger contractions and higher risk premia. De Leo, Gopinath, and Kalemli-Özcan (2022) show that even if EMDEs run monetary expansions as a response to tight US policy, they still suffer the same contractionary outcomes. This result is consistent with the results of Obstfeld and Zhou as they show that floaters do not increase their monetary policy rates as a response to a strong US dollar but still suffer contractionary effects. These results open the door for other policies.<sup>5</sup>

In Kalemli-Özcan (2019) I state:

Countries can act on the transmission channel cyclically by limiting credit growth and leverage during the booms and doing reverse during downturns. This can be achieved by the use of macroprudential policies. . . . The policies that limit

4. Gabaix and Maggiori (2015) and Itskhoki and Mukhin (2021) also rationalize these results, using a different theoretical mechanism than endogenous risk aversion. In those models, financial markets are segmented, limiting the amount of bonds on financial intermediaries' balance sheets.

5. The Integrated Policy Framework of the IMF models several optimal policies (Basu and others 2020).
#### COMMENTS and DISCUSSION

un-hedged foreign currency denominated liabilities not only in the financial sector but also in the nonfinancial corporate sector must be a priority. The rationale for these policies is to provide insulation from spillovers that arise from balance sheet effects of exchange rate fluctuations with large levels of un-hedged foreign currency denominated debt....

However, dealing with excessive credit growth and foreign currency denominated debt may not be enough. A significant component of international risk spillovers for EMEs is related to country-specific risk. . . . Long-run improvements in the quality and transparency of institutions will reduce idiosyncratic country risk and reduce the sensitivity of capital flows in EMEs to global risk premia and to foreign investors risk perceptions. . . . Strong institutions will also provide the needed credibility for implementing desirable macroprudential policies, to dampen the severe effects of financial cycles.

... A collective reform agenda aimed at improving transparency, governance, accountability, fighting with corruption, protecting institutional integrity, and improving bureaucratic quality with an emphasis on central bank independence will be beneficial in terms of attracting long-term stable capital flows. These policies reduce the sensitivity of capital flows to changes in the center country monetary policy and associated risk sentiments. (156–58)

Interestingly, Obstfeld and Zhou reach the exact same policy conclusion: "more-flexible exchange rate regimes do not shut out the global financial cycle, but they are indeed helpful in buffering external financial shocks and can do so most effectively when supported by relatively high inflation credibility at the central bank and relatively low external dollarization."

These same policy conclusions in Kalemli-Özcan (2019) and in Obstfeld and Zhou suggest that the risk premia channel underlines the negative effects of both the GFC and the global dollar cycle on EMDEs. In Kalemli-Özcan (2019) I show that uncovered interest rate parity (UIP) deviations in EMDEs vis-à-vis the US dollar are a strong correlate of the risk premia channel. This is because UIP deviations are endogenous to both domestic and US monetary policy. There are several models in the literature that work through endogenous or exogenous UIP deviations. Obstfeld and Zhou provide a very useful framework to connect different pieces of this literature through the simple equation below.

UIP deviations,  $\lambda_{t+h}^e$  can be written as the nonzero difference between the country and the US interest rate differentials minus the expected depreciation over *h* horizon in the nominal exchange rate defined as the local currency per the US dollar (so expected US dollar appreciation if the country interest rate is higher than that of the United States):

$$\lambda_{t+h}^{e} = \underbrace{\left(\underline{i}_{t}^{'} - \underline{i}_{t}^{US}\right)}_{IR \ Differential} - \underbrace{\left(\underline{s}_{t+h}^{e} - \underline{s}_{t}\right)}_{ER \ Adjustment} \neq 0 = \underbrace{\gamma_{t}^{s}}_{convenience/ \ liquidity \ premium} + \underbrace{\rho_{t}}_{excess \ returns}$$



Figure 2. Incomplete Pass-Through between UIP and CIP Deviations

Source: Kalemli-Özcan and Varela (2022); reproduced with authors' permission.

Using this equation, Obstfeld and Zhou equate the UIP deviations, where they formulate these deviations only for AE currencies vis-à-vis the US dollar, to a convenience/liquidity yield of the US Treasuries term plus an excess return term for AE currencies. They call the excess return part of the equation "dark matter." Risk aversion and financial frictions drive this part. One may consider excess returns as coming from risk-averse global intermediaries or financial frictions on global intermediary balance sheets or both. If we want to extend these UIP deviations to EMDEs, then adding a local part to the excess returns term is important as EMDE currencies provide much higher and persistent excess returns than AEs in the data (Kalemli-Özcan and Varela 2021). So dark matter is:

Dark Matter = 
$$\rho_t = \rho_t^{US} + \rho_t^{COUNTRY} = Global + Local$$

The authors focus on the relation between UIP/CIP (covered interest parity) deviations and the convenience/liquidity yield of US Treasuries. I want to make the point that these deviations look very different in the data, and there is no one-to-one pass-through between UIP and CIP deviations, as most often assumed in the literature. As shown in figure 2, regardless of measuring the CIP deviations with cross-currency basis swaps taken from Du and Schreger (2022) in panel A or CIP deviations based on forward rates in panel B, they are nowhere close to the 45 degree line, hence drastically different objects than UIP deviations. This suggests that understanding

the underlying primitive behind the dollar shocks and why a strong dollar leads to contractionary responses in EMDEs but not in AEs requires an understanding of both UIP and CIP deviations. The convenience/liquidity yield of US Treasuries can be correlated with both, but due to very different reasons. CIP deviations are about arbitrage failing in hedging markets, where investors insure for currency risk, whereas UIP deviations can be about a higher price of risk for local currency bonds from which investors are expecting to earn higher excess returns.

In fact, the authors' mechanism is exactly about these types of UIP deviations; when they dig deeper on what causes the dollar shock, they lean toward the explanation of the risk sentiments of global financial intermediaries. The million dollar question is how to measure the changing risk sentiments of global investors in the data. In the literature others have tried to do this using several different measures of investors' risk sentiments that are independent of the response of US monetary policy to developments in the US economy, such as the VIX or exogenous shocks to US monetary policy. The latter is estimated based on high-frequency identification capturing surprise reactions in financial markets to the Federal Reserve's decisions. The authors argue that these exogenous US monetary policy shocks can account for only a small share of dollar variability or sudden stops for EMDEs and that their dollar shock is broader. This is true, but the advantage of using exogenous tightening of US monetary policy is the ease of interpretation. The dollar shock is the dollar's weighted nominal exchange rate against other AEs, which is why it's not obvious how to interpret it structurally. What drives the strong US dollar? US monetary policy? Expansionary global economic activity? Contractionary financial conditions? The answer is important in order to be able to answer questions about EMDEs' optimal policy response and international coordination of monetary policies.

The authors are aware of this problem, which is why they try to instrument their dollar shock with a measure that picks up the risk sentiments of investors. They use the excess bond premium (EBP) of Gilchrist and Zakrajšek (2012). As EBP is the most significant correlate of CIP deviations, this measure fits well with the authors' purposes. But it is still not clear why this measure is a good measure to pick up financial intermediaries' risk sentiments. EBP is the residual spread in US corporate bonds after cleaning the default risk. An increase in EBP is shown in the literature to be correlated with de-leveraging of the financial sector and a slowdown in economic activity. In the literature it is interpreted as a measure capturing a reduction in the risk-bearing capacity of the financial sector as it relates to a contraction in the supply of credit in the United States.

Why would a higher EBP lead to contractionary outcomes in EMDEs? Going back to the authors' general framework, if the balance sheet constraint of global financial intermediaries prevents arbitrage, leading to CIP deviations only, this would not lead to higher spreads on local currency borrowing by EMDEs (UIP deviations), and hence it becomes harder to link real contractionary outcomes both to capital outflows and higher spreads. If, however, the existing balance sheet constraint of long-lived and forwardlooking global financial intermediaries will be even tighter in the future due to higher pricing of currency risk, then all data facts can be explained, where higher risk sentiment is captured by EBP. Akinci, Kalemli-Özcan, and Queralto (2022) provide such a model. The reason why global financial intermediaries become more risk averse and want to de-lever their EMDE assets (captured by higher EBP premium) is an exogenous increase in uncertainty that can be captured by stock market volatility in the United States. Such earnings volatility in the United States hurts the balance sheets of the US intermediaries, and hence they become endogenously more risk averse and want to get out of their other risky investments such as EMDE assets. Such uncertainty spillovers can generate all the facts shown by Obstfeld and Zhou, as seen in figure 3: strong dollar, higher UIP deviations on EMDEs (higher emerging markets bond index and other spreads), sudden stops in EMDEs (capital outflows), depreciating EMDE currencies, and contractionary outcomes in EMDEs.

To conclude, this is a valuable paper providing a unifying framework on how to think about the global dollar cycle and the GFC and their detrimental effects, especially on EMDEs. The policy implication is clear: the case for flexible exchange rates is stronger. If the contractionary effects of a strong dollar work through higher excess bond premia, this means that risk spillovers of US monetary policy, as originally argued (Kalemli-Özcan 2019), is central to understanding the negative effects of a strong US dollar on EMDEs. In a world of risk spillovers, the coordination of monetary policy will be much more difficult; if any country loses its own monetary policy credibility for the sake of international coordination, risk premia can be higher due to higher uncertainty in financial markets, leading to worse contractionary outcomes in EMDEs (Coy 2022). This is why Obstfeld and Zhou conclude that flexible exchange rate regimes can buffer external financial shocks most effectively when supported by relatively high inflation credibility at the central banks.



Figure 3. The Effects of US Risk-Off Shocks in the Rest of the World

Source: Akinci, Kalemli-Özcan, and Queralto (2022); reproduced with authors' permission.

#### REFERENCES FOR THE KALEMLI-ÖZCAN COMMENT

- Akinci, Ozge, Şebnem Kalemli-Özcan, and Albert Queralto. 2022. "Uncertainty Shocks, Capital Flows, and International Risk Spillovers." Working Paper 30026. Cambridge, Mass.: National Bureau of Economic Research. https://www.nber.org/ papers/w30026.
- Basu, Suman S., Emine Boz, Gita Gopinath, Francisco Roch, and Filiz D. Unsal. 2020. "A Conceptual Model for the Integrated Policy Framework." Working Paper 2020/121. Washington: International Monetary Fund. https://www.imf.org/ en/Publications/WP/Issues/2020/07/07/A-Conceptual-Model-for-the-Integrated-Policy-Framework-49558.
- Bruno, Valentina, and Hyun Song Shin. 2015. "Capital Flows and the Risk-Taking Channel of Monetary Policy." *Journal of Monetary Economics* 71:119–32.
- Calvo, Guillermo A., and Carmen M. Reinhart. 2002. "Fear of Floating." *Quarterly Journal of Economics* 107, no. 2: 379–408.

- Coy, Peter. 2022. "A Strong Dollar Is Hurting Other Countries. Should the Fed Care?" *New York Times*, September 30. https://www.nytimes.com/2022/09/30/ opinion/us-dollar-global-impact.html.
- De Leo, Pierre, Gita Gopinath, and Şebnem Kalemli-Özcan. 2022. "Monetary Policy Cyclicality in Emerging Economies." Working Paper 30458. Cambridge, Mass.: National Bureau of Economic Research. https://www.nber.org/papers/w30458.
- Di Giovanni, Julian, Şebnem Kalemli-Özcan, Mehmet Fatih Ulu, and Yusuf Soner Baskaya. 2022. "International Spillovers and Local Credit Cycles." *Review of Economic Studies* 89, no. 2:733–73.
- Du, Wenxin, and Jesse Schreger. 2022. "CIP Deviations, the Dollar, and Frictions in International Capital Markets." In *Handbook of International Economics, Volume 6*, edited by Gita Gopinath, Elhanan Helpman, and Kenneth Rogoff. Amsterdam: North Holland.
- Gabaix, Xavier, and Matteo Maggiori. 2015. "International Liquidity and Exchange Rate Dynamics." *Quarterly Journal of Economics* 130, no. 3: 1369–420.
- Gertler, Mark, and Peter Karadi. 2015. "Monetary Policy Surprises, Credit Costs, and Economic Activity." *American Economic Journal: Macroeconomics* 7, no. 1: 44–76.
- Gilchrist, Simon, and Egon Zakrajšek. 2012. "Credit Spreads and Business Cycle Fluctuations." *American Economic Review* 102, no. 4: 1692–720.
- Gopinath, Gita, Emine Boz, Camila Casas, Federico J. Díez, Pierre-Olivier Gourinchas, and Mikkel Plagborg-Møller. 2020. "Dominant Currency Paradigm." *American Economic Review* 110, no. 3: 677–719.
- Itskhoki, Oleg, and Dmitry Mukhin. 2021. "Exchange Rate Disconnect in General Equilibrium." *Journal of Political Economy* 129, no. 8: 2183–232.
- Kalemli-Özcan, Şebnem. 2019. "U.S. Monetary Policy and International Risk Spillovers." In *Economic Policy Symposium Proceedings: Challenges for Monetary Policy*. Jackson Hole, Wyo.: Federal Reserve Bank of Kansas.
- Kalemli-Özcan, Şebnem, and Liliana Varela. 2021. "Five Facts about the UIP Premium." Working Paper 28923. Cambridge, Mass.: National Bureau of Economic Research. https://www.nber.org/papers/w28923.
- Rey, Hélène. 2013. "Dilemma Not Trilemma: The Global Financial Cycle and Monetary Policy Independence." In *Economic Policy Symposium Proceedings: Global Dimensions of Unconventional Monetary Policy*. Jackson Hole, Wyo.: Federal Reserve Bank of Kansas.

### COMMENT BY

**MATTEO MAGGIORI**<sup>1</sup> It is a pleasure to have the opportunity to discuss this paper by Maurice Obstfeld and Haonan Zhou on the role of the dollar nominal exchange rate in transmitting financial conditions globally,

1. I am grateful to Janice Eberly and James Stock for inviting me to discuss this paper at the *BPEA* annual conference, and to Maurice Obstfeld and Haonan Zhou for interesting discussions of the contents of their paper. *BPEA* provided an honorarium for this discussion.

especially to emerging economies. The paper builds on a view of the determination of the dollar exchange rate in imperfect financial markets, whereby financial flows more than macro fundamentals pin down the exchange rate, and then goes on to provide evidence that a dollar appreciation negatively affects real economic activity in emerging economies. That is, dollar appreciation shocks, which tend to occur at times of global financial stress, predict economic downturns in emerging economies.

The paper is particularly timely, since in 2022 the dollar appreciated strongly, and many commentators and policymakers worry that soon we will observe the consequent deleterious effects on emerging economies. It is too soon to tell whether, in this instance, the view and evidence put forward by the authors will pan out. It is certainly not my comparative advantage to make such forecasts, and my reading of the empirical evidence to date leaves me wary of making such forecasts. I mention it here, instead, with the intent of highlighting the importance of the topic this paper is devoted to, and the need to assess what we know thus far and where academic research might go hunting for more evidence next.

In this respect, my summary judgment is that the paper is an excellent overview of the current stock of knowledge. It provides new evidence on the dollar's importance in shaping the global business cycle and highlights some challenges for policy in addressing unwanted swings in exchange rates. I recommend it as a read for both practitioners and academics.

THE IMPORTANCE OF GLOBAL GROSS POSITIONS Obstfeld and Zhou start their analysis by reminding the reader of the fast increase in global gross external positions that has occurred since the collapse of the Bretton Woods system in 1973. The liberalization of capital accounts which accompanied the move to a floating exchange rate system has been followed by an explosion in global financial positions. Figure 1 in the paper provides a great summary of the evidence. To clarify, a country's foreign asset is an asset that the country's domestic residents own abroad. Similarly, a country's foreign liability is an asset that residents of foreign countries own in that country. Figure 1 in the paper plots the sum of all countries' foreign assets and liabilities scaled by gross domestic product (GDP). These gross positions moved from being a small fraction of GDP in the early 1970s to a multiple of GDP today: a remarkable growth over this period.

These positions are interesting and consequential for several different reasons. The authors focus on two key elements. First, these large positions have to be intermediated at least in the medium run by financial intermediaries with limited risk-bearing capacity. The intermediaries' willingness to absorb the exchange rate risk is an important determinant of the level and dynamics of exchange rates. Second, many of these positions are in dollars, even when the United States is neither the holder nor the issuer. Further, financial (funding) conditions in the dollar market might affect the intermediaries' willingness to bear risks since much of the world financial sector is funded in dollars. I will briefly discuss each of these two elements; I tend to agree strongly on both points, even while recognizing that much progress is yet to be made in understanding these topics.

EXCHANGE RATE DETERMINATION WITH IMPERFECT FINANCIAL MARKETS The field of international macroeconomics and finance has in recent years progressed both empirically and theoretically by focusing on the question of who owns which assets around the world. On the theoretical front, this has required not only new models but also, in some cases, going back to older insights that had been largely forgotten, such as the portfolio balance theories in the 1970s. On the empirical front, we have witnessed, starting in 2007, the breakdown of the covered interest parity (CIP) condition, a central condition for the absence of arbitrage. It is rare to witness such a dramatic change in a basic condition of one of the most established financial markets. This prime evidence for currency market segmentation, reviewed extensively by Du and Schreger (2022), is inconsistent with models of perfect financial markets, including those that generate imperfect substitutability among currencies via risk premia.

The authors rightly focus on the recent literature that used financial frictions as a foundation for imperfect substitutability of assets in different currencies. The presence of market segmentation and financial frictions generates a set of specific predictions: CIP deviations, a direct effect of gross portfolio flows on exchange rates, and the effectiveness of foreign exchange intervention. It also casts a different light on classic stylized facts in the field, such as the disconnect of exchange rates from macro fundamentals and the carry trade.

In models with imperfect financial intermediation, the exchange rate is pinned down by imbalances in the demand and supply of assets in different currencies and, crucially, by the limited risk-bearing capacity of financiers that absorb these imbalances. The demand for the assets, the resulting gross capital flows, or the financiers' risk-bearing capacity might only have a distant relation with macro fundamentals, thus contributing to generating the disconnect. By placing global portfolios at center stage, this line of research stresses the importance of better data to understand these financial forces and their impact on the real economy, an ongoing effort in the field.

The intellectual origin of this modeling can be traced back to the Nurkse (1944) view of capital flows as inducing volatile and destabilizing exchange

rate movements. The field has been inspired by the pioneering work of Pentti Kouri (1976, 1983). At the core of the portfolio balance approach is the idea of imperfect substitutability of assets denominated in different currencies. This contrasts with the traditional macroeconomics approach of imposing, either explicitly or implicitly via solution methods, the uncovered interest rate parity (UIP) condition of perfect substitutability. Gabaix and Maggiori (2015) provide a simple general equilibrium framework of the portfoliobalance determination of exchange rates under segmented currency markets, and Maggiori (2022) reviews the growing literature on this exchange rate determination framework.

THE DOLLAR AS AN INTERNATIONAL CURRENCY IN GLOBAL POSITIONS The authors rightly emphasize the dominance of the dollar in global positions and capital flows. Figure 7 in the paper provides an overview of the usage of the dollar to denominate cross-border debt (bonds and loans), settle payments (SWIFT), and more generally in foreign exchange transactions. In all these dimensions the dollar is used to a greater extent than what the economic size of the United States alone would predict. Plainly, the dollar is being used as an international currency, and used in relationships that never directly involve the United States. For example, think of a eurozone investor buying dollar denominated bonds of a Brazilian corporation.

The authors emphasize the importance of the centrality of the dollar in three main respects: (1) demand for dollar (safe) debt increases when global conditions worsen and, via the equilibrium determination described above, the dollar appreciates (Jiang, Krishnamurthy, and Lustig 2020); (2) intermediaries fund themselves in dollars, and when funding becomes tight in times of stress this makes the intermediaries less willing to absorb risk, including currency risk (Avdjiev and others 2019); and (3) the dollar importance in asset and goods trade denomination in emerging markets leaves these economies vulnerable to swings in the dollar exchange rate. The third aspect is crucial in transmitting variation in the dollar exchange rate to real economic activity in emerging economies.

THE DOLLAR AND EMERGING ECONOMIES' REAL PERFORMANCE The authors provide new evidence that dollar appreciation shocks predict downturns in emerging economies over the next few quarters. This is the most innovative part of the paper and the more relevant for policy. Figure 8 in the paper provides a great summary of the authors' main results. A 10 percent dollar appreciation against a basket of developed currencies is associated with a persistent fall in the GDP of emerging economies over the following eight quarters, reaching a trough of about -1.5 percent compared to trend. Investment also falls and the local currency depreciates. The authors measure the dollar exchange rate against a basket of advanced economies' currencies to avoid any direct effect of local currencies of emerging economies contaminating their results. They also break down their analysis by the exchange rate and monetary policy regime and the amount of dollar external liabilities for each emerging economy. Overall, the analysis is careful, and the results are appropriately caveated.

There is much we do not know about how dollar exchange rate movements affect real activity in emerging markets. Which channels are important? Is the relationship stable or highly state dependent? How have changes in the policy response of emerging economies affected (or are likely to affect going forward) this relationship? The answers to these questions are beyond the scope of the current paper, and rightly so; solid answers will need future contributions to the literature, not a single paper. My own reading of the existing evidence is that it is supportive of a negative effect of dollar appreciation on emerging economies, but in judging the quality and extent of the evidence the proverbial bottle is at best half full. To fill up the bottle, future literature should focus on identification and carefully tracing each of the channels using micro data (and of course aggregation to macro). This is not just the call of an academic discussant for more evidence and careful work, it is a cautionary statement not to be overconfident in policy about these mechanisms given the state of the evidence.

WHAT CAN EMERGING MARKETS' POLICYMAKERS DO ABOUT THIS? The policy framework, especially in emerging markets, has evolved substantially since the global financial crisis of 2007–2009. Policies such as ex ante capital controls and foreign exchange interventions are now an integral part of the policy tool kit. These policies were previously regarded with diffidence, especially by Washington multilateral institutions. Such changes came about from the interplay of actual events (like crises); policy experimentations, often with emerging market central banks further ahead than the policy consensus; academic research on what inefficiencies these policies might help address and how; and finally multilateral discussions. I regard the changes that have taken place as beneficial, in the sense that welfare is probably higher with these policies in use in their current imperfect form than it would have been otherwise.

Especially in emerging markets these policies are used to tame waves of foreign capital that wash up on their shores. In buoyant times in global markets, capital chases assets in emerging economies in search for higher returns. When the eventual fall in global risk appetite comes, the fast withdrawal of capital produces welfare losses due to either the fire sale of local assets (a pecuniary externality) or a disproportionate fall in demand (a demand externality). The boom-and-bust pattern is excessive from an optimal policy perspective. Policy interventions aim to reduce the bust a lot by reducing the boom a little. Bianchi and Lorenzoni (2022) offer a great review of these issues, and Basu and others (2020) and Adrian and others (2022) provide a view into the IMF's evolving thinking about these policies.

An interesting question, based on the paper, is to what extent emerging market policymakers should aim to counteract the effect that movements in the dollar exchange rate might have on their economies. And if so, with which policies? Monetary policy alone might be limited or too blunt of a tool. In fact, it is not entirely obvious if the right response should be higher local interest rates in the hope of limiting local currency depreciation or lower rates to stimulate domestic demand. The answers might very well depend on the underlying channel through which the dollar is affecting the local economy.

Ex ante macroprudential policy in the form of capital controls or foreign exchange intervention to smooth exchange rate movements might be necessary to complement monetary policy and target specific margins like foreign capital flows or the exchange rate. These policies, however, are not free of problems. A prominent one is that these policies could be prone to abuse, especially in countries with a weak institutional framework. In this light, capital controls implemented as taxes are more likely to be abused as another way to inefficiently generate fiscal revenue. To minimize these risks, these policies should be directed by an independent body, like the central bank, with the best hope of isolating their implementation from political abuse.

CONCLUSION The paper both consolidates and pushes in new directions the existing literature on the role of the dollar in transmitting and setting global financial conditions. Swings in the value of the dollar are potentially affecting emerging economies, and policy has a role to play in reducing potential inefficiencies coming from boom-and-bust cycles. It is a timely paper worth reading and thinking about, as the world in 2022 is witnessing a strong appreciation of the dollar and many policymakers in emerging economies are contemplating how to react to this environment.

#### REFERENCES FOR THE MAGGIORI COMMENT

Adrian, Tobias, Christopher J. Erceg, Jesper Linde, Marcin Kolasa, and Pawel Zabczyk. 2022. "Managing Monetary Tradeoffs in Vulnerable Open Economies." Discussion Paper 16972. London: Centre for Economic Policy Research. https:// cepr.org/publications/dp16972.

- Avdjiev, Stefan, Wenxin Du, Catherine Koch, and Hyun Song Shin. 2019. "The Dollar, Bank Leverage, and Deviations from Covered Interest Parity." *American Economic Review: Insights* 1, no. 2: 193–208.
- Basu, Suman S., Emine Boz, Gita Gopinath, Francisco Roch, and Filiz D. Unsal. 2020. "A Conceptual Model for the Integrated Policy Framework." Working Paper 2020/121. Washington: International Monetary Fund. https://www.imf.org/ en/Publications/WP/Issues/2020/07/07/A-Conceptual-Model-for-the-Integrated-Policy-Framework-49558.
- Bianchi, J., and G. Lorenzoni. 2022. "The Prudential Use of Capital Controls and Foreign Currency Reserves." In *Handbook of International Economics, Volume 6*, edited by Gita Gopinath, Elhanan Helpman, and Kenneth Rogoff. Amsterdam: North Holland.
- Du, Wenxin, and Jesse Schreger. 2022. "CIP Deviations, the Dollar, and Frictions in International Capital Markets." In *Handbook of International Economics, Volume 6*, edited by Gita Gopinath, Elhanan Helpman, and Kenneth Rogoff. Amsterdam: North Holland.
- Gabaix, Xavier, and Matteo Maggiori. 2015. "International Liquidity and Exchange Rate Dynamics." *Quarterly Journal of Economics* 130, no. 3: 1369–420.
- Jiang, Zhengyang, Arvind Krishnamurthy, and Hanno Lustig. 2020. "Dollar Safety and the Global Financial Cycle." Working Paper 27682. Cambridge, Mass.: National Bureau of Economic Research. https://www.nber.org/papers/w27682.
- Kouri, Pentti J. K. 1976. "The Exchange Rate and the Balance of Payments in the Short Run and in the Long Run: A Monetary Approach." *Scandinavian Journal of Economics* 78, no. 2: 280–304.
- Kouri, Pentti J. K. 1983. "Balance of Payments and the Foreign Exchange Market: A Dynamic Partial Equilibrium Model." In *Economic Interdependence and Flexible Exchange Rates*, edited by Jagdeep S. Bhandari and Bluford Putnam. Cambridge, Mass.: MIT Press.
- Maggiori, Matteo. 2022. "International Macroeconomics with Imperfect Financial Markets." In *Handbook of International Economics, Volume 6*, edited by Gita Gopinath, Elhanan Helpman, and Kenneth Rogoff. Amsterdam: North Holland.
- Nurkse, Ragnar. 1944. International Currency Experience: Lessons of the Interwar Period. Geneva: League of Nations.

**GENERAL DISCUSSION** Pierre-Olivier Gourinchas began the discussion by considering the current dollar appreciation episode and the absence of significant turmoil in emerging markets and developing economies (EMDEs) thus far. The United States is in the midst of sharp dollar appreciation, particularly in comparison to other advanced economies (AEs), Gourinchas pointed out. This paper, in addition to existing literature, demonstrates how tightening financial conditions associated with dollar appreciation indicate

trouble for EMDEs.<sup>1</sup> Furthermore, Gourinchas noted that previous episodes have suggested that this trouble is front-loaded. In the early 1980s, following the Volcker disinflation, there were almost instant effects in EMDEs, with sharp increases in interest rates and, most notably, the Latin American debt crisis. In the 2013 taper tantrum, merely the announcement of tightening financial conditions elicited trouble in EMDEs.

Gourinchas challenged the authors to consider why, in the current circumstances of dollar appreciation and tightening financial conditions and given the precedent of front-loaded trouble in emerging markets, we have not yet seen major crises in emerging markets. Gourinchas wondered if this turmoil could be yet to come or if there had been improvements in how EMDEs have been dealing with the circumstances of dollar appreciation, for example, the early tightening of monetary policies, ahead of AEs, in Latin America.

Arvind Krishnamurthy, in response to Gourinchas's query, noted that India is currently going through foreign exchange reserves at a fast rate, suggesting that there may be signs of beginning trouble in EMDEs.

Gian Maria Milesi-Ferretti added to this discussion by positing three potential factors driving this episode of dollar appreciation. First, there are domestic factors of the United States, excess demand, inflation pressures, and interest rates. Second, there are massive negative shocks coming from Europe. As the paper considers the exchange rate of the dollar relative to other AEs, some of the observed dollar appreciation could be a product of war in Europe and trade shocks from segmented energy markets, which, Milesi-Ferretti explained, would be less indicative of real trouble for EMDEs. The third driving factor Milesi-Ferretti discussed was increasing global risk aversion.

Maurice Obstfeld responded, providing context for multiple important factors. First, Obstfeld observed that in the current episode EMDEs have been more proactive in raising interest rates in comparison to AEs, pointing to Brazil as an example of early and dramatic increases in interest rates. Second, Obstfeld noted that in the current situation the dollar had appreciated approximately 12 percent since mid-2021, through August 2022, which, while significant, is not as great as previous episodes. For example, from mid-2014 to the end of that appreciation episode, over an equivalent length

<sup>1.</sup> Julian T. Chow, Florence Jaumotte, Seok G. Park, and Yuanyan S. Zhang, *Spillovers from Dollar Appreciation* (Washington: International Monetary Fund, 2015); Şebnem Kalemli-Özcan, "U.S. Monetary Policy and International Risk Spillovers," working paper 26297 (Cambridge, Mass.: National Bureau of Economic Research, 2019), https://doi.org/10.3386/ w26297; M. Ayhan Kose, Csilla Lakatos, Franziska Ohnsorge, and Marc Stocker, "The Global Role of the U.S. Economy: Linkages, Policies and Spillovers," working paper, Social Science Research Network, February 10, 2017, https://doi.org/10.2139/ssrn.2914672.

of time, the appreciation of the dollar was much greater, approximately 20 percent, breeding turmoil in China and other EMDEs. Considering the current appreciation as modest in comparison may clarify why substantial turmoil has not yet been seen in EMDEs. Lastly, Obstfeld suggested that the United States likely has further to go with interest rate increases, as the labor market has not yet slowed, high-yield spreads have not risen much, and the housing market has only slowed slightly. As these factors develop with further attempts from the Federal Reserve to reduce inflation, Obstfeld posited that more turmoil may be seen in EMDEs. Haonan Zhou concluded this discussion, mentioning a 1985 paper by Guillermo Calvo which argues that it is not the absolute level of the dollar exchange rate but the rate of appreciation that matters.<sup>2</sup>

Another thread of discussion considered the responsibilities of the United States given the wide impacts of US monetary policy. Jason Furman considered that foreign central bankers could approach the Federal Reserve and utilize this paper's research to advocate on account of the effects the dollar and US monetary policy have on their economies. Following, Furman asked if there were any elements of this paper that should encourage the Federal Reserve to care more about considering effects on EMDEs than they have before.

Building on this, Hanno Lustig remarked on the United States' exorbitant privilege, as the United States acts as the world's safe asset supplier and earns large convenience yields on Treasuries. Relatedly, Lustig continued, foreign issuers are incentivized to borrow in US dollars to capture some of this convenience yield. Lustig considered that as the dollar appreciates a problem is created for foreign borrowers, as the cost of servicing their debt increases. Trends of expansionary monetary policy and abrupt contraction especially create a problem. In conclusion, Lustig questioned if the exorbitant privilege of the United States in this position demands responsibility from US monetary policymakers to consider effects on the rest of the world. Additionally, Lustig noted the difficulty of the US-centric nature of the field, considering that the United States is an ineffective benchmark in macroeconomics as most countries are far more limited in what they can do in terms of fiscal policy.

Obstfeld responded briefly, commenting that in the past the Federal Reserve has considered effects on EMDEs. For example, after the lift-off

<sup>2.</sup> Guillermo A. Calvo, "Reserves and the Managed Float: A Search for the Essentials," *Journal of International Money and Finance* 4, no. 1 (1985): 43–60, https://doi.org/10.1016/0261-5606(85)90005-1.

rate hike in December 2015 the Federal Reserve waited to raise interest rates again for a full year. Obstfeld argued that a substantial motivation for this delay was the potential effects on turmoil in China and other EMDEs.

Reflecting on the importance of the dollar, Krishnamurthy raised a question on the safety of the Treasury. Analogizing Treasuries and safe dollar assets to gold stores, Krishnamurthy questioned what would occur if Treasuries were no longer safe or liquid and substantially lost value, comparing this to a world where half the gold suddenly disappeared. In response, Obstfeld considered this an interesting query on the confidence in the dollar's global role but noted that this subject would necessitate a lengthy discussion.

Additionally, Krishnamurthy pointed out that this paper added to evidence of strong spillover effects from the global financial cycle and global dollar cycle. This, Krishnamurthy remarked, challenged traditional international macroeconomic models, which contend that there should be no spillover effects with floating exchange rates.

In response to the discussants' comments from Şebnem Kalemli-Özcan and Matteo Maggiori, Obstfeld remarked on the need to consider the endogeneity of policy regimes and policies. Obstfeld expressed that a barrier to being able to know if interventions and capital controls are effective is that these policy actions are triggered by events, making controlled experiments difficult or impossible. Additionally, in response to Maggiori's discussion of causally identifying the effect of the dollar on the real economy, Zhou noted that some existing research has investigated this, such as research showing that dollar appreciation could causally increase the borrowing cost of syndicated loans.<sup>3</sup> Zhou added that this would be an important area for further research.

Lastly, Zhengyang Jiang asked about the potential need to include a default risk term in the model of currency excess return. Obstfeld clarified that in the paper the uncovered interest rate parity (UIP) condition referred to the dollar versus other AEs. In Kalemli-Özcan's comment, she discussed the potential for a UIP condition focused on the dollar versus EMDEs. Obstfeld explained that the inclusion of a default risk term might be appropriate in Kalemli-Özcan's UIP condition, but not in that of this paper.

<sup>3.</sup> Ralf R. Meisenzahl, Friederike Niepmann, and Tim Schmidt-Eisenlohr, "The Dollar and Corporate Borrowing Costs," International Finance Discussion Paper 1312 (Washington: Board of Governors of the Federal Reserve System, 2021), https://doi.org/10.17016/IFDP. 2021.1312.

# Online appendix to The Global Dollar Cycle

Maurice Obstfeld and Haonan Zhou

This appendix provides details on our data collection and reports additional results. We note generic sources and specific cases for which we take a different approach or extra steps.

# A Additional Results

## A.1 Emerging markets and the dollar: Additional local projections

In this section we present the full set of local projections relating emerging market macro aggregates, prices, and financial variables to the strength of the dollar as in Section II.



Figure A1: Impulse response: 10% appreciation of advanced economies dollar index





**Figure A1:** Impulse response: 10% appreciation of advanced economies dollar index (cont'd)

(c) Credit, stock prices, and interest rates

Note: Figure A1 reports the impulse response functions of EMDE economic and financial variables to a 10% appreciation of the dollar exchange rate against a basket of advanced economy currencies, based on the local projection (1). For regressions involving the GDP deflator and consumer-price inflation (panel (b)), country-quarter observations with a year-on-year change over 50 percent are dropped. Bilateral exchange rates are expressed as units of local currency per one USD. Equity prices are local-currency stock market indices. Heteroskedasticity-robust 90% and 68% confidence bands are reported.





(a) Macro aggregates

**Figure A2:** Impulse response: 10% appreciation of AE-dollar index, by FX regime (cont'd)



(b) Prices and bilateral dollar exchange rate



(c) Credit, stock prices, and interest rates

Note: Figure A2 shows the impulse responses of EMDE economic and financial variables to a 10% dollar appreciation against a basket of advanced economy currencies, conditional on the exchange rate regime. Estimates are derived from the state-dependent local projection (2). The state indicator  $I_{t-1}$  is defined based on the Ilzetzki, Reinhart and Rogoff (2019) (IRR) exchange rate regime one quarter prior to the current quarter *t*. A country is considered to have a floating exchange rate ( $I_t = 1$ ) if it is assigned an IRR coarse regime code of 3 or 4 in quarter *t*. Countries with a pegged exchange rate have an IRR coarse regime code of 1 or 2. The figure plots 68% robust standard error bands. The blue band applies to estimates for countries with a pegged exchange rate while the gray band applies to countries with a floating rate. For regressions involving the GDP deflator and consumer-price inflation (panel (b)), country-quarter observations with year-on-year change over 50 percent are dropped. Bilateral exchange rates are exprfessed as units of local currency per one USD. Equity prices are local-currency stock market indices.





(b) Prices and bilateral dollar exchange rate

Other regimes

Inflation targeting

Other regimes

Inflation targeting

Other regimes

Inflation targeting

**Figure A3:** Impulse response: 10% appreciation of AE-dollar index, by monetary regime (cont'd)



(c) Credit, stock prices, and interest rates

Note: Figure A3 plots the impulse responses of EMDE economic and financial variables to a 10% dollar appreciation against a basket of advanced economy currencies, conditional on the monetary policy regime. Estimates are derived from the state-dependent local projection (2). The state indicator  $I_{t-1}$  is defined based on the classification of Ha, Kose and Ohnsorge (2021). A country is in state  $I_{t-1} = 1$  only if it practices inflation targeting in the previous year. The figure plots 68% robust standard error bands. The gray band applies to countries adopting inflation targeting while the blue band applies to countries adopting other monetary policy regimes. For regressions involving the GDP deflator and consumer-price inflation (panel (b)), country-quarter observations with year-on-year change over 50 percent are dropped. The bilateral exchange rate is expressed as units of local currency per one USD. Equity prices are local-currency stock market indices.

**Figure A4:** Impulse response: 10% appreciation of AE-dollar index, by dollar liability to GDP



(a) Macro aggregates



**Figure A4:** Impulse response: 10% appreciation of AE-dollar index, by dollar liability to GDP (cont'd)

(b) Prices and bilateral dollar exchange rate





Note: Figure A4 plots the impulse responses of EMDE economic and financial variables to a 10 percent dollar appreciation against a basket of advanced economy currencies, conditional on the degree of balance-sheet exposure to the dollar. Estimates are derived from the local projection (2). The state indicator  $I_{t-1}$  is based on the cross-border currency exposure dataset of Bénétrix and others (2019). A country is in state  $I_{t-1} = 1$  if its external dollar liabilities as a share of GDP in the previous year exceed the median of all country-quarter observations. The figure plts 68% robust standard error bands. The gray band applies to countries with abovemedian balance-sheet exposure while the blue band applies to countries with below-median balance-sheet exposure. For regressions involving the GDP deflator and consumer-price inflation (panel (b)), country-quarter observations with year-on-year change over 50 percent are dropped. The bilateral exchange rate is expressed as units of local currency per one USD. Equity prices are local-currency stock market indices.

### A.2 U.S. financial conditions and the dollar: VAR evidence

The exchange rate equations we estimated in the Section III illustrate the important connection between dollar movements and U.S. financial conditions. Among the financial indicators we studied, the excess bond premium EBP stands out for the consistency and strength of its association with short-term exchange rate movements. The EBP is based on U.S. data and is a strong predictor of U.S. recessions, but it could also capture broader global movements in risk appetite. In this section we establish two more facts about the EBP. First, we show in a vector autoregression (VAR) framework that the dollar appreciation due to a rise in the EBP is strong and persistent, and that shocks to the EBP could account for a sizable share of the variation in the dollar exchange rate in a dynamic setting. Second, returning to the LP framework of Section II, we show that EBP shocks predict sharp contractions in emerging market economies. Section II reported the average results of "generic" dollar shocks, possibly driven by a range of factors including the EBP, but here we home in on the specific role of EBP shocks, as have a number of other recent studies.

Guided by our previous empirical estimates, we consider a parsimonious Bayesian VAR for the following vector of variables at monthly frequency,

$$Y_t \equiv [i_t - i_t^*, EBP_t, x_t, s_t]', \tag{13}$$

where  $x_t$  again denotes the U.S. Treasury basis and  $s_t$  is the trade-weighted dollar exchange rate against advanced economy currencies. The trade weights underlying  $s_t$  are also used to calculate cross-sectional weighted averages of the short-term interest rate differential in favor of Treasurys,  $i_t - i_t^*$ , and the Treasury basis. This compact VAR system comprises the most significant correlates of the dollar exchange rate found in estimating equation (8); we choose the Treasury basis rather than the LIBOR basis because it is a more comprehensive measure of the convenience yield on Treasury liabilities. The recursive VAR ordering in (13) reflects an assumption on the underlying structural forces driving the dynamics of each variable.<sup>57</sup> We order the interest rate differential first, given the ample evidence on monetary policy shocks driving shifts in U.S. financial conditions and credit costs (Gertler and Karadi, 2015) as well as relative convenience yield of U.S. government securities (Valchev, 2020). Our previous discussion has established how the Treasury basis captures preferences for dollar liquidity, the relative liquidity of Treasurys and, importantly, financial conditions (see equation (12)). We order EBP ahead of the Treasury basis in line with this reasoning.

<sup>&</sup>lt;sup>57</sup>The shape of the impulse responses we obtain is robust to alternative ordering assumptions.

We impose standard Minnesota priors and include twelve lags in estimating our VAR on monthly data spanning 1999–2021.<sup>58</sup> Figure A5 displays the impulse responses to a one standard deviation (23 basis point) increase in the excess bond premium. All impact responses are estimated with high precision. The Treasury basis immediately jumps upward and enters into a persistent reversal only in the sixth month. The difference between U.S. and foreign government yields narrows by a cumulative 5 basis points after one year. This finding is consistent with the finding of Gilchrist and Zakrajšek (2012) for the United States of a monetary easing in response to the contractionary impact of the EBP. Meanwhile, the dollar appreciates against other advanced-economy currencies. The response is strong and persistent, reaching a peak of around 60 basis points after five months.

Decomposition of the dollar forecast error variance highlights the near-term importance of EBP shocks in the currency's dynamics. At very short horizons of a quarter or below, EBP shocks explain most of the exchange rate forecast error variance among shocks to variables other than the exchange rate itself. The explanatory power of EBP reaches a level close to 8 percent by the sixth month. On the other hand, the Treasury basis accounts for a higher share of explanatory power over longer horizons. Perhaps surprisingly, the short-term interest rate differential explains only a small amount of the dollar exchange rate's variance at any horizon, possibly owing to the zero lower bound period that comprises a large portion of our sample.

	1m	3m	6m	9m	12m	24m
Interest rate	0.72	0.81	1.23	1.26	1.34	2.04
EBP	4.13	6.99	7.88	7.39	6.29	3.84
Treasury basis	1.39	6.56	8.55	10.23	10.65	10.38

Table A1: Forecast error variance decomposition for the dollar

Note: Table A1 reports the forecast error variance decomposition of the BVAR(12). Each cell reports the percentage of the variance of the nominal AE-dollar index explained at the horizon corresponding to the column by the shock corresponding to the row.

## A.3 EBP and emerging market: Complete LP results

Figure A6 plots the full set of impulse responses of EMDE economic and financial variables to a 250 basis point increase in EBP.<sup>59</sup> We find an overwhelmingly contractionary

<sup>&</sup>lt;sup>58</sup>For a similar BVAR(12) model used to analyze international transmission of U.S. monetary shocks, see Degasperi, Hong and Ricco (2021).

<sup>&</sup>lt;sup>59</sup>As noted in the main text, we replace the contemporaneous dollar appreciation shock in equation 1 with quarterly EBP changes, while keeping the lagged change in the nominal advanced economy dollar index in the same forecasting equation to control for any lagged dollar impact on EMDE variables not



Figure A5: Impulse response: One standard deviation increase in excess bond premium

Note: Figure A5 reports impulse responses to a one standard deviation increase in the Gilchrist and Zakrajšek (2012) excess bond premium (EBP) in a Bayesian VAR of the 3-month treasury yield differential, the EBP, the 3-month treasury basis, and the nominal dollar index against a basket of advanced economy currencies (recursively ordered as such). The average U.S. Treasury yield differential and Treasury basis are taken versus AUD, CAD, CHF, EUR, GBP, JPY, and SEK using yearly currency weights from the Federal Reserve H.10 release, consistent with the calculation of the AE-dollar index. The Bayesian VAR is estimated using a standard Minnesota prior with hyperparameters determined according to Canova (2007) and Giannone, Lenza and Primiceri (2015). The BVAR is estimated with 12 lags using the toolkit of Canova and Ferroni (2021). Our sample period is 1999M1 to 2021M12. Shaded areas report 68% and 90% confidence sets.

impact as in Section II, but the slump seems to gather strength more slowly and then become deeper and more persistent than the one caused by a general dollar shock. Real output contracts below trend by a cumulative 5 percentage points after 10 quarters, driven by steep declines in consumption and investment that more than offset a rise in net exports (panel (a)). The peak exchange rate depreciation against the dollar exceeds 10 percent, accompanied by worsening terms of trade and an overall contraction in trade volumes. The shock also has a deflationary impact on both domestic and trade-related prices (panel (b)). Looking at financial variables (panel (c)), nominal credit shrinks. The policy rate jumps upward by nearly 5 percentage points on impact (and peaks at 10 percentage points) while dollar borrowing costs, proxied by the EMBI spread, rise on

captured by the EBP. We still control for the Chicago Fed adjusted financial condition index (ANFCI) in our local projection exercise. That index does not take EBP as an input, and the quarterly innovations of both series are only moderately correlated from 1980 to 2021 (with a correlation coefficient of 0.3). We thus view EBP shocks as capturing disturbances to U.S. financial condition that are not captured by the common factor that the ANFCI measures.

impact and the domestic equity prices enter a prolonged decline.

While U.S. dollar appreciation is generally negative for EMDEs' economic health, dollar movements associated with the the risk appetite shifts that EBP captures have especially severe impacts. A back-of-the-envelope calculation based on our estimates of exchange rate equation (8) and Figure A6 suggests that a 10 percent dollar appreciation driven entirely by a 2.5 percentage point increase in EBP within a quarter (see Table 2) would lead to a peak EMDE real GDP fall below trend nearly 3 percentage points larger than the fall implied by Figure A1.<sup>60</sup> Prices drop by a bigger amount in the case of EBP-induced dollar appreciation compared with the case of a comparably sized generic dollar shock. In particular, the sharp decline in export prices results in a much bigger deterioration of the terms of trade. Finally, heightened risk aversion further drives up sovereign dollar borrowing cost and leads to a much sharper hike in the policy interest rate.

# **B** Details on Empirical Methods and Data Sources

## **B.1** EMDE indicators and GDP common factor

### **Data sources**

*EMDE economic and financial indicators* are inputs to the local projection exercise (Secion II). But they might be of independent interest, as the database seeks to cover a long timespan (>20 years) with a reasonably high frequency (quarterly) for a wide range of economic and financial variables. The time series are divided into three groups:

- *Macro aggregates*: National account series are obtained from national central banks through data aggregator CEIC. In a few cases, OECD provides long time series without the need for manual splicing. We use these series if available. <sup>61</sup>
  - *China*: Most of our quarterly time series come from Chang and others (2015, updated to 2021), who compile a standardized dataset with series comparable to commonly used databases. In particular, it includes otherwise unavailable GDP estimates by expenditure.<sup>62</sup>

<sup>&</sup>lt;sup>60</sup>Taking the advanced-economy dollar index as a response variable in our LP framework, the dollar appreciates by 9.3 percent against other advanced-economy currencies one quarter after a 2.5 percentage point EBP increase. This number is also in line with the regression evidence presented in Table 2.

<sup>&</sup>lt;sup>61</sup>We splice multiple series (potentially with different bases) together using quarter-over-quarter growth rates wherever needed.

<sup>&</sup>lt;sup>62</sup>https://www.atlantafed.org/cqer/research/china-macroeconomy.



Figure A6: Impulse response: 2.5 percentage point increase of excess bond premium

(b) Prices and bilateral dollar exchange rate

Note: See the next page below Panel (c) for details on specifications.

- *Seasonal adjustment*: If national sources provide seasonally adjusted (or seasonally and workday adjusted for a few European countries) series, we always use the series as is. For a number of economies without seasonally adjusted series, we adjust the series manually using X-13.<sup>63</sup>
- *Prices and bilateral dollar exchange rates*: IMF International Financial Statistics (IFS) provides long time series on consumer price indices and nominal exchange rate

<sup>&</sup>lt;sup>63</sup>For national accounts, these countries include Croatia, Indonesia, India, Malaysia (1991Q1-2011Q4), Peru, Philippines, Thailand, and Uruguay.



Figure A6: Impulse response: 1% increase of excess bond premium (cont'd)

(c) Credit, stock prices, and interest rates

against the U.S. dollar. For European EMDEs we primarily rely on the Harmonized Index of Consumer Prices (HICP) published by Eurostat. GDP deflators are obtained from national central banks (through CEIC) along with the national accounts data.<sup>64</sup>

Export and import price indices come from a variety of sources. We combine publications from national central banks and statistical offices, as well as commercial vendors including Global Financial Data, Oxford Economics, and (for Poland) the Economist Intelligence Unit. Our preferred price indices are of high frequency, often monthly, computed from customs or trade data. If the preceding are unavailable, we use estimated export/import deflators from national accounts data (through Oxford Economics). We verify the deflator series using data from International Financial Statistics (IMF). In the case of Morocco, for which neither type of series is available, we use Eurostat series on Euro Area-19 trade with Morocco. We try to make sure the indices are denominated in local currency, but this certainty is not always achievable given lack of detailed metadata for the price indices. Terms

Note: Figure A6 reports impulse responses of EMDE economic and financial variables to a 2.5 percentage point increase in the Gilchrist and Zakrajšek (2012) excess bond premium (EBP). Estimates are derived from the local projection (1), but with the change in the dollar index against advanced economy currencies replaced by quarterly changes in EBP. The lagged AE-dollar index is an additional control variable. For regressions involving the GDP deflator and consumer-price inflation (panel (b)), country-quarter observations with year-on-year change over 50 percent are dropped. The bilateral exchange rate is expressed as units of local currency per one USD. Equity prices are local-currency stock market indices. Heteroskedasticity-robust 90% and 68% confidence bands are reported.

<sup>&</sup>lt;sup>64</sup>The GDP deflators are often published without seasonal adjustment. In that case, we also use X-13 to adjust the deflators.

of trade are obtained by dividing the export price index by the import price index.

- Uruguay: Quarterly GDP deflator data combine three sources and extend back to 2001. Uruguayan data based on the United Nations' SNA 2008 methodology (based as 2016 = 100) cover 2016 onwards. SNA 1993 estimates (with 2005 = 100) cover 2005–2015. For older data, the Banco Central del Uruguay publishes another real GDP series running from 1988 to 2008. However, the corresponding implicit deflator series starts only in 2001. As a result our GDP deflator data for Uruguay extends only from 2001 to 2021.<sup>65</sup> Note that because the nominal GDP series before 2005 are published only at annual frequency, one cannot derive a quarterly implicit deflator series simply as the ratio of nominal to real GDP.
- *Credit, stock prices, and interest rates*: Our series on nominal credit denominated in local currencies rely on BIS long series on credit to the non-financial sector as the primary input. For each country, we use credit to the private non-financial sector from banks, as these data cover the longest time span. For countries with no coverage or less complete coverage in the BIS data, we use domestic credit series from IFS, manually seasonally adjusting the series whenever appropriate. For both sources, in a few cases we extend back the series using the data provided by Monnet and Puy (2021), who compile IFS data from paper sources (although they are not used in the LP exercise).

The primary source for central bank policy rates is the BIS, expanded using IFS. The EMBI spread comes from World Bank Global Economic Monitor (GEM). Equity price indices (denominated in local currency) come from Datastream, Refinitiv, and (in the case of Uruguay) CEIC.

Table A3 records the starting dates of each time series in our sample for the local projection estimates. The actual dates covered by the local projections would be determined by the intersection of the sets of response variables and the local controls (real GDP, exchange rate, deflators, and policy rate). Table A4 reports data sources for export and import price indices, nominal credit, and equity prices. Data tickers are included if the source is a commercial vendor.

*EMDE GDP factor*: We extract one common real GDP factor,  $f_t$ , from an unbalanced panel of 61 emerging and developing economies using a simple dynamic factor model

<sup>&</sup>lt;sup>65</sup>Available at https://www.bcu.gub.uy/Estadisticas-e-Indicadores/Cuentas%20Nacionales/ base\_1983/PRESENTACION83t.HTM, last accessed July 20, 2022.

(DFM):

$$y_{it} = \lambda_i f_t + \xi_{it}$$
$$f_t = \phi_1 f_{t-1} + \varepsilon_t$$

for each country i = 1, ..., n, with  $\xi_{it}$  denoting idiosyncratic components of real GDP not captured by the common factor f, and  $\varepsilon_t$  is a normally-distributed disturbance term. The sample is quarterly, covering 1990–2019. Similar to the assumption in Miranda-Agrippino and Rey (2020), we allow  $\xi_i$  to be autocorrelated, but we assume independence between  $\xi_i$  and  $\xi_j$  for any country pair (i, j). In addition, we assume that  $\xi$  and  $\varepsilon$  are independent.

Table A2 lists the EMDEs included in our DFM sample, as well as the start date of real GDP data for each country. Table A2 also indicates whether the country is included in our LP exercise (Section II.) Similar to Miranda-Agrippino and Rey (2020), we estimate the DFM in log first differences, using an expectation-maximization algorithm.<sup>66</sup> The common factor of the log-differenced quarterly GDP is used as a control in the LPs (equations 1 and 2). Figure A7 plots the cumulated sum of the common factor changes— a series capturing the common movement of EMDE real GDP in levels.

Global controls and country characteristics have been introduced in Section II.

## **B.2** Exchange rate regressions

**Term premium estimates** We use zero-coupon sovereign yield curves provided by Bloomberg to estimate a term structure model for each G10-currency economy using the approach of Adrian, Crump and Moench (2013, henceforth ACM). In particular, we use four principal components extracted from log yields as observed state variables and estimate the model parameters using excess holding-period returns. The term premia are backed out from the fitted yield curve and estimated risk-neutral yields. Data tickers are provided in Table A5.<sup>67</sup>

Figure A8, Panel (a) plots the 10-year zero-coupon yield provided by Bloomberg, along with the fitted yield from our ACM procedure for G10-currency countries. At the

<sup>&</sup>lt;sup>66</sup>We adapt the code suite provided by Silvia Miranda-Agrippino: http://silviamirandaagrippino. com/code-data.

<sup>&</sup>lt;sup>67</sup>We adapt the code shared by Michael Abrahams: https://github.com/miabrahams/ PricingTermStructure. Moench (2019) conducts a similar term premium extraction exercise and relates U.S. monetary policy to the shape of global yield curves.

Country	<b>RGDP</b> start	Used in LP	Country	<b>RGDP</b> start	Used in LP
Albania	2009Q1		Malta	2000Q1	
Algeria	2012Q1		Mexico	1980Q1	$\checkmark$
Argentina	1980Q1	$\checkmark$	Moldova	1996Q1	
Azerbaijan	2001Q1		Mongolia	2011Q1	
Belarus	2006Q1		Morocco	2007Q1	$\checkmark$
Bolivia	1990Q1		Mozambique	2007Q1	
Bosnia and Herzegovina	2009Q1		Nigeria	2010Q1	
Brazil	1996Q1	$\checkmark$	North Macedonia	2000Q1	
Brunei	2005Q1		Panama	2007Q1	
Bulgaria	1995Q1	$\checkmark$	Paraguay	1994Q1	
Chile	1987Q1	$\checkmark$	Peru	1980Q1	$\checkmark$
China	1992Q1	$\checkmark$	Philippines	1981Q1	$\checkmark$
Colombia	2001Q1	$\checkmark$	Poland	1995Q1	$\checkmark$
Costa Rica	1991Q1		Qatar	2012Q1	
Croatia	1995Q1	$\checkmark$	Romania	1995Q1	$\checkmark$
Cyprus	1995Q1		Russia	1996Q1	$\checkmark$
Czech Republic	1995Q1	$\checkmark$	Serbia	2006Q1	
Ecuador	1994Q1		Slovakia	1995Q1	
Egypt	2001Q3		Slovenia	1995Q1	
Estonia	1995Q1		South Africa	1961Q1	$\checkmark$
Georgia	1998Q1		South Korea	1960Q1	$\checkmark$
Hungary	1995Q1	$\checkmark$	Sri Lanka	2011Q1	
India	2005Q1	$\checkmark$	Taiwan	1982Q1	$\checkmark$
Indonesia	1994Q1	$\checkmark$	Thailand	1993Q1	$\checkmark$
Israel	1995Q1	$\checkmark$	Tunisia	2001Q1	
Iran	1989Q2		Turkey	1998Q1	$\checkmark$
Jordan	1993Q1		Ukraine	2001Q1	
Kazakhstan	2005Q1		UAE	2012Q1	
Latvia	1995Q1		Uruguay	1998Q1	$\checkmark$
Lithuania	1995Q1		Vietnam	2010Q1	
Malaysia	2001Q1	$\checkmark$			

Table A2: List of EMDEs for dynamic factor model and local projection



Figure A7: Emerging market real GDP common factor

Note: Figure A7 plots the estimated EMDE common factor of real GDP. A dynamic factor model is estimated over the log firstdifferences of real GDP series of 58 EMDEs, with the common factor directly used as a control variable in our local projection exercise (Section II), and we plot the normalized cumulative sum.

10-year tenor, our estimated term structure model fits the observed yields very well, with an average pricing error below 10 basis points. In general, 10-year term premia display a secular decreasing trend and exhibit high comovement with 10-year yields.

To compare our term premium estimates with other off-the-shelf estimates, we focus on the U.S. and plot four series of estimated 10-year U.S. government term premia in Panel (b) of Figure A8. The blue line plots the estimate of Kim and Wright (2005) using a three-factor term structure model. The dark red line shows the official Adrian, Crump and Moench (2013) estimates, downloaded from the New York Fed website.<sup>68</sup> In addition to the estimates based on Bloomberg zero-coupon yield curves (orange line), we also estimate the term premia based on the nominal Nelson-Siegel-Svensson yield curve of Gürkaynak, Sack and Wright (2006)—the same input used in the official ACM estimates.<sup>69</sup> That series is plotted in green. All four time series are strongly mutually correlated (with pairwise correlations around 0.9). The differences in levels between our ACM procedure and the official ACM models owe to two factors: 1) The input yield curves are different. In addition to the estimated levels, the Bloomberg series starts from a more recent period, and the regression-based ACM procedure is highly sensitive to the starting point; 2) In accordance with the input changes, we use four principal factors as

<sup>&</sup>lt;sup>68</sup>https://www.newyorkfed.org/research/data\_indicators/term-premia-tabs.

<sup>&</sup>lt;sup>69</sup>https://www.federalreserve.gov/data/nominal-yield-curve.htm.

observed states to achieve a better fit, while the official ACM estimates use five.

**Data tickers** The financial time series are obtained from Bloomberg and Refinitiv (previousy Datastream,) unless otherwise specified. Table A5 provides a list of data tickers by categories of series and currency.



### Figure A8: Term premium estimates

(a) Term premium estimates: countries of G10 currencies



### (b) Comparison with other U.S. term premium estimates

Note: Panel (a) of Figure A8 plots, country-by-country, the zero-coupon Bloomberg 10-year government yields as well as the fitted yields and term premium estimates using the Adrian, Crump and Moench (2013) estimation procedure of a affine term structure model. The model uses four principal components of the observed yield curves as state variables. Panel (b) compares the 10-year term premium estimated using our approach with the official ACM estimates (green line) using five principal components, the Kim and Wright (2005) three-factor model estimates, as well as our approach applied to Gürkaynak, Sack and Wright (2006) U.S. nominal yield curves, fitted using a Nelson-Siegel-Svensson model.

## Table A3: EMDE indicators: Start dates

Panel	(a	):	M	lacro	ag	ggr	ega	ates
-------	----	----	---	-------	----	-----	-----	------

Country	GDP	Private Consumption	Govt Consumption	Gross Fixed Capital Formation	Export	Import
Argentina	1993Q1	1993Q1	1993Q1	1993Q1	1993Q1	1993Q1
Brazil	1996Q1	1996Q1	1996Q1	1996Q1	1996Q1	1996Q1
Bulgaria	1995Q1	1995Q1	1995Q1	1995Q1	1995Q1	1995Q1
Chile	1996Q1	1996Q1	1996Q1	1996Q1	1996Q1	1996Q1
China	1992Q1	1992Q1	1992Q1	1992Q1	1992Q1	1992Q1
Colombia	1994Q1	1994Q1	1994Q1	1994Q1	1994Q1	1994Q1
Croatia	1995Q1	1995Q1	1995Q1	1995Q1	1995Q1	1995Q1
Czech Republic	1995Q1	1995Q1	1995Q1	1995Q1	1995Q1	1995Q1
Hungary	1995Q1	1995Q1	1995Q1	1995Q1	1995Q1	1995Q1
India	1996Q2	1996Q2	1996Q2	1996Q2	1996Q2	1996Q2
Indonesia	1993Q1	1993Q1	1993Q1	1993Q1	1991Q1	2000Q1
Israel	1995Q1	1995Q1	1995Q1	1995Q1	1995Q1	1995Q1
Korea	1980Q1	1980Q1	1980Q1	1980Q1	1980Q1	1980Q1
Malaysia	1991Q1	1991Q1	1991Q1	1991Q1	1991Q1	1991Q1
Mexico	1993Q1	1993Q1	1993Q1	1993Q1	1993Q1	1993Q1
Morocco	1998Q1	1998Q1	1998Q1	1998Q1	1998Q1	1998Q1
Peru	1980Q1	1980Q1	1980Q1	1980Q1	1980Q1	1980Q1
Philippines	1981Q1	1981Q1	1981Q1	1981Q1	1981Q1	1981Q1
Poland	1995Q1	1995Q1	1995Q1	1995Q1	1995Q1	1995Q1
Romania	1995Q1	1995Q1	1996Q1	1995Q1	1995Q1	1995Q1
Russia	1995Q1	1995Q1	1995Q1	1995Q1	1995Q1	1995Q1
South Africa	1980Q1	1980Q1	1980Q1	1980Q1	1993Q1	1993Q1
Taiwan	1982Q1	1982Q1	1982Q1	1982Q1	1982Q1	1982Q1
Thailand	1993Q1	1993Q1	1993Q1	1993Q1	1993Q1	1993Q1
Turkey	1998Q1	1998Q1	1998Q1	1998Q1	1998Q1	1998Q1
Uruguay	1988Q1	1988Q1	1988Q1	1988Q1	1988Q1	1988Q1

Panel (b): Prices	and bilateral	dollar	exchange	rate
			0	

Country	GDP Deflator	CPI	Exchange Rate (LC/USD)	Export/Import Price
Argentina	1993Q1	1980Q1	1980Q1	1986Q1
Brazil	1996Q1	1980Q1	1980Q1	1980Q1
Bulgaria	1995Q1	1996Q4	1988Q4	1980Q1
Chile	1996Q1	1980Q1	1980Q1	1996Q1
China	1992Q1	1984Q1	1980Q1	1991Q1
Colombia	1994Q1	1980Q1	1980Q1	1980Q1
Croatia	1995Q1	1998Q1	1992Q1	1994Q1
Czech Republic	1995Q1	1996Q1	1993Q1	1998Q1
Hungary	1995Q1	1996Q1	1980Q1	1995Q1
India	1996Q2	1980Q1	1980Q1	1999Q1
Indonesia	1993Q1	1980Q1	1980Q1	1998Q1
Israel	1995Q1	1980Q1	1980Q1	1995Q1
Korea	1980Q1	1980Q1	1980Q1	1980Q1
Malaysia	1991Q1	1985Q1	1980Q1	1999Q1
Mexico	1993Q1	1980Q1	1980Q1	1980Q1
Morocco	1998Q1	1980Q1	1980Q1	2000Q1
Peru	1990Q1	1980Q1	1980Q1	1990Q1
Philippines	1981Q1	1980Q1	1980Q1	1981Q1
Poland	1995Q1	1988Q1	1980Q1	1993Q1
Romania	1995Q1	1996Q1	1980Q1	1995Q1
Russia	1995Q1	1992Q1	1992Q2	1996Q1
South Africa	1980Q1	1980Q1	1980Q1	1980Q1
Taiwan	1980Q1	1981Q1	1980Q1	1981Q1
Thailand	1993Q1	1980Q1	1980Q1	1993Q1
Turkey	1998Q1	1996Q1	1980Q1	1982Q1
Uruguay	2001Q1	1980O1	1980O1	1994O1

Note: See next page after Panel (c) for details on sample coverage.

### Table A3: EMDE indicators: Start dates (cont'd)

Country	Nominal Credit	Policy Rate	LC equity price index	EMBI
Argentina	1980Q1	1994Q4	1993Q2	1993Q4
Brazil	1980Q1	1994Q4	1986Q2	1994Q2
Bulgaria	1991Q4	2000Q4	1991Q1	1997Q4
Chile	1983Q1	1994Q4	1995Q2	1999Q2
China	1985Q4	1994Q4	1996Q1	1997Q4
Colombia	1980Q1	1994Q4	1995Q2	1997Q4
Croatia	1994Q2	1998Q1	1993Q4	1997Q4
Czech Republic	1993Q4	1994Q4	1995Q4	N/A
Hungary	1980Q1	1994Q4	1985Q1	1999Q1
India	1980Q1	1994Q4	1980Q1	2015Q1
Indonesia	1980Q1	1994Q4	1990Q1	2004Q2
Israel	1980Q1	1994Q4	1995Q1	N/A
Korea	1980Q1	1994Q4	1999Q2	N/A
Malaysia	1980Q1	1994Q4	1995Q4	1997Q4
Mexico	1980Q4	1994Q4	1981Q2	1997Q4
Morocco	1980Q1	1994Q4	1997Q1	1997Q4
Peru	1980Q1	1994Q4	1997Q1	1997Q4
Philippines	1980Q1	1994Q4	1986Q1	1997Q4
Poland	1992Q1	1991Q2	1993Q1	1997Q4
Romania	1996Q4	1997Q3	1993Q4	N/A
Russia	1995Q2	1997Q3	1992Q1	1997Q4
South Africa	1980Q1	1995Q2	1980Q4	1997Q4
Taiwan	1980Q1	1994Q4	1980Q1	N/A
Thailand	1980Q1	1994Q4	1980Q1	N/A
Turkey	1986Q1	1994Q4	1986Q2	1997Q4
Uruguay	1980Q1	2003Q2	1996Q3	2001Q2

# Panel (c): Credit, equity prices, and interest rates

Note: Table A3 reports time series start dates for each economic and financial variables and for each of the 26 EMDEs used in the LP exercise (Section II). Cells with "N/A" denote country-variable pair for which no data is available, or too short to be included in the sample. In Panel (c), EMBI is J.P. Morgan EMBI+ sovereign spread for dollar-denominated government issuances.
#### Table A4: Selected EMDE indicators: Data sources and identifiers

Country	Export Price	Import Price
Argentina	NS (INDEC)	NS (INDEC)
Brazil	NS (FUNCEX)	NS (FUNCÉX)
Bulgaria	OE (via Datastream): BLXPXTF	OE (via Datastream): BLXPMTF
Chile	NS (Banco Central de Chile)	NS (Banco Central de Chile)
China	GFD: EXPCHNM	GFD: IMPCHNM
Colombia	NS (DANE; Banco de la República)	NS (DANE; Banco de la República)
Croatia	OE (via Datastream): CTXPXTE	OE (via Datastream): CTXPMTE
Czech Republic	NS (CZSO)	NS (CZSO)
Hungary	OE (via Datastream): HNXPXTF	OE (via Datastream): HNXPMTF
India	OE (via Datastream): INXPXT	OE (via Datastream): INXPMTF
Indonesia	NS (via Datastream, Badan Pusat Statistik):	NS (via Datastream, Badan Pusat Statistik):
	IDEXPPRCF	IDIMPPRCF
Israel	NS (via Datastream, Central Bureau of Statistics):	NS (via Datastream, Central Bureau of Statistics):
	ISEXPPRCF	ISIMPPRCF
Korea	IFS	IFS
Malaysia	NS (Department of Statistics, unit value index)	NS (Department of Statistics, unit value index)
Mexico	NS (Bank of Mexico)	NS (Bank of Mexico)
Morocco	Eurostat (UVI from EA19 trade)	Eurostat (UVI from EA19 trade)
Peru	NS (BCRP)	NS (BCRP)
Philippines	NS (via Datastream, see note for sources)	NS (via Datastream, see note for sources)
Poland	Economist Intelligence Unit	Economist Intelligence Unit
Romania	NS (via Datastream, National Institute of Statistics):	NS (via Datastream, National Institute of Statistics):
	RMEXNGSGE	RMIMNGSGE
Russia	OE (via Datastream): RSXPXTF	OE (via Datastream): RSXPMTF
South Africa	NS (South African Reserve Bank)	NS (South African Reserve Bank)
Taiwan	NS (DGBAS)	NS (DGBAS)
Thailand	OE (via Datastream): THXPXTF	OE (via Datastream): THXPMTF
Turkey	NS (Turkish Statistical Institute, unit value index)	NS (Turkish Statistical Institute, unit value index)
Uruguay	NS (via Datastream): UYEXPPR0F	NS (via Datastream): UYIMPPRSF

### Panel (a): Export and import prices

Note: For the Philippines, the export price and import price indices combine multiple series from national sources and Oxford Economics, obtained via Datastream. National sources include National Statistics Office, National Statistical Coordination Board, and Philippine Statistics Authority. Datastream tickers: PHEXPPRQF, PHGNEX85F, PHGNPEXGF, PHXPXT..F (export prices); PHIMP-PRQF, PHGNLI85F, PHGNPLIGF, PHXPMT..F (import prices).

#### Table A4: Selected EMDE indicators: Data sources and identifiers (cont'd)

Country	Credit	Equity price index
Argentina	BIS	Datastream: ARGMERV
Brazil	IFS	Datastream: WIBRAZL
Bulgaria	IFS	Refinitiv: .SOFIX
Chile	BIS	Datastream: IGPAGEN
China	BIS	Datastream: CHSASHR
Colombia	IFS / BIS	Datastream: WICOLML
Croatia	NS (HNB)	Refinitiv: .CRBEX
Czech Republic	BIS	Datastream: CZPXIDX
Hungary	BIS	Datastream: BUXINDX
India	BIS	Datastream: ICRI500
Indonesia	BIS	Datastream: JAKCOMP
Israel	IFS	Datastream: ISTA100
Korea	BIS	Datastream: KORCOMP
Malaysia	BIS	Datastream: FBMKLCI
Mexico	BIS	Datastream: MXIPC35
Morocco	IFS	Datastream: WIMORCL
Peru	IFS	Datastream: PEGENRL
Philippines	IFS	Datastream: PSECOMP
Poland	BIS	Refinitiv: .WIG
Romania	IFS	Datastream: RMBETRL
Russia	BIS	Datastream: RSMICEX
South Africa	BIS	Datastream: JSEOVER
Taiwan	IFS	Datastream: TAIWGHT
Thailand	IFS	Datastream: BNGKSET
Turkey	BIS	Datastream: TRKISTB
Uruguay	IFS	CEIC (BEVSA: 133650908)

## Panel (b): Credit and equity prices

Note: Table A4 reports data sources and identifiers of a selected set of data series for the 26-country sample for the local projection exercise. Data source abbreviations: NS stands for national sources; OE stands for Oxford Economics; GFD stands for Global Financial Data.

	3MIO 1 Curncy 1 Curncy 10 Curncy 10 V3 Curncy 10 N3 Curncy M Index Y Index Y Index SD Curncy M Curncy M Curncy O BGN CURNCY 0EZ19M086NEST USD	BBUSD3MIO USSWAP1 Curncy USSW10 Curncy C0823M Index C0821Y Index C0821V Index C0821V Index N/A N/A N/A N/A V/A USACPIALLMINMEI
EUR	Curncy EUSA Curncy EUSA mcy EUSA USW EUSA umcy EUSW EUSW EUSW EUSW EUSW EUSW EUSW EUSW	SIBOR3MIO SKSW1 Curncy SKSW10 Curncy C2593M Index C2591Y Index C2591Y Index C2591Y Index C2591Y Index USDSER Curncy SK3M Curncy SKR310 BGN CURNC SWSC7PIALLMINMEI
DKK	<ul> <li>CIBORSMI</li></ul>	NZBB90DIR NDSWAPI Curncy NDSWAPI0 Curncy C2503M Index C25019Y Index C25019Y Index C25019Y Index D4910Y Index NZDUSD Curncy NZD3M NZD3M NZD3M Curncy NZD3M Curncy NZD3M NZD3M Curncy NZD3M NZD3M Curncy NZD3M NZD3M Curncy NZD3M NZD3M Curncy NZD3M NZD3M NZD3M NZD3M NZD3M NZD2M NZD
CHF	<ul> <li>BBCHFBMIO</li> <li>BBCHFBMIO</li> <li>SFSWI Cumc</li> <li>SFSWI OLumc</li> <li>SFSWI OLUMC</li> <li>SFSWI OLUMC</li> <li>SFSWI OLUC</li> <li>SFSWI OLUC</li> <li>SFSWI OLUC</li> <li>SFSWI OLUC</li> <li>USDCHF Cur</li> <li>USDCHF Cur</li></ul>	NWIBK3MIO NOKAB3O1Y=ICAP NKSW10 Curncy C2663M Index C2663M Index 07810Y Index 07810Y Index 07810Y Index 07810Y Index 07810Y Index 07810Y Index 07810Y Curncy NOK1Y= NOK1Y= NOK1ZM Curncy NOK1Y= NOK1ZM Curncy NOK1Y= NOK1ALIMINMEI
CAD	CIDORBMIR CDSW1 Cumc They CDSW10 Cum CDSW10 Cum CDSW10 Cum TRCN3MT TRCN3MT CI0111Y Index CI0111Y Index CO1011Y Index CO101Y Index CO101Y Index CO101Y Index CO101Y Index CO101Y Index CO101Y Index CO101Y Index CO101Y	BBJPY3MIO JYSW1 Curncy JYSW10 Curncy TRJP3MT C1051Y Index C10510Y Index C10510Y Index C10510Y Index USDJPY Curncy JPY1Y= JPY12M Curncy JPY12M Curncy JPY12M Curncy JPY12M Curncy JPY12M Curncy JPY12M Curncy JPY12M Curncy
AUD	TAU3MBAIO ADSWAPI Curr ADSWAPI Curr ADSWAPI Curr ADSWAPIO Curr ADSWAPIO Curr ADSWAPIO Curr ADSWAPIO Curr ADDUSD Curry AUDUSD Curry AUD3M CURY AUD3M CURRY AUD3M CURRY AUD3M CURRY AUD3M CU	BBGBP3MIO BPSW1 Curncy BPSW105 Curncy BPSW100 Curncy BPSW1007 Curncy C110101 Index C110101 Index C11010 Index C1100 Ind
	3M IBOR rate 1Y IRS rate 10Y IRS rate 3M Treasury yield 10Y Treasury yield 10Y Treasury yield 10Y Treasury yield 10Y Treasury zero-coupon y 5pot exchange rate 3M forward points (pefore 20 1Y forward points (pefore 20 10Y cross-currency basis Consumer price index	3M IBOR rate 11Y IRS rate 10Y IRS rate 3M Treasury yield 10Y Treasury yield 10Y Treasury zero-coupon yield 5pot exchange rate 3M forward points (before 2002) 11Y forward points (2002 onwards) 10Y cross-currency basis Consumer price index

Table A5: Data tickers for exchange rate regressions

Note: Table A5 reports data tickers for selected economic and financial time series used in the exchange rate regressions (Section III.) Data sources except CPI: Bloomberg if the ticker contains "Curncy" or "Index"; Refinitiv if the ticker contains "="". Datastream if not either of the above. CPI data comes from FRED. Australia and New Zealand report CPI in quarterly frequency. Monthly real exchange rate use linearly interpolated CPI between quarters.

# References

- Adrian, T., R. K. Crump, and E. Moench (2013). Pricing the term structure with linear regressions. *Journal of Financial Economics* 110(1), 110–138.
- Canova, F. (2007). Bayesian time series and dsge models. In *Methods for Applied Macroeconomic Research*, pp. 418–462. Princeton University Press.
- Canova, F. and F. Ferroni (2021). A hitchhiker's guide to empirical macro models. Chicago Fed Working Paper, No. 2021-15.
- Chang, C., K. Chen, D. F. Waggoner, and T. Zha (2015, June). Trends and cycles in china's macroeconomy. Working Paper 21244, National Bureau of Economic Research.
- Degasperi, R., S. S. Hong, and G. Ricco (2021, March). The global transmission of U.S. monetary policy. Working paper.
- Gertler, M. and P. Karadi (2015, January). Monetary policy surprises, credit costs, and economic activity. *American Economic Journal: Macroeconomics* 7(1), 44–76.
- Giannone, D., M. Lenza, and G. E. Primiceri (2015, 05). Prior Selection for Vector Autoregressions. *The Review of Economics and Statistics* 97(2), 436–451.
- Gilchrist, S. and E. Zakrajšek (2012, June). Credit spreads and business cycle fluctuations. *American Economic Review* 102(4), 1692–1720.
- Gürkaynak, R. S., B. P. Sack, and J. H. Wright (2006, 06). The U.S. Treasury yield curve: 1961 to the present. Finance and Economics Discussion Series 2006-28, Board of Governors of the Federal Reserve System (U.S.).
- Kim, D. H. and J. H. Wright (2005, 8). An arbitrage-free three-factor term structure model and the recent behavior of long-term yields and distant-horizon forward rates. Finance and Economics Discussion Series 2005-33, Board of Governors of the Federal Reserve System (U.S.).
- Miranda-Agrippino, S. and H. Rey (2020, November). U.S. monetary policy and the Global Financial Cycle. *Review of Economic Studies* 87, 2254–2276.
- Moench, E. (2019). The term structures of global yields. BIS Papers 102.
- Monnet, E. and D. Puy (2021, March). One ring to rule them all? new evidence on world cycles. CEPR Discussion Paper 15958.
- Valchev, R. (2020, April). Bond convenience yields and exchange rate dynamics. *American Economic Journal: Macroeconomics* 12(2), 124–66.