Currency composition of foreign exchange reserves

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Abstract

This paper analyses the factors that govern the choice of the currency composition of foreign exchange reserves. First, we introduce a new panel dataset that contains the data on the composition of major currencies in foreign exchange reserves for more than 50 countries in the 1999-2017 period. Second, we show the currency composition of reserves is strongly related to the co-movement of the domestic currency with key currencies, the currency denomination of trade and the currency denomination of financial liabilities. Other things equal, a country that faces a depreciation trend in its currency tends to hold more dollar-denominated assets in its reserve portfolio. Also, a country with more open financial markets tends have lower USD and higher EUR shares in its foreign exchange reserves.

Keywords: international reserves, safe asset, currency zones, trade invoicing

JEL classification: F31, F32, F33, F41

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Contents

1. Introduction

The Great Financial Crisis (GFC) of 2007-08, the rise of China and its currency, the renminbi (RMB), and the euro debt crisis, all revived debate on what constitutes an international currency. The debate continues. The dollar predominates, and the euro runs a distant second. The renminbi's rise has reversed in a number of dimensions since 2014, but its share of foreign exchange reserves continues to edge up.

Despite the recent ascent of the RMB to become one of the IMF's Special Drawing Rights' composite currencies in 2015, the predominance of the US dollar has shown few signs of waning. This is a puzzle for scholars like Chinn and Frankel (2007) who seek to explain the dollar's prominence in reserves in the time series with mostly US variables, such as its GDP.[1] The US GDP share in the world GDP at market prices has been on a moderately declining trend for decades. The US economy accounted for 29% of the world total in 1975, but its share declined unevenly to 24% as of 2017. In the last two decades, especially, the US share of global GDP or trade has been on a declining trend (Graph 1). If one takes the size of the US economy or its international trade or the size of its bond market to explain the dollar's share, it is hard to avoid the inference that the reserve share should have declined gradually rather than shown such stability. According to International Monetary Fund (IMF), the share of the US dollar (USD) in total foreign exchange reserves declined by eight percentage points in the last two decades, still marking 63% and followed by a distant second currency, the euro (EUR) whose share is a mere 20%. These data show that the role of the USD as the most dominant international currency has not been challenged by other currencies.

Much recent work on the dollar, however, has looked beyond the US economy to the use of key currencies by other countries. Regarding the dollar as an international unit of account, Gopinath (2015) has emphasised the outsized role of the dollar in the denomination of international trade. Gopinath and Stein (2018) have taken the currency of trade denomination to explain the currency denomination of foreign exchange reserves.

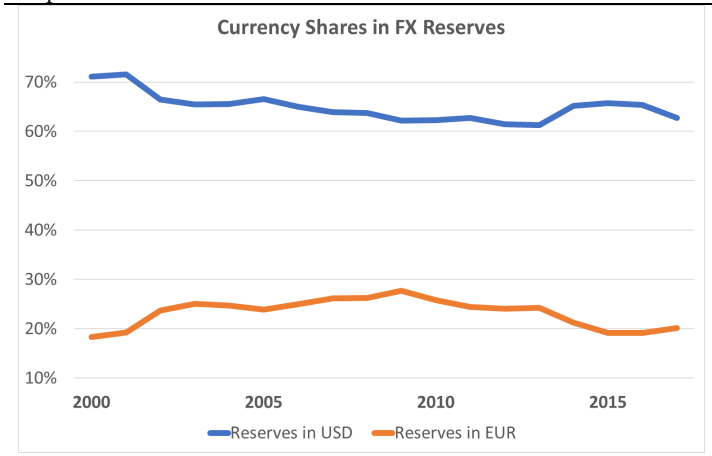
Regarding the dollar or the euro as an anchor for other currencies, Ilzetzki et al (2017) have shown how about 70% of the currencies of the world by country GDP shares show less volatility against the US dollar than against other key currencies. Taking quite a different approach that allows economies to straddle key currency zones, Ito and McCauley (2019) find that, throughout the last four decades, the "dollar zone" has covered a fairly consistent 50-60% of world GDP.[2] We find that the euro's influence has extended east in Europe (ECB (2014)), to commodity currencies, and even to emerging Asia (McCauley and Shu (2019)). However, Asia's fast growth has offset the euro's wider influence, given the diminished yet still strong dollar linkage of Asian currencies.

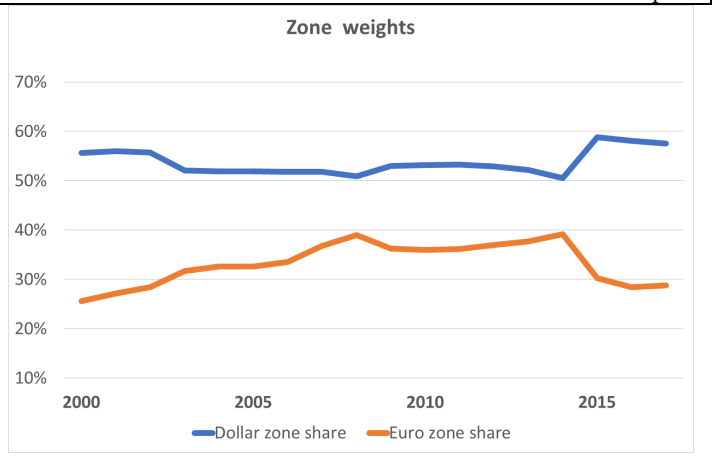
[1] Chinn and Frankel (2007, 2008) ascribe the dollar's high share of reserves to the size of the US economy in an inductively non-linear relationship. This allows reserves in dollars to amount to more than twice those held in euros while the economy of the United States is only a third larger than that of the euro area.

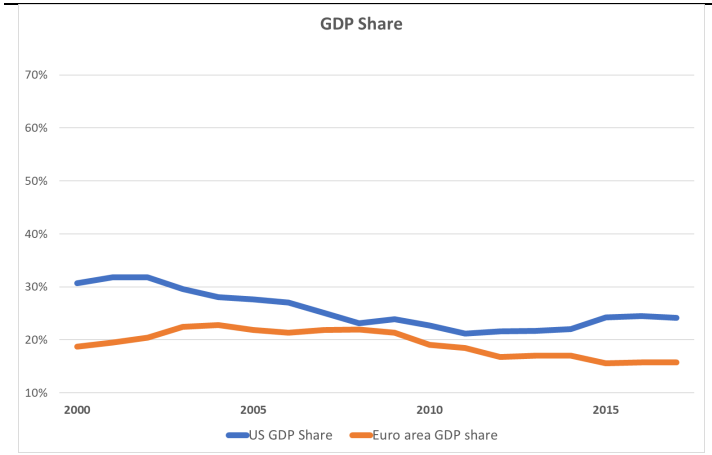
[2] See Graph 1. As we explain in a later section, we use the inductive technique of Haldane and Hall (1991) and Frankel and Wei (1996) to divide economies among currency zones according to the co-movement of their currencies. An economy forms part of the dollar zone not only if its currency is pegged to the dollar, but also to the extent that its floating currency varies less against the dollar than against euro, yen or sterling. Other works using this methodology include Kawai and Akiyama (1998, 2000), McCauley and Chan (2014), BIS (2015), Ito and Kawai (2016), and Ito and McCauley (2019). While Ilzetzki et al (2017) find that the dollar zone covers 70%+ of world GDP in recent years Tovar and Nor (2018), who use much the same technique as we do, find the share to be about 60%.

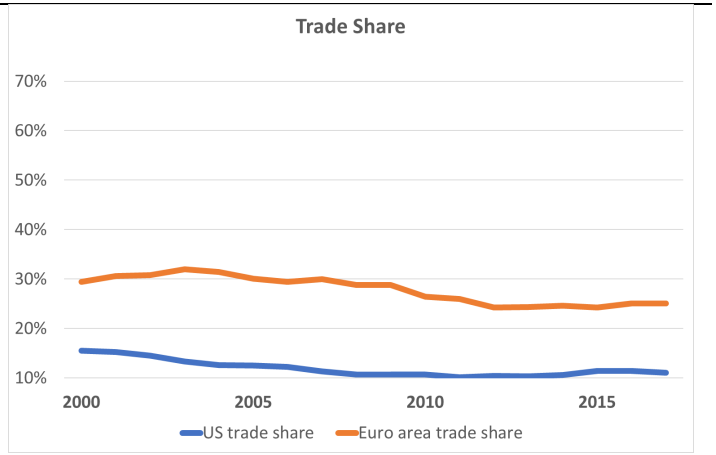
Size of currency zones, GDP, trade, and shares in foreign exchange reserves

In per cent Graph 1









The co-movement of the domestic currency with major currencies shows a strong bivariate cross-sectional correlation with the currency denomination of reserves in a small sample (McCauley and Chan (2014)). A first attempt to assess the impact of the currency denomination of international trade and currency zones in a multivariate setting had difficulty in distinguishing the two factors owing to the small sample (Ito et al (2015)).

This study stands in this recent stream of work that emphasises the use of the dollar outside the United States. In this paper, we investigate to what extent currency co-movements with key currencies, namely the US dollar (USD) and the euro (EUR), explain the cross-country and over-time variation in the shares of these currencies in foreign exchange reserves. We also examine the roles that other aspects of international currency, namely, the currency denomination in international trade and the denomination of stocks of international bank and bond debt, play in the choice of currencies in foreign exchange reserves. We also test for the impact of trade with the United States or euro area, and demonstrate that this bilateral trade variable adds little in the presence of the dollar or euro variables.

Consistent with this stream of work, we find in a sizeable sample that economies with currencies that co-move with the dollar against other key currencies hold more dollar reserves. Thus, the stability of the dollar share of foreign exchange reserves in aggregate reflects not the shrinking share of the US economy or US trade but rather the surprisingly stable half or more of global GDP in the "dollar zone". In countries whose currencies are more stable against the dollar than against the euro, a reserve composition that favours the dollar produces more stable returns in terms of the domestic currency. Other research on the currency composition of reserves has not used co-movement with key currencies zones as an explanation save the use of dummies for the polar case of currency pegs by Dooley, Lizondo and Mathieson (1989) and Eichengreen and Mathieson (2000).

To get to this key finding, we first introduce a new dataset on the currency composition of foreign exchange reserves. The aggregated data of the currency composition of international reserves is available only for the entire world, the group of advanced economies, and that of emerging economies from the International Monetary Fund's (IMF) currency composition of official foreign exchange reserves (COFER). However, such data are not publicly available for individual countries. We overcome the data constraint by collecting the data from central banks' annual reports, financial statements, and other publicly available information sources and construct the dataset of the currency composition of international reserves for 53 economies in the 1999-2017 period. This dataset allows us to observe the development of reserve management over time for individual economies. Our data collection provides us with a sample size between extant studies ((McCauley and Chan (2014), Ito et al (2015) and Gopinath and Stein (2018)) and the IMF studies (Heller and Knight (1978), Dooley, Lizondo and Mathieson (1989) and Eichengreen and Mathieson (2000)).

Using this dataset, we examine in both cross-sectional and panel settings how the shares of the US dollar and the euro are related to other aspects of international currency, namely, the currency denomination of international trade, currency zone weights and stocks of debt.

As noted, we find that the greater the extent to which an economy belongs to the dollar zone, the higher dollar share of official reserves the economy tends to hold. This generalization also holds in the relationship between the euro shares in foreign reserves and the extent of belonging to the euro zone. We also find in smaller samples that, the higher share of exports is denominated in the US dollar, the higher the dollar share in foreign reserves. This finding confirms that of Gopinath and Stein (2018b) in a multivariate setting.

The effect of the co-movement of currencies appears to be at par with that of the currency denomination of trade as the determinants of reserve composition. When we standardize the coefficients of the determinants of the dollar share in foreign reserves, we find that the impact of a one standard deviation increase in the dollar zone weight on the dollar share is about the same as that of the denomination of trade.

The positive relationship to the dollar reserve share also holds for the dollar share of cross-border debt stocks. However, we are cautious in interpreting this result because both the reserve share and the debt share could be seen as responding to currency zone and denomination of trade.

We also test the robustness of the explanatory variables by adding other variables to the estimation model. Greater openness of the domestic country's financial markets lead to a smaller share of USD in its foreign exchange reserves, but leave intact the main findings from the baseline estimation.

The remainder of this paper is structured as follows. The second section introduces our dataset on the currency composition of foreign exchange reserves and provide some summary statistics. The third section explains how we estimate the currency zone weights, and describes the variables for currency shares in trade and those in debt stocks. In this section, bivariate relationships between each of these variables and the currency share in foreign reserves are briefly examined. In the fourth section, we provide and discuss the results from a panel data analysis on the determinants of the USD and EUR shares in foreign reserves. We also conduct robustness checks. The fifth section concludes.

2. Data on currency shares in foreign exchange reserves

The question of what constitutes an international currency is a fundamental question in international finance. Among the different roles of international currency as summarized by Cohen (1971) and Kenen (1983), foreign reserves play an important role as an official store of value, reflecting monetary and trade policy. While different aspects of international currency have been investigated in the literature,[1] studies on what factors affect the currency composition of international reserves of individual countries have been quite limited because the data is only limitedly available.

The International Monetary Fund (IMF) publishes comprehensive data on the shares of major currencies in international reserves (aka, COFER data) only for the entire world, the group of industrialized countries, and that of developing countries, not for individual countries. Heller and Knight (1978), Dooley et al. (1989), and Eichengreen and Mathieson (2000) have used individual countries' data from the COFER database. Others have more recently exploited limited public data (ie from central banks' websites) on the currency shares (McCauley and Chan (2014), Ito et al (2015) and Gopinath and Stein (2018), which possibly suffer from self-selection bias.

To overcome the data constraint, we have gone through annual reports, financial statements, and other relevant materials of the central banks across the world and collected data on the currency composition of foreign exchange reserves of individual countries.

Not surprisingly, central banks do not report in uniform manner. Some central banks report the currency composition of (gross) foreign assets (ie, assets denominated in foreign currencies) in their annual reports or financial statements. Others report the currency distribution of foreign currency exposure, that is based on net foreign assets, or foreign exchange balance. Reporting the currency composition in terms of foreign currency exposure can be more appropriate than reporting the currency composition of (gross) foreign assets. For example, the Riksbank's assets mainly consist of US dollars and euro. To achieve its desired currency composition, the Riksbank converts some of its dollar holdings into Norwegian kroner using forwards, selling dollars at future value dates for Norwegian kroners. Hence, the Riksbank reports the composition of currency exposure by incorporating such financial derivatives (including currency forwards) and foreign liabilities instead of reporting the currency composition of gross financial assets. Reporting currency exposure based on net foreign assets, or foreign exchange balance, is more reflective of the

[1] Cohen (2005) and Ito and Rodriguez (2015) investigated the shares of major currencies in international debt. Ito and Chinn (2015), Ito and Kawai (2016), Kamps (2006) and Gopinath and Stein. (2018) examined the currency shares in trade invoicing.

country's reserve management. Therefore, in this case, the Riksbank's reports of the currency composition of foreign exchange reserves (ie, the currency composition of gross foreign assets) to the IMF's COFER necessarily differs from the bank's report on the composition of currency exposure (based on *net* foreign assets).[2]

Among the central banks whose annual reports or financial statements we examine, not all of them report the composition of currency exposure in the way the Riksbank does. Few countries employ currency overlays to achieve their desired exposures. In other words, as the style of reserve management is not uniform across central banks, neither is the style of reporting the currency composition of foreign reserves. We collect the currency composition of currency risk exposure whenever the information is available. For those central banks which do not report such currency composition, we look at the disaggregation of (gross) foreign assets by currency in the financial statements.

When we calculate the currency shares of foreign exchange reserves, we exclude gold and the IMF's Special Drawing Rights (SDR).

As for the data for Latin America, we have collaborated with the Fondo Latinoamericano de Reservas (FLAR). FLAR collected data on the shares of major currencies in international reserves as well as those in international trade for nine Latin American countries. This allowed us to expand the dataset we originally constructed for Ito et al (2015) to include 53 economies, out of which 9 countries are advanced economies; 44 emerging and developing economies; 9 in the Asia-pacific region; 12 in the Africa and Middle East region; 6 in Western Europe; 14 in Eastern Europe and Central Asia; and 12 in the West Hemisphere.[3] Our dataset intentionally excludes the issuers of the key international currencies, ie, the US, the euro member countries, and Japan.

Emerging market economies in East Asia tend not to publish information on the currency composition of foreign exchange reserves. For some economies in the region, large international reserves holdings raise the risks of transparency setting in train adverse market dynamics.

The economies for which we have the data of currency shares in foreign exchange reserves account for 32% of the world GDP (Table 1). However, once we remove the GDP of the major currency issuers (ie, the US, the euro area, and Japan) from world GDP, the coverage rate goes up to 47%. Among the non-major currency issuers, China, whose data we do not have, is by far the largest international reserves holder while it also accounts for the largest share in the world GDP that excludes the US, the euro area, and Japan. Once we remove not just the key currency issuers and China from the world total, the coverage of our reserve currency share data rises to 64% of the rump of world GDP.

In terms of the world's total international reserves, the economies in our sample cover 33% of the world's total and 38% of the total when we exclude the key currency issuers. When we also remove China from the world total, our reserve currency share accounts for 55%.

Thus, outside the COFER database, our dataset of the currency shares in foreign exchange reserves is probably the largest in the literature.

[2] In this particular case, the dollar share of foreign exchange reserves reported in the COFER dataset tends to be inflated.

[3] "Advanced economies" are traditional OECD countries whose IMF code is less than 186. For more details on the country compositions of our sample, refer to Appendix 1.

Country coverage of the data of currency shares in foreign exchange reserves			Table 1
Country coverage *In terms of:*	As a share of the world	Excluding the key currency issuers*	Excluding key currency issuers and China
World GDP	.322	.468	.636
World International reserves	.327	.380	.551

Note: *The "key currency issuers" refer to the US, the euro member economies, and Japan.

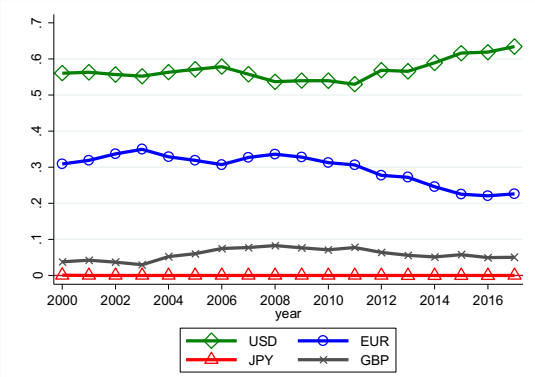
Source: Authors' calculation

On the aggregate basis, our data on the shares of USD, EUR, JPY, and GBP appear comparable to that of the IMF-COFER (Graphs 2(a) and 2(b)). Both datasets show the USD share has been stable, though our dataset shows it is on a moderately rising trend after 2010 or so. Also, for the EUR share, both show a moderate rise followed after the European debt strains of 2011 by a decline. The lower level of the USD share in our dataset can be explained at least in part by that our dataset does not include those of key currency issuers Japan and the euro area, whose reserves are larger than those of the United States and which are thought to hold high shares (90%?) of USD-denominated assets in their foreign exchange reserves. Because of this reason, and perhaps also because of tendency toward disclosure in Europe outside of the euro area, the EUR share based on our dataset appears to be higher than that based on the IMF-COFER.

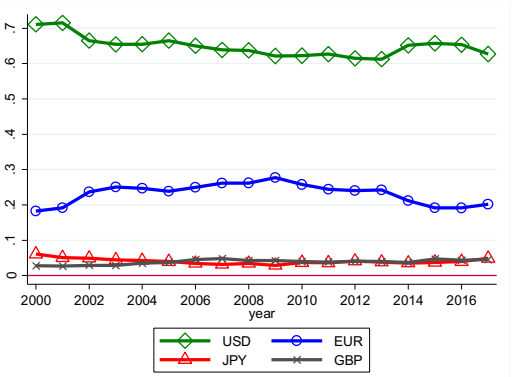
This paper's dataset on currency shares in foreign exchange reserves vs. the IMF's COFER database

Graph 2

(a) Shares of USD, EUR, JPY, and GBP based on this paper's dataset

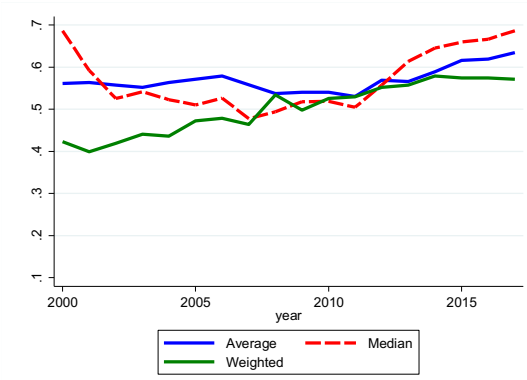


(b) Shares of USD, EUR, JPY, and GBP based on the IMF-COFER

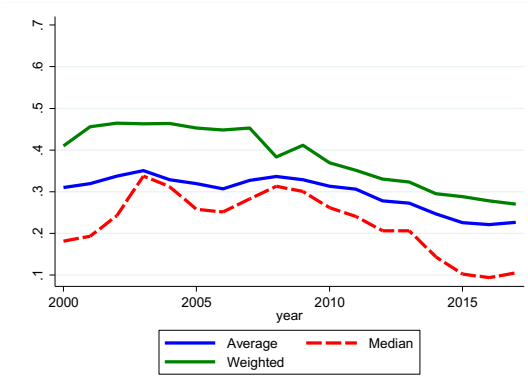


Graph 2, continued

(c) Share of USD

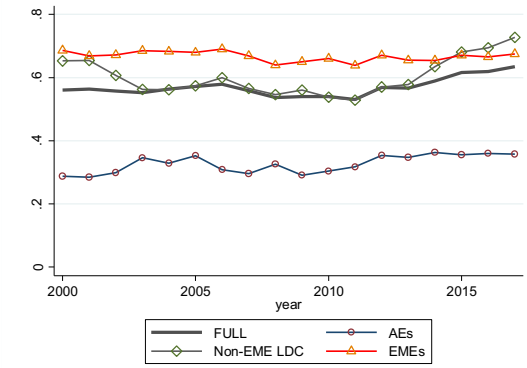


(d) Share of EUR

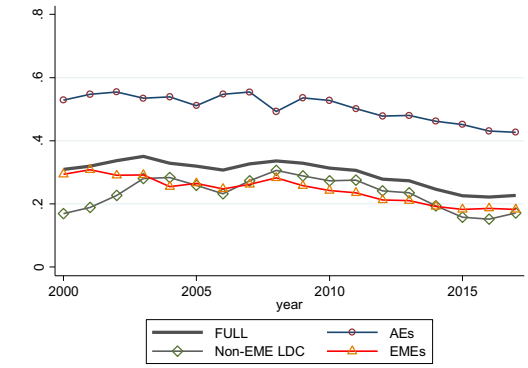


Graph 2, continued

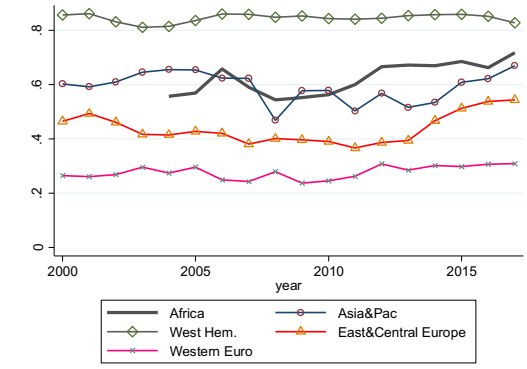
(e) Share of USD by income levels



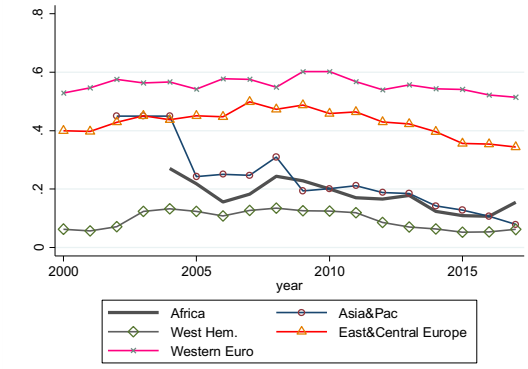
(f) Share of EUR by income levels



(g) Share of USD by region



(h) Share of EUR by region



Our dataset illustrates that on average, the USD share is flat, or on a slightly declining trend, before 2010, after which both the average and the median are on a moderately rising trend (Graph 2, panel (c)). The weighted average of the USD share has been on a rising trend throughout the sample period, reflecting large emerging economies increasing their holdings of USD-denominated assets. The euro share appears to be on a gradually declining trend in either the simple or weighted average or the median. The slope of the decline is steeper after 2011.

Across different country groups based on the income levels, emerging market economies (EME)[4] have persistently had the highest levels of USD share in their reserves, though non-emerging market developing countries on average have higher USD shares in the last few years than EMEs (panel (e)). AEs have the lowest USD share on average, which is not surprising considering many of the AEs are (non-euro) European countries in Northern or Western Europe.

Among different regional groups, countries in the West Hemisphere (ie, Canada and Latin American countries) have had persistently high USD shares, followed by economies in the African continent and Asia. Not surprisingly, the EUR share in reserves is high for Western and East/Central European countries. The moderate declining trend of the EUR is observable across the geographical groups.

3. Currency zone weights and currency denomination of trade and debt stocks

Different roles of money reinforce one other. Monetary authorities whose currency is anchored to a key currency, whether owing to policy or market forces, may tend to hold reserve assets denominated in that key currency, which have a relatively stable value in domestic currency. And, if the economy conducts international trade with its large portion denominated in a key currency, its foreign reserves may tend to be composed of assets denominated in that currency, matching the cash flows. And if a large part of an economy's bank and bond debt is denominated in a key currency, matching cash flows may lead to reserve assets held in the key currency. In this section, we examine the bivariate relationship between the dollar share of reserves and the home currency's co-movement with the dollar, the dollar's share of the denomination of trade and the dollar share in external debt.

3.1 Currency weights

Previous studies using confidential IMF data acknowledged the importance of exchange rate arrangements, but only in extreme form. Heller and Knight (1978) show that if a country pegs its currency to a major reserve currency, it tends to hold a large portion of its foreign exchange reserves in that major currency. Dooley et al (1989) and Eichengreen and Mathieson (2000) followed suit by using dummies for pegs. This restricts to extreme cases a test of the connection between currency anchoring and reserve composition. The insight that the way a managed or free-floating currency trades against the key currencies guides the choice of the currency denomination of reserves is new to our work.

Against this backdrop, we first estimate how much each currency co-moves with the US dollar, the euro, and the Japanese yen. Our choice of these key currencies is a prior that reflects their pre-eminent turnover in the central bank Triennial Survey of foreign exchange (BIS (2016)).

The co-movement of currencies arises from exchange rate policy, monetary policy and underlying trade relations.[5] Policy fixes the Hong Kong dollar and the Bulgarian lev to the dollar and the euro, respectively. Policy also governs the Singapore dollar, managing it against its trade-weighted basket. The authorities may intervene in the market less systematically to stabilise the dollar exchange rate, as in Dooley et al (2004). Elsewhere, the setting of policy interest rates with reference to that of a major central bank can link the two exchange rates (Hofmann and Bogdanova (2012); Hofmann and Takáts (2015)). For

[4] The emerging market countries (EMG) are defined as the countries classified as either emerging or frontier during the period of 1980-1997 by the International Financial Corporation plus Hong Kong and Singapore.

[5] See further discussion and references in McCauley and Shu (2018).

instance, the Norges Bank explicitly discusses the spread of its policy rate over that of the ECB, and the kroner shares most of the euro's moves against the dollar. Trading relations matter as well: the Mexican peso and the Polish zloty tend to co-move with the dollar and euro, respectively, consistent with each one's predominant trading partner.

The key currency weights for each currency for each time period are estimated using a method based on Haldane and Hall (1991) and Frankel and Wei (1996).[6] The estimated weights indicate the extent that an economy belongs to each zone.

Specifically, we estimate the following:

$$\Delta e_t^{i/\$} = \alpha_i \ + \beta_{i€t}\Delta e_t^{€/\$} + \beta_{i¥t}\Delta e_t^{¥/\$} + \varepsilon_{it} \qquad (1)$$

Here, $e_t^{i/\$}$ is the bilateral exchange rate of home currency *i*, against the dollar (USD) while $e_t^{h/\$}$ on the right-hand side of the equation is the exchange rate of the euro and yen against the dollar. The movements of each currency against the dollar on the left-hand side are reduced to a weighted average of the movements of the euro and yen against the dollar on the right-hand side, leaving a residual of idiosyncratic movement. Thus, $\hat{\beta}_{iht}$, the estimated coefficient on the rate of change in the exchange rate of key currency h vis-à-vis the US dollar in period t, represents the weight of currency h in the behavioural basket. The dollar's weight is calculated as $\hat{\beta}_{i\$t} = 1 - \left(\hat{\beta}_{i€t} + \hat{\beta}_{i¥t}\right)$. For a currency pegged to the US dollar (eg the Hong Kong dollar), then $\sum_{h=1}^{H} \hat{\beta}_{ih} = 0$ so that $\hat{\beta}_{i\$t} = 1$. Similarly, for a currency pegged to the euro (eg the Bulgarian lev), $\hat{\beta}_{i€t}$=1. When the Russian authorities monitored and intervened to limit fluctuations in a dollar-euro basket with 45% euro (ECB (2013, p 67)), the regression estimated betas of about one-half for the dollar and the euro.

We estimate weights for the currencies of each of our sample economies over rolling windows of 36 months. Hence, the coefficients $\hat{\beta}_{iht}$ vary over time at the monthly frequency. We exclude monthly observations of any currency that depreciates by 10% or more against the dollar to prevent outliers during currency crises from producing spurious weights.[7,8]

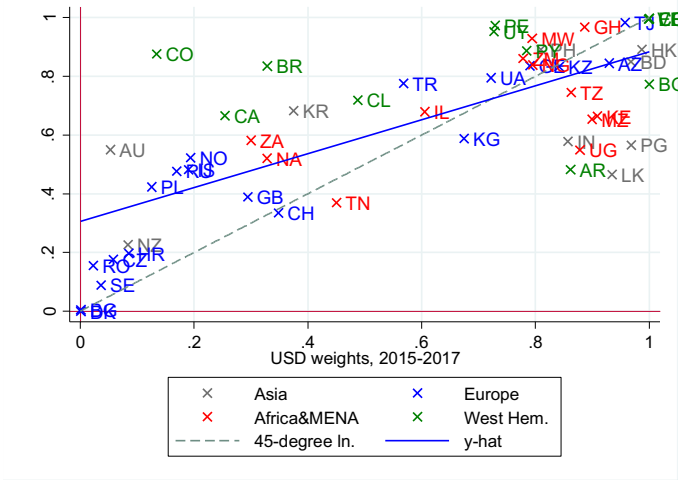
Our data supports that a currency's dollar zone weight is positively correlated with the dollar share in the corresponding country's official reserves (Graph 3). Broadly, central banks in Latin America, Africa and the Middle East heavily weight the dollar, which remains the most important influence on their currencies. Several Latin American economies, notably Colombia and Brazil, hold more USD-denominated foreign reserves than the lowish dollar weights might suggest. Western and central European economies have smaller USD shares in reserves and lower USD weights, whereas central Asian economies tend to have high USD shares in reserves and high USD weights.

Dollar zone weight and dollar share of forex reserves, 2015-17 — Graph 3

[6] Haldane and Hall (1991) applied their technique to sterling over a period that included both Bank of England management and relatively free floating, while Frankel and Wei (1996) sought to discover weights in an undisclosed official basket. See also Bénassy-Quéré et al (2006), Ito and Kawai (2016), Kawai and Akiyama (1998, 2000) and Kawai and Pontines (2016).

[7] Relatedly, Ilzetzki et al (2017) exclude countries where annual inflation reaches 40%.

[8] We convert the monthly weights into annual weights by following certain rules. In particular, any significantly negative $\hat{\beta}_{iht}$ is taken to be a missing value, while a statistically insignificant negative $\hat{\beta}_{iht}$ is replaced with the value of zero. Likewise, any $\hat{\beta}_{iht}$ that is significantly greater than one is taken to be a missing value, while a $\hat{\beta}_{iht}$ that is insignificantly greater than one is replaced with the value of one. Once estimated betas outside the unit interval are thereby censored to zero or one or taken to be missing values, the average of the months becomes the annual observation. See Ito and McCauley (2019) for more details.



y = .31+.58x, R^2 = .53, n = 52

Source: Authors' calculations.

The slope of the least squares line (in blue in Graph 3) is not 1 (dashed grey line), as would be the case if reserve managers on average chose the dollar weight to minimise the variance of their portfolios in domestic currency. Instead, the estimate of the slope closer to one half points to some departure from the minimum variance portfolio, perhaps in some cases to raise expected returns.

3.2 Invoicing of trade in key currencies

Dollar trade invoicing encourages exporters (especially commodity exporters) to borrow dollars to hedge and importers to borrow dollars for working capital. Servicing dollar debts tilts trading towards the dollar, encouraging reserve managers to hold dollars.

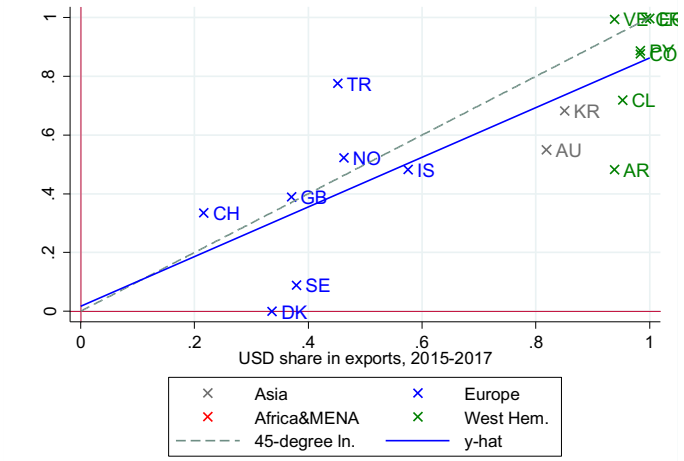
As for the currency shares in trade invoicing, we use the dataset of Ito and Chinn (2015) and Ito and Kawai (2016). We update the dataset to include currency shares in Latin America[9] and in recent years. The initial version contained the datasets developed by Goldberg and Tille (2008) and Kamps (2006), while also including data collected from Eurostat, the websites of central banks and other government agencies, other studies that examined the issue of currency invoicing for trade, as well as through personal communication.[10]

Despite a limited number of observations, we find a positive relationship between the two (Graph 4, left hand panel). The slope is steeper than that of the relationship between the dollar zone weight and dollar share of forex reserves, but the regression line fits the data about the same as the dollar weight. Most of Latin American economies, Turkey, Norway, and Switzerland hold more reserves in the dollar than one might guess from the share of dollars in their export invoicing. Sweden and Denmark do not hold dollar reserves even though a fair fraction of their exports in the US dollar.

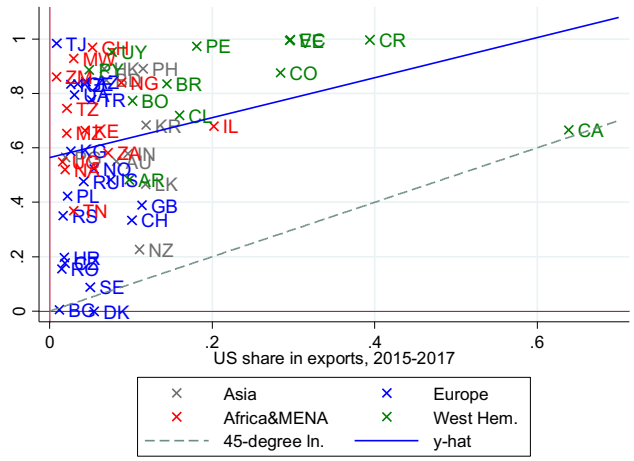
Dollar share in exports and dollar share in forex reserves, 2015-17 Graph 4 (a)	US share in exports and dollar share in forex reserves, 2015-17 Graph 4 (b)

[9] We thank FLAR for its generous cooperation.

[10] The dataset contains the shares of major currencies in export and import invoicing for about 70 countries. Most of the data start in the 1990s, though the data for legacy currencies is also available for the 1970s and 1980s. The dataset is highly unbalanced. The data tend to lack for Africa and the Middle-East and central Asia.



y = .02+.85x, R² = .59, n = 16



y = .56+.74x, R² = .07, n = 53

Since the data on the USD share in export invoicing is limited, we also use the data on the share of the US as a trading partner in total trade as a robustness check.[11] In fact, Dooley et al. (1989), Eichengreen and Mathieson (2000) examined the impact of trade links with the US and other key currency issuer countries on the USD and respective major currency shares in foreign reserves instead of using the currency share in export or trade invoicing. That is probably due to data limitations of currency shares in trade invoicing. From the point of view that different roles of money affect one other, it is more appropriate to use currency shares in trade invoicing than the share of the US and other key currency issuer countries in total trade. Furthermore, the currency composition of a country's trade does not necessarily reflect the pattern trade invoicing.[12]

In fact, Graph 4 (b) illustrates the link between the US trade share and the USD share in foreign reserves is much looser. Only 7% of the variation of the USD shares in foreign reserves can be explained by the US trade shares in the 2015-2017 period, a contrast to the link between the USD share in export invoicing and that in foreign reserves.[13]

However, although the US share in international trade does not proxy well for the dollar share of trade invoicing, we still test the impact of trade links with the US instead of the USD share in export invoicing because it will allow us to benefit from testing with a larger sample and thereby larger degrees of freedom.

3.3 Debt stocks in key currencies

A country with debt denominated in a key major currency may also hold its foreign exchange reserves in that currency. Again, this behaviour could be interpreted as hedging cash flows.

We measure the extent of use of a major currency in financial links as the average of the share of that currency in international debt securities and that in cross-border debt and bank loans. The currency

[11] That is the sum of exports to and imports from the US divided by the world trade (ie, total exports plus total imports).

[12] Ito and Chinn (2015) show that countries invoice their exports in dollars much more than proportionally to the share of their exports to the US. Not to mention, commodity trade tends to be invoiced in USD regardless of the volumes of trade with the US.

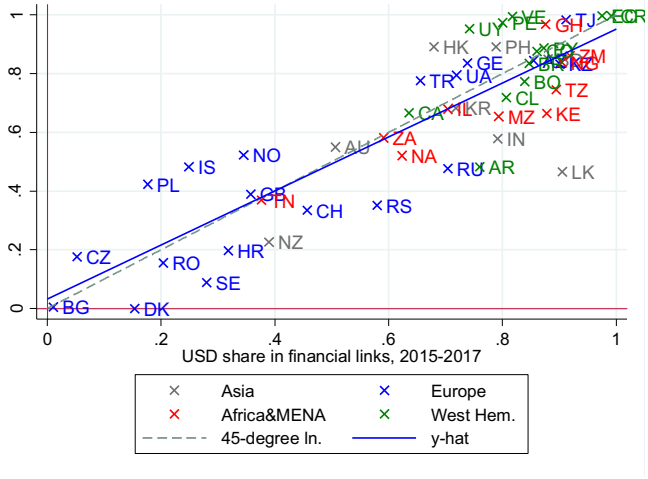
[13] Ito and Chinn (2015) also show that the EUR share in export invoicing is much more correlated with the share of the euro area as an export destination in total exports. Hence, for the euro, the euro area's share in trade can be a better proxy for the EUR share in trade invoicing.

composition in international debt securities is from the BIS debt securities database, and that in cross-border debt and bank loans from the BIS database of international banking.[14]

Updating and confirming McCauley and Chan (2014), the USD share of foreign reserves and that of financial links have almost one-to-one ratio while the goodness of fit is quite high. Having a high USD exposure a country has in its cross-border financial flows, the higher USD share it would have in its foreign exchange reserves.

However, the very strength of this relationship raises questions. Are the firms, banks and governments that contract the debt to international banks and bondholders not performing an optimisation on the liability side closely resembling that of reserve managers? If currency co-movements and the denomination of trade determine both the currency denomination of reserves and international debt, it is appropriate to explain the asset choice with the liability choice? Below we report the impact of the debt denomination on the currency composition of reserves, but we put more weight on the regressions that exclude this variable.

Dollar share in aggregate financial links and dollar share in forex reserves, 2015-17 Graph 5



y = .03+.92, R^2 = .74, n = 49

4. Estimation

We have seen that in the bivariate setting, the share of the US dollar in reserves holding is highly correlated with the extent of belonging to the dollar zone, and denominating exports and cross-border financial links in the dollar. Naturally, there are limits to this kind of exercise with unconditional correlations. The estimated coefficients may not hold in a multivariate setting. Furthermore, luckily, the dataset on the currency composition of foreign reserves is rich enough for us to conduct a panel data analysis. Hence, we implement a more formal empirical analysis in this section.

[14] The international banking data is based on the reports of 47 countries' assets and liabilities with respect to more than 190 countries. To get the data on international banking exposure, we use the total assets of the reporting countries to the sample countries. This way allows us to see the sample countries' exposure through their *liabilities.*

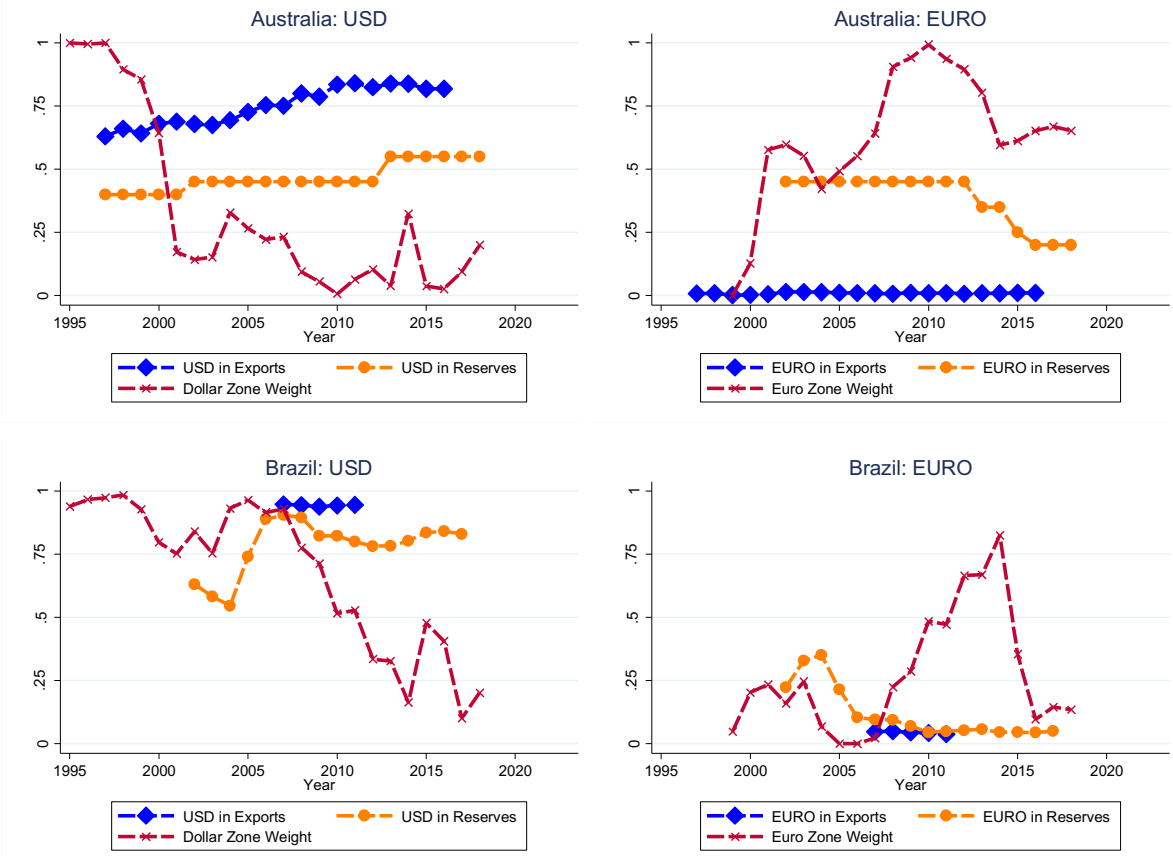
4.1 Observations of currency shares in different aspects of international currency

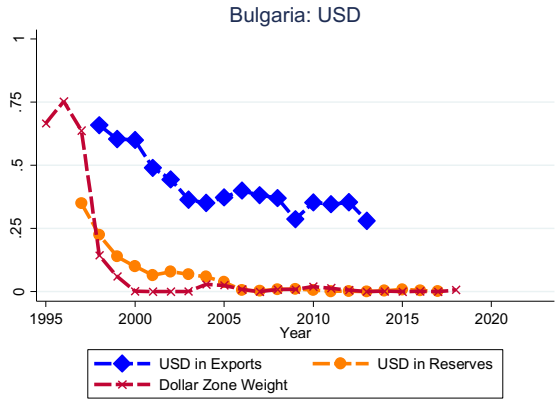
While the choice of reserve currencies can be relatively stable for developed economies, emerging market economies, may experience changes in the underlying drivers and thus change the currency composition of their official reserves. Furthermore, reserve managers may manage their reserves more cautiously when these are demanded for precautionary reasons, but less cautiously if reserves accumulate as a side effect of policies to nurture the traded goods sectors (Aizenman and Lee (2007)).

Graph 6 illustrates the development of the share of the US dollar or the euro in reserves holding, the dollar or euro zone weight, and export invoicing for selected countries in the period of 1995 – 2017.

Shares of US dollar in export invoicing, currency movements and reserve holding

Graph 6




Bulgaria: USD
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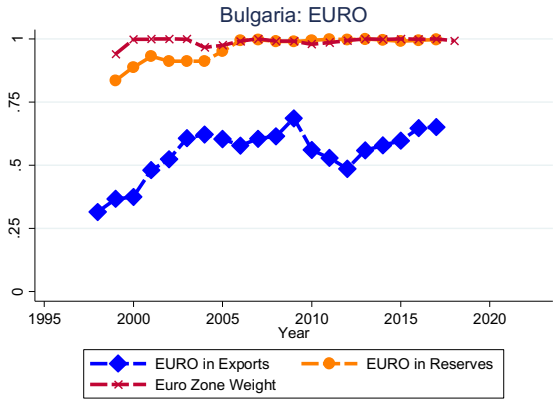
Year
USD in Exports
USD in Reserves
Dollar Zone Weight


Bulgaria: EURO
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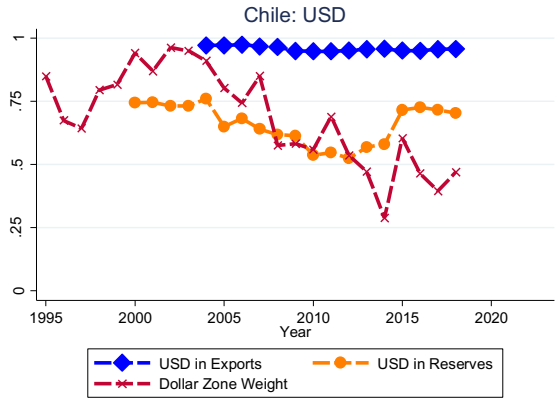
EURO in Exports
EURO in Reserves
Euro Zone Weight


Chile: USD
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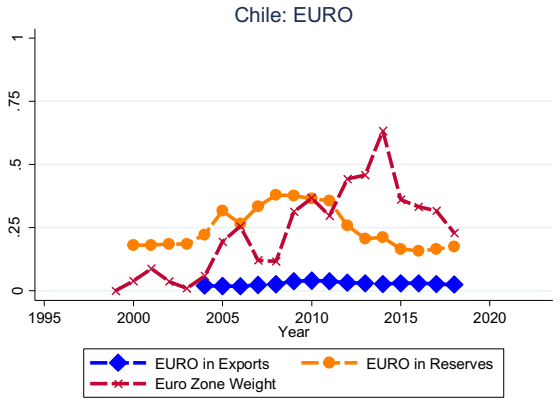
USD in Exports
USD in Reserves
Dollar Zone Weight


Chile: EURO
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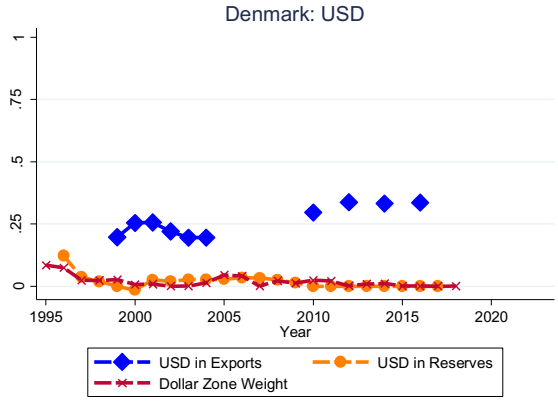
Euro Zone Weight


Denmark: USD
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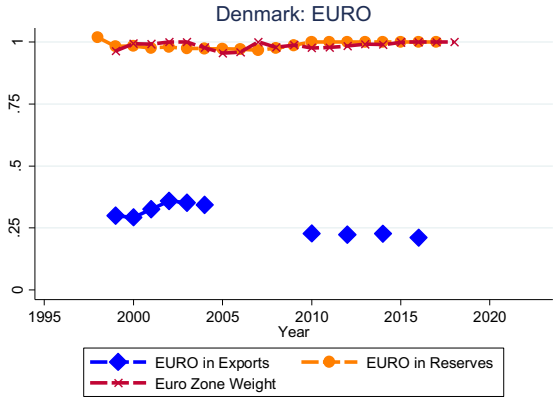
Dollar Zone Weight


Denmark: EURO
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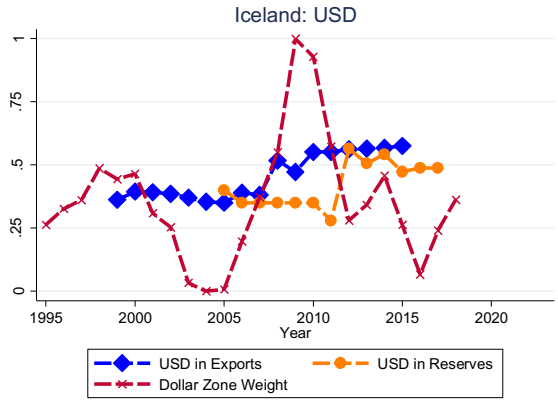
Euro Zone Weight


Iceland: USD
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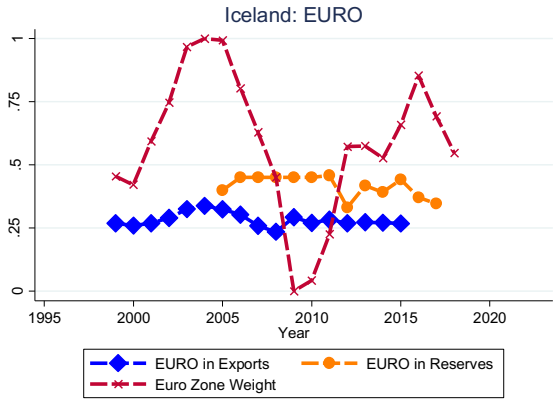
Dollar Zone Weight


Iceland: EURO
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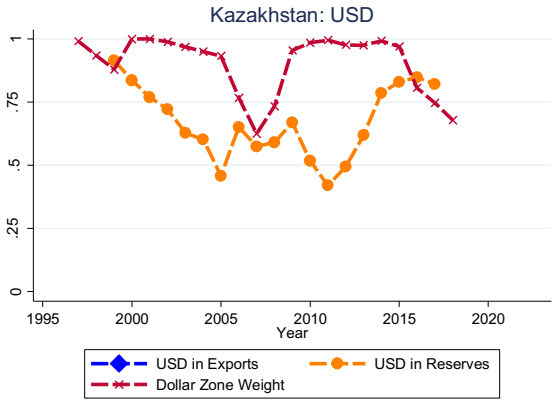
EURO in Reserves
Euro Zone Weight


Kazakhstan: USD
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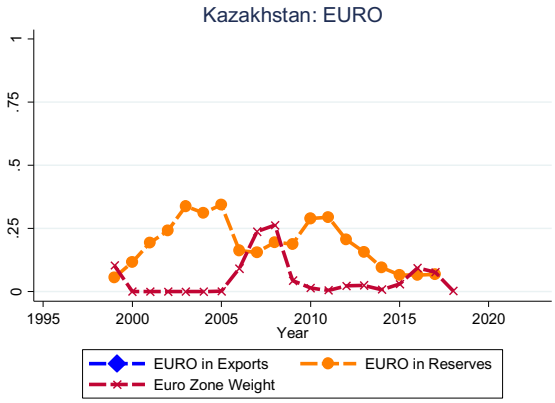
USD in Exports
USD in Reserves
Dollar Zone Weight


Kazakhstan: EURO
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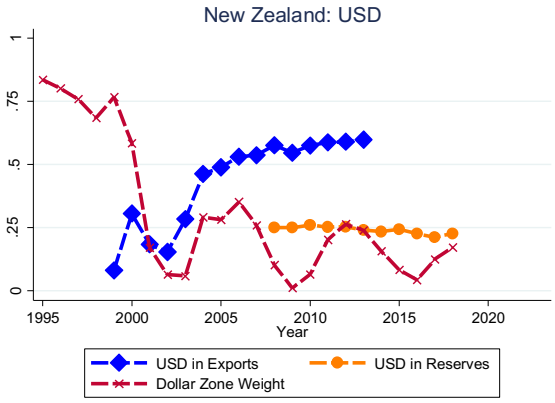
EURO in Reserves
Euro Zone Weight


New Zealand: USD
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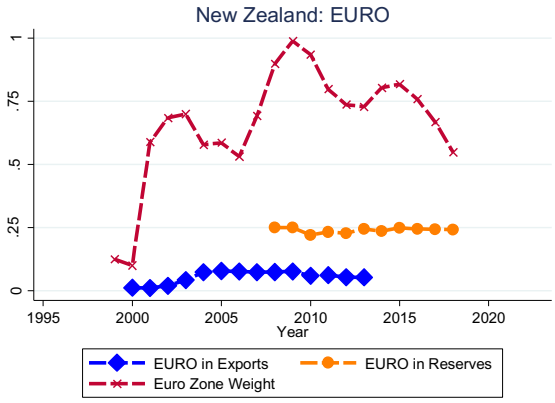
USD in Reserves
Dollar Zone Weight


New Zealand: EURO
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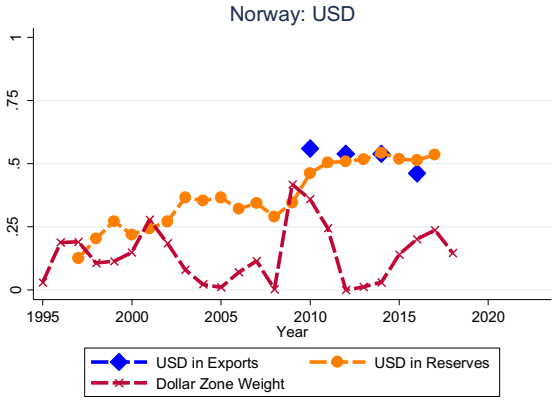
Euro Zone Weight


Norway: USD
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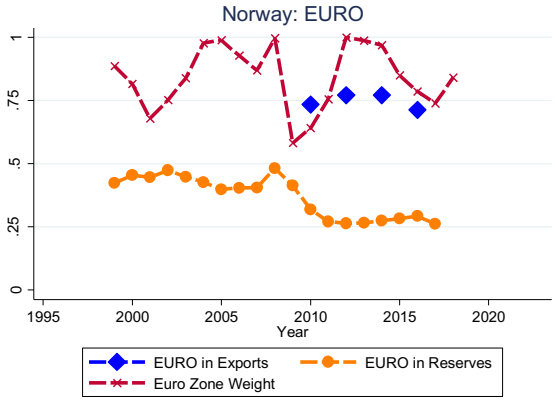
USD in Reserves
Dollar Zone Weight


Norway: EURO
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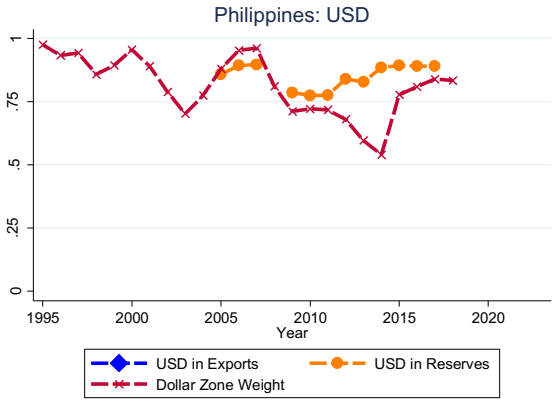
Euro Zone Weight


Philippines: USD
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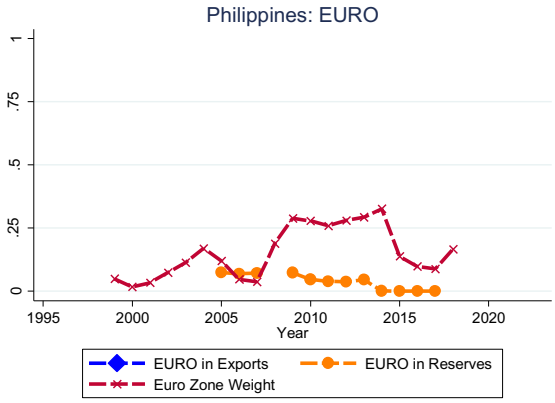
Dollar Zone Weight


Philippines: EURO
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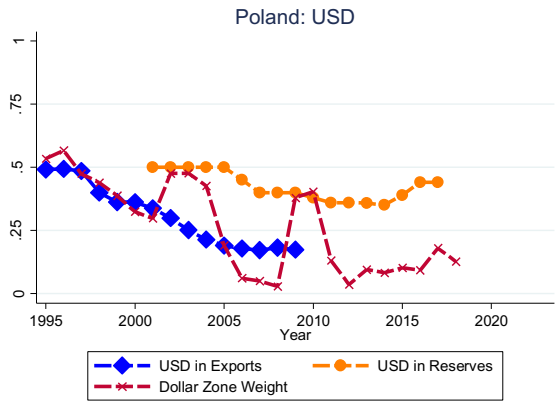
Euro Zone Weight


Poland: USD
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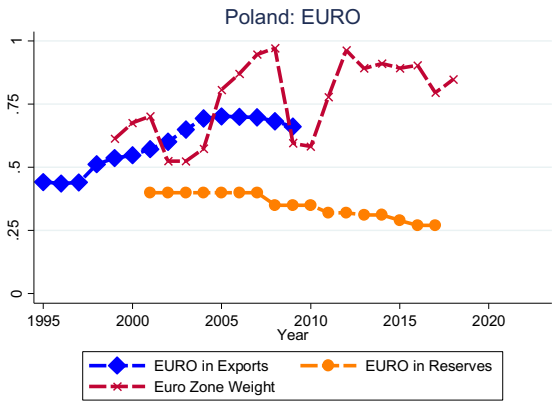
Dollar Zone Weight


Poland: EURO
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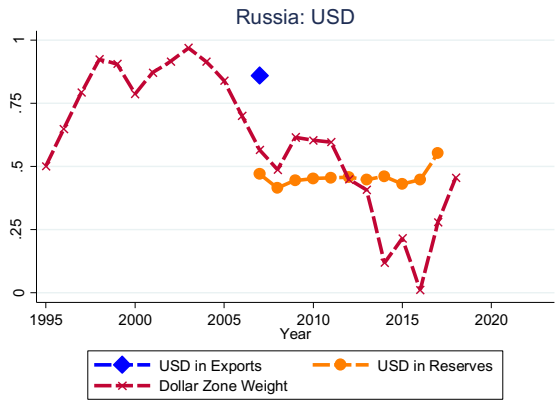
Russia: USD
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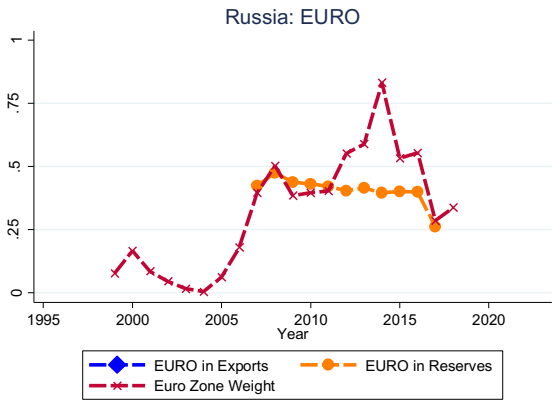
Russia: EURO
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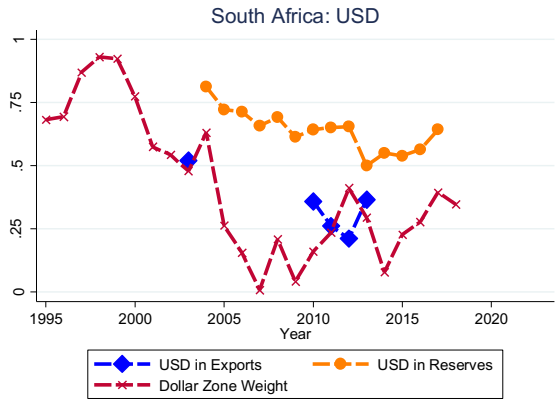
Euro Zone Weight


South Africa: USD
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USD in Exports
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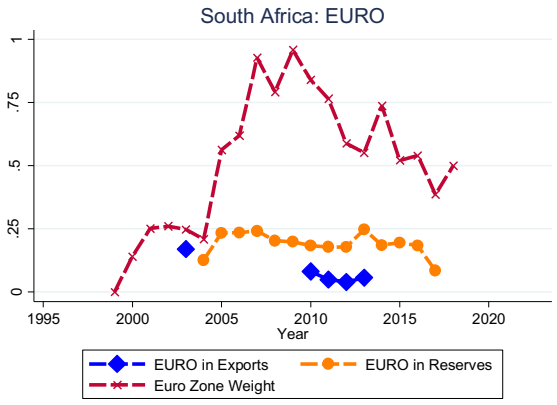
Dollar Zone Weight


South Africa: EURO
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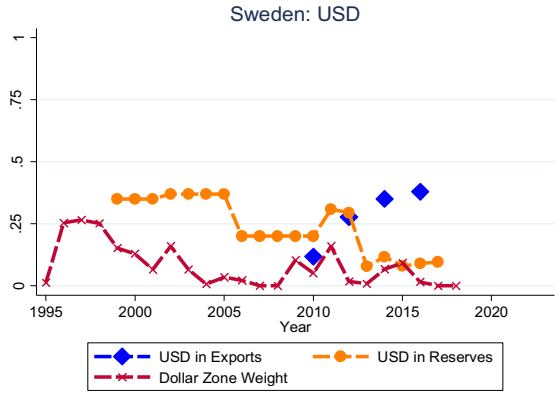
Euro Zone Weight


Sweden: USD
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USD in Exports
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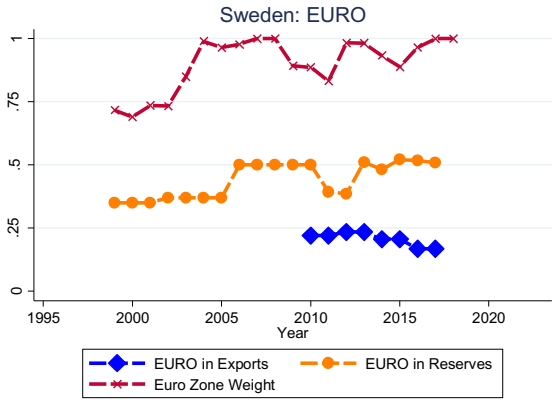
Dollar Zone Weight


Sweden: EURO
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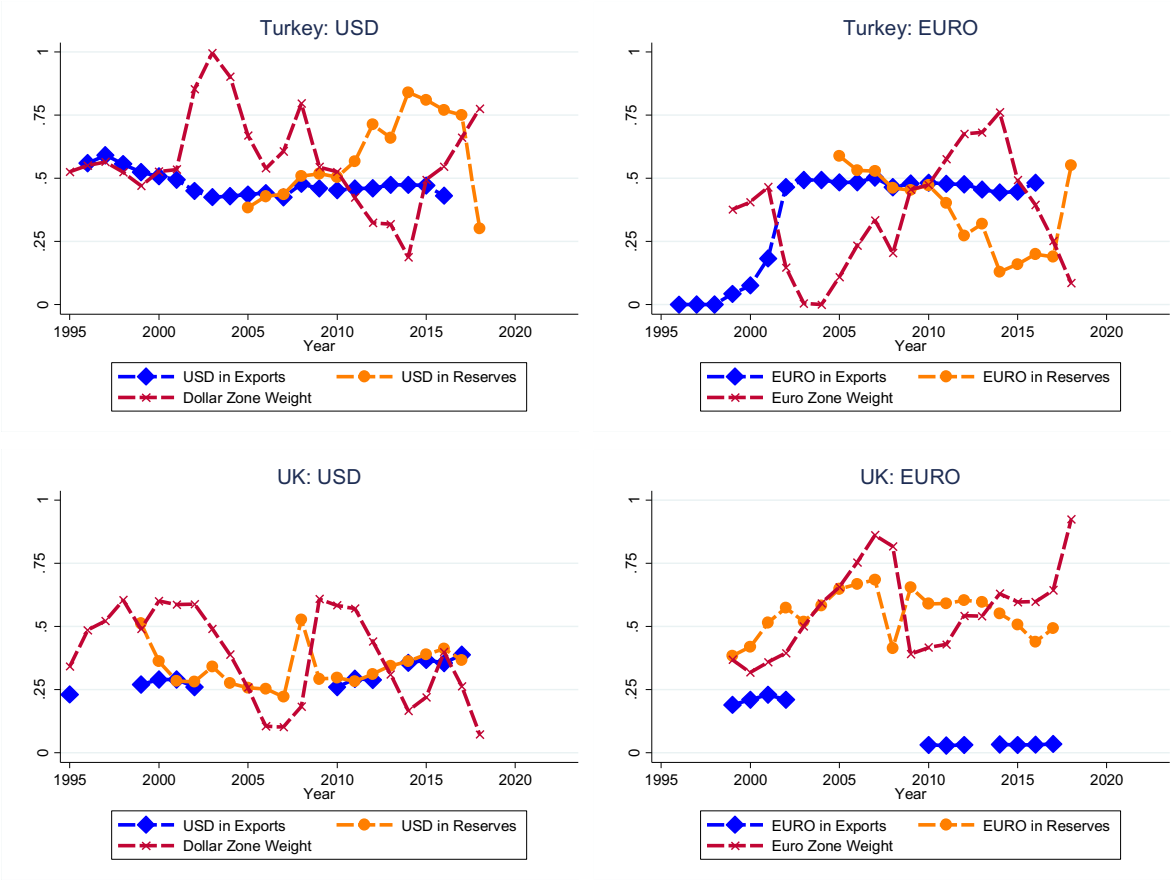
Euro Zone Weight



From Graph 6 (and other graphs that are not displayed), while no generalization can be made to summarize the experience of our sample countries in terms of the dollar or euro shares in reserves and export invoicing, and the dollar or euro weights, we can characterize some commonalities across countries and currencies.

First, among the three variables, generally, the currency shares in export invoicing appear to be the most persistent, or the least variant, while the currency weights are the most variant, with the currency share in foreign reserves somewhere in-between.

Second, some countries, such as those in Latin America (except for large ones), East Asia and the Pacific, and Central Asia, are persistently dollar-oriented economies, with all types of USD shares scoring high values constantly throughout the sample period.

Third, many Eastern European economies went through structural changes toward becoming more euro-oriented economies, that reflect dramatic changes in their economic systems and structures since the demise of the Soviet-bloc in the early 1990s. These economies have experienced varying degrees of integration with the European Union. These countries' initial orientation toward the dollar or baskets giving substantial weights to the dollar (McCauley (1997)) after the breakdown of the Soviet bloc tended to give way to the euro as regional economic integration deepened.

Fourth, large Latin American economies such as Argentina, Brazil, and Chile, experienced euroization in recent years. Considering these economies are also commodity exporters, it can be noted that the euro has started playing an increasingly important role in commodity trade.

Fifth, several countries steadily shifted toward more use of the euro in terms of either currency weights or foreign reserves, or both in the early 2000s, but also they also rebounded toward dollarization in the

aftermath of the GFC. It suggests that the GFC may have contributed to the comeback of the USD and the fall of the euro as international currencies.[15]

4.2 Panel regression analysis

Thus, the currency composition of foreign exchange reserves has been stable for some countries (e.g., small Latin American countries, East and Central Asian economies) while it went through drastic changes for others (Eastern European EMEs). These experiences could be expected to have led to interrelated variation in the trade denomination, currency movements and the composition of their reserves holdings.

Now, using our panel data, we investigate how different aspects of international currency are correlated with each other. More specifically, we regress the USD share in foreign exchange reserves on the following variables or groups of variables:

- the share of USD denomination in exports or the share of the US in total international trade as a proxy;
- the estimated USD weights that represent the extent of stable exchange rate movements against the USD; and
- a variable that represent the share of USD denomination in cross-border debt stock, for which we will use the average of the USD share in cross-border debt and bank loans and the USD share in international debt securities, though we do not focus on this variable and do not report the results of the estimations with this variable.

We estimate this model, by including the above variables both individually and jointly, on the panel of 53 countries between 2000 and 2017. For the estimation, we use the non-overlapping three-year averages of both the dependent and the independent variables with the hope that that would allow us to focus on medium-term variations in the currency shares and their determinants, rather than characterizing their short-term, cyclical or long-term behaviour.

We report the results for two samples. The "small sample" is composed of the USD share in export invoicing and the estimated weight of the USD (and the variable for cross-border debt stock as a robustness check). While this group of variables capture more nuanced aspects of international currency, it comes with a cost of a smaller sample because the data on the USD share in export invoicing is highly limited. Hence, we have another sample, "large sample," that does not include the USD share in export invoicing, but instead does include the share of the US in total international trade as a proxy for the USD share in export invoicing. This makes the sample size much larger compared to the "small sample."

As observed in the cross-sectional analysis, a higher dollar share in export invoicing leads to a higher dollar share in reserves holding (Table 2, column (1)). In fact, the estimate retains its statistical significance even when the estimation model includes other variables such as the USD weights and the USD share in cross-border debt and loans. A one percentage point increase in the dollar invoicing share would lead to a 0.50 to 0.79 percentage points increase in the dollar reserve share. In addition to the USD invoicing effect, the intensity of trade with the US also matters; the more trade a country conducts, the more dollar-denominated reserve assets it tends to hold.

A significantly positive effect with similar magnitudes to USD share in trade invoicing is found for the dollar zone share, with the magnitude ranging from 0.34 to 0.54.

The results of the analysis focused on the euro share prove consistent with the results of the analysis focused on the dollar. The greater use of the euro in export invoicing leads to higher levels of euro-

[15] Ito and Rodriguez (2015) show this trend for international debt securities.

denominated foreign reserves, which is still the case when we control for the euro zone weight (Table 3, columns (1, 5)). The euro area's share in international trade is also positively correlated with the EUR share in foreign reserves.

These observations are confirmed in Table 4 which show the beta coefficients for the estimation originally shown in Tables 2 and 3. The estimates in this table should be interpreted as showing by how many standard deviations the dependent variable, ie, the dollar or the euro shares in foreign reserves, should move if one of the explanatory variable moves by one standard deviation *ceteris paribus*. The beta coefficients are often used as measures to show the level of relative importance among the explanatory variables. According to the table, the USD share in export invoicing and the USD currency weights are equally important variables; a one standard deviation increase in the USD share in export invoicing and the USD currency weights would lead 0.15 and 0.13 standard deviation increases in the USD share in foreign reserves, respectively. For the EUR share in foreign reserves, the EUR weights seem to be more influential than the EUR share in export invoicing.

Overall, the currency composition of reserves is strongly related to the currency denomination of trade and currency co-movements with the key currency, consistent with the findings in past studies such as Heller and Knight (1978), Dooley et al. (1989), Eichengreen and Mathieson (2000), McCauley and Chan (2014), and Ito et al (2015).

Panel analysis of the dollar share of reserves — Table 2
Dependent variable: share of the USD in reserves,
unbalanced 3-year panels 2000-2017

					"Small"	"Large"
	(1)	(2)	(3)	(4)	(5)	(6)
USD share in export invoicing	0.79				0.50	
	(0.06)***				(0.08)***	
US share in trade		0.93				0.60
		(0.17)***				(0.12)***
USD currency weights			0.54		0.37	0.49
			(0.03)***		(0.07)***	(0.03)***
Constant	0.04	0.48	0.26	0.09	0.06	0.22
	(0.05)	(0.02)***	(0.02)***	(0.02)***	(0.04)	(0.02)***
N	90	258	254	215	90	254
Adj. R2	0.63	0.18	0.50	0.65	0.72	0.58
# of countries	26	53	52	49	26	52

Notes: The estimation is conducted with the OLS (ordinary least squares) methodology. * p<0.1; ** p<0.05; *** p<0.01. Robust standard errors are in brackets.

Source: authors' estimates.

Panel analysis of the euro share of reserves — Table 3
Dependent variable: share of the EUR in reserves,
unbalanced 3-year panels 2000-2017

					"Small"	"Large"
	(1)	(2)	(3)	(4)	(5)	(6)
EUR share in export invoicing	0.65				0.30	
	(0.07)***				(0.10)***	
EUR share in trade		1.04				0.57
		(0.07)***				(0.07)***
EUR currency weights			0.54		0.47	0.34
			(0.04)***		(0.08)***	(0.04)***
Constant	0.22	0.02	0.08	0.11	0.06	0.01
	(0.03)***	(0.02)	(0.01)***	(0.02)***	(0.03)**	(0.01)
N	97	250	246	148	97	246
Adj. R2	0.39	0.52	0.56	0.56	0.59	0.65

# of countries	24	50	49	30	24	49

Notes: The estimation is conducted with the OLS (ordinary least squares) methodology. * p<0.1; ** p<0.05; *** p<0.01. Robust standard errors are in brackets.

Source: authors' estimates.

Beta coefficients for the estimations on the dollar and the euro shares in foreign reserves, unbalanced 3-year panels 2000-2017

Table 4

	USD share			EUR share	
	Small (1)	Large (2)		Small (3)	Large (4)
USD share in export invoicing	0.15 (0.02)***		EUR share in export invoicing	0.09 (0.03)***	
US share in trade		0.08 (0.01)***	EUR share in trade		0.10 (0.01)***
USD currency weights	0.13 (0.02)***	0.18 (0.01)***	EUR currency weights	0.17 (0.03)***	0.12 (0.02)***
Constant	0.53 (0.02)***	0.58 (0.01)***	Constant	0.41 (0.02)***	0.28 (0.01)***
N	90	254	*N*	97	246
Adj. R2	0.72	0.58	Adj. R2	0.59	0.65
# of countries	26	52	# of countries	24	49

Notes: The estimation is conducted with the OLS (ordinary least squares) methodology. * p<0.1; ** p<0.05; *** p<0.01. Robust standard errors are in brackets. The estimates in this table should be interpreted as showing by how many standard deviations the dependent variable, i.e., the dollar or the euro shares in foreign reserves, should move if one of the explanatory variable moves by one standard deviation ceteris paribus.

Source: authors' estimates.

Cross-currency estimation

The factors that contribute a rise in the dollar share in foreign exchange reserves should contribute to the euro share with a negative sign, vice versa. Thus, by regressing the dollar share on the euro shares in trade invoicing and currency weights, we can observe cross-elasticity.

The EUR share in export invoicing has a significantly negative impact on the USD share of foreign reserves; a one percentage increase in the EUR share in trade invoicing leads to a 0.15 percentage fall in the dollar share of foreign reserves, which is much smaller in magnitude compared to the impact of the USD share in trade invoicing on the dollar share (compare Column (1) of Table 5 with column (5) of Table 2). The impact of the euro weight on the dollar share in foreign reserves is similar in magnitude to that of the dollar weight.

Such cross-currency relations are also more or less observed for the euro shares.

These results are not surprising considering that the euro share should rise when the dollar share declines, or vice versa. However, they reinforce the findings of the baseline regression results.

Panel analysis of cross-relationship between the dollar and the euro shares in foreign reserves, unbalanced 3-year panels 2000-2017

Table 5

	USD share			EUR share	
	Small (1)	Large (2)		Small (3)	Large (4)

EUR share in export invoicing	-0.15		USD share in export invoicing	-0.50	
	(0.08)*			(0.08)***	
EUR share in trade		-0.32	US share in trade		-0.24
		(0.08)***			(0.10)**
EUR currency weights	-0.60	-0.45	USD currency weights	-0.28	-0.49
	(0.07)***	(0.04)***		(0.07)***	(0.04)***
Constant	0.86	0.82	Constant	0.79	0.59
	(0.03)***	(0.02)***		(0.05)***	(0.03)***
N	97	254	*N*	89	246
Adj. R2	0.66	0.54	Adj. R2	0.60	0.53
# of countries	24	52	# of countries	25	49

Notes: The estimation is conducted with the OLS (ordinary least squares) methodology. * p<0.1; ** p<0.05; *** p<0.01. Robust standard errors are in brackets.

Source: authors' estimates.

4.3 Robustness checks

Alternative measure of currency zones

While past studies estimated the impact of fixed exchange rate regimes on the currency composition in foreign reserves, our studies take a nuanced approach by estimating the time-variant weights in currency baskets. Now, what if we used the "winner take all" assignment of currencies to zones of Ilzetzki et al (2017), rather than our proportional, Frankel-Wei assignment?

Although Ilzetzki et al's (henceforward, IRR) share with us the goal of identifying currency zones, their approach differs from ours in several ways. First, and most importantly, IRR assign each currency a single, dominant anchor currency for each country-year. In effect, IRR let the "winner take all". We generate continuous weights between one and zero for each candidate anchor currency. Second, IRR exclude the country-years when the rate of inflation exceeds 40%, dubbing the currency "freely falling," and assigning it no anchor currency. We exclude months of dollar depreciations in excess of 10% but still attach high inflation currencies to an anchor. Third, IRR assign even key currencies to the zones of other key currencies according to an algorithm. For example, Japan belongs to the US dollar zone from 1948 to 1977, and the UK, Germany, and France belong to it until 1972.[18] We choose key currencies

Panel analysis of the dollar share of reserves Table 6
With IRR's binary exchange rate regime identification
Dependent variable: share of the dollar in reserves, unbalanced 3-year panels 2000-2017

		Small	Large
	(1)	(2)	(3)
USD share in export invoicing		0.51	
		(0.09)***	
US share in trade			0.54
			(0.15)***
USD zone dummy	0.41	0.25	0.37
	(0.02)***	(0.05)***	(0.03)***
Constant	0.31	0.11	0.28
	(0.02)***	(0.04)***	(0.02)***
N	259	90	258

[18] As an additional minor difference, we exclude the Soviet bloc currencies, while IRR put them in a rouble bloc.

Adj. R2	0.50	0.74	0.55
# of countries	53	26	53

Notes: The estimation is conducted with the OLS (ordinary least squares) methodology. * p<0.1; ** p<0.05; *** p<0.01. Robust standard errors are in brackets. Columns (1) and (2)-(3) of this table are comparable to Columns (3) and (5)-(6) of Table 2.

Source: authors' estimates.

currencies ex ante and assume each to centre its own currency zone, assigning a weight of one.

Using the binary dummy for the dollar zone instead of using the continuous currency weights does not alter the estimation results (Table 6). There is a tendency for the magnitude of the estimate on the exchange rate regime dummy to be generally smaller than that of the estimate on the dollar zone weights, possibly suggesting that using the dummy variable for regimes with dollar-pegs may underestimate the impact of the dollar on the USD share.[19]

The volume of foreign reserves holding

While holding a large volume of foreign reserves can function as an insurance for financial crisis (Gourinchas and Rey, 2007), it can be costly (Jeanne, O. and R. Rancière, 2011), which is especially the case when the currency composition of the reserves is lopsided to one currency, the USD. In reality, however, countries can afford to diversify portfolios of foreign reserves only when they hold a sufficient amount of dollar-denominated assets because the dollar provides liquidity most conveniently at the time of a financial crisis.

Hence, one can hypothesise that a country tends to become more able to hold non-USD assets when it holds a larger amount of aggregate foreign exchange reserves.[20]

Our estimation does not yield results consistent with this hypothesis. The estimated coefficient on the aggregate amount of foreign exchange reserves (as a share of GDP) is negative, but statistically insignificant (Columns (1) and (2) of Table 7). The estimates on the USD share in export invoicing and on the USD weight are robust to the inclusion of this variable.

However, in the EUR share estimation, the estimated coefficient on the aggregate amount of foreign exchange reserves persistently significantly *positive,* indicating larger foreign reserve holders may tend to diversify their reserve portfolio more toward including euro-denominated reserve assets (not reported).[21]

The impacts of the interest rate and the exchange rates

In the aftermath of the GFC, all the issuers of the major currencies, namely, the US Federal Reserve, the Bank of England, the Bank of Japan, and the European Central Bank, implemented unconventional monetary policies, such as quantitative easing and the zero

[19] The euro share estimations also yield significantly positive estimates on the euro peg dummy, and they tend to be smaller in magnitude.

[20] Beck, R and S Weber (2011) do not find any evidence for such a hypothesis. In fact, they argue that increases in reserves and reserve diversification can be positively related only if the motives to hold international reserves is not for precautionary reasons.

[21] The results are available from authors upon request.

or negative interest rate policy. While these policies were implemented around the same time, the timing and the degree of monetary loosening differ across these economies, which can make the rate of returns from holding assets denominated in different key currencies differ from one another.

The rate of returns reserve managers see is surely affected by the exchange rate of their domestic currency against the key currencies as well.

The interest rate differentials between the domestic country and the US do not enter the estimation significantly (Columns (3) and (4) of Table 7), while the other estimates are intact. This result also holds for the euro share estimation (not reported). The rate of depreciation against the USD (ie, positive values indicate domestic currency depreciation) contributes positively to the dollar share but only for the large sample, possibly indicating that *dollar appreciation* tends to raise the dollar share in the domestic country's foreign exchange reserves (Columns (5) and (6)).[22]

This exchange rate impact survives even when both interest rate differentials and the USD exchange rate are included in the estimation (Column (8)).

A country with its currency on the depreciation trend has some risk of encountering a macroeconomic or financial instability (especially when it is indebted largely in the USD), for which securing access to USD liquidity would be helpful. This may explain the positive impact of the rate of depreciation against the USD on the USD share in foreign exchange reserves. In fact, when the variable for inflation differentials with respect to the US is included in the estimation in place of the interest rate differential or the rate of depreciation, its estimated coefficient is consistently significantly positive across different estimation models (not reported). When the same exercise is done for the euro share, the estimate is negative, mostly significantly so. Again, a country with macroeconomic or financial instability tends to have a higher USD share in its exchange reserves.

The impacts of financial development and financial openness

A country with more developed financial markets can provide a wider variety of financial instruments and products and face lower transaction costs of converting the portfolio among different assets and currencies. While it is USD-denominated assets for which large, liquid, and deep markets exist, a developed financial market can increase the liquidity of other non-USD assets the central bank holds. That is, more financial development may help reduce the USD share in exchange reserves while the opposite may hold for non-USD denominated assets of the central bank.

This generalization may also apply to financial openness in the sense that it can lower transaction costs and increase the liquidity of non-USD assets held by the central bank.

Greater financial development, which we measure with the IMF index on financial development (Sahay et al., 2015),[23] does not have any impact on the USD share in

[22] In the euro share estimation, the rate of depreciation is found to be a significantly *negative* factor in the estimation with the large sample.

[23] This index is based on measures of depth, access and efficiency of financial institutions and markets. Greater values of this index indicate more developed financial markets. For more details, refer to Sahay et al. (2015).

exchange reserves, however (columns (9) and (10) of Table 7).[24] Greater financial openness, based on the Chinn and Ito index (2006, 2008, updates), does lead to a smaller USD share. The negative impact remains even when it is controlled for financial development.[25]

This result is different from Eichengreen and Mathieson's (2000) who find the *positive* relationship between capital account openness and the USD and GBP shares in foreign exchange reserves. They argue that capital account openness "works to the advantage of the countries with particularly active international financial markets." Considering that financial globalization after the millennium yielded many active financial centres (as shown in Lane and Milesi-Feretti (2017)), such positive impact of financial openness should not be confined to New York or London. Rather, financial globalization may have led to more portfolio diversification in reserve management and consequently to a lower USD share in exchange reserves.

Previously, we found that reserve managers of a country with ample foreign reserves does not necessarily increase the USD share in the reserve portfolio, but they would increase the EUR share in foreign reserves. We now find the negative contribution of financial openness to the USD share in exchange reserves. These two factors, aggregate foreign reserves and financial openness, can be correlated with each other; a country with more open financial markets may hold more foreign reserves for precautionary reasons (Aizenman and Lee, 2007), which may lead the impact of financial openness to spuriously reflect that of the aggregate volume of foreign reserves, or vice versa.

Including both financial openness and foreign reserves in the estimation model still retains the significantly negative effect of financial openness (Columns (15) and (16)).

[24] The impact of financial development on the EUR share is found to be positive, often significantly when the euro currency weight is not included in the estimation.

[25] The impact of financial openness on the EUR share is significantly positive in most of the estimation models.

Panel analysis of the dollar share of reserves with additional control variables

Table 7

Dependent variable: share of the dollar in reserves, unbalanced 3-year panels 2000-2017

	Aggregate international reserves		Interest rate differentials		Rate of depreciation		Interest rate differentials & the rate of depreciation	
	Small (1)	Large (2)	Small (3)	Large (4)	Small (5)	Large (6)	Small (7)	Large (8)
USD share in export invoicing	0.47		0.51		0.50		0.51	
	(0.08)***		(0.08)***		(0.08)***		(0.08)***	
US share in trade		0.60		0.61		0.59		0.60
		(0.12)***		(0.12)***		(0.12)***		(0.12)***
USD currency weights	0.37	0.48	0.34	0.47	0.37	0.49	0.32	0.46
	(0.07)***	(0.03)***	(0.07)***	(0.03)***	(0.07)***	(0.03)***	(0.08)***	(0.03)***
Aggregate IR as % of GDP	-0.19	-0.08						
	(0.15)	(0.10)						
Interest rates differentials w/ US			0.27	0.35			0.29	0.31
			(0.34)	(0.23)			(0.35)	(0.23)
Rate of depreciation against USD					0.01	0.01	0.01	0.01
					(0.01)	(0.00)***	(0.01)	(0.00)***
Constant	0.10	0.24	0.05	0.21	0.06	0.22	0.05	0.22
	(0.05)*	(0.03)***	(0.04)	(0.02)***	(0.04)	(0.02)***	(0.04)	(0.02)***
N	89	247	89	240	90	251	89	238
Adj. R2	0.72	0.57	0.72	0.59	0.72	0.57	0.71	0.58
# of countries	26	51	26	52	26	52	26	52

Notes: The estimation is conducted with the OLS (ordinary least squares) methodology. * p<0.1; ** p<0.05; *** p<0.01. Robust standard errors are in brackets.

Source: authors' estimates.

Table 7, continued

Panel analysis of the dollar share of reserves with additional control variables, continued

Dependent variable: share of the dollar in reserves, unbalanced 3-year panels 2000-2017

	Financial development		Financial openness		Financial development and openness		Financial development and aggregate international reserves	
	Small (9)	Large (10)	Small (1)	Large (12)	Small (13)	Large (14)	Small (15)	Large (16)
USD share in export invoicing	0.50		0.50		0.50		0.48	
	(0.07)***		(0.07)***		(0.07)***		(0.07)***	
US share in trade		0.63		0.66		0.66		0.67
		(0.12)***		(0.12)***		(0.12)***		(0.12)***
USD currency weights	0.34	0.48	0.31	0.45	0.31	0.45	0.31	0.43
	(0.08)***	(0.04)***	(0.07)***	(0.04)***	(0.09)***	(0.04)***	(0.07)***	(0.04)***
Financial development	-0.08	-0.04			-0.01	-0.00		
	(0.08)	(0.06)			(0.09)	(0.06)		
Financial openness			-0.13	-0.09	-0.13	-0.09	-0.13	-0.11
			(0.06)**	(0.04)**	(0.07)*	(0.04)**	(0.06)*	(0.04)***
Aggregate IR as % of GDP							-0.17	-0.03
							(0.16)	(0.10)
Constant	0.11	0.24	0.17	0.29	0.17	0.30	0.20	0.32
	(0.07)	(0.04)***	(0.07)**	(0.04)***	(0.08)**	(0.05)***	(0.07)***	(0.04)***
N	90	254	90	254	90	254	89	247
Adj. R2	0.72	0.58	0.74	0.59	0.73	0.58	0.73	0.58
# of countries	26	52	26	52	26	52	26	51

Notes: The estimation is conducted with the OLS (ordinary least squares) methodology. * p<0.1; ** p<0.05; *** p<0.01. Robust standard errors are in brackets.

Source: authors' estimates.

6. Conclusions

Although researchers and commentators have rekindled their interest in issues related to international currency in recent years, they usually find that the dollar dominance continues as if the post-WWII international monetary system is unscathed. When they research on what factors contribute to the dominance of the dollar especially as the currency predominantly held as foreign reserves, they encounter the fact that data limitations on the currency compositions of foreign reserves exist for individual countries and thereby inhibit an insightful empirical analysis. We attempt to overcome the lack of data availability by compiling a dataset composed of the data we have collected from the annual reports, financial statements, and other relevant documents of the central banks across the world. That has led us to have a dataset on the currency composition of foreign reserves for 53 countries in the last two decades. Using this, we are able to conduct several analyses and obtain interesting results.

The share of the dollar in foreign exchange reserves is higher where the domestic currency varies less against the dollar than other major currencies (ie, the higher degree to which the domestic economy belongs to the dollar zone). Two thirds of the variation in the dollar share of foreign exchange reserves is related to the respective currency's dollar zone weight. That reflects that if a currency varies less against the dollar than against other major currencies, then a reserve portfolio with a substantial dollar share poses less risk when returns are measured in domestic currency.

If a larger share of trade is denominated in the USD, the USD share in foreign exchange reserves would be higher as well.

A country that faces the higher tendency to experience currency depreciation tends to hold more dollar-denominated assets in its reserve portfolio, possibly reflecting a higher possibility of currency depreciation leading to economic or financial turbulence.

By having more open financial markets, a country can afford to diversify its reserve portfolio; such an economy tends to have lower USD and higher EUR shares in its foreign exchange reserves.

Appendix 1: Country list (53 economies)

Asia & Pacific (9)
Australia[AE]
Bangladesh[EME]
Hong Kong, China[EME]
India[EME]
Korea, Rep.[EME]
New Zealand[AE]
Papua New Guinea
Philippines[EME]
Sri Lanka[EME]

Western Europe (6)
Denmark[AE]
Iceland[AE]
Norway[AE]
Sweden[AE]
Switzerland[AE]
United Kingdom[AE]

Eastern Europe and Central Asia (14)
Azerbaijan
Bulgaria[EME]
Croatia
Czech Republic[EME]
Georgia
Kazakhstan
Kyrgyz Republic
Poland[EME]
Romania
Russian Federation[EME]
Serbia
Tajikistan
Turkey[EME]
Ukraine

West Hemisphere (12)
Argentina[EME]
Bolivia
Brazil[EME]
Canada[AE]
Chile[EME]
Colombia[EME]
Costa Rica
Ecuador[EME]
Paraguay
Peru[EME]
Uruguay
Venezuela, RB[EME]

Africa and Middle East (12)
Ghana[EME]
Israel[EME]
Kenya[EME]
Malawi
Mozambique
Namibia
Nigeria[EME]
South Africa[EME]
Tanzania
Tunisia[EME]
Uganda
Zambia

Note: "AE" stands for "advanced economies"
"EME" stands for emerging market economies

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