Emerging market currency composition of reserves, denomination of trade and currency movements

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Abstract

This article analyses the relationships among the unit of account and means of exchange functions of an international currency, on the one hand, and its store of value in official use, on the other hand. Historical evidence links the currency composition of reserves to currency movements. The currency composition of reserves is strongly related in the cross-section to both currency movements and the currency denomination of trade. Data limitations make it hard to distinguish these two factors. A panel analysis of 5 countries from central and eastern Europe shows that both trade invoicing and currency movements drive changing official reserve composition. Implications are suggested for the prospects for the renminbi enlarging its current small portion of official foreign exchange reserves.

Keywords: International currency, currency denomination of trade, currency composition of official reserves, dollar zone.

JEL classification:

1. Introduction

The renminbi has recently reached 1% of global foreign exchange reserves, according to the BIS (2015, p 85) and IMF (2015, p 23). This follows a rising share of Chinese trade that is denominated in, or at least settled in, renminbi (Ito and Chinn (2014)). This also follows analyses that claim (and deny) that the renminbi's movements substantially influence movements of neighbouring currencies (Subramanian and Kessler (2013); Shu et al (2014); Kawai and Pontines (2014).

The precocious internationalisation of the renminbi recalls the long-running discussion of the various functions of international currencies, as summarised in the famous table of Kenen (1983, Table 1). The issues raised by the renminbi's increasing international use also bring to mind the many unresolved questions of the relationship among the various uses of international currencies.

This article places itself in the line of Heller and Knight (1998), Dooley et al (1989) and Eichengreen and Mathieson (2000) by investigating the empirical determinants of the currency composition of foreign exchange reserves (the bolded upper-right entry in Table 1). In particular, we focus for explanation of reserve composition on the two unit of account concepts, the anchoring of a given currency as between dollar, euro and yen (Haldane and Hall (1991), Frankel and Wei (1996)), on the one hand, and the currency denomination of trade, on the other (the bolded and italicised entries in the middle column of Table 1). For the latter we use updated data as described in Ito and Chinn (2014).

International currency functions by sector   Table 1

	Means of exchange	Unit of account	Store of value
Official	Intervention currency	***Currency anchoring***	**Foreign exchange reserves**
Private	Vehicles in forex market	***Denomination of trade***	Internat'l assets and debts

Sources: Kenen (1983).

Understanding the currency composition of official foreign exchange reserves is of particular interest now. At the end of 2014, emerging market reserves reached $7.7 trillion. There is now a debate regarding whether 2014 may prove to have been the time of "peak reserves", to be followed by an extended draw-down of reserves as countries, including China, resist currency depreciation against a rising dollar (Winkler et al (2015)). In a world in which portfolio balance helps to determine major exchange rates (Blanchard et al (2005)), the repayment of dollar debt by the emerging market firms matched by a liquidation of official reserves invested in, say, government bonds of the SDR currencies, can serve further to strengthen the dollar and to put upward pressure on bond yields.[1] (The latter portfolio balance effect has been dubbed "quantitative tightening" by some market economists, to contrast it to the ongoing bond buying of the ECB and the Bank of Japan.[2]) The more that

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[1]   For a discussion of net repayment of foreign currency debt by the non-official sector in China in the first quarter of 2015, see McCauley (2015), and for emerging market dollar debt more generally, see McCauley et al (2015).

[2]   Winkler et al (2015). See discussion in BIS (2015, pp 94-95. Debelle (2015) frames the Chinese reserve decumulation as a sectoral shift from the public sector holdings of external assets to private sector holdings: "That is, a fair part of what is going at the moment is a shift in *who* is

emerging market central banks have diversified from the dollar, the more their reserve decumulation might put added upward pressure on the dollar, as they sell dollars for domestic currency and then sell euros for dollars to rebalance their portfolios.

This article is structured as follows. The second section recalls the grounds on which the currency composition of foreign exchange reserves can be chosen. The third section discusses historical evidence on the role of changes in the orientation of the domestic currency to key international currencies and changes in the currency composition of reserves. The fourth section uses the current cross-section of evidence to run a horserace between currency movements and the currency composition of the invoicing of trade. The fifth section discusses the evidence of central and eastern European currencies from the 1990s to date as their trade became increasingly dominated by the euro area. The sixth section concludes.

2. Explaining the currency composition of forex reserves

How should reserve managers choose the currency composition of their reserves? The numeraire that is used to measure risks and returns has a very strong influence on calculated optimal currency allocations (Papaioannou et al (2006), Borio et al (2008a)). Its choice depends on the intended uses of the reserves. If reserves are held mainly to intervene in the currency market, then a plausible numeraire would be the currency against which the domestic currency trades most heavily, especially in the spot market where most central banks operate. If reserves are held mainly to insure purchases of foreign goods and services, then an import basket would be plausible, or the currency denomination of trade might be the point of reference. Or, if reserves are held mainly as a hedge against (or to pay) debt service, the currency composition of outstanding debt would be a plausible choice.

The domestic currency may serve as the numeraire for economic or institutional reasons. Where reserves exceed transaction or insurance needs, their value as domestic wealth can be measured in terms of domestic currency. Or, the domestic currency may be used as numeraire owing to its use in valuing foreign exchange reserves in striking the central bank's accounting profit and reported capital. These may affect a central bank's reputation or even its operational independence.

A survey found a considerable range of choice (Borio et al (2008b)). About a third of central banks used the domestic currency, a fifth a basket of foreign currencies and the rest a single foreign currency. One third used the US dollar. Some central banks used different numeraires for different portfolio tranches, which themselves were distinguished by use (eg liquidity versus investment).

The next section provides historical evidence consistent with the use of the domestic currency as numeraire. The share of the dollar in reserves is higher where the domestic currency varies less against the dollar than other major currencies.

holding foreign assets in China, not necessarily a large change in the total quantity of foreign assets being held by China. What matters for global financial markets is the difference in portfolio allocation between the public and private sector in China". However, if the counterpart of the reserve decumulation is the private sector's building up US dollar deposits, then the sale of bonds from reserves has no counterpart in private purchases of bonds.

3. The historical evidence

The spotty historical record of changes in the composition of reserves is quite telling. Looking back to the interwar period and the 1960s and 1970s: as economies joined (or left) the sterling area, their reserve composition shifted towards (or away from) sterling. In the period since 1990, the relative stability of the dollar share of reserves reflects the stability of the dollar zone at more than half of global output. In both cases, we observe that reserves are held in the major currencies that move less against the domestic currency.

3.1 Entering and leaving the sterling area

Historically, reserve shifts by those authorities whose currencies entered or left the sterling area show the logic of matching the reserve portfolio to the currency anchor at work. After the Scandinavian currencies joined the sterling area in the wake of the UK currency's 1931 floating (Drummond (2008)), central banks shifted their reserves into sterling.[3] Similarly, after the yen was pegged to sterling in 1934, sterling's share of Japanese reserves soared from 15% in 1932 to 90% in 1935 (Hatase and Ohnuki (2009), Figure 3).

Conversely, after leaving the sterling area, monetary authorities cut their holdings of sterling. For instance, in the 1968 Basel sterling agreement, the Bank of England guaranteed the dollar value of the 99% of Hong Kong's reserves that were invested in sterling (Schenk (2010), pp 295–6). After Hong Kong replaced its peg to sterling with its first dollar peg in July 1972, the proportion of Hong Kong's reserves held in dollars rose to 20% in September 1974 (Schenk (2009)) – and to 75% now, 31 years after the subsequent peg to the dollar in 1983.

Similar observations hold for less extreme reserve portfolios in the sterling area. In 1968, the Bank of England guaranteed the dollar value of the 70%, 45% and 40% of their reserves that were invested in sterling by New Zealand, Iceland and Australia, respectively. After the Australian and New Zealand dollars were pegged to the US dollar in the Smithsonian Agreement of December 1971, and then both to baskets by July 1973, the sterling share fell to about 20% by 1974 for Australia and by 1977 for New Zealand (Schenk and Singleton (2015)). Today, New Zealand, Iceland and Australia hold 15%, 15% and 0% of their reserves in sterling and 25%, 40% and 55% in dollars, as described below.

3.2 The dollar zone and the dollar share of reserves since 1990

The dollar's role as reference for other countries' exchange rates ranges from dollar pegs to largely market-driven co-movements under free-floating regimes as influenced by interest rate policies. By examining the degree of co-movements, and predefining the set of key currencies, we derive a measure of each such currency's zone of influence using simple regression techniques (see Annex of McCauley and Chan (2014) for details). We use the euro (before 1999, the Deutsche mark) and yen as the other candidate reference currencies, consistent with their status as the

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[3]   Personal communication with Marc Flandreau.

second and third most transacted currencies in the Triennial Central Bank Survey of Foreign Exchange and Derivatives Market Activity.

We then define not a tightly linked dollar bloc, but rather a fuzzier dollar zone. A given country's GDP contributes to this zone in proportion to its currency's dollar weight. So defined, the dollar zone accounts for more than half of global GDP.[4]

By this measure, the US dollar's pre-eminence as a reference currency lines up with its relative role as store of value for official reserves. The dollar zone has been close to 60% of global GDP and has shown little trend since 1990 (Graph 1, blue line in the left-hand panel). This 60% is much closer to the dollar share of reserves than the global share of the US economy (here measured in PPP terms, but the point would still hold at market values). The euro zone share of global GDP is now around 25%, just above the euro's (reduced) share of reserves. The yen trails.

A stable dollar zone share of global GDP is at first puzzling, given that the euro's influence has extended east in Europe (ECB (2014)), to commodity currencies and even to emerging Asia. However, Asia's fast growth has offset the euro's wider influence, given the diminished yet still strong dollar linkage of Asian currencies.

In sum, the dollar's share in global forex reserves tracks over time the share of the dollar zone in global output. Together with the cross-sectional evidence to which we now turn, this evidence suggests the importance of portfolio considerations and the domestic currency numeraire. With the cross-sectional evidence, we can also test the importance of the currency denomination of trade.

Size of currency zones and global reserve composition

In per cent   Graph 1
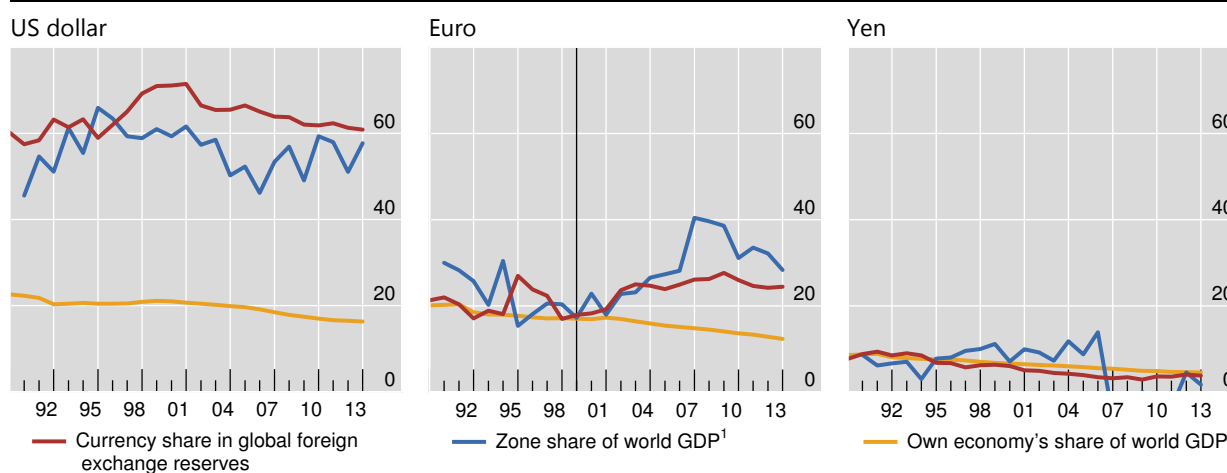
¹ Zone share estimated as own economy's share of PPP GDP, plus the elasticity-weighted share of all other economies' PPP GDPs. The elasticities are derived from a regression of weekly changes in the domestic currency/US dollar rate against a constant, and changes in the euro/dollar (prior to 1999, Deutsche mark/dollar) and yen/dollar rates, during the corresponding year. Negative values of the yen bloc arise from negative coefficients on the yen, which can be interpreted as reflecting the use of the yen as the funding currency in carry trades.

Sources: IMF; Datastream; national data; BIS calculations.

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[4]   Cf Kawai and Akiyama (1998), Bénassy-Quéré et al (2006) and Bracke and Bunda (2011).

4. Current cross-sectional evidence

The insight that the way a currency trades against the major currencies guides the choice of the currency denomination of reserves has found only limited use in previous cross-sectional studies. IMF studies of confidential data, whether Heller and Knight (1978), Dooley et al (1989) or Eichengreen and Mathieson (2000), use dummies for pegs. They thus restrict to only extreme cases a test of the connection between currency anchoring and reserve composition.

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.

Does a currency's dollar weight influence the share of the US dollar in the corresponding country's official reserves? Or, does the country's share of the US dollar in trade invoicing matter more for the share of the US dollar in its official reserves? We examine first bivariate relationships then run the horserace.

4.1 Bivariate relationships

The limited cross-sectional evidence strongly suggests both linkages. In a sample selected by availability, a currency's dollar zone weight is positively correlated with the dollar share in the corresponding country's official reserves (Graph 2). Broadly, central banks in the Americas heavily weight the dollar, which remains the most important influence on their currencies despite the rising importance of the euro. Most European central banks do not hold such a high share of dollars, and Russia, Turkey, the United Kingdom, Australia and New Zealand are in between. Fully two thirds of the variation in the dollar share in foreign exchange reserves can be accounted for by the currencies' average dollar zone weight in 2010–13.

The slope of the least squares line (in red in Graph 2) is not 1 (dashed blue 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 of one half points to some departure from the minimum variance portfolio, perhaps in some cases to raise expected funds. The two exceptions are countries with currencies pegged to the euro, Bulgaria and Lithuania.

The necessary caveat to this strong finding is that the sample may not be representative. At the end of 2013, the 25 economies in Graph 2 accounted for $3.1 trillion of reserves, 30% of the global total not held by the United States, the euro area and Japan.[5] The 25 clearly oversample small and advanced economies. Among the top 20 holders of reserves, emerging market economies Brazil, Hong Kong SAR, India, Korea, Russia, and Turkey are included, but seven are not: China, Saudi Arabia, Chinese Taipei, Singapore, Mexico, Algeria and Thailand.

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[5] Since the G3 countries cannot hold their own currencies in their reserves, they face a different set of choices from other reserve holders.

Dollar zone weight and dollar share of forex reserves, 2013   Graph 2

$y = 25 + 0.5x$
$\bar{R}^2 = 0.666$
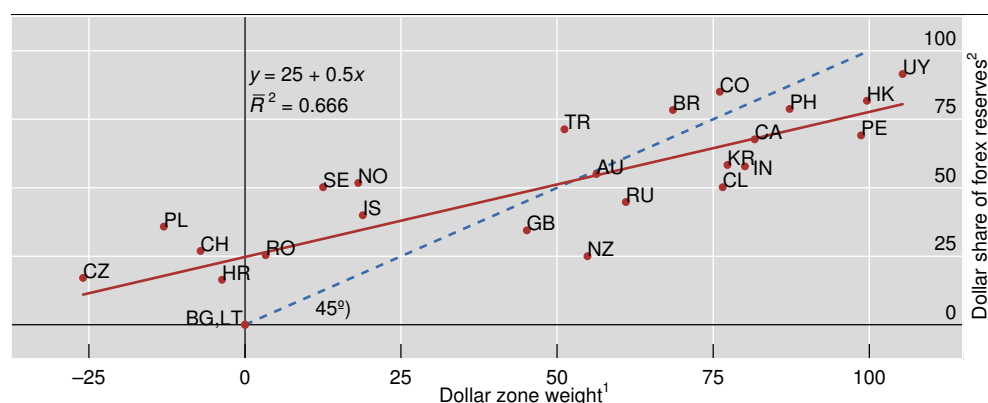
AU = Australia; BG = Bulgaria; BR = Brazil; CA = Canada; CH = Switzerland; CL = Chile; CO = Colombia;
CZ = Czech Republic; GB = United Kingdom; HK = Hong Kong SAR; HR = Croatia; IN = India; IS = Iceland;
KR = Korea; LT = Lithuania; NO = Norway; NZ = New Zealand; PE = Peru; PH = Philippines; PL = Poland;
RO = Romania; RU = Russia; SE = Sweden; TR = Turkey; UY = Uruguay.

[1] Average over four years.   [2] For AU, June 2013; CO, March 2011; IN, 2014; NZ, September 2010; TR, 2012.

Sources: R Sarin and S Singh, "RBI: Raise share of dollar in foreign exchange reserves", *The Indian Express,* 9
January 2015; national data; BIS calculations.

Given that previous work has used currency pegs, but not behavioural anchors,
to explain the currency composition of reserves, it strengthens our result to note
that it does not depend on pegs. In particular, if we exclude Bulgaria, Hong Kong
and Lithuania, the estimated relationship is indistinguishable statistically from that
in Graph 2. Furthermore, if we exclude currencies that the IMF (2013, pp 5–6)
characterises as having a "crawl-like" (Croatia) or "other managed arrangement"
(Russia and Switzerland), the result does not change much. All in all, the relationship
does not depend on economies where the currency is heavily managed.

What about the link between the dollar share in official reserves and that in
trade invoicing? Despite a limited number of observations, we find a positive
relationship between the two (Graph 3, left hand panel).[6] The slope is about the
same, but the regression line fits the data less well. Brazil, Sweden, and Turkey hold
more reserves in the dollar than one might guess from the share of dollars in their
export invoicing. Bulgaria and Lithuania do not hold dollar reserves even though a
fair fraction of their exports in the US dollar.

This result warrants further examination. We should expect the dollar zone
weight and the dollar share in trade invoicing to be correlated. At the limit, if a
country pegs its currency to another anchor currency such as the U.S. dollar or the
euro, it surely would tend to invoice its exports in the anchor currency.[7] Or, given
pervasive dollar invoicing, the policy of a dollar peg may have appeal: the reverse
causality can also be valid. In fact, regressing the dollar share in export invoicing on

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[6]   Using the dollar share in import invoicing instead, the positive correlation is no longer significant
        with the adjusted R^2 falling considerably. The UK, Lithuania, Romania, and Bulgaria are outliers with
        their dollar share in reserves low but the dollar share in import invoicing high; conversely, Turkey
        and Brazil have high dollar shares in reserves but low dollar shares in import invoicing.

[7]   Ito and Chinn (2014) show that those countries that peg their currencies to the dollar (euro) tend to
        invoice their exports in the dollar (euro).

Dollar shares of forex reserves and export invoicing   Graph 3
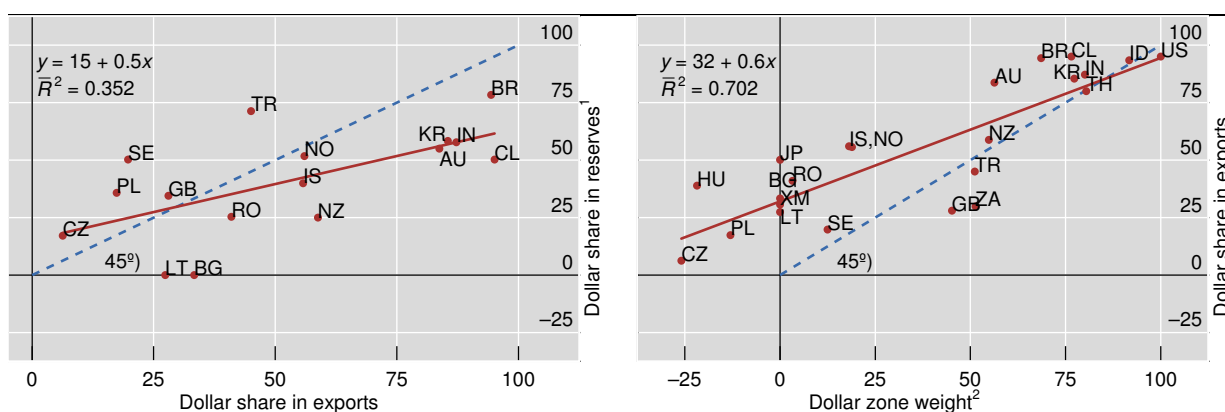
AU = Australia; BG = Bulgaria; BR = Brazil; CL = Chile; CZ = Czech Republic; GB = United Kingdom; HU = Hungary; ID = Indonesia; IN = India; IS = Iceland; JP = Japan; KR = Korea; LT = Lithuania; NO = Norway; NZ = New Zealand; PL = Poland; RO = Romania; SE = Sweden; TH = Thailand; TR = Turkey; US = United States; XM = Euro area; ZA = South Africa.

[1] For AU, June 2013; IN, 2014; NZ, September2010; TR, 2012.   [2] Average over four years.

Sources: H Ito and M Chinn (2014 and updates); R Sarin and S Singh, "RBI: Raise share of dollar in foreign exchange reserves", *The Indian Express,* 9 January 2015; national data; BIS calculation.

the dollar zone weight yields an estimated coefficient of 0.6, significantly different from zero, and an adjusted R^2 of 70% (Graph 3, right-hand panel).

Since the various functions of an international money mutually reinforce each other, it is interesting to bring into the analysis the private means of exchange function, namely the vehicle currency against which the domestic currency trades in the currency market (the lower left-hand entry on Table 1). Particularly if reserves are not large, the extent to which domestic currency trades against the dollar in the foreign exchange market could constrain the choice of the dollar share of reserves. Our measure of the share of dollar trading is derived from the results for spot trading in the Triennial Survey of April 2013, which improved on reporting on a range of emerging market currencies.

On a bivariate basis, the share of dollar trading in the spot market does line up with the share of dollar reserves (Graph 4, left-hand panel). This is not surprising because the share of dollar trading is also linked to the dollar zone share (Graph 4, right-hand panel).[8] A one percent increase in the dollar share of spot trading is associated with a half percentage point increase in the share of dollar reserves.

To summarise the bivariate analysis of the cross-section, the currency composition of reserves is strongly related to both currency movements and the currency denomination of trade, which are themselves quite strongly related. The vehicle currency in the foreign exchange market is less strongly related to the currency composition of reserves or currency movement. We turn to a multivariate analysis of the limited cross-sectional evidence.

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[8]   The share of dollar trading is also correlated with the dollar share in export invoicing. However, the goodness of fit is much smaller (10%) and the slope is about half of that in the estimation on the dollar zone share (0.327) with a lower level of significance (10%).

Dollar share in reserves vs dollar share in FX transactions

Graph 4
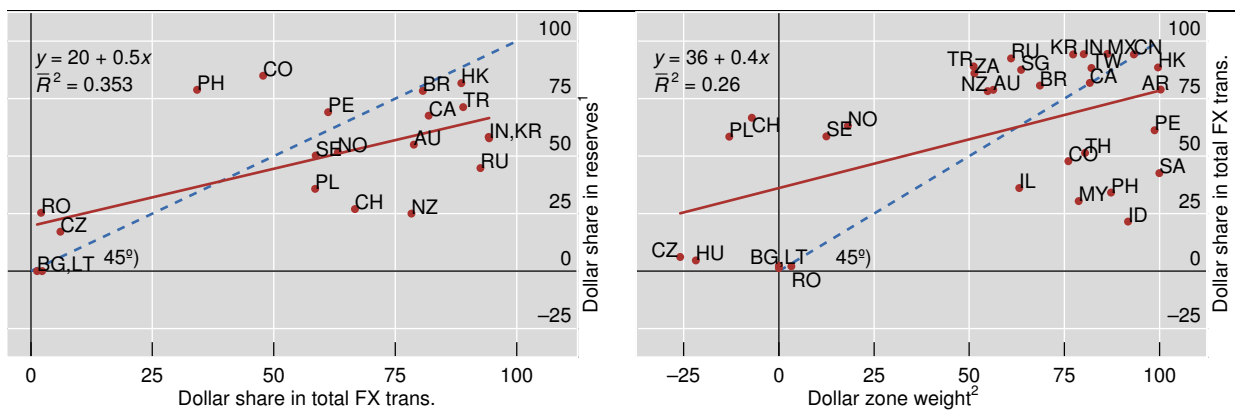
AU = Australia; AR = Argentina; BG = Bulgaria; BR = Brazil; CA = Canada; CH = Switzerland; CN = China; CO = Colombia; CZ = Czech Republic; HK = Hong Kong SAR; HU = Hungary; ID = Indonesia; IL = Israel; IN = India; KR = Korea; LT = Lithuania; MY = Malaysia; NO = Norway; NZ = New Zealand; PE = Peru; PH = Philippines; PL = Poland; RO = Romania; RU = Russia; SA = Saudi Arabia; SE = Sweden; SG = Singapore; TH = Thailand; TR = Turkey; TW = Chinese Taipei; ZA = South Africa.

[1] For AU, June 2013; CO, March 2011; IN, 2014; NZ, September2010; TR, 2012.   [2] Average over four years.

Sources: R Sarin and S Singh, "RBI: Raise share of dollar in foreign exchange reserves", *The Indian Express,* 9 January 2015; national data; BIS Triennial Survey; BIS calculation.

4.2 Multivariate relationships

In a multivariate setting, we regress the dollar share of reserves on various combinations of the dollar share in export invoicing, the dollar zone share, and the dollar share in spot market turnover. As plotted above, these three variables are correlated with each other. Despite the small number of observations, our purpose is to run a horserace among currency movements, currency transaction volumes, and the currency composition of the invoicing of trade. Which variable(s) best explain the cross-sectional variation in the dollar share in official reserves?

As shown above, the three variables explain well the dollar share in official foreign reserves individually (columns (1) through (3) in Table 2) with the dollar zone share scoring the highest bivariate goodness of fit. The multivariate estimations in columns (4) through (7) confirm multicollinearity among these variables with the estimated coefficients and the statistical significance of individual variables dropping toward zero. In the head-to-head race between trade invoicing and the dollar zone weight (column (4)), with its limited number of observations (just 16!), the individual effects of the dollar share in export invoicing or of the dollar zone cannot be distinguished, though they are jointly significant. The dollar zone share dominates the dollar share in foreign-exchange trading (column (6)), which in turn dominates the dollar share of export invoicing (column (5)).

To summarise the multivariate analysis, trade invoicing and the dollar zone share are jointly significant, but too closely related to each other to distinguish. There is thus scope for further analysis using a small panel of European emerging market economies.

Cross-section analysis: reserves, trade denomination and currency movements

Dependent variable: share of US dollar in reserves in 2013   Table 2

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
% of USD	0.49			0.19	0.07		0.29
in exports	(0.16)***			(0.33)	(0.20)		(0.39)
$ Zone		0.51		0.29		0.43	-0.28
Weight		(0.08)***		(0.28)		(0.11)***	(0.41)
%USD in			0.48		0.53	0.15	0.63
FX			(0.15)***		(0.16)***	(0.14)	(0.22)**
N	16	25	20	16	13	20	13
Adj. R2	0.36	0.64	0.34	0.36	0.67	0.63	0.65

Notes: * p<0.1; ** p<0.05; *** p<0.01. t-statistics are in brackets. The estimates of the constant term are omitted.

Source: Authors' estimates.

5. The central and eastern European panel

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)).

The European emerging market economies for which we have collected data on currency composition of foreign exchange reserves have gone through dramatic changes in their economic systems and structures since the demise of the Soviet-bloc in the early 1990s. In particular, the six emerging market economies in Eastern Europe, namely, Bulgaria, Czech Republic, Croatia, Poland, Romania, and Russia have experienced varying degrees of integration with the European Union. In terms of currency, 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 Deutsche mark and then the euro as regional economic integration deepened. These experiences could be expected to have led to interrelated variation in the trade denomination, currency movements and the composition of their reserves holdings.
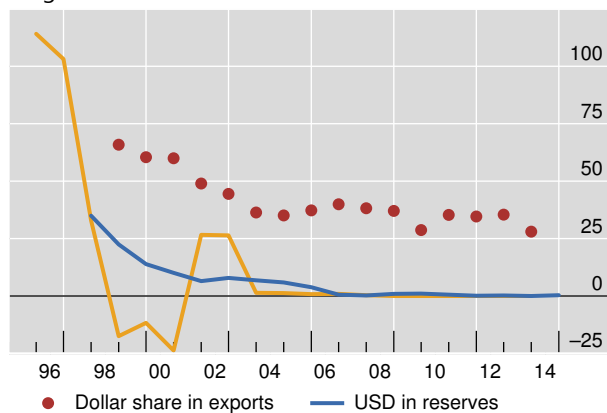
Graph 5 illustrates the development of the share of the US dollar in reserves holding, the dollar zone weight, and export invoicing for the six Easter European countries in the period of 1997 – 2013. While the US dollar share in reserves holding is moderately declining for all the economies, the share in the dollar zone weight shows a drastic decline. The rise in the euro share in export invoicing reflects the economic integration these economies experienced in this period, as well as the observed tendency for the euro area's trade to be denominated in euro to a greater extent over time. This means the US dollar share in export invoicing gradually fell for Croatia, Czech Republic and rather drastically for Bulgaria, Poland, and Romania.

Shares of US dollar in export invoicing, currency movements and reserve holding
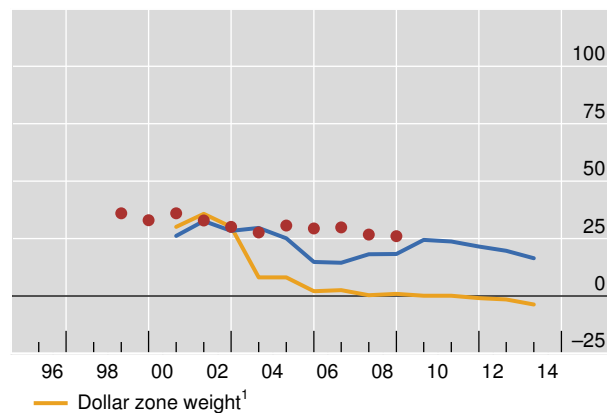
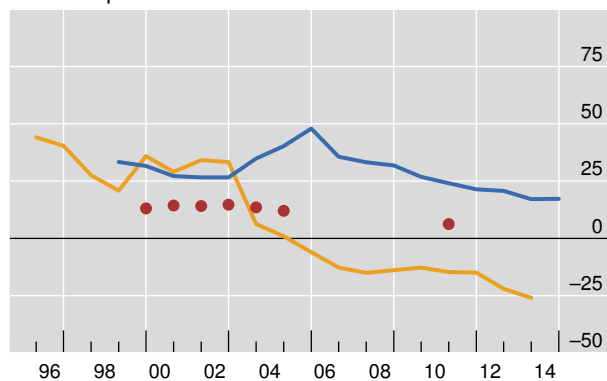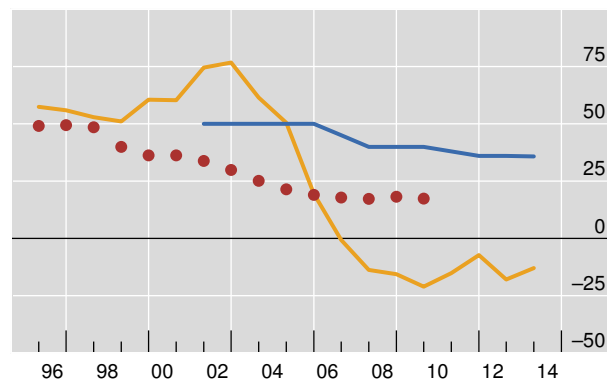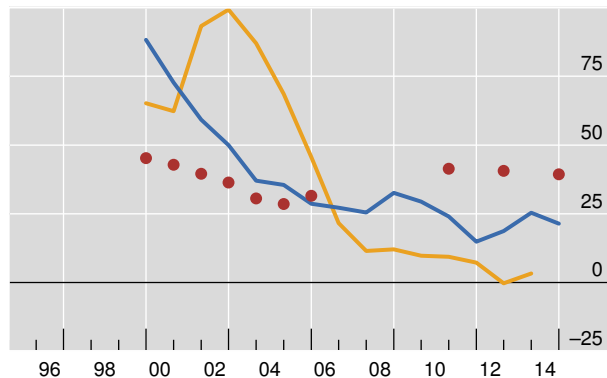In percent   Graph 5

Bulgaria

Legend:
● Dollar share in exports   ━ USD in reserves   ━ Dollar zone weight[1]
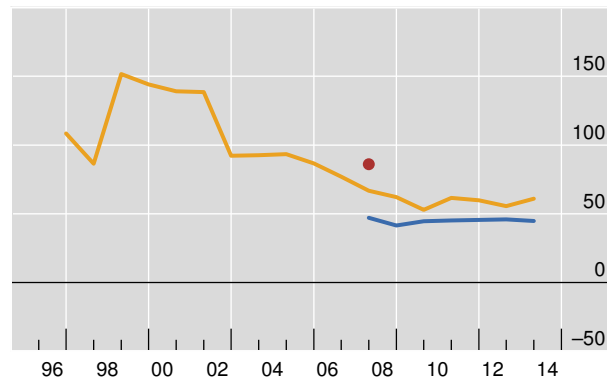
Croatia

Czech Republic

Poland

Romania

Russia

[1] Average over four years.

Sources: H Ito and M Chinn (2014 and updates); Datastream; national data, BIS calculations.

Although it is difficult to generalise the patterns of development in the US dollar share in the three different types of transactions, inspection of the panels for Bulgaria, Poland, and Romania suggests that the decline in the US dollar share may start with export invoicing, then proceed in the dollar zone weight and finally reach foreign exchange reserves. This seems to follow the sequence of economic liberalisation recommended by McKinnon (1993): current account transactions, then capital account transactions. However, in fact, these countries tended to embrace big bang liberalisation, liberalising everything at once. The gravity model tells us

that these countries naturally trade with the euro area, their small size suggests their exporting to the big euro market with euro invoicing. Both trade partners and trade invoicing encourage a more stable exchange rate against the euro than the dollar, either as a market outcome (eg Poland) or as a policy choice (eg Bulgaria). Once the currency is more stable against the euro than the dollar, euro-denominated reserves make for more stable reserves when valued in domestic currency.

Our sample of Eastern European countries allows us to assemble a panel dataset and to investigate whether and to what extent the cross-sectional correlation holds between the US dollar share in reserves and the share in dollar zone weight or export invoicing. Due to data limitations, we do not further analyse the correlation between the dollar reserve share and the dollar share in spot exchange market turnover.

The panel structure of the dataset suggests the estimation exercise should account for potential unobservable country effects. However, it is not clear whether unobservable country effects are systematic (i.e., correlated with predictors), which requires estimation with fixed effects, or not systematic, which requires random effects. Hausman tests give mixed results depending on the sample, which must be partly due to the small sample sizes. Hence, we report the results from OLS (i.e., pooled) estimates and those with random and fixed effects.

As observed in the cross-sectional analysis, a higher dollar share in export invoicing leads to a higher dollar share in reserves holding, but only when we control for country specific effects (Table 3, column (2-3)). A one percentage point increase in the dollar invoicing share would lead to a 0.65 increase in the dollar reserve share in the estimation with fixed effects (column (2)) and a 0.51 increase with the random effects (column (3)). A smaller, but strongly significant, effect is found for the dollar zone share regardless of whether or not one controls for country effects (columns (4-9)). Unlike in the cross-sectional analysis, both effects emerge as significant when we include both the dollar invoicing share and the dollar zone weight (columns (8) and (9)), with the impact of the former larger in magnitude, especially with fixed effects (column (8)).

Panel analysis of the US dollar share of reserves in central and eastern Europe

Dependent variable: share of US dollar in reserves, unbalanced panel 1998-2013   Table 3

	OLS	FE	RE	OLS	FE	RE	OLS	FE	RE
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
% of USD	-0.15	0.67	0.53				-0.24	0.61	0.26
in exports	(0.20)	(0.20)***	(0.17)***				(0.15)	(0.19)***	(0.15)*
Dollar Zone				0.31	0.23	0.24	0.41	0.15	0.20
Weight				(0.05)***	(0.04)***	(0.04)***	(0.07)***	(0.06)**	(0.06)***
N	51	51	51	82	82	82	51	51	51
Adj. R2	-0.01	0.10	.	0.31	0.22	.	0.40	0.21	.
Overall R2	.	0.01	0.01	.	0.32	0.32	.	0.04	0.22
Between R2	.	0.06	0.06	.	0.46	0.46	.	0.14	0.30
Within R2	.	0.21	0.21	.	0.28	0.28	.	0.32	0.26

Notes: OLS denotes ordinary least squares; FE, fixed effects; RE, random effects. * p<0.1; ** p<0.05; *** p<0.01. t-statistics are in brackets. Estimates of the constant term are not reported.
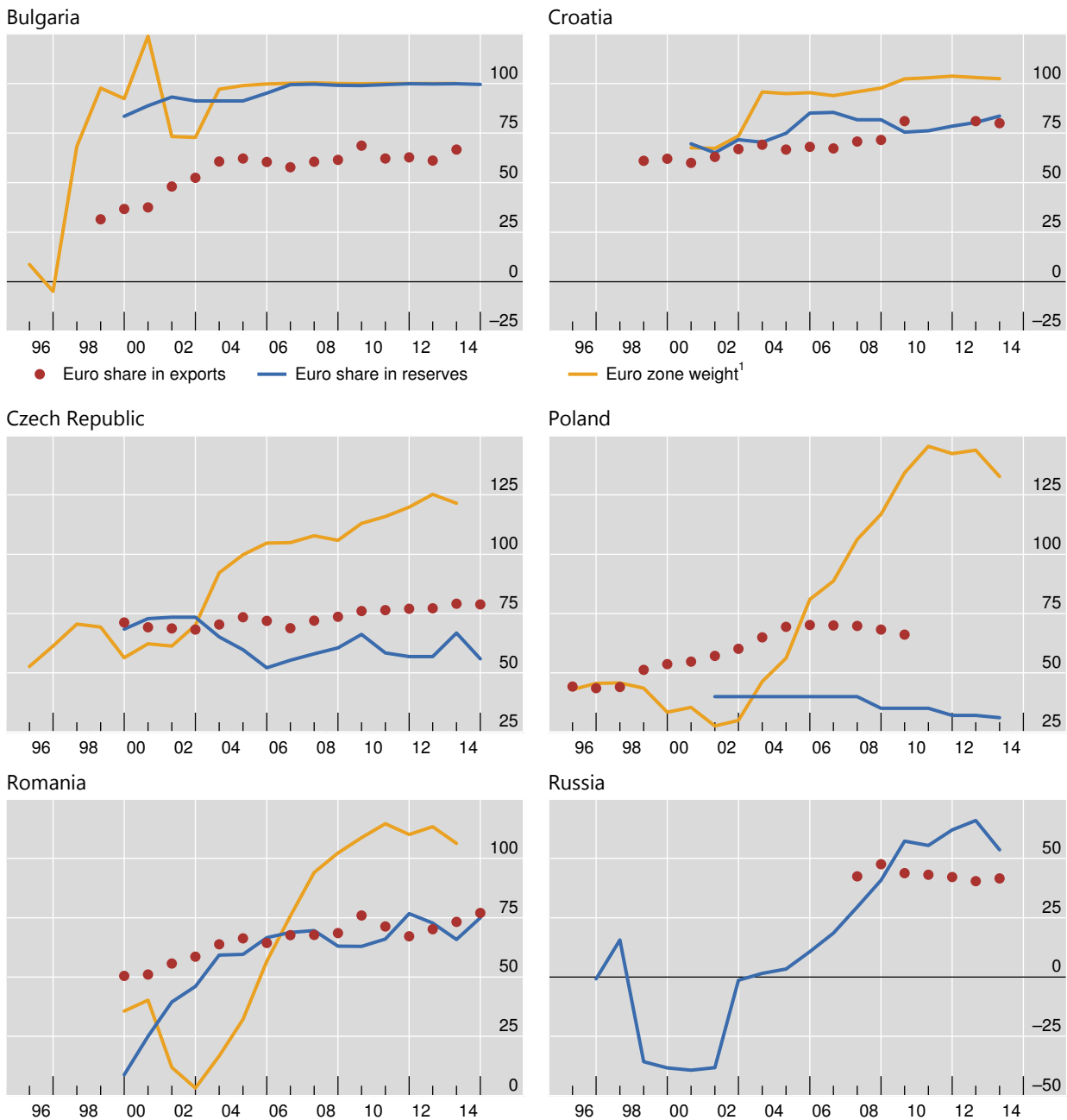
Source: authors' estimates.

As Graph 6 shows, the data on the euro share in export invoicing is more available than that of the dollar. The Annex repeats the analysis of Table 3 using the euro share in exports instead of the dollar share, in order to gain observations. The results are qualitatively similar, albeit more demanding to interpret share.

The data plotted on Graph 6 allow us to examine our question from entirely different angle. That is, we examine whether the euro share of foreign reserves for our sample countries is driven by the euro share in the countries' export invoicing, the euro zone weight, or both. One expects the estimates of the coefficients on the

Shares of euro in export invoicing, currency movement, and reserves holding

In per cent   Graph 6

Bulgaria

Croatia

● Euro share in exports   —— Euro share in reserves   —— Euro zone weight[1]

Czech Republic

Poland

Romania

Russia

[1] Average over four years.

Sources: H Ito and M Chinn (2014 and updates); Datastream; national data, BIS calculations.

explanatory variables to have the same signs as in the dollar share estimations. So; the higher euro share in a country's exports, and the more stability the country pursues in the exchange rate movement against the euro, the higher should be the share of reserves in the euro. Besides getting us more observations, this different perspective provides a robustness check.

The results of the analysis focused on euro 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-denominated foreign reserves, which is still the case when we control for the euro zone weight (Table 4, columns (1-3, 7-9)). Compared to the estimations with the US dollar share in reserves (Table 3), the magnitude of the estimates for the effect of the euro share in export invoicing on the euro reserve share is generally greater in size. A percentage point increase in the euro share in export invoicing leads to a 0.72-0.82 increase in the euro share in foreign reserves (Table 4, columns (1-3, 7-9)), with its effect closer to the 1:1 ratio. Conversely, the impact of the euro zone weight on the euro reserve share is smaller compared to that of the dollar zone weight on the dollar share of foreign reserves. Furthermore, when the estimation includes both the euro share in export invoicing and the euro zone weight measure, the euro zone weight becomes insignificant.

When the above estimations are repeated using the dollar- or euro-share in import invoicing, the results are qualitatively similar. That strengthens the results presented in Tables 3 and 4.

Stepping back, we find that the decline in the dollar share of official foreign exchange reserves that was observed in all six emerging market economies in central and eastern Europe resulted from both shift away from dollar export invoicing and a shift toward greater currency movement against the dollar. Increasing trade integration with the euro area led to more euro export invoicing, and more discontinuously, to a shift toward more stable currencies vis-à-vis the euro. Given these dynamics, the more gradually moving trade invoicing emerges from the panel analysis as a stronger drive in the declining dollar sharer of reserves.

Panel analysis of the euro share of reserves in central and eastern Europe

Dependent variable: share of Euro in reserves, unbalanced panel 1998-2013   Table 4

	OLS	FE	RE	OLS	FE	RE	OLS	FE	RE
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
% of Euro in exports	-0.20	0.82	0.80				-0.63	0.78	0.72
	(0.30)	(0.16)***	(0.16)***				(0.29)**	(0.19)***	(0.19)***
Euro Zone Weight				0.18	0.07	0.08	0.34	0.02	0.03
				(0.08)**	(0.04)*	(0.04)**	(0.09)***	(0.05)	(0.05)
N	66	66	66	79	79	79	66	66	66
Adj. R2	-0.01	0.24	.	0.05	-0.03	.	0.18	0.23	.
Overall R2	.	0.01	0.01	.	0.07	0.07	.	0.00	0.00
Between R2	.	0.19	0.19	.	0.21	0.21	.	0.16	0.13
Within R2	.	0.30	0.30	.	0.05	0.05	.	0.30	0.30

Notes: OLS denotes ordinary least squares; FE, fixed effects; RE, random effects. * p<0.1; ** p<0.05; *** p<0.01. t-statistics are in brackets. Estimates of the constant term are not reported.

Source: authors' estimates.

6. Conclusions

This article analyses the relationships among the unit of account and means of exchange functions of an international currency, on the one hand, and its store of value in official use, on the other hand. Historical evidence links the currency composition of reserves to currency movements. The currency composition of reserves is strongly related in the cross-section to both currency movements and the currency denomination of trade. In particular, we find that the higher the extent of export invociing in the dollar and the higher the co-movement of a given currency with the dollar, the higher the economy's dollar share of official reserves. Two thirds of the variation in the dollar share of foreign exchange reserves is related to the export invoicing in dollars or the respective currency's dollar zone weight. Data limitations make it hard to distinguish these two factors.

A panel analysis of five countries from central and eastern Europe shows that both trade invoicing and currency movements drove a decline in the portion of official reserves invested in the dollar. The gravity model tells us that these countries naturally traded more with the euro area, and, since they are small countries selling to a big market, invoicing exports in euros also came naturally. Both factors encouraged a more stable exchange rate against the euro than the dollar, either as a market outcome (eg Poland) or as a policy choice (eg Bulgaria).

Looking forward, our findings also have implications for the possible evolution of China's reserves and the renminbi as a reserve currency. Ito and Chinn (2014) show that the average of the dollar share in export invoicing among the Asian economies is as high as 90%, indicating that the supply chain network in Asia is highly dollar-dependent. If the renminbi displaces the dollar in trade invoicing, it will not provide guidance in the choice of China's own reserve composition, since China cannot hold its own currency in its reserves. Instead, the management of the renminbi against major currencies will, according to Graph 2, provide the guidance. The basket management of the renminbi that figures in official statements would suggest a smaller share of dollar reserves than the global average of 60%.[9]

For China's trading partners, both changing trade invoicing and currency movements could make renminbi reserves more attractive. The strategy of renminbi internationalisation since 2009 has been to allow the renminbi to be used across borders in the settlement of trade. If this leads to the denomination of trade in the renminbi, that is, a redistribution of currency risk between the two trading counterparties relative to invoicing in the dollar, euro or yen, then our results suggest that the renminbi will become more attractive as a reserve currency.

But our results also suggest that larger co-movement of the currencies of China's trading partners with the renminbi is part of the story. We have seen in central and eastern Europe how changes in currency movements eventually accompanied changes in trade invoicing. On this view the debate over the extent to which the other currencies are co-moving with the renminbi is important (Subramanian and Kesssler (2013), Kawai and Pontines (2014), and Shu et al (2014). Changes in the co-movement of currencies could result in more rapid than commonly thought shifts in the composition of reserves, potentially boosting the renmiinbi.

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[9] For discussion, see Frankel and Wei (2007), Frankel (2009), and Ma and McCauley (2010).

Annex: Further panel analysis of central and eastern Europe

By using the euro share of exports instead of the dollar share of exports in a panel otherwise identical to that reported in Table 3, we are able to boost the size of the sample. Estimations with larger samples yield results that are qualitatively similar (Table A). Since the euro share should rise when the dollar share declines, or vice versa, we should expect the opposite sign for the variable for the euro share in export invoicing. The magnitude of the euro share of trade coefficient is larger in absolute terms while that of the dollar zone share is smaller.

Panel analysis of the US dollar share of reserves in central and eastern Europe

Dependent variable: share of USD in reserves   Table A

	OLS	FE	RE	OLS	FE	RE
	(1)	(2)	(3)	(4)	(5)	(6)
% of Euro	0.01	-0.94	-0.91	0.27	-0.77	-0.68
in exports	(0.23)	(0.15)***	(0.15)***	(0.19)	(0.15)***	(0.16)***
Dollar Zone				0.35	0.13	0.15
Weight				(0.06)***	(0.04)***	(0.05)***
N	67	67	67	67	67	67
Adj. R2	-0.02	0.34	.	0.31	0.41	.
Overall R2	.	0.00	0.00	.	0.05	0.08
Between R2	.	0.27	0.27	.	0.04	0.01
Within R2	.	0.39	0.39	.	0.47	0.46

Notes: OLS denotes ordinary least squares; FE, fixed effects; RE, random effects. * p<0.1; ** p<0.05; *** p<0.01. t-statistics are in brackets. Estimates of the constant term are not reported.

Source: authors' estimates.

References

Aizenman, J and J Lee (2007): "International reserves: precautionary versus mercantilist views, theory and evidence", *Open Economies Review*, vol 18, pp 191-214.

Bank for International Settlements (2015): *Annual Report*, Chapter V, June.

Bénassy-Quéré, A, B Coeuré and V Mignon (2006): "On the identification of de facto currency pegs", *Journal of the Japanese and International Economies*, vol 20, pp 112–27.

Blanchard, O, F Giavazzi and F Sa (2005): "International investors, the U.S. current account, and the dollar", Brookings Papers in Economic Activity, 2005:1, pp 1-65.

Borio, C, J Ebbesen, G Galati and A Heath (2008a): "FX reserve management: elements of a framework", *BIS Papers*, no 38, March.

Borio, C, G Galati and A Heath (2008b): "FX reserve management: trends and challenges", *BIS Papers*, no 40, May.

Bracke, T and I Bunda (2011): "Exchange-rate anchoring: is there still a de facto dollar standard?", ECB *Working Paper Series*, no 1353, June.

Debelle, G (2015): "Bond market liquidity, long-term rates and China", speech to Actuaries Institute "Banking on Change" Seminar, Sydney, 16 September.

Dooley, M (1986): "An analysis of the management of the currency composition of reserve assets and external liabilities of developing countries", in R Aliber (ed), *The reconstruction of international monetary arrangements*, Macmillan, pp 262–80.

Dooley, M, S Lizondo and D Mathieson (1989): "The currency composition of foreign exchange reserves", *IMF Staff Papers*, vol 36, pp 385–434.

Eichengreen, B and D Mathieson (2000): "The currency composition of foreign exchange reserves: retrospect and prospect", *IMF Working Papers*, no 00/131, July.

Eichengreen, B, L Chiţu, and A Mehl (2014): "Stability or upheaval? The currency composition of international reserves in the long run," European Central Bank *Working Paper Series* 1715.

European Central Bank (2014): *The international role of the euro*, July.

Frankel, J (2009): "New estimates of China's exchange rate regime", *Pacific Economic Review*, no 14 (3), pp 346–60.

_____ and S-J Wei (1996): "Yen bloc or dollar bloc? Exchange rate policies in East Asian economies", in T Ito and A Krueger (eds), *Macroeconomic linkage: savings, exchange rates, and capital flows*, University of Chicago Press, pp 295–329.

——— (2007): "Assessing China's exchange rate regime", *Economic Policy*, July, pp 577–627.

Haldane, A and S Hall (1991): "Sterling's relationship with the dollar and the Deutschemark: 1976–89", *Economic Journal*, vol 101, no 406, May.

Hatase, M and M Ohnuki (2009): "Did the structure of trade and foreign debt affect reserve currency composition? Evidence from interwar Japan", Bank of Japan Institute for Monetary and Economic Studies, *Discussion Paper Series*, 2009-E-15.

Heller, H and M Knight (1978): "Reserve currency preferences of central banks", *Princeton Essays in International Finance*, no 131, December.

IMF, "Review of the method of the valuation of the SDR—initial considerations", 3 August 2015.

Ito, H and M Chinn (2014): "The rise of the 'redback'", *In Eichengreen, B. and M. Kawai, Eds., Renminbi Internationalization: Achievements, Prospects, and Challenges (January 2015).*

Kawai, M and S Akiyama (1998): "The role of nominal anchor currencies in exchange rate arrangements", *Journal of the Japanese and International Economies*, vol 12, pp 334–87.

Kawai, M and V Pontines (2014): "Is there really a renminbi bloc in Asia?", Asian Development Bank Institute *Working Paper Series*, no 467, February.

Kenen, P (1983): *The role of the dollar as an international reserve currency, Occasional Papers* No. 13, Group of Thirty.

Ma, G and R McCauley (2010): "The evolving renminbi regime and implications for Asian currency stability", *Journal of the Japanese and International Economies*, vol 25, no 1, pp 23-38.

McCauley, R (2015): "Capital flowed out of China through BIS reporting banks in Q1 2015", *BIS Quarterly Review,* September, pp 28-29.

_____ (1997): *The euro and the dollar,*

McCauley, R and T Chan (2014): "Currency movements drive reserve composition", *BIS Quarterly Review,* December, pp 23-36.

McCauley, R, P McGuire and V Sushko (2015): "Global dollar credit: links to US monetary policy and leverage", *Economic Policy*, vol 30, issue 82, April, pp 187-229.

McKinnon, R I (1993): *Order of economic liberalization.* Baltimore: Johns Hopkins University Press.

Nixon, W, E Hatzvi and M Wright (2015): "The offshore renminbi market and renminbi internationalization", in L Song, R Garnaut, C Fang and L Johnston, eds, *China's domestic transformation in a global context*, Canberra, ANU Press, pp - .

Schenk, C (2009): "The evolution of the Hong Kong currency board during global exchange rate instability, 1967–1973", *Financial History Review*, vol 16, pp 129–56.

_____ (2010): *The decline of sterling: managing the retreat of an international currency, 1945–1992*, Cambridge University Press.

_____ and J Singleton (2015): "The shift from sterling to the dollar 1965–76: evidence from Australia and New Zealand", *Economic History Review,* vol 68, pp 1-23.

Shu, C, D He and X Cheng (2014): "One currency, two markets: the renminbi's growing influence in Asia-Pacific", BIS *Working Papers*, no 446, April.

Subramanian, A and M Kessler (2013): "The renminbi bloc is here", Peterson Institute for International Economics *Working Paper Series*, WP 12-19, August.

Winkler, R, M Sachdeva and G Saravelos (2015): "The "Great Accumulation" is over: FX reserves have peaked, beware QT", Deutsche Bank Markets Research *Special Report*, 1 September.