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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

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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.[1] 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.[2]

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

2. 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

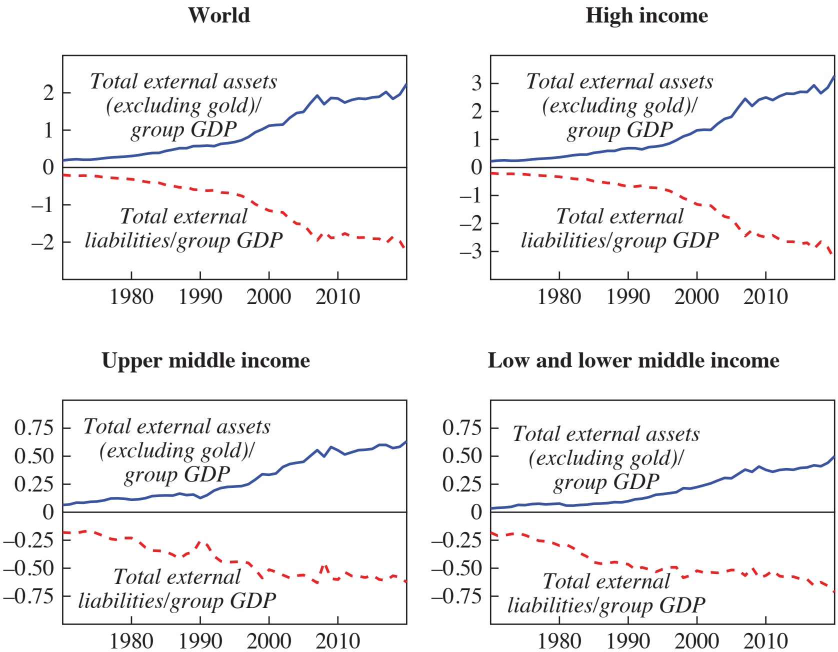
The modern system of floating exchange rates was born in March 1973, just short of fifty years ago. Having faced a long period of intense speculative pressure in foreign exchange markets, Japan and a large group of European countries suspended nearly three decades of postwar practice in that month and 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 macroeconomic 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.[3]

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.

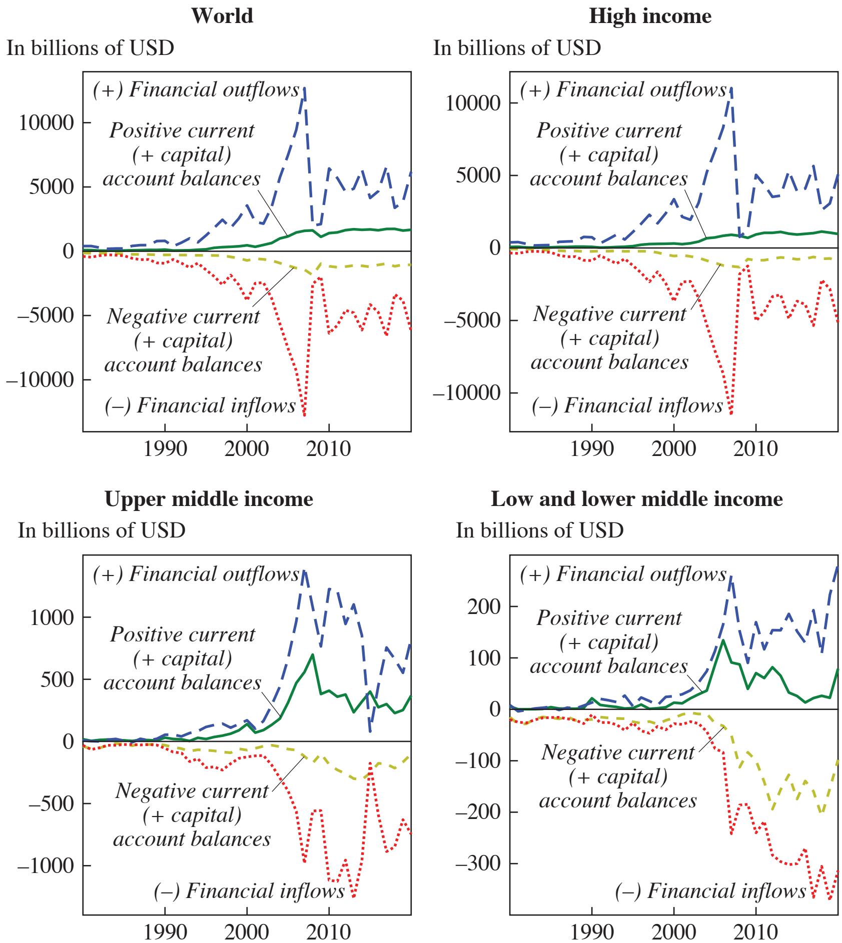
The two EMDE income groups hold broadly similar levels of external assets and liabilities, but lower-income countries hold fewer external assets and more liabilities, making many of them substantial net foreign debtors. If we measure average financial integration by external asset ratios, EMDEs are now 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.[4] 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' net 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

4. 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.[5] 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.[6] 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.[9]

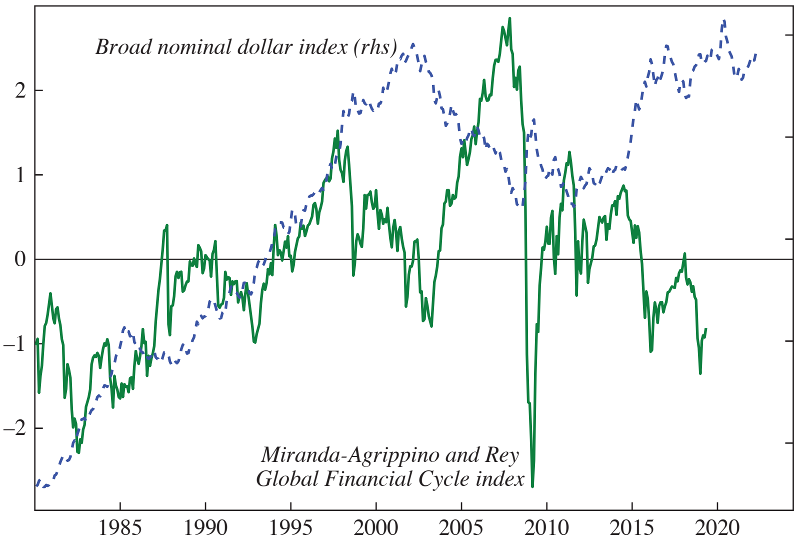
Figure 3 shows the relationship between monthly levels of the nominal effective US dollar exchange rate and the global financial cycle index constructed by Miranda-Agrippino and Rey (2020), as extended and updated by Miranda-Agrippino, Nenova and Rey (2020). Their index is defined as the common global 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).

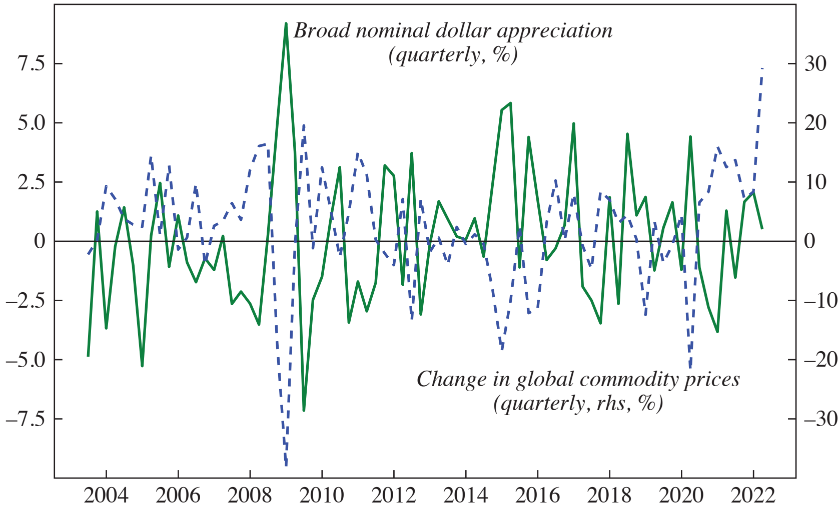
Note: The underlying currency weights are based on goods and services trade and are available at https://www.federalreserve.gov/releases/h10/weights/default.htm. The dollar index prior to 2006 is provided by von Beschwitz, Collins, and Datta (2019), the currency weights of which incorporate estimated 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.[10] 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).

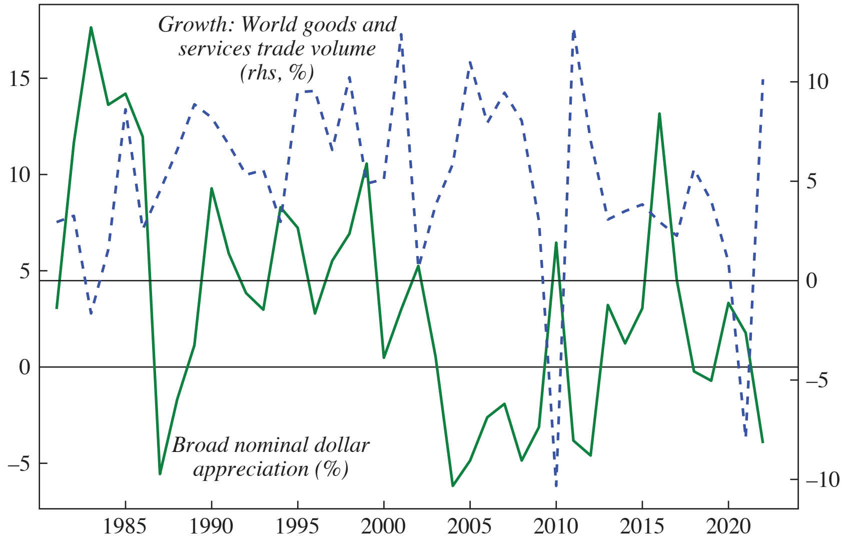
Note: The underlying currency weights are based on goods and services trade and are available at https://www.federalreserve.gov/releases/h10/weights/default.htm. The dollar index prior to 2006 is provided by von Beschwitz, Collins, and Datta (2019), the currency weights of which incorporate estimated 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.[11]

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.[12] 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

12. 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).

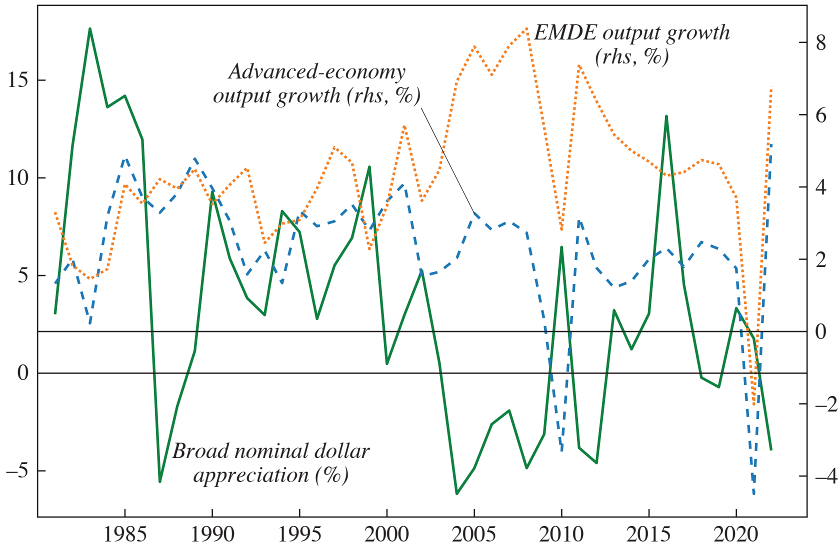
Table 1. Dollar Appreciation and Global Aggregates

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

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 exchange-rate 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.[13] 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 risk-averse 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.[16] A challenge for empirical work is to find measurable counterparts of these financial shocks.

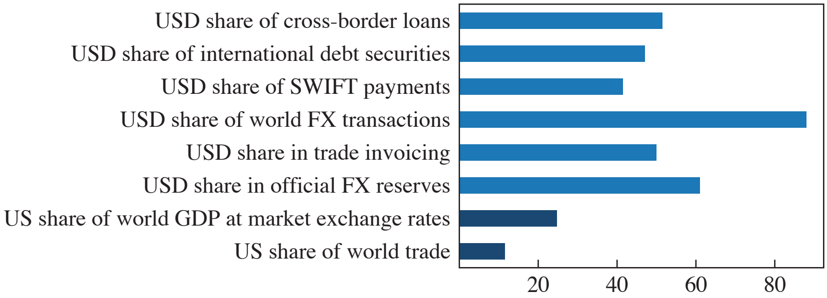
Although financial shocks need not be driven by monetary policy, monetary policy can affect financial conditions in ways that propagate internationally. Ammer and others (2016) find that US monetary policy tightening transmits abroad primarily through a financial channel—long-term US interest rates rise 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.[17] 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.

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.

the euro area or China.[18] 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.[19] 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.[20]

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):

$$(1) \qquad y_{i,t+h} - y_{i,t-1} = \mu_{i,h} + \beta_h \Delta s_t + \gamma_h' \Delta z_t + \sum\nolimits_{l=1}^{p} \delta_{h,l}' \Delta w_{i,t-l} + \varepsilon_{i,h,t}.$$

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 $t + h$, $h = 0, \ldots, H$. 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, Δs_t, 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.[21] 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 $\{\beta_h\}_{h=0}^{H}$.[22]

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 Δz_t 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_t, 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_t 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.[23] 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 Δz_t, is to capture EMDE business cycle fluctuations at a reasonably high frequency.[24]

Equation (1) also includes the vector of lagged controls $\Delta w_{i,t-l} \equiv (\Delta s_{t-l}, \Delta z_{t-l}, \Delta q_{i,t-l})'$, $l = 1, \ldots, p$, 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.[25] 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.[26]

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.

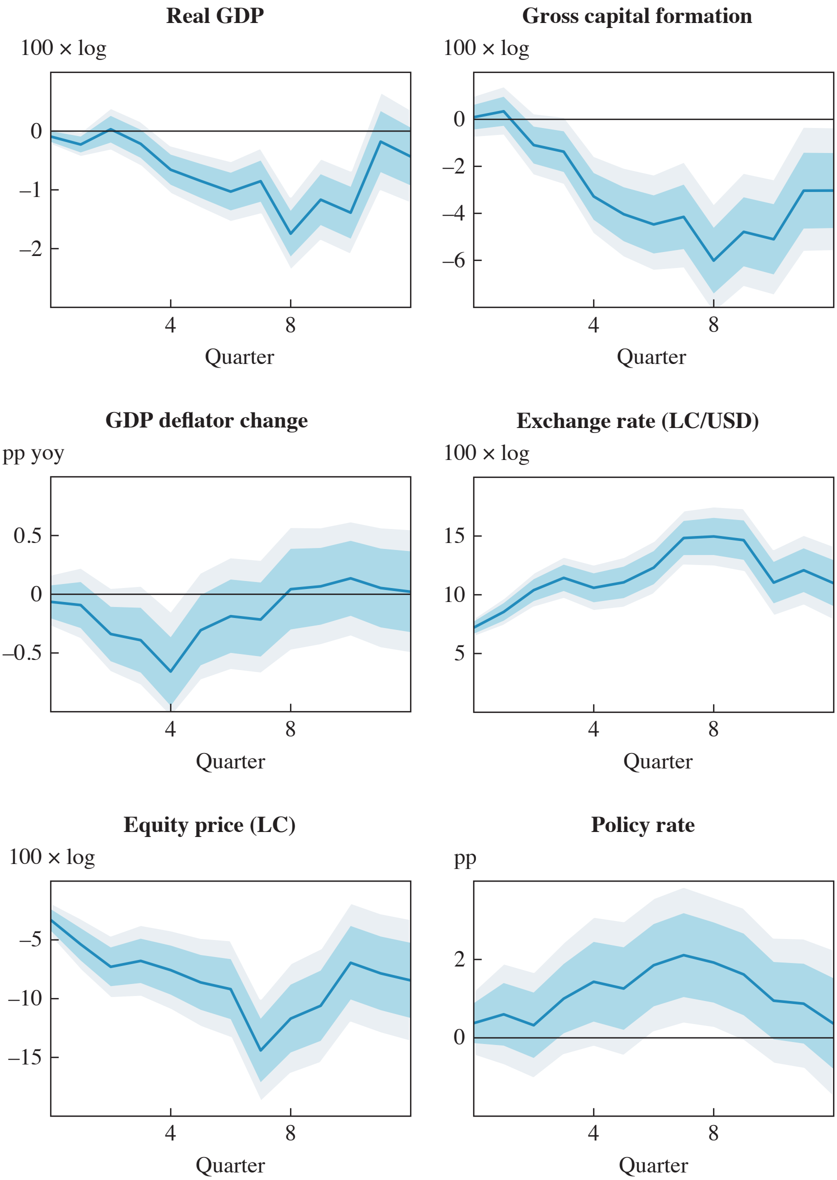
26. Plagborg-Møller and Wolf (2021) discuss the implementation of structural vector autoregressive (SVAR) restrictions in local projections.

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



Source: Authors' calculations.

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:

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

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 Δs_t) and 0 if it is in state B.[28] 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.[29] 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.[30]

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.[31]

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.[32] 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.[33] 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).[34]

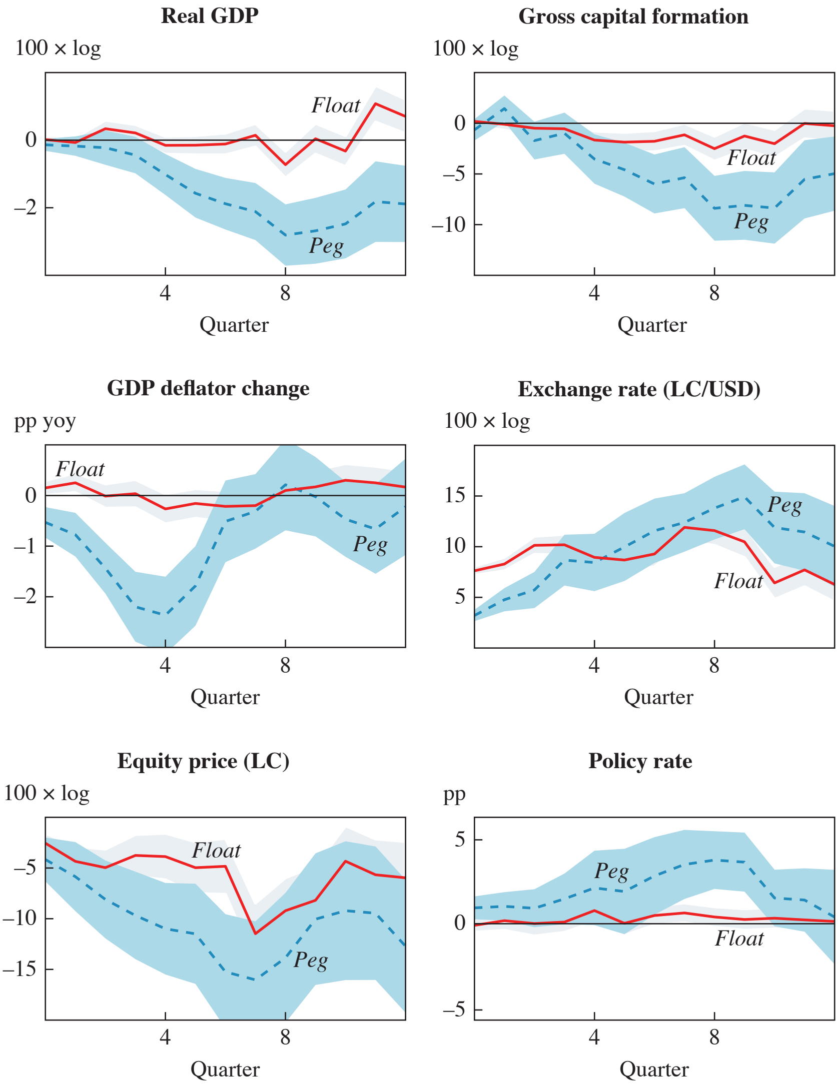
The general picture that emerges is one in which countries with more exchange rate flexibility do better in coping with the external shock of dollar appreciation.

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 inflation-targeting 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.

Figure 9. Impulse Response: 10 Percent Appreciation of Advanced Economies' Dollar Index, by FX 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 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 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 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.[35]

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.

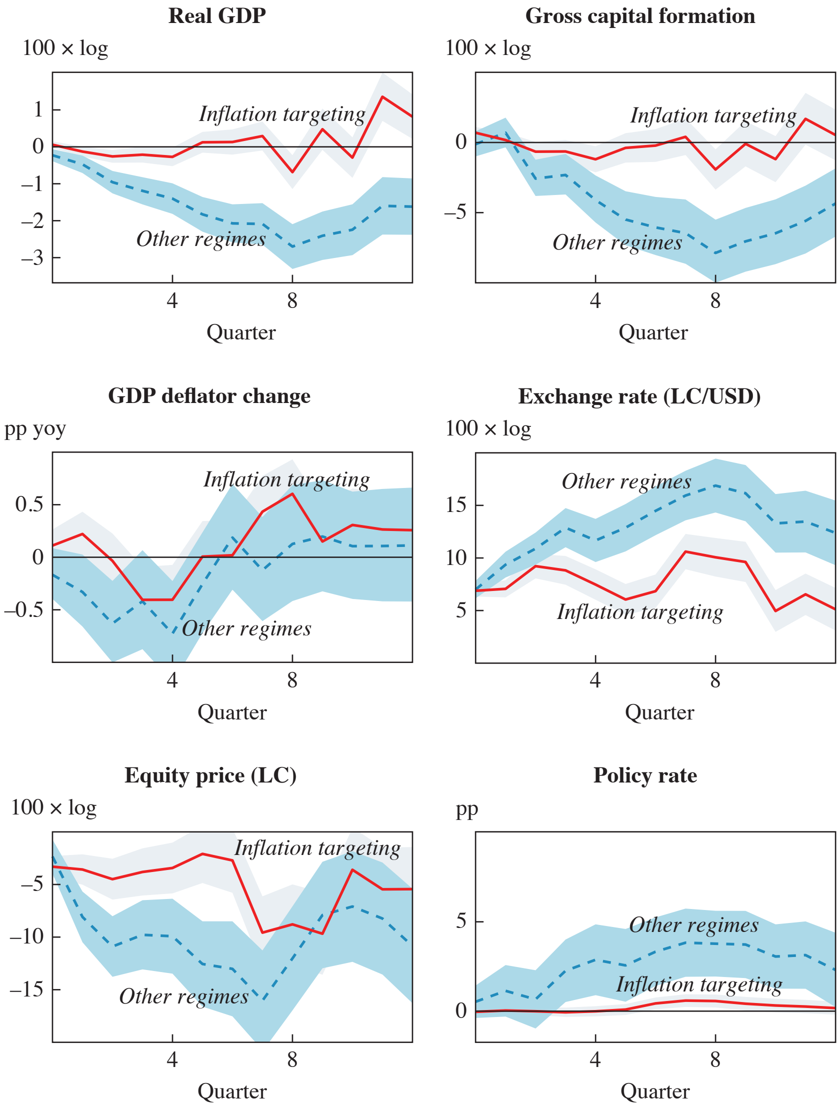
DOLLAR LIABILITIES Finally, EMDEs with large dollar-denominated liabilities are potentially vulnerable to unexpected domestic currency depreciation against the dollar that increases real debt burdens. Less dollarization of external liabilities should mitigate the procyclical effects of dollar movements 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.

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

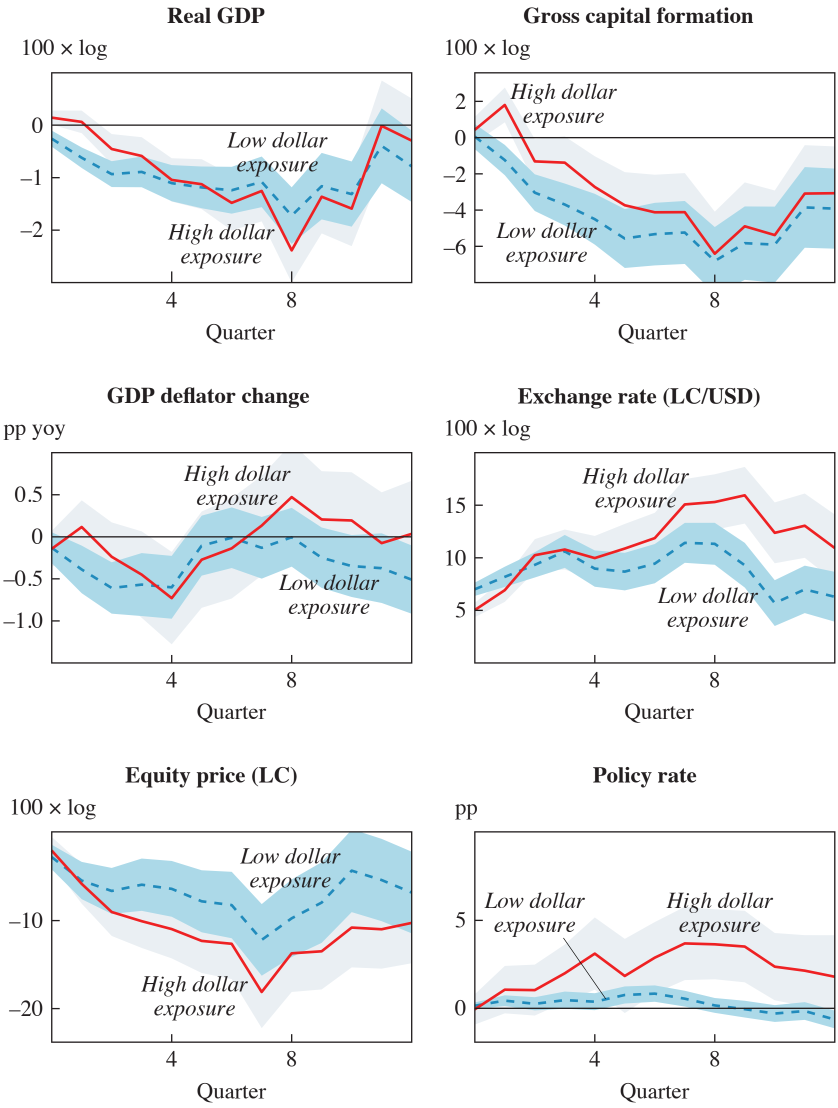
Figure 10. Impulse Response: 10 Percent Appreciation of Advanced Economies' Dollar Index, by Monetary Regime



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_{t-1} is based on the cross-border currency exposure data set 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 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.[36] 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.[37]

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.[38] 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:

$$i_t^{L*} - \left(i_t^L + \mathbb{E}_t s_{t+1} - s_t\right) = 0. \tag{3}$$

There is extensive evidence against this simple form of interest parity. We modify it by introducing two additional factors. Let ρ_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 $\lambda_t^{\$}$ 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:

$$i_t^{L*} - \left(i_t^L + \mathbb{E}_t s_{t+1} - s_t\right) = \rho_t + \lambda_t^{\$}.$$

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:

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

A skeptical view of equation (4) would be that the composite term $\rho_t + \lambda_t^{\$}$ 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 ρ_t and $\lambda_t^{\$}$ 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 ρ_t and $\lambda_t^{\$}$.[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, γ_t differences out the pure relative liquidity value of dollar denomination captured by $\lambda_t^{\$}$. The last definition, together with equation (4), allows us to express the exchange rate in terms of relative government bond yields as:

$$(5) \qquad s_t = \sum_{s=0}^{k-1} \mathbb{E}_t \left(i_{t+s} - i_{t+s}^{*} \right) + \sum_{t=0}^{k-1} \mathbb{E}_t \left(\rho_{t+s} + \lambda_{t+s}^{\$} + \gamma_{t+s} \right) + \mathbb{E}_t \left(s_{t+k} \right).$$

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

39. 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 $i_t^{(k)}(i_t^{(k)*})$ be the k-period long-term Treasury (foreign government bond) zero coupon yield. According to a standard approximation, $i_t^{(k)}$ is related to the path of expected future short rates by:

$$i_t^{(k)} = \frac{1}{k}\sum_{s=0}^{k-1}\mathbb{E}_t\left(i_{t+s}\right) + \tau_t^{(k)},$$

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:

$$(6) \qquad s_t = k\left(i_t^{(k)} - i_t^{(k)*}\right) - k\left(\tau_t^{(k)} - \tau_t^{(k)*}\right) + \sum\nolimits_{t=0}^{k-1}\mathbb{E}_t\left(\rho_{t+s} + \lambda_{t+s}^{\$} + \gamma_{t+s}\right) + \mathbb{E}_t\left(s_{t+k}\right).$$

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 $\rho_{t+s}^{(k)}$, $\lambda_{t+s}^{(k)\$}$, and $\gamma_{t+s}^{(k)}$, we translate the longer-term interest parity relationship into an expression for the current spot exchange rate:

$$(7) \qquad s_t = k\left(i_t^{(k)} - i_t^{(k)*} + \rho_t^{(k)} + \lambda_t^{(k)\$} + \gamma_t^{(k)}\right) + \mathbb{E}_t\left(s_{t+k}\right).$$

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

$$(8) \qquad \Delta s_t = \alpha + \beta_1\Delta\left(i_t - i_t^*\right) + \beta_2\Delta\rho_t + \beta_3\Delta\lambda_t^{\$} + \beta_4\Delta\gamma_t + X_{t-1}\delta + \varepsilon_t,$$

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 $\rho_t^{(k)} + \lambda_t^{(k)\$} + \gamma_t^{(k)} = \frac{1}{k}\sum_{s=0}^{k-1}\mathbb{E}_t(\rho_{t+s} + \lambda_{t+s}^{\$} + \gamma_{t+s}) - (\tau_t^{(k)} - \tau_t^{(k)*})$.

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 ε_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.[42] Using equation (6) and an approximation suggested by Du, Pflueger, and Schreger (2020), we derive an alternative regression equation:[43]

$$(9) \qquad \Delta s_t = \alpha + \beta_1 k \Delta\left(i_t^{(k)} - i_t^{(k)*}\right) + \beta_2 k\left(\tau_t^{(k)} - \tau_t^{(k)*}\right) + \beta_3 \Delta\rho_t + \beta_4 \Delta\lambda_t^{\$} + \beta_5 \Delta\gamma_t + X_{t-1}\delta + \varepsilon_t,$$

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:

$$(10) \qquad \Delta s_t = \alpha + \beta_1 k \Delta\left(i_t^{(k)} - i_t^{(k)*}\right) + \beta_2 k \Delta\rho_t^{(k)} + \beta_3 k \Delta\lambda_t^{(k)\$} + \beta_4 k \Delta\gamma_t^{(k)} + X_{t-1}\delta + \varepsilon_t.$$

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,

42. 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.

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

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 $\lambda_t^{(k)\$}$ 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.[44] 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.

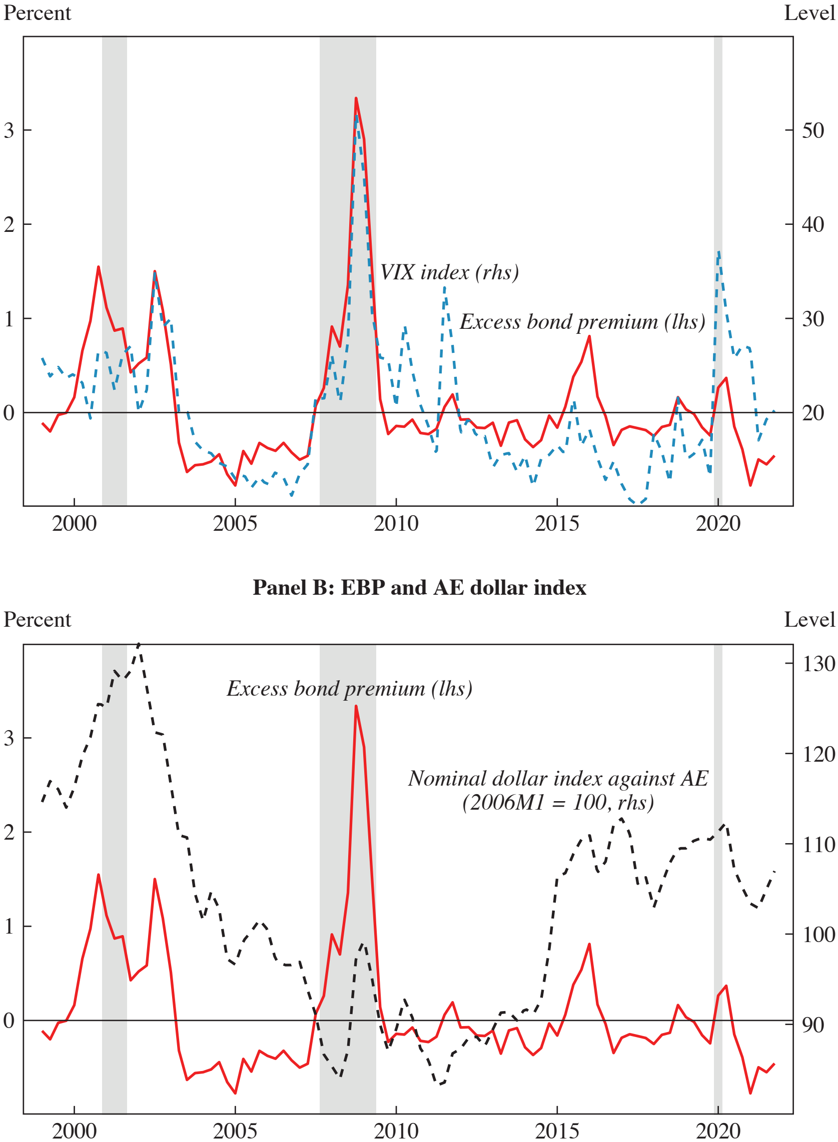
In estimating equations (8)–(10), we use two proxy variables to capture potential variation in the excess return terms, the Chicago Board Options Exchange Volatility Index (VIX) and the EBP of Gilchrist and Zakrajšek (2012). The VIX appears in many studies to capture generalized shifts in global risk aversion.[45] 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

Panel A: Risk measures



Panel B: EBP and AE dollar index

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 γ_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.[46]

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

The primary variable we will use to capture the dollar premium, $\lambda_t^{\$}$, 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:

$$i_t^{L*} = i_t^L + f_t - s_t. \tag{11}$$

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,

46. 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).[47] 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.

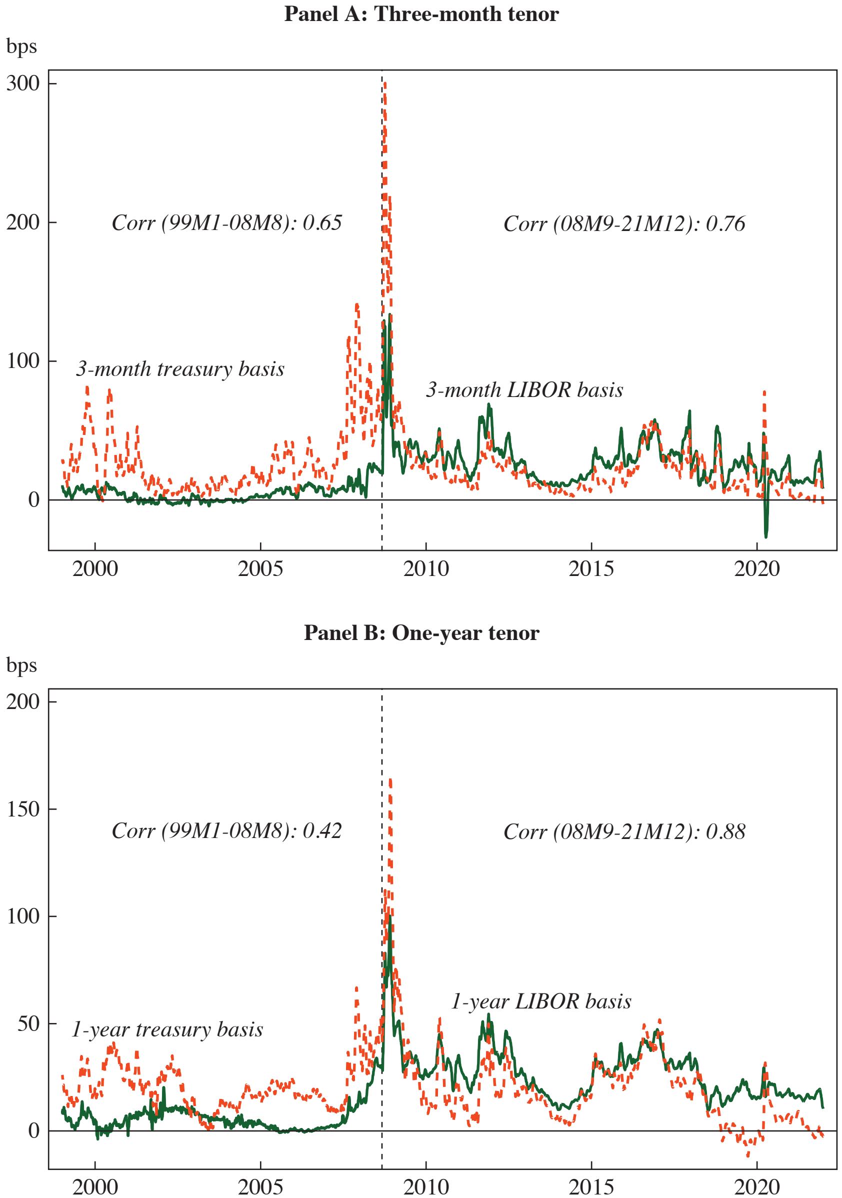
Du, Im, and Schreger (2018) have highlighted the Treasury premium as a measure of the relative convenience yield from holding US Treasury securities. Krishnamurthy and Lustig (2019), Jiang, Krishnamurthy, and Lustig (2021), and Engel and Wu (forthcoming) posit that Treasury basis fluctuations have a 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:

$$\begin{aligned}\gamma_t &= i_t^L - i_t - \left[i_t^{L*} + s_t - f_t - \left(i_t^* + s_t - f_t\right)\right] \\ &= i_t^L - \left(i_t^{L*} + s_t - f_t\right) - \left[i_t - \left(i_t^* + s_t - f_t\right)\right] \\ &= x_t - x_t^L,\end{aligned}$$

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:

$$x_t = x_t^L + \gamma_t. \tag{12}$$

Equation (1) is the key to our rationale for proxying $\lambda_t^{\$}$ 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 $\lambda_t^{\$}$. 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 $\lambda_t^{\$}$ and γ_t would be factors like global safe asset demand, risk aversion, and bond supplies that alter marginal convenience yields even with unconstrained intermediaries.[48]

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.[49] 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). Notwithstanding 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, γ_t.

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 $\lambda_t^{\$}$, 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 γ_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 γ_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 γ_t does not do so. The data support that approach.[50]

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.[51] 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.[52] 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_t and γ_t in the regression, the estimated coefficient of γ_t is negative and smaller in absolute value than the estimated coefficient of x_t, which itself is the same as the estimated coefficient of x_t^L in our baseline regressions. On the other hand, as our findings below show, the estimated coefficient of x_t, when entered alone without γ_t, is biased downward owing to omitted variable bias from leaving out γ_t. These patterns are consistent with the assumption that x_t^L and γ_t indeed capture different components of the Treasury liquidity yield, but with the pure dollar effect $\lambda_t^\$$ 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 $\lambda_t^\$$ after the crisis and for γ_t before. The substantial correlation coefficient of the two bases before the crisis, however, suggests a significant role for $\lambda_t^\$$ 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 γ_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 points over that quarter. The same column in panel B implies that a 10 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 γ_t variable measuring the relative liquidity of Treasuries (apart from their

Table 2. Exchange Rate Equations: Short-Term Rates

	Δ = 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***
	(2.772)	(2.751)	(4.641)	(3.989)
$\Delta\gamma_{3m,t}$	2.990		4.706	
	(3.214)		(5.756)	
Δ three-month LIBOR basis (pp)	10.093***		11.080**	
	(2.776)		(4.797)	
Δ three-month Treasury basis (pp)		6.274***		8.877**
		(2.402)		(3.445)
Δ log VIX	0.052	0.052	0.085**	0.086**
	(0.034)	(0.034)	(0.041)	(0.041)
Δ excess bond premium	17.701***	17.400***	15.058***	14.263***
	(3.454)	(3.382)	(4.610)	(4.457)
Lag RER	–0.198***	–0.211***	–0.448***	–0.447***
	(0.070)	(0.072)	(0.078)	(0.079)
Observations	2,757	2,757	1,440	1,440
Adjusted R^2	0.252	0.250	0.220	0.219
Currency FE	✓	✓	✓	✓
Lagged controls	✓	✓	✓	✓
Driscoll and Kraay (1998) lags	3	3	3	3

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 $\lambda_t^{\$}$ with the weaker effect γ_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

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

	Δ = 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				
$\Delta(i^{US}_{1y,t} - i^{*}_{1y,t})$	4.069***	4.043***	4.069***	4.062***
	(1.060)	(1.063)	(1.103)	(1.168)
$\Delta\gamma_{1y,t}$	2.252		4.080	
	(1.917)		(3.067)	
Δ one-year LIBOR basis (pp)	2.807		8.102**	
	(2.604)		(3.392)	
Δ one-year Treasury basis (pp)		2.621		5.595**
		(1.794)		(2.738)
Δ log VIX	−0.024	−0.023	−0.003	−0.003
	(0.019)	(0.020)	(0.023)	(0.024)
Δ excess bond premium	7.534***	7.490***	6.143***	6.301***
	(1.205)	(1.223)	(1.722)	(1.861)
Lag RER	−0.205***	−0.200***	−0.386***	−0.383***
	(0.044)	(0.044)	(0.049)	(0.052)
Observations	2,725	2,742	1,440	1,440
Adjusted R^2	0.449	0.447	0.489	0.476
Currency FE	✓	✓	✓	✓
Lagged controls	✓	✓	✓	✓
Driscoll and Kraay (1998) lags	12	12	12	12

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 $\Delta\gamma_{3m,t}$ and $\Delta\gamma_{1y,t}$ 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 $i^{*}_{j,t} - (i^{US}_{j,t} + f_{j,t} - s_t)$, 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 ≈ 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.[53]

53. In standard deviation terms, a one standard deviation increase in 100 × 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).

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

	Δ = 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				
$\Delta(i^{US}_{10y,t} - i^{*}_{10y,t})$	38.975***	39.928***	42.666***	44.166***
	(4.190)	(4.112)	(5.579)	(5.233)
$\Delta(tp^{US}_{10y,t} - tp^{*}_{10y,t})$	–23.773***	–24.609***	–25.408***	–26.635***
	(3.882)	(3.762)	(5.334)	(5.134)
$\Delta\gamma_{3m,t}$	–1.933		–0.189	
	(2.804)		(4.687)	
Δ three-month LIBOR basis (pp)	5.325**		9.792**	
	(2.382)		(4.313)	
Δ three-month Treasury basis (pp)		1.307		5.914*
		(1.875)		(3.046)
Δ log VIX	0.074**	0.074**	0.113***	0.112***
	(0.036)	(0.036)	(0.043)	(0.042)
Δ excess bond premium	20.091***	19.729***	16.956***	15.770***
	(2.795)	(2.683)	(4.072)	(3.755)
Lag RER	–0.177***	–0.188***	–0.422***	–0.421***
	(0.060)	(0.061)	(0.072)	(0.072)
Observations	2,757	2,757	1,440	1,440
Adjusted R^2	0.350	0.348	0.338	0.334
Currency FE	✓	✓	✓	✓
Lagged controls	✓	✓	✓	✓
Driscoll and Kraay (1998) lags	3	3	3	3

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^2s are between 0.2 and 0.3. In panel B, however, R^2s 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

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

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

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, $tp^{US}_{10y,t} - tp^{*}_{10y,t}$ 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 $\Delta\gamma_{3m,t}$ and $\Delta\gamma_{1y,t}$ 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 $i^{*}_{j,t} - (i^{US}_{j,t} + f_{j,t} - s_t)$, 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 ≈ 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 γ_t 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 may come from estimates of equation (10), in which the role 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 γ_t and cross-currency bases using ten-year LIBOR interest rate

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

	Δ = *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				
$\Delta(i^{US}_{10y,t} - i^{*}_{10y,t})$	26.918***	24.342***	24.332***	24.108***
	(3.337)	(3.310)	(3.296)	(3.375)
$\Delta\gamma_{10y,t}$	32.875***		19.870**	
	(4.382)		(9.511)	
Δ ten-year LIBOR basis (pp)	53.786***		49.961***	
	(10.316)		(14.653)	
Δ ten-year Treasury basis (pp)		33.648***		23.271**
		(5.188)		(9.085)
Δ log VIX	0.063*	0.071*	0.097**	0.106**
	(0.037)	(0.038)	(0.045)	(0.048)
Δ 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	✓	✓	✓	✓
Lagged controls	✓	✓	✓	✓
Driscoll and Kraay (1998) lags	3	3	3	3

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 γ_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

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

	Δ = *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				
$\Delta(i^{US}_{10y,t} - i^{*}_{10y,t})$	9.421***	8.153***	7.486***	7.589***
	(1.601)	(1.616)	(1.316)	(1.438)
$\Delta\gamma_{10y,t}$	10.159***		4.846*	
	(2.571)		(2.813)	
Δ ten-year LIBOR basis (pp)	16.031***		17.810***	
	(4.879)		(5.018)	
Δ ten-year Treasury basis (pp)		10.952***		8.227**
		(2.566)		(3.305)
Δ log VIX	0.002	−0.006	0.018	0.018
	(0.019)	(0.018)	(0.017)	(0.017)
Δ excess bond premium	6.721***	6.918***	5.846***	7.625***
	(1.173)	(1.243)	(1.416)	(1.655)
Lag RER	−0.197***	−0.203***	−0.371***	−0.371***
	(0.048)	(0.042)	(0.056)	(0.060)
Observations	2,624	2,673	1,440	1,440
Adjusted R^2	0.472	0.446	0.510	0.485
Currency FE	✓	✓	✓	✓
Lagged controls	✓	✓	✓	✓
Driscoll and Kraay (1998) lags	12	12	12	12

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 $\Delta\gamma_{10y,t}$ 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^2s 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.[54] To that end, we replace the

54. Ben Zeev (2019) conducts an exercise similar to ours but focusing on the state-dependent 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.

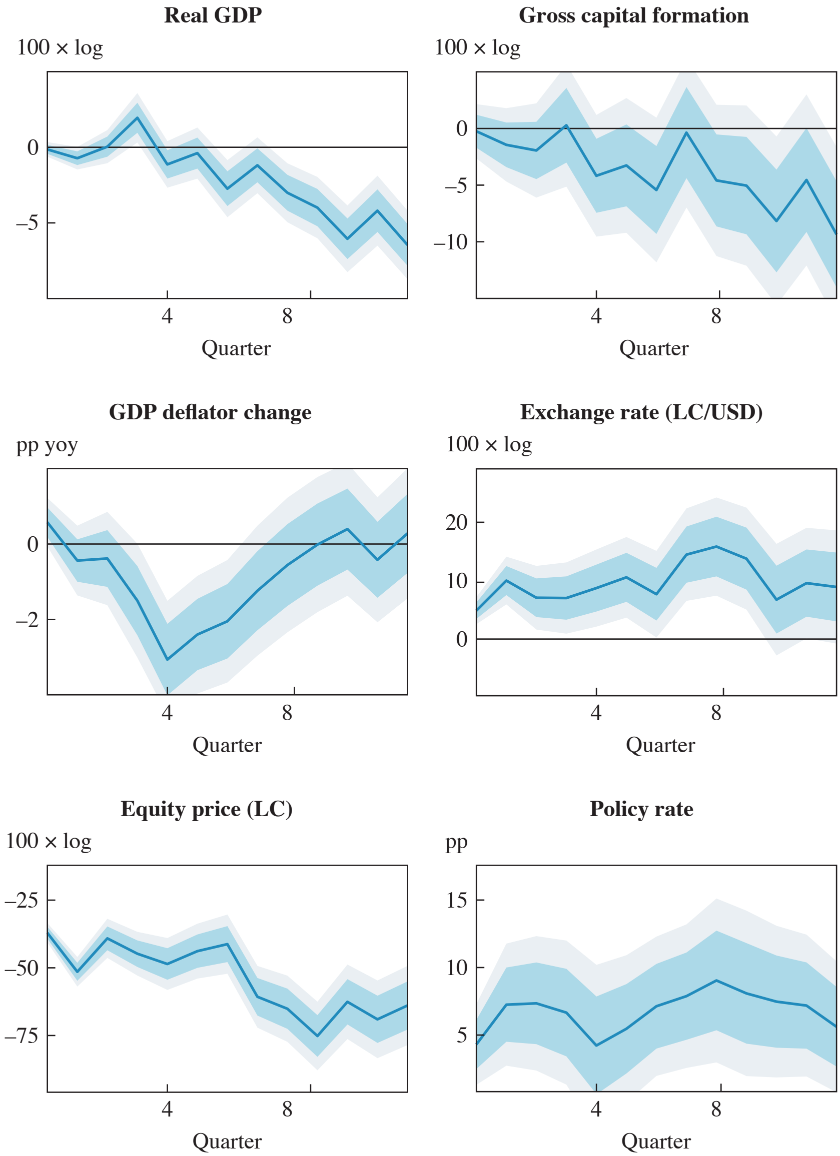
Figure 14 plots selected impulse responses of EMDE economic and financial variables to a 250 basis point increase in EBP. We find an overwhelmingly contractionary impact as in section II, but the slump seems to gather strength more slowly and then becomes deeper and more persistent than the one caused 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

55. 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

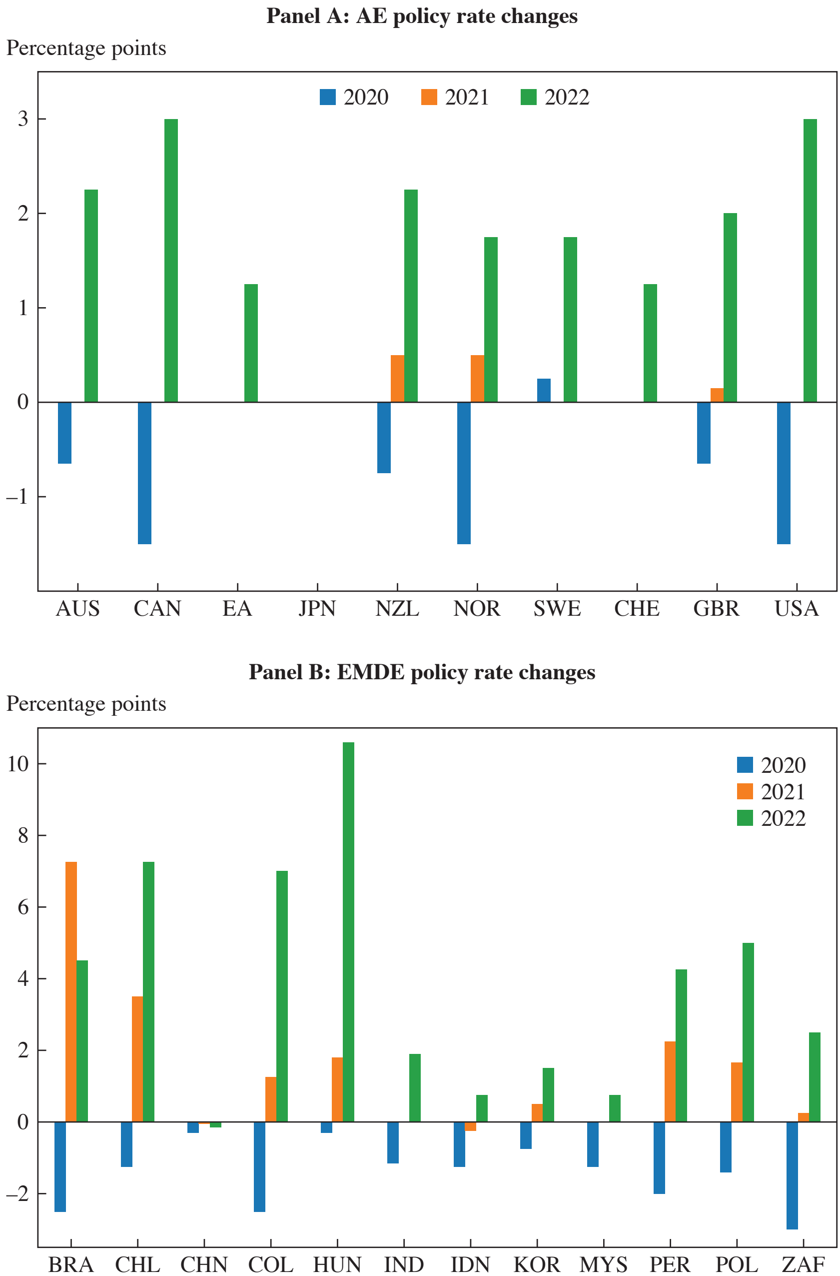
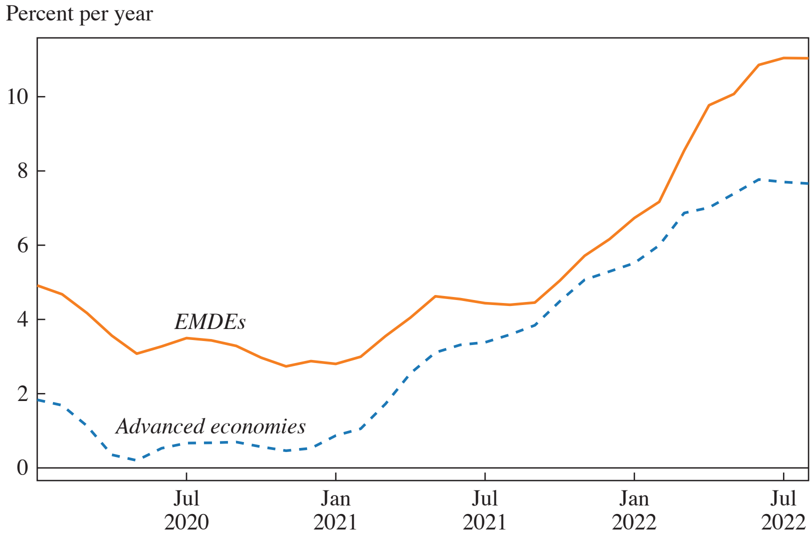
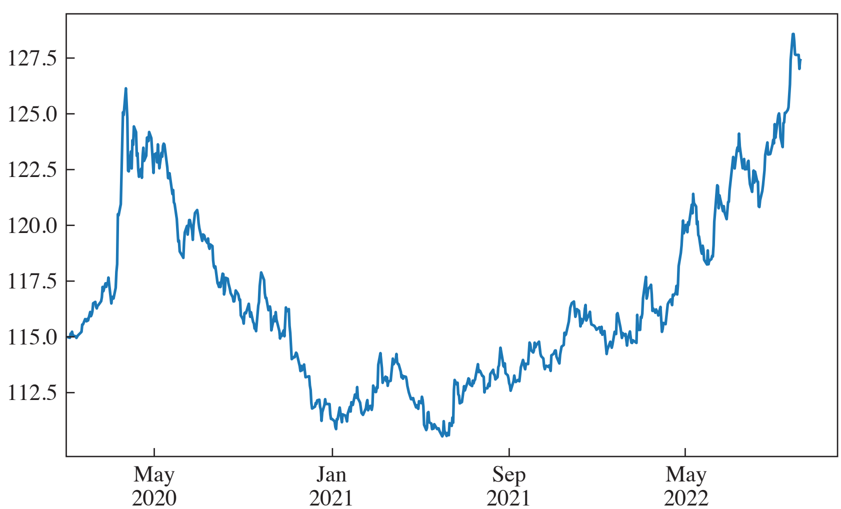


Figure 15. Monetary Policies, Global Inflation, and the US Dollar Exchange Rate, 2020–2022 *(Continued)*

Panel C: Global inflation



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.[56] 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.

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