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The global role of the US dollar and its consequences

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The global role of the US dollar and its consequences

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- This article outlines and quantifies a range of global roles of the US dollar. It then describes how these roles can form additional channels through which changes in the value of the US dollar spill over to the rest of the world above and beyond the standard trade channel.
- We find that periods of US dollar appreciation are typically associated with below-average output growth in the rest of the world, in contrast to the boost we might normally expect through the standard trade channel. This is true for both advanced and emerging market economies.

Overview

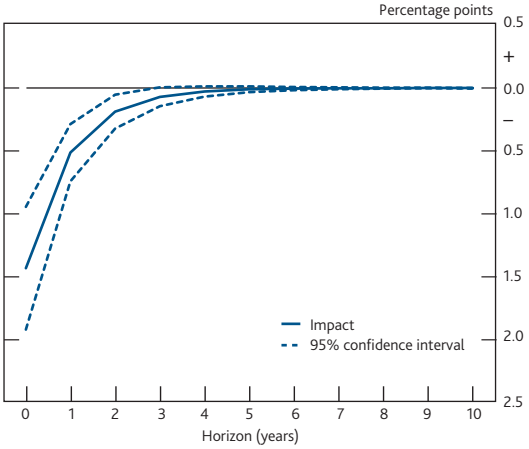
The US dollar is widely used in international trade and finance. It is the currency of choice for cross-border bank lending and international debt issuance, particularly for emerging market firms. It is also the dominant invoicing currency for trade transactions between non-US countries. Its global acceptance means that it has achieved 'reserve currency' status, which means that it is widely used as a store of wealth, accounting for more than half of the foreign exchange reserves of central banks and about half of the external assets of non-US countries.

These global roles of the US dollar form channels through which changes in its value can have consequences outside US borders. These go beyond the standard effect on bilateral trade flows with the United States.

The traditional external trade channel would imply that when the US dollar appreciates against another country's currency, the products of that country become more competitive relative to US products, boosting its exports and output. But if its exports are invoiced in dollars, that gain in competitiveness may not materialise. And if companies have borrowed in dollars, the amount of domestic currency needed to repay that debt will have increased, raising the burden of the debt, and acting as a drag on growth. By contrast, those who hold dollar assets, for example governments with large US dollar reserves, will experience a gain in wealth, which might support spending and hence growth. These various channels mean that it is not straightforward to estimate the impact of an appreciation of the dollar on the output growth of the rest of the world.

Excluding the direct effects of what is causing the appreciation in the first place, such as tighter US monetary policy or shifts in investors' risk sentiment, we find empirically that periods of US dollar appreciation are associated with lower real output growth in the rest of the world, both in advanced and emerging market economies. This result is in contrast to the boost that might be expected from the traditional external trade channel. The size of this effect is significant: a 10% US dollar appreciation on average takes 1.5 percentage points off emerging market economies' real output growth (**summary chart**).

Summary chart Average real GDP growth reaction in emerging market economies to a 10% US dollar appreciation[a]



Source: Bank calculations.

(a) Response obtained using a Panel Vector Autoregressive (PVAR) model described in the annex.

(1) The authors would like to thank Stuart Berry, Hiro Ito, Rana Sajedi, Sameeta Thakrar and Simon Whitaker for their help producing this article.

Introduction

The US dollar is the currency of the largest economy in the world,[1] but it is also more than that. It is widely used outside the United States, including as a reserve currency by non-US savers, as an invoicing currency by non-US exporters and importers, and as a funding currency by a wide array of non-US borrowers.

These global uses of the US dollar mean that changes in its value have consequences for the global economy that go beyond the traditional direct effects on external trade with the United States.

Given the potential importance of these spillovers it is surprising that they have not been studied more thoroughly by economists in the past. That said, there is a recent drive, both within policy and academic circles, to study the relevance and magnitude of these cross-border effects.[2]

This article fits within this emerging literature and has three objectives. First, it sets out and quantifies the various global roles of the US dollar, including its role as a reserve, invoicing and funding currency. Second, it explores the consequences of this for the world economy. It describes how the global roles of the US dollar form additional channels through which changes in its value affect the rest of the world over and above standard trade effects. Third, it presents empirical estimates of the effect of changes in the value of the US dollar on output growth in the rest of the world, and of the importance of the different channels. It concludes by outlining some policy lessons.

The goal of this article is to assess the numerous channels through which US dollar movements can have an impact on the global economy. It does not attempt to explain what causes these dollar movements in the first place. For this reason, the estimates of the effect of changes in the value of the US dollar on global output growth do not take into account what is causing the appreciation, such as tighter US monetary policy or shifts in investors' risk sentiment, and the other spillovers that those drivers may have. They represent the average response to dollar movements driven by any of these factors.

Global roles of the US dollar

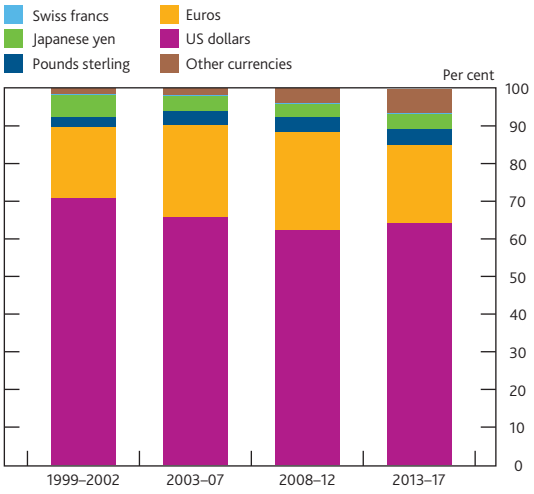
Money has three traditional functions: it acts as a medium of exchange, as a store of value and as a unit of account. Among the 151 currencies of the world,[3] the US dollar is the predominant provider of these functions in an international context. As the main global reserve currency, it acts as a store of value with a large fraction of international safe assets denominated in dollars. It is also the most widely used international medium of exchange, with a large share of cross-border trade and financial transactions (including bank and debt funding) conducted in dollars. Finally, the US dollar is also the main international unit of account as a lot of exports and imports are invoiced in dollars.

In this section, we describe and quantify some of these international roles of the US dollar.

Reserve currency

The US dollar is the currency of denomination for a large share of the foreign assets investors choose as a store of value. That is, the US dollar is typically used as a reserve currency, both by governments and the private sector. For example, **Chart 1** shows the key role it plays as the main currency in which foreign exchange reserve assets held by central banks are denominated, with a share of about 70% of total holdings.[4]

Chart 1 Currency composition of official foreign exchange reserves[a]



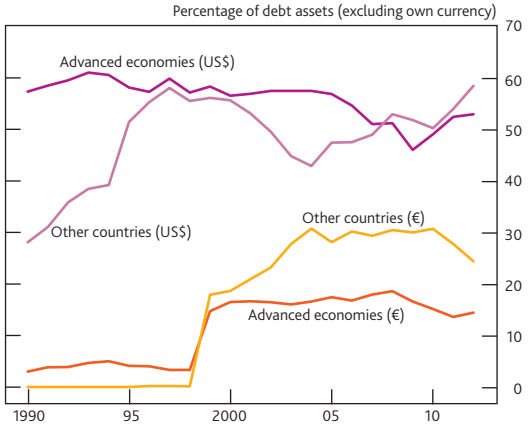
Sources: International Monetary Fund COFER and Bank calculations.

(a) Shares exclude 'unallocated reserves', ie reserves for which the currency composition is not known.

This phenomenon is not restricted to official holdings. Looking at countries as a whole, and focusing on holdings of foreign assets, US dollar-denominated assets still dominate. **Chart 2** shows the share of external debt assets denominated in dollars and euros for advanced economies and other countries (mainly emerging markets), including private external holdings. The dollar accounts for more than half of the external assets and its share has been stable for most of the past 25 years. It accounts for almost double the share of the second most used currency, the euro (around 30% for 'other' economies and below 20% for advanced economies).

(1) Measured by market price GDP.
(2) See, for example, Avdjiev, McCauley and Shin (2015). A more established strand is the literature related to 'original sin'. See the section on the impact of changes in the US dollar on sovereign yields on page 5.
(3) The UN Operational Rates of Exchange lists 220 countries using 151 currencies.
(4) Most central banks hold their US dollar-denominated reserves in the form of US Treasury bonds, typically regarded as a highly liquid and safe asset.

Chart 2 Share of non-home currency external debt assets in US dollars and euros[a]



Sources: Bénétrix, Lane and Shambaugh (2015) and Bank calculations.

(a) The classification of 'advanced' and 'other' countries follows the International Monetary Fund (IMF). The country or region that issues the currency is excluded from the sample. This is the case for the United States in 'Advanced economies (US$)' and the Eurozone countries in 'Advanced economies (€)' group. Euro data are the sum across old legacy currencies (such as the mark and the franc) for the period pre-1999. In this data set, countries with non-zero euro positions (for the pre-1999 period) are the Czech Republic, Japan and Russia.

Invoicing currency

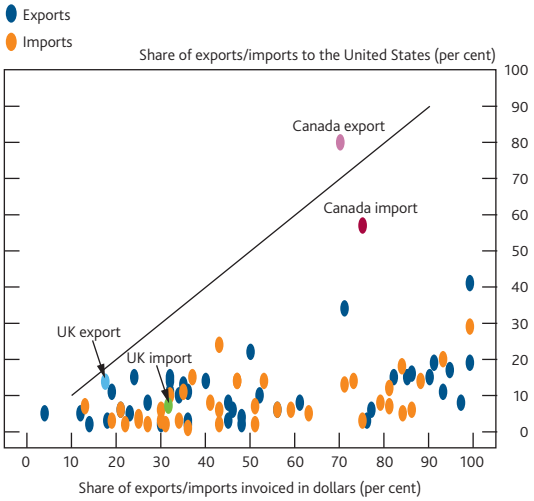
The US dollar is also widely used as an invoicing currency in external trade, even among non-US countries.(1) For example, exports from Brazil to the United Kingdom can be invoiced in US dollars, even though it is not the national currency of either country involved in the transaction. **Chart 3** quantifies this by comparing the share of exports and imports invoiced in US dollars with the share of exports to and imports from the United States for a range of advanced and emerging market economies. Most of the observations are below the 45 degree line (Canada is the only exception), which means that the share of trade invoiced in US dollars is typically higher than the share of trade with the United States. In the case of the United Kingdom, for example, the share of imports invoiced in US dollars is around 35%, but the share of imports from the United States is around 10%. Most commodities are priced in US dollars, which contributes to the higher shares of dollar invoicing.

Funding currency

Finally, the US dollar plays a key role in the funding of companies outside the United States, both via bank loans and in international debt markets. That is, non-US corporates issue debt and obtain bank loans denominated in US dollars even when they are not US residents and/or their source of revenues are not predominantly US dollar-denominated.

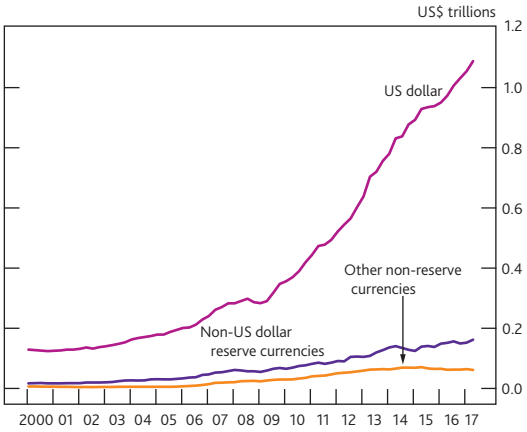
This is particularly true for companies in emerging market economies, where both the stocks of US dollar debt outstanding in international markets (**Chart 4**) and cross-border bank lending in US dollars (**Chart 5**) are larger than the equivalent amounts denominated in all other currencies combined.(2) This could be because the risk of currency volatility is greater in emerging markets, which

Chart 3 Share of imports and exports from/to the United States and invoiced in dollars



Sources: Chinn and Ito (2015), Ito and Kawai (2016) and Bank calculations.

Chart 4 Debt securities issued in international markets by corporates from emerging markets[a]



Sources: Bank for International Settlements (BIS) and Bank calculations.

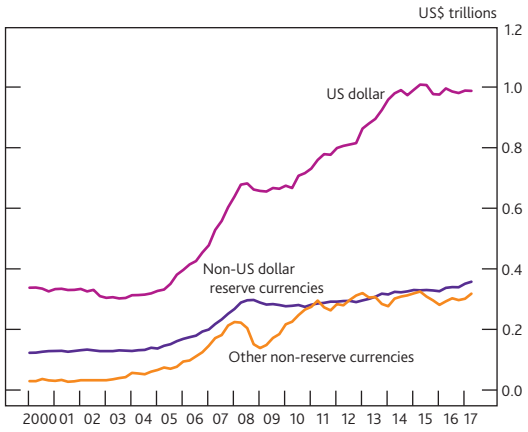
(a) International debt securities refer to amounts outstanding of international debt securities issued on a nationality basis by corporates from emerging markets. Non-US dollar reserve currencies: British pound, euro, Japanese yen and Swiss franc.

makes it cheaper to borrow in foreign currencies, and in particular the US dollar. Both the corporate sector and the broader non-bank sector share this pattern.(3)

The reliance on US dollar funding has become increasingly marked for emerging markets since the global financial crisis in international debt markets (**Chart 4**). And while the stock of US dollar-denominated cross-border lending to emerging

(1) Casas *et al* (2016) point out that 'the vast majority of trade is invoiced in a small number of 'dominant currencies', with the US dollar playing an outsized role'.
(2) We classify advanced economies (AEs) and emerging market economies (EMEs) along similar lines to the Bank for International Settlements (BIS) in their International Banking Statistics which split countries/entities into developed, developing and offshore centres. This implies that most central and eastern European as well as most non-Japan Asian countries are part of the EME sample.
(3) This holds even when loans from banks in the United States are excluded from the data set. That is, the US dollar is the currency of choice for bank lending to emerging markets even when these loans come from countries other than the United States.

Chart 5 International bank lending — to emerging markets, non-bank sector[a]



Sources: BIS and Bank calculations.

(a) Cross-border loans and deposits from all BIS-reporting banking systems to residents in emerging markets. To account for exchange rate valuation effects, the chart shows cumulative exchange rate adjusted changes in bank loans and deposits added to their respective start period (2000 Q1) stocks. Non-US dollar reserve currencies: British pound, euro, Japanese yen and Swiss franc.

markets from international banks has levelled off over the past few years, it remains at very high levels (**Chart 5**).

The predominance of US dollar cross-border borrowing is not restricted to emerging market economies. Shares of US dollar international debt and cross-border loans for advanced economies are smaller than for emerging markets, but still sizable.

The various roles described above are not independent. For example, the fact that the US dollar is a popular invoicing currency is likely to be linked to its role as a store of value. A safe asset is only safe if it can be exchanged for a known quantity of goods and services in the future. If a large share of exports and imports are invoiced in US dollars, it is reasonable for agents to hold their safe assets in the same currency so that they can easily be exchanged for goods and services at a later date.[1]

The impact of changes in the US dollar on the global economy

In the previous section we outlined and quantified the various global roles of the US dollar. In this section we will describe how these global roles can form channels through which changes in the value of the US dollar spill over to the rest of the world.[2]

The effects of changes in the value of any currency (including the US dollar) on the rest of the world are typically thought of in terms of bilateral external trade. In this article, this is called the 'classical' trade channel. Changes in the value of the US dollar lead to a change in the relative prices of US exports and imports with respect to foreign alternatives. In the event of a US dollar appreciation, the price of US goods in other countries goes up in comparison to local alternatives, which decreases local demand for them. In addition, foreign goods become relatively cheaper for US consumers, boosting imports from the rest of the world. In many traditional economic models, these dynamics boost economic growth abroad and depress growth within the United States.

However, the various international roles of the US dollar described above mean that changes in its value have global consequences beyond the classical trade channel. The rest of this section analyses some of these channels. We focus our examples on the case of a US dollar appreciation for simplicity.

The US dollar as an invoicing currency

The classical trade channel should mostly affect countries that trade directly with the United States. However, as the previous section explains, there is an additional dimension to be considered given the large amount of US dollar-invoiced trade between non-US countries. Changes in the value of the US dollar could have different effects on countries depending on their shares of US dollar-invoiced exports and imports.

Export and import prices are often slow to change in their currency of invoicing.[3] For example, exporters may care about their competitors' prices when they choose their own prices and so they keep these unchanged even when the exchange rate moves.[4] Instead, mark-ups (the difference between the cost of producing the good or service and the selling price) fluctuate in tandem with the exchange rate. For example, Brazilian exporters to the United Kingdom do not necessarily lower the US dollar price they charge for their exports as the Brazilian real depreciates, even though their costs have gone down when measured in US dollars. Moreover, the cost of producing exports may increase to the extent that exporting firms use US dollar-denominated imported inputs in production.

What are the consequences of sticky (US dollar) prices and the use of imported inputs for exports? To answer this question, let us consider an appreciation of the US dollar with respect to country A's domestic currency. The standard trade channel predicts that this will make country A's goods cheaper for the United States and raise A's exports. It will also make US goods more expensive for country A, reducing imports.

(1) See Gopinath and Stein (2017).
(2) Some of these channels would not be relevant if agents were fully hedged (insured) against exchange rate changes. However, agents tend to hedge only partially. As the qualitative effects of partial hedging should be similar to no hedging at all, we abstract from these considerations in the analysis that follows.
(3) See Gopinath (2016) and Casas *et al* (2016).
(4) This phenomenon of a firm taking competitors' pricing decisions to decide on its own price is called 'strategic complementarities in pricing'. When complementarities are high, firms obtain higher profits by keeping constant prices relative to their competitors.

These effects are dampened by sticky export prices and the use of imported inputs in production. If, in response to a dollar appreciation, firms in country A do not change export prices in dollars very much, then A's goods do not appear cheaper to US consumers. A's exports do not increase by a large amount.

The use of imported inputs in production exacerbates this effect. If country A's exports use a lot of US dollar-denominated imported inputs (which have gone up in price), firms' production costs go up, which in turn further decreases their incentives to reduce export prices in US dollars. Export demand, therefore, increases by less and exports do not receive the boost that the classical trade channel predicts.

On the other hand, following a depreciation against the US dollar, the price of dollar-denominated imports goes up compared to domestic alternatives, which leads to a decrease in imports by country A. This affects all US dollar-invoiced trade, not just trade with the United States. Thus, a dollar appreciation reduces export demand in non-US countries as well.

In aggregate, depending on the number of countries with high shares of imports and exports invoiced in US dollars, an appreciation of the US dollar might not necessarily translate into higher exports and higher growth in non-US countries as the classical trade channel predicts.(1)

The US dollar as a funding currency

(a) Balance sheet effects and risk-taking

The fact that the US dollar is a global funding currency means that corporates in the rest of the world are likely to take out loans or issue debt in US dollars, sometimes not matched with US dollar assets nor 'hedged' (insured) in derivatives markets.

For these companies, a US dollar appreciation means that in order to honour the amount they have borrowed in US dollars, they will have to pay back more in domestic currency. This would put pressure on the corporates' balance sheets (the net value of the firm would fall), with a number of resulting effects. Most immediately, these companies could find it harder to borrow, potentially leading to cuts in hiring, investment and production. This could reduce growth in the affected countries.

For the lenders to which these companies owe US dollars, a dollar appreciation could reduce the likelihood of them getting their money back. Such uncertainty would increase the riskiness of their portfolios. Banks usually have internal risk management practices or external regulatory constraints that limit the amount of risk that they are willing or allowed to take. Affected lenders might therefore need to decrease lending more broadly which could in turn reduce output growth.

These dynamics, which have been dubbed the risk-taking channel of exchange rates, are typically related to a cut back in cross-border US dollar lending (in the case of a US dollar appreciation).(2)

(b) Domestic financial conditions

The effect on companies' balance sheets resulting from changes in the value of their US dollar debt not only affects those that lent them the money (as described above), but potentially also their home financial system more broadly. One potential channel is via corporates that obtain cross-border US dollar funding and place part of those proceeds in deposits in the domestic financial system.(3) If these proceeds are converted into local currency or if banks extend loans in dollars to residents, this in turn loosens domestic financial conditions. The opposite dynamic occurs when the US dollar appreciates. Domestic financial conditions tighten beyond the directly affected companies, potentially affecting output growth negatively.(4)

(c) Sovereign yields

Changes in the value of the US dollar can have additional impacts on governments. When companies find it more difficult to obtain loans, they might reduce production and employment. The drag on growth from a dollar appreciation might be amplified by direct and indirect impacts on governments.

For instance, a US dollar depreciation can lead to a direct effect on debt-servicing costs.(5) If governments have borrowed in dollars, their interest payments will go up in local currency terms. This is commonly described as 'original sin'.(6)

In addition, a US dollar appreciation could also lead to reduced activity by companies, which depresses government tax revenues. Given a worse fiscal position, investors could increase the return they demand for holding government bonds.(7) To offset the increase in funding cost, the government might cut spending and increase taxes, tightening financial conditions even more and amplifying the hit to activity. This is the indirect effect.

(1) See Casas *et al* (2016) for a formal model of these channels.
(2) See Bruno and Shin (2015) and Aoki, Benigno and Kiyotaki (2016).
(3) See Chung *et al* (2014) and Bruno and Shin (2017).
(4) If the origin of US dollar strength was higher interest rates in the United States (tighter financial conditions), then the resulting tightening of financial conditions abroad via the logic described above could constitute one of the channels behind the spillovers of financial conditions, as studied by Rey (2016).
(5) 'Original sin' as related to sovereign issuers was an important financial stability risk in the 1990s, subsiding in the 2000s. Foreign exchange sovereign debt issuance increased after the 2008 crisis, but only to a moderate extent. The main source of concern comes from non-sovereign issues, as described in the 'Funding currency' section on pages 3–4 of this article. See the IMF's 2015 *Global Financial Stability Report* (Chapter 1) for more details.
(6) For a summary of the literature, see Eichengreen, Hausmann and Panizza (2007).
(7) See Hofmann, Shim and Shin (2016) for empirical evidence supporting this hypothesis. They find that episodes of bilateral depreciation against the US dollar are associated with widening sovereign spreads (the difference between the interest rate on a government bond and the interest rate on a safe asset), even for local currency debt.

The indirect effect holds even in the case of local currency denominated debt and therefore applies in addition to any direct original sin effect.

The US dollar as a reserve currency

A large share of assets (and liabilities) worldwide are denominated in US dollars. Although both assets and liabilities might be dollar-denominated, every country and sector's dollar assets and liabilities are not always exactly matched. In these circumstances, the net wealth of households and sovereigns is also affected by changes in the value of the US dollar, which can cause changes in their spending and hence affect output.

For example, an agent that has more US dollar assets than liabilities will see an increase in wealth (when measured in domestic currency) in the event of a US dollar appreciation. This boost in wealth might translate into an increase in consumption. Not all agents inside a country might benefit from a dollar appreciation. Some, as might be the case for the companies analysed in the funding channel, may have more dollar liabilities than assets. These agents are affected in the opposite way.

Distributional considerations aside, at an aggregate level a country with external assets mostly in US dollars and liabilities in local currency will experience a positive wealth effect when the dollar appreciates. The push on demand and investment could in principle boost GDP growth, while the opposite would be true for a country with more US dollar liabilities than assets.

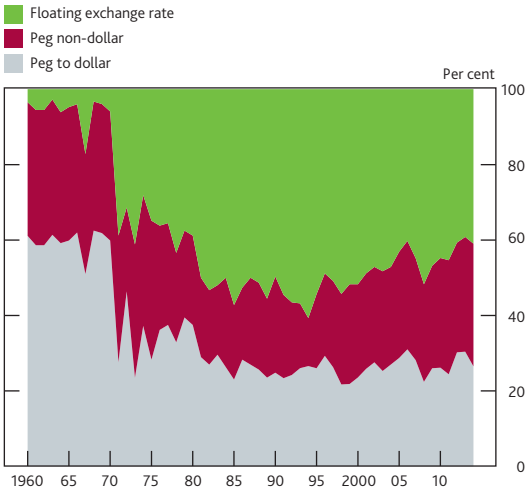
The role of countries with currency pegs

Some countries choose to fix the value of their currency with respect to another currency. Countries that 'peg' their currencies to the US dollar represent 25%–30% of the total number of countries in the world. This share has been stable for the past 30 years (**Chart 6**).

For many of the channels described above, countries that peg their currencies to the US dollar are part of an extended dollar area. In order to maintain their pegs, these countries have to keep significant dollar reserves in order to intervene in foreign exchange markets.(1) And their international liabilities in local currency are indexed to the dollar as long as the peg holds. Moreover, their exports and imports are almost completely invoiced in US dollars. In their case, a dollar appreciation translates into lower exports and higher imports.

In theory, countries that peg their currencies to the US dollar should eliminate balance sheet effects and potential funding difficulties, as the value of local liabilities would be fixed in dollar terms. The main caveat is the risk of a country being forced to float its currency during a crisis. The literature presents a variety of mechanisms through which this can happen.(2) The latest models incorporate self-fulfilling crises — when investors start a crisis by believing it will happen. A sudden depreciation of the currency during a crisis could generate large changes in the value of assets and difficulties in repaying debt, with concerns for financial stability.

Chart 6 Share of countries with currency pegs and floating exchange rates(a)



Sources: Klein and Shambaugh (2008) and Bank calculations.

(a) Countries using the euro are considered non-dollar peggers.

Spillover effects of changes in the value of the US dollar: empirical assessment

The previous section shows that the boost to growth in non-US countries from the classical trade channel during episodes of US dollar appreciation might be offset by some of the channels described. Depending on the relative strength of the various channels, a dollar appreciation could even lead to lower growth in non-US countries. The overall effect is therefore an empirical question — we have to look at the data to understand what has happened during past episodes of dollar appreciation.

We begin by looking at the aggregate effect, and then go on to explore which of the channels described in the previous section are most important.

It is worth noting that the cause of a change in the value of the US dollar will also matter, as different underlying shocks could lead to different effects on the rest of the world. Here we do not take into account what is causing the appreciation, such as tighter US monetary policy or shifts in investors' risk sentiment.(3) Hence, our results should be interpreted as

(1) The IMF's Assessing Reserve Adequacy Framework recommends that countries with fixed exchange rates hold more reserves in comparison to its exports, broad money and other liabilities than countries with floating exchange rates.
(2) See Krugman (1979) and Chang and Velasco (2001).
(3) In the econometric exercise presented in this article, we isolate the dollar movement from monetary policy and changes in risk sentiment by including the VIX index and US Treasury rates in the regressions. This is equivalent to analysing the net dollar effect on growth excluding monetary policy and risk.

representing the average response to movements of the dollar driven by any of these factors, but not directly to the factors themselves.

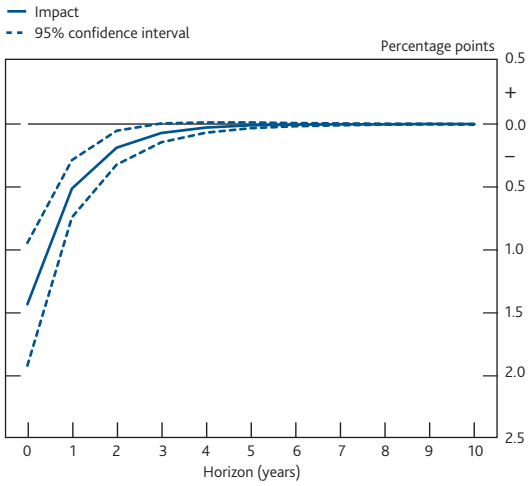
Aggregate effect

We want to measure the effect of changes in the value of the US dollar on output growth for a large set of non-US countries. For this, we rely on a Panel Vector Autoregressive (PVAR) model. The PVAR takes into account a small set of variables of interest, and allows us to estimate the reaction of real output growth across a large number of countries to exogenous changes in the value of the US dollar. More details on the specification and dynamics of the model can be found in the annex.

We compile data for 24 advanced economies and 39 emerging markets over 1987–2015.(1) Given potential differences between advanced and emerging economies, we estimate two separate models for these groups of countries.

Chart 7 shows the average effect on real output growth in emerging market economies (EMEs) of a 10% appreciation in the value of the US dollar at different time horizons, together with confidence bands that reflect the uncertainties around the estimation. Real GDP growth falls significantly as soon as the US dollar shock occurs. The size of the effect is quite big: a 10% US dollar appreciation takes about 1.5 percentage points off GDP growth in EMEs.(2)

Chart 7 Average real GDP growth reaction in EMEs to a 10% US dollar appreciation(a)

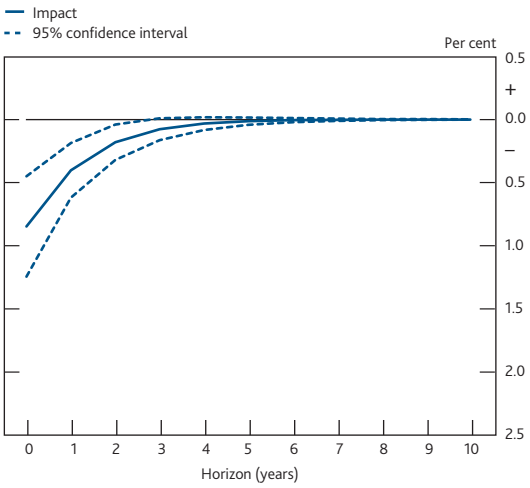


Source: Bank calculations.

(a) Response obtained using a PVAR model described in the annex.

However, this is not just limited to emerging markets: the effect on advanced economies (excluding the United States) is also significant (**Chart 8**), albeit of a smaller size. In both cases, the effect persists for about three years.

Chart 8 Average real GDP growth reaction in advanced economies to a 10% US dollar appreciation(a)



Source: Bank calculations.

(a) Response obtained using a PVAR model described in the annex.

These results are consistent with a set of recent papers, most closely that of Druck, Magud and Mariscal (2015), which find that periods of US dollar appreciation are associated with lower growth in the rest of the world.(3) This would suggest that the channels set out in the previous section outweigh the boost from the classical trade channel.

Underlying channels

Having established the negative effect of episodes of US dollar appreciation on output growth in the rest of the world, we now explore the relevance of the potential channels outlined above. That is, we want to see whether countries that are more exposed to a particular channel are affected more during periods of US dollar appreciation.

In particular, and due to data availability constraints, we explore three channels: the wealth effect channel (dollar as a reserve currency), the balance sheet channel, and the sovereign yields channel (both derived from dollar as a funding currency). We quantify (approximately) countries' exposures to each of these channels and then feed this information into a panel data regression model to assess their relevance. While the balance sheet channel captures the direct consequences of the accumulation of dollar liabilities by domestic agents, the wealth effect relates to the aggregate net position of the country (the size of its dollar-denominated assets in comparison to its dollar-denominated liabilities).

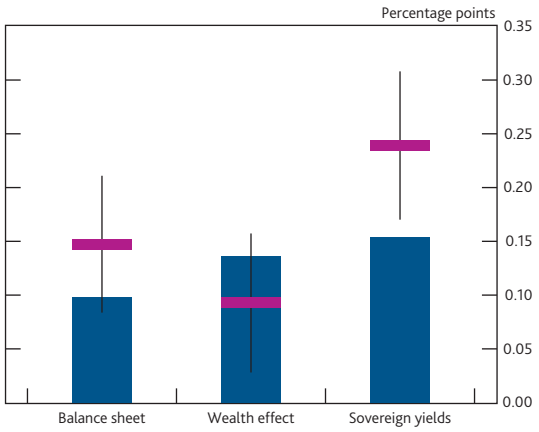
(1) Countries are classified according to the International Monetary Fund classification in 2010.
(2) The period analysed includes the 1997 Asian financial crisis. Since then, many countries tried to address their vulnerabilities, such as large stocks of private debt in dollars. In this sense, the impact of a dollar appreciation on growth might be less negative than estimated above if we take into consideration only the post-1997 period.
(3) The approach used by Kearns and Patel (2016) is relatively similar to ours.

The model and the proxies used to measure exposure are described in more detail in the annex. We consider that: (i) countries with significant past US dollar inflows are particularly exposed to the balance sheet channel, (ii) countries with negative US dollar net foreign asset positions are particularly exposed to the wealth effect channel, and (iii) countries for which sovereign debt spreads go up by a greater extent in the event of US dollar appreciations are particularly exposed to the sovereign yields channel.

In this exercise, owing to the relatively small number of observations, we do not discriminate between advanced and emerging economies and estimate this panel regression model on the data set as a whole.

Chart 9 shows the effect of an increased exposure to our channels of interest in terms of output cost in the face of US dollar appreciation episodes. The blue bar shows the average contraction in real GDP growth in the face of a 1% US dollar appreciation for a country that has an average exposure to each of the three channels.(1) On top of it, the magenta bar shows the impact on real GDP growth for countries that have an exposure that is one standard deviation above average. The vertical lines show how confident we are in our estimates.

Chart 9 Average real GDP growth decrease in reaction to a 1% US dollar appreciation, given exposure to balance sheet, wealth effect and sovereign yields channels(a)



Source: Bank calculations.

(a) Responses obtained using a panel regression model described in the annex. The blue bars show the average contraction in real GDP growth in the face of a 1% US dollar appreciation for a country that has an average exposure to each of the three channels. The magenta bars show the impact on real GDP growth for countries that have an exposure that is one standard deviation above average. The sizes of the vertical lines crossing the magenta bars are the levels of confidence of the estimation of the magenta bars.

When the US dollar appreciates, countries that are particularly exposed to the balance sheet and sovereign yields channel suffer a bigger hit to their real GDP growth. In contrast, the wealth effect channel does not seem to be particularly relevant. This may reflect the importance of the within-country distribution of assets between agents (eg the government and private sector might act in offsetting ways) which means that the aggregate net foreign asset position of the country is not a sufficient statistic of exposure to these dynamics.

Conclusion

This article studies the various global roles of the US dollar, and the consequences of these uses in terms of spillovers to the rest of the world from changes in its value.

The US dollar is used as a reserve currency by a wide array of non-US savers, as a funding currency by non-US borrowers, and as an invoicing currency in external trade transactions between non-US countries. In turn, these global uses can form additional channels through which changes in the value of the US dollar have consequences for the rest of the world that go beyond standard external trade effects with the United States.

The empirical evidence we present points to episodes of US dollar appreciation resulting in below-average growth in the rest of the world. This goes against the classical trade channel, which in principle should push up growth in the rest of the world via increased import demand and decreased export competition from the United States.

There are several policy-relevant lessons to be learnt from this article. First, we should be aware of the potential adverse effects on global growth of periods of sustained US dollar appreciation, and use models that factor in these dynamics. Second, the article also points to potential financial stability risks that could arise during periods of persistent US dollar strengthening, such as those from increased strain on companies' and banks' balance sheets.

The channels described are not necessarily related to times of financial distress. But, if domestic vulnerabilities are high, dollar movements could trigger crises and the effects on growth might be larger than captured above. An example is a dollar appreciation causing a wave of firm failures due to a steep increase in their foreign currency liabilities.

It is clear that the US dollar is more than just the currency of the largest economy in the world. This means that the consequences of changes in its value need to be understood and monitored appropriately.

(1) These bars are different across channels because of different samples owing to data availability issues.

Annex
A quick overview of the models
PVAR

We rely on a Panel Vector Autoregressive model (PVAR) to estimate the effect of changes in the value of the US dollar on output growth in the rest of the world.

PVARs comprise a set of *endogenous* variables, the dynamics of which are modelled and, on occasion, a set of *exogenous* variables, which are assumed to move independently of the set of endogenous variables. In our case, the endogenous variables are countries' real GDP growth rates and changes in the nominal effective exchange rate index. In turn, the set of exogenous variables contains (changes in) the US dollar index, the variable which will be *shocked* to get at our object of interest, and a set of *control* variables, namely changes in one-year US Treasury yields and in the VIX index, which is typically used as a proxy measure of the market's risk aversion.

In functional terms, the model takes the following form:

$$\begin{pmatrix} \Delta rgdp_{i,t} \\ \Delta neer_{i,t} \end{pmatrix} = A + B \begin{pmatrix} rgdp_{i,t-1} \\ \Delta neer_{i,t-1} \end{pmatrix} + C \begin{pmatrix} \Delta usd_t \\ \Delta VIX_t \\ \Delta UST_t \end{pmatrix} + \varepsilon_i + u_{i,t}$$

Where $\Delta rgdp_{i,t}$ is real GDP growth in country i at time t, $\Delta neer_{i,t}$ is the analogue for the nominal exchange rate, Δusd_t is the (percentage) change in the US nominal effective exchange rate at time t, ΔVIX_t is the change in the VIX index, and ΔUST_t is the change in the yield of a one-year US Treasury bond. ε_i corresponds to country fixed-effects, a device to control for time-invariant heterogeneity across countries.

The inclusion of the exchange rate in the set of endogenous variables responds to the fact that we are interested in measuring the effect of changes in the US dollar itself, rather than the consequences of the resulting mirror effect on other countries' exchange rates. By incorporating information on countries' exchange rate indices, we can hold these fixed when analysing the effect of changes in the US dollar. Moreover, we also 'orthogonalise' the US dollar index from changes in the bilateral exchange rate *vis-à-vis* the country in question, on a country-by-country basis. That is, we only use the portion of changes in the US dollar index that is independent from changes in the bilateral exchange rate *vis-à-vis* the country being analysed.

In terms of the addition of control variables, the rationale behind them is that we want our measured effect on output to be the actual response to changes in the value of the US dollar, and not the response to a third variable that could be having a simultaneous effect on both world output growth and the US dollar. For example, both an increase in US interest rates and/or a rise in risk aversion could lead to an appreciation of the US dollar (which typically moves up in these circumstances) and a decrease in output growth in the rest of the world for reasons other than the appreciating US dollar. Hence, we add information on US interest rates and the VIX index to be able to hold these fixed when looking at the effects of changes in the value of the US dollar.

The PVAR estimates the average response of real GDP to changes in the US dollar index for the set of countries considered. Confidence intervals around these estimates (as seen in **Charts 7** and **8**) are obtained via a bootstrap procedure, which factors in sample and estimation uncertainty.

We compile real GDP growth and nominal effective exchange rate indices for a set of 43 countries, while the US dollar index, US interest rates and the VIX index are shared across countries.

Panel regressions

In order to explore the channels underlying the effect of changes in the value of the US dollar on output growth in the rest of the world, we rely on panel data regressions, which are more flexible than the PVAR described in the section above.

In particular, we regress real GDP growth on lagged effective exchange rate changes, changes in the (orthogonalised) US dollar index and the interaction of these changes in the US dollar and a range of proxy variables for the exposure of particular country-time observations to a range of potential channels.

In equation form:

$$\begin{aligned} \Delta rgdp_{i,t} = \alpha &+ \beta_1 \Delta neer_{i,t-1} + \beta_2 \Delta usd_t \\ &+ \beta_3 \left(\Delta usd_t * channel_{i,t-1} \right) \\ &+ \beta_4 \, channel_{i,t-1} + \varepsilon_i + u_{i,t} \end{aligned}$$

Where most variables have the same interpretation as the PVAR, and $channel_{i,t-1}$ is a regression-specific proxy for the exposure to one of the channels described above.

The key component in this set-up is the interaction term of changes in the value of the US dollar and the exposure to a particular channel. If this interaction is significant (and has the expected sign), it means that countries that are particularly exposed to a given channel suffer more in terms of reduced GDP growth when the US dollar appreciates.

Due to data limitations, we are only able to look at three of the channels described in the main text. Specifically, we look at the balance sheet, wealth effect and sovereign yields channels. The proxies used and expected sign are as follows:

- **Balance sheet channel:** we use the sum of US dollar inflows into the country in question over the preceding three years, both in the form of bank loans and debt securities. These flows are normalised by GDP to make them comparable across countries. We would expect that the larger these inflows, the larger the potential effect of the balance sheet channel, and hence the larger the negative impact of US dollar moves on real GDP.

- **Wealth effect channel:** we use countries' net US dollar foreign assets (normalised by GDP). We would expect that the larger US dollar assets are in comparison to liabilities (the larger the US dollar net position), the smaller the negative impact of US dollar moves on real GDP, as this would be counteracted by a positive wealth effect.

- **Sovereign yields channel:** we use (changes in) countries' sovereign US dollar debt spreads. We would expect that the larger the increase in borrowing costs in the event of a US dollar appreciation, the larger the negative impact of US dollar increases on real GDP.

Data: definitions and sources

Nominal Gross Domestic Product in National Currency: International Monetary Fund *International Financial Statistics*. Indicator NGDP_XDC. For countries adopting the euro, the indicator is NGDP_EUR.

National Currency per US Dollar: International Monetary Fund *International Financial Statistics*. Indicator ENDA_XDC_USD_RATE.

Nominal Effective Exchange Rate: Bank for International Settlements. Broad indices.

Interest Rates, Government Securities, Treasury Bill Rate, Percent per annum: Federal Reserve Economic Data (FRED), St. Louis Fed.

Countries' net US dollar foreign assets: Bénétrix, Lane and Shambaugh (2015). The measure used for each country is the sum of external assets in dollars to GDP (A_USD_GDP) subtracted of external liabilities in dollars to GDP (L_USD_GDP) over the sum of total external assets and liabilities over GDP (A_DC_GDP + L_DC_GDP + A_FC_GDP + L_FC_GDP).

Sovereign spreads: Countries' sovereign US dollar debt spreads from EMBI Global (JPMorgan).

CBOE Volatility Index (VIX): Federal Reserve Economic Data (FRED), St. Louis Fed.

Sum of US dollar inflows into the country: Bank for International Settlements *Locational Banking Statistics*. The measure used for each country is the sum of US dollar bank inflows to each country and international debt securities issued in US dollars from each country normalised by the country's GDP.

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