Markets vs. policies: Can the US dollar's dominance in global trade be dented?*

Georgios Georgiadis[†] Helena Le Mezo[‡] Arnaud Mehl[§]
European Central Bank *European Central Bank* *European Central Bank*

Cedric Tille[¶]
Geneva Graduate Institute & CEPR

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Abstract

The US dollar is the dominant currency in global trade, used in a majority of cross-border transactions even when the US is not involved as a trading partner. However, a non-trivial share of global trade is invoiced in non-US dollar currencies, begging the question which factors have prevented even broader use of the US dollar. Moreover, the emergence of China as a major player in the global economy begs the question whether the renminbi may challenge the US dollar's dominant status. Using a novel and comprehensive global panel data set on trade invoicing currency patterns, we explore empirically how the euro has prevented absolute US dollar dominance, and whether there are first signs that the renminbi may challenge the US dollar's dominant status. We find that in particular the importance of the euro area in world trade and its involvement in global value chains have underpinned the use of the euro as invoicing currency, in part at the expense of the US dollar. Moreover, we find that while the renminbi is emerging as an invoicing currency especially in countries which have exhibited strengthening trade ties with China, so far this has generally occurred at the expense of the euro and thus not eroded the US dollar's dominance. However, we find that increases in renminbi invoicing associated with the establishment of swap lines with the People's Bank of China for countries with a large trade exposure to China have occurred at the expense of both the euro and the US dollar.

Keywords: Trade invoicing currency, dominant currency paradigm.
JEL-Classification: F14; F31; F44.

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[†]georgios.georgiadis@ecb.europa.eu
[‡]helena.lemezo@ecb.europa.eu
[§]arnaud.mehl@ecb.europa.eu
[¶]cedric.tille@graduateinstitute.ch

1 Introduction

The US dollar is the dominant currency in global trade invoicing, used in an outsized share of transactions compared to the share of the US in global trade (Goldberg and Tille, 2008; Boz et al., 2020). This dominant-currency paradigm (DCP) stands in contrast to the traditional Mundellian assumption of producer-currency pricing (PCP) under which trade prices are sticky in the currency of the exporter, as well as to the assumption of local-currency pricing (LCP) under which trade prices are sticky in the currency of the importer. The status of the US dollar in global trade is related to its dominant role in the global financial system (Gopinath and Stein, 2018), with implications for global imbalances, the global financial cycle and eventually the stability of the world economy (Caballero et al., 2008; Gourinchas and Rey, 2013; Gourinchas, 2019; Miranda-Agrippino and Rey, 2020).

In the first years after its creation, the euro was believed by some to challenge the US dollar's dominant status (Chinn and Frankel, 2008). European authorities did not actively pursue initiatives to foster the use of the euro. Instead, the view was that market forces shall underpin the international role of the euro. While it is clear by now that the euro has not challenged the dominant status of the US dollar, it is noteworthy that a significant share of global trade is invoiced in non-US dollar currencies and in particular in euro. The euro has therefore played a key role in preventing absolute US dollar dominance in global trade invoicing. However, little is know through which mechanisms the euro has held up so well against the dominance of the US dollar. This is the first gap in the literature we fill in this paper.

More recently, the emergence of China as a major player in the global economy has begged the question whether the renminbi may become another, potentially more successful challenger to the US dollar (Eichengreen, 2011; Eichengreen and Lombardi, 2017). Different to the case of the euro, China's authorities have actively supported renminbi internationalisation, for example through the 'Pilot Programme of RMB Settlement of Cross-border Trade Transactions' or the establishment of renminbi swap lines with the People's Bank of China (Chen and Cheung, 2011; Frankel, 2012; Prasad, 2016). However, little is known about whether China's emergence on the global landscape and its authorities' efforts aimed at renminbi internationalisation have started to challenge the US dollar's dominant status. This is the second gap in the literature we fill in this paper.

We frame the analysis in the paper in terms of markets vs. policies, exploring whether economic determinants predicted by economic theory—cross-border input output linkages and strategic complementarities in price setting—in case of the euro and

policy initiatives—such as central bank swap lines—in case of the renminbi have underpinned a limitation or even an unfolding challenging of the US dollar's dominant status. Our empirical analysis is based on the novel and comprehensive global panel data set on trade invoicing currency patterns, which covers up to 114 countries for 1990 to 2019 set up by Boz et al. (2020).

We find that the importance of the euro area in world trade and its involvement in global value chains have underpinned the use of the euro as an invoicing currency, in part at the expense of the US dollar. Moreover, we find that while the renminbi is emerging as an invoicing currency especially in countries which have exhibited strengthening trade ties with China, so far this has generally occurred at the expense of the euro and thus not eroded the US dollar's dominance. However, we find that increases in renminbi invoicing associated with the establishment of swap lines with the People's Bank of China (PBoC) especially for countries with a large trade exposure to China have occurred at the expense of both the euro and the US dollar.

Our paper is related to and expands existing work. Novy (2006) as well as Goldberg and Tille (2008) were the first to empirically test rigorously predictions from the theoretical literature on trade invoicing currency choice using cross-country data, but their sample included only 24 economies. Moreover, of those most were advanced economies, for which vehicle-currency use is arguably less relevant than for emerging market economies (Boz et al., 2020). In our analysis we make use of data for up to 93 economies, of which many are emerging market economies. Ito and Chinn (2014) use the data set of (Gopinath, 2015) which covers around 50 countries—a substantial portion of which is accounted for by advanced and/or EU economies—but they do not tie their analysis to the predictions from the theoretical literature discussed above. Ito and Kawai (2016) use a historical data set to study invoicing in US dollar, Japanese yen, Deutsche Mark from the 1970s through the 1990s. In contrast to Bahaj and Reis (2020) as well as Song and Xia (2019) who also test for the effect of swap lines on renminbi invoicing, we additionally explore whether any increasing use of the renminbi has come at the expense of the US dollar and/or the euro. Finally, our analysis builds on and tests theoretical predictions regarding the determinants of invoicing currency choice, in particular cross-border input-output linkages (Bacchetta and van Wincoop, 2005; Novy, 2006; Goldberg and Tille, 2008; Gopinath et al., 2010; Mukhin, 2018).

The rest of this paper is organised as follows. In Section 2 we explore empirically the relationship between global invoicing currency patterns for the US dollar and the euro on the one hand, and, on the other hand, cross-border input-output linkages and strategic complementarities in price setting. In Section 3 we then examine empirically the relationship between global invoicing currency patterns for the US dollar, the euro

and the renminbi on the one hand, and, on the other hand, trade exposures and PBOC swap lines. In Section 4 we provide concluding remarks.

2 Markets: The case of the euro

2.1 Background on euro internationalisation

[Some historical discussion, mention European Commission (2018) and Panetta (2020).]

2.2 The theory on the market determinants of trade invoicing currency choice

Several theoretical contributions have studied the determinants of a firm's choice of export invoicing currency (Bacchetta and van Wincoop, 2005; Novy, 2006; Goldberg and Tille, 2008; Gopinath et al., 2010). According to this literature, under sticky prices the exporter chooses the invoicing currency so as to minimise deviations of the pre-set price from the optimal level under flexible prices. A general finding in this literature is that complementarities in price setting and cross-border input-output linkages are key determinants of the exporter's invoicing currency choice: it is optimal for the exporter to invoice in a vehicle currency in order to limit deviations of (i) its price from that of its competitors and (ii) its marginal costs from marginal revenues.[1] Other factors identified by the theory as being relevant for the exporter's invoicing currency choice include exchange rate volatility (Devereux et al., 2004; Novy, 2006), differences in foreign exchange transaction costs across different vehicle currencies (Rey, 2001; Devereux and Shi, 2013), the correlation between firms' marginal costs and the exchange rate more generally (Devereux et al., 2004; Goldberg and Tille, 2008), and the relative bargaining power between exporters and importers (Goldberg and Tille, 2013).

[1] Strategic complementarities matter because firms lose market share significantly when their prices rise relative to their competitors and do not gain much market share when their prices fall relative to their competitors, and therefore profit maximising firms chose to keep prices relative to their competitors stable. If competitors have sticky dollar prices this will encourage the marginal firm to also price in dollars. Cross-border input-output linkages matter because firms would like to keep their prices fixed in the currency in which their marginal costs are most stable. If, for example, the US dollar appreciates against the euro when European producers use intermediate inputs imported from the US so that they face higher costs, invoicing in US dollar is appealing for European exporters as their revenue in euro will increase when their costs in euro high. Note that exchange rate volatility *per se* does not affect these invoicing decisions; instead, the relevant statistic is the correlation between firms' marginal costs, their revenues, and the exchange rate.

More recently, Mukhin (2018) has developed a comprehensive multi-country, dynamic general equilibrium model with endogenous invoicing currency choice that integrates strategic complementarities in price setting and input–output linkages in order to track the historical evolution of global trade invoicing currency patterns. Consistent with the earlier theory, Mukhin (2018) illustrates how the US dollar has emerged as a dominant currency in global trade. In particular, at first, the large size of the US market encourages foreign suppliers to use dollar invoicing in order to better align their prices with those of local competitors. Then, dollar prices of US producers' intermediate inputs are stable, and hence they are more likely to use dollar invoicing for their exports as well. In turn, this increases the share of inputs invoiced in dollars for producers outside the US, which then tend to invoice their exports in dollars, too. As more US and non-US exporters switch to dollar invoicing, the incentives for exporters that do not yet invoice in dollars to do so become ever greater. Eventually, through a mutually reinforcing feedback loop, the dollar emerges as a dominant currency in global trade.

Theory thus suggests that the use of a vehicle currency in export invoicing at the country level is greater for economies (i) whose export bundle is tilted toward goods that are subject to greater complementarities in price setting and (ii) that are more strongly integrated in cross-border input-output linkages. We focus on these factors in our analysis of how the euro has limited the US dollar's dominant status.

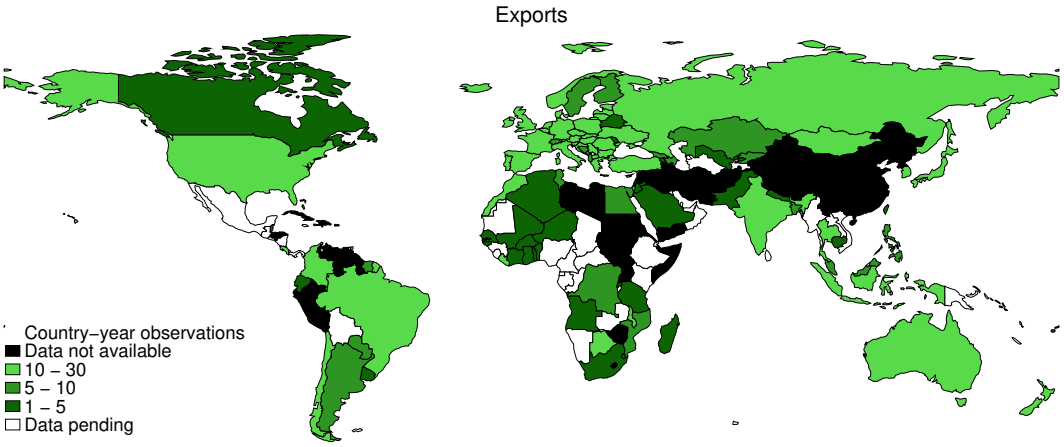
2.3 Stylised facts on US dollar and euro invoicing shares

Boz et al. (2020) assemble the most comprehensive and up-to-date panel data set of trade invoicing currency patterns for the US dollar, the euro and the exporter's home currency for 102 countries over the period from 1990 to 2019. They obtain the data from official sources through the websites of and data requests sent to central banks, statistics offices and customs/revenue authorities. In this paper, we make use of an expanded update of the data set of Boz et al. (2020) that includes the annual shares of exports and imports invoiced in US dollars and euros for 114 countries, as well as exports and imports invoiced in renminbi for up to 52 countries.[2] Figure 1 illustrates the coverage for US dollar export invoicing shares in the data set; coverage of the shares of euro invoicing and imports is very similar.[3]

[2]See Table A.1 for the list of countries and country-specific information on the data.

[3]As information on trade *invoicing* currency is recorded by customs/revenue authorities, which only record *goods* trade, the data in general does not reflect invoicing currency patterns in *services* trade. However, to the extent that the data reflect information on *settlement* currency, services trade may be covered.

Figure 1: Country coverage of US dollar export invoicing data



Note: The figure shows the global country coverage of our data on US dollar export invoicing shares. Different shades of green correspond to different numbers of available annual observations. For the countries marked in black, data are either unavailable (as confirmed by national authorities) or have not been requested. Countries marked in white are those for which data requests are pending.

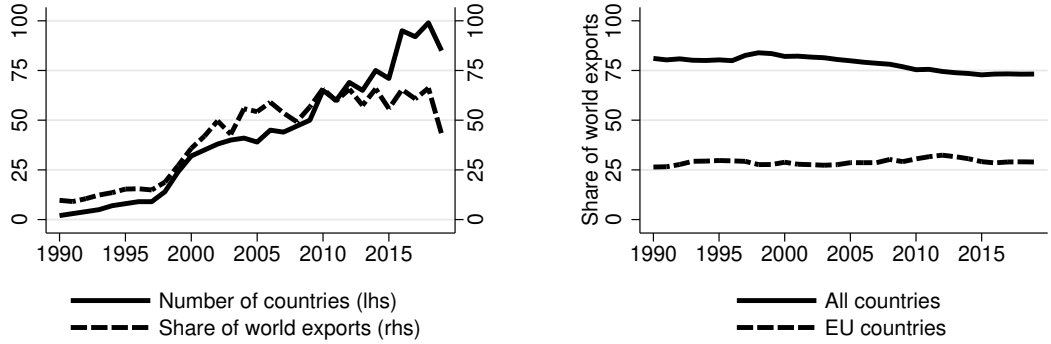
The country coverage of the data set changes over time. The solid line in the left-hand side panel of Figure 2 reveals that the maximum country coverage for data on countries' exports invoiced in US dollars in a given year is 109 (in 2018).[4] The dashed line shows that the data for US dollar invoicing shares covers more than half of world exports since the early 2000s and as much as about two thirds of world trade after 2010. Coverage for euro invoicing and for imports is very similar.

The left-hand side panel of Figure 2 indicates that most of the variation over time in the coverage of the share of world trade stems from changes in country coverage. Those changes make it difficult to explore trends in invoicing currency patterns at the level of regional or income-level country aggregates over time, since variation would largely reflect countries entering and dropping out from the sample rather than from changes in invoicing currency choices. For the purpose of presenting trends over time—but not for the regressions we run below—as in Boz et al. (2020) we interpolate and extrapolate missing data to obtain a balanced panel.[5] The solid line in the right-hand side panel of Figure 2 shows that after this interpolation and extrapolation the data cover around 75% of global exports. The dashed line in shows that EU countries account for roughly one third of the share of global exports covered by our data. The data for euro invoicing

[4]The maximum number of countries for which data is available on dollar import invoicing shares in a given year is 110; it is 106 and 109, respectively, for euro export and import invoicing shares (all in 2018).

[5]For extrapolation, we use the earliest (latest) available data point to extend backward (forward); in each case, we hold constant the value of the first (last) available data point.

Figure 2: Evolution of country and world export share coverage



Note: The figure plots the coverage of the data on the invoicing currency shares of exports over time. The left-hand side panel shows the evolution of our country count and of the share of world exports covered in the raw data; the right-hand side panel shows the share of world exports that our data cover after interpolation and extrapolation.

and imports are again similar.

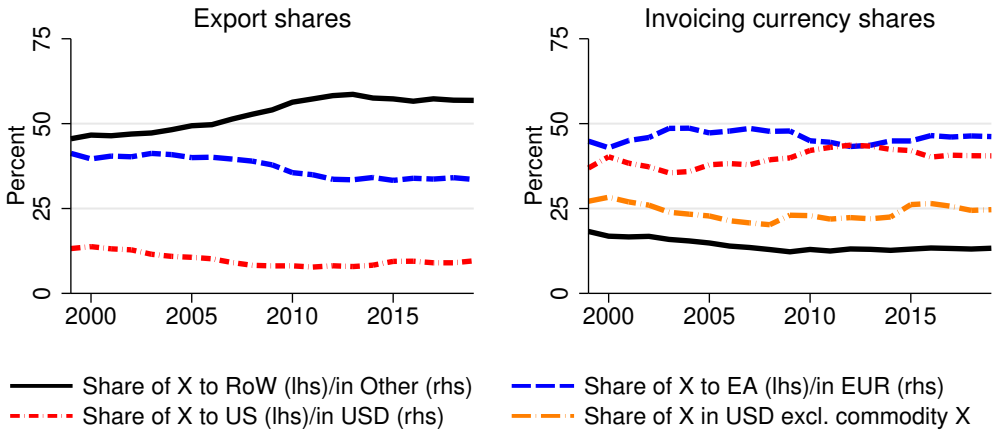
Figure 3 plots the evolution of the average export (left-hand side panel) and invoicing currency shares (right-hand side panel). The data indicate that especially compared to the US's share in world trade the US dollar is the dominant currency in global trade invoicing. However, only around 40% of world trade are invoiced in US dollar, with around 45% being invoiced in euro. Of course, a large part of the euro invoicing concerns intra-EA and trade with the EA; nonetheless, Figure 3 shows that the euro has prevented absolute US dollar dominance in global trade invoicing.

The data in the right-hand side panel in Figure 3 indicate that after 2010 there has been a slight increase in the share of world exports invoiced in euros (blue dashed line). At the same time, the left-hand side panel indicates that after 2010 the shares of world exports destined to the EA have been relatively stable. The data thus seem to suggest that there has been a slight increase in the use of the euro as a vehicle currency.

For the US dollar, the right-hand side panel points to a decline in the share of world exports invoiced in US dollar after 2010 (red dash-dotted line). However, when focusing on non-commodity exports, US dollar invoicing has actually increased (orange dashed line). Consistent with this, the left-hand side panel shows that since 2010 the share of world exports destined to the US has also increased.

Finally, the right-hand side panel shows that the share of world exports invoiced in currencies other than the US dollar and the euro has slightly increased since 2010 (black solid line). The corresponding share of world exports depicted in the left-hand side panel has however not changed much after 2010, even if there was an initial increase

Figure 3: Global trade and invoicing currency shares over time



Note: The left panel depicts the evolution of the share of exports to the US, the EA, and the rest of the world in total global exports; the right panel plots the share of global exports that are invoiced in US dollars, euros, and other currencies. Only exports to countries for which we have invoicing data are considered. The graphs are based on interpolated and extrapolated data.

that reversed after 2013. The data thus seem to suggest that there has been a slight decrease in the use of the US dollar and the euro as vehicle currencies since 2010.

However, several caveats call for caution in drawing conclusions from Figure 3. First, Figure 3 rests on extrapolated and interpolated data that might cloud the actual trends. Moreover, it is not possible to make inferences about the mechanisms that have underpinned the trends in invoicing patterns after 2010 shown in Figure 3. And finally, it is not clear to what extent compositional and factors related to valuation effects in the recording of invoicing share data rather than changes in actual invoicing decisions account for these trends. To address these caveats, we next resort to regression analysis.

2.4 Empirical strategy

We follow Novy (2006), Goldberg and Tille (2008) as well as Ito and Chinn (2014) and estimate linear regressions

$$S_{i,t}^{k,\ell} = \alpha_i^{k,\ell} + \tau_t^{k,\ell} + \boldsymbol{\beta}^{k,\ell\prime} \boldsymbol{W}_{i,t}^{k} + u_{i,t}^{k,\ell}, \tag{1}$$

where $S_{i,t}^{k,\ell}$ is the share of country i's period-t trade flow $k \in \{x, m\}$ invoiced in currency $\ell \in \{\$, €\}$, $\boldsymbol{W}_{i,t}^{k,\ell}$ is a vector of explanatory variables discussed below, and $\alpha_i^{k,\ell}$ and $\tau_t^{k,\ell}$ are country and time fixed effects, respectively.

Against the background of the theoretical discussion in Section 2.2, the two main

variables of interest that we include in $\boldsymbol{W}_{i,t}^{k,\ell}$ are countries' integration in cross-border input-output linkages and their exposure to strategic complementarities in price setting in export markets. We additionally enter in $\boldsymbol{W}_{i,t}^{k,\ell}$ the share of country i's total exports accounted for by the US and the EA as well as the exchange rate between country i's currency and the US dollar or the euro. We include the share of country i's total exports accounted for by the US and the EA in order to account for changes in invoicing patterns that are driven purely by changes in the composition of country i's trading partners rather than invoicing currency decisions in a given trade relationship. In turn, we include the exchange rate between country i's currency and the US dollar or the euro in order to account for changes in the recorded invoicing shares that arise due to exchange rate valuation effects.[6]

2.5 Measuring integration in cross-border input–output linkages and exposure to strategic complementarities

We measure countries' integration in cross-border input-output linkages by using the "vertical specialisation" index of Hummels et al. (2001), which aims to capture the imported input content of exports. We draw on data from the UNCTAD-EORA Global Value Chain Database (Lenzen et al., 2013).[7] The upper panel of Figure B.1 in Appendix B presents the average backward GVC integration over 1999-2019 for the countries in our sample.

We follow Goldberg and Tille (2008) and use the share of a country's total exports that is due to goods classified by Rauch (1999) as "homogeneous" to measure exposure to strategic complementarities in price setting in export markets. Rauch (1999) provides a careful classification of commodities at the 3- and 4-digit Standard International Trade Classification levels into one of three categories: an "organised exchange" good (e.g., precious metals) has an overt market; a "referenced priced" good (e.g., some chemical products) is homogeneous but does not have enough volume for an "official" market; however, such goods do have reference prices that are published in trade magazines. Rauch (1999) classifies all other goods, including most manufactured products, as "differentiated". It is intuitive that goods traded on an organised exchange are most easily substitutable across producers. Hence, we expect that firms

[6]We use data on nominal bilateral exchange rates from the IMF International Financial Statistics. We calculate export shares using data from the IMF Direction of Trade Statistics; for Taiwan we use data from the Ministry of Finance.

[7]We calculate the time series of backward GVC integration based on the foreign and domestic value added data available on the EORA website. Alternative sources, such as the World-Input-Output Database (Timmer et al., 2015) and the OECD Trade in Value Added database, provide data for much smaller country samples.

producing these goods face greater strategic complementarities. In contrast, we expect firms producing differentiated goods—which are presumably less substitutable—are less exposed to strategic complementarities. We apply Rauch's (1999) classification to detailed United Nations COMTRADE data for countries' goods exports.[8] The bottom panel in Figure B.1 in Appendix B presents the average share of homogeneous goods in countries' total exports over 1999-2019.

Because changes in the exposure to strategic complementarities in price setting and the extent of integration in cross-border input-output linkages may not affect invoicing decisions instantaneously, in $\boldsymbol{W}_{i,t}^{k,\ell}$ in Equation (1) we consider the average of the share of homogeneous goods in total exports and backward GVC integration over the last three years. Figure B.2 in Appendix B displays unconditional cross-sectional correlations between backward GVC integration, the share of homogeneous goods in exports, and US dollar/euro invoicing shares.

2.6 Regression results

In our baseline specification, we estimate the regressions on all data for US dollar and euro invoicing shares available from 1999 and include as many countries as possible given the data availability limitations for the independent variables. However, we exclude a number of countries for various reasons. First, we exclude India and Uganda because their data—which are recorded from June to May—cannot be cleanly assigned to a particular calendar year. We also exclude Bahamas, Cyprus, and Gambia owing to irregularities in their invoicing share data. And we cannot include Burkina Faso, Benin, Guinea-Bissau, Mali, Niger, and Togo because we only have information on their aggregated invoicing currency shares at the currency-union wide level (see Boz et al., 2020). Our regressions are run until 2018 only, because, at the time of writing, data on trade shares from the IMF Direction of Trade Statistics and on backward GVC integration from the UNCTAD-EORA Database are not available for 2019. Note again that for the regressions we do *not* use interpolated and extrapolated data as in Figures 2 and 3.[9]

Table 1 reports the results from the regression of Equation (1) for the shares of

[8]Taiwan is excluded from COMTRADE. As in Hallak and Schott (2011), we identify Taiwan's trade from flows reported by all countries in COMTRADE in which the partner is classified under UN code 490 ("other Asia, not elsewhere specified"), which reporting countries generally use to classify trade with Taiwan.

[9]Our results are robust to a number of alternative specifications, such as weighting observations by global export shares, additionally controlling for the share of a country's total exports accounted for by countries whose currencies are pegged to the US dollar or the euro, omitting observations with extreme exchange rate movements, and running the regression in first differences.

countries' exports (columns (1) to (4)) and imports (columns (5) to (8)) invoiced in US dollars. The table reports results for the baseline sample (columns (1) and (5)), the full time sample starting from 1990 already (columns (2) and (6)), a country sample without EA countries (columns (3) and (7)), and a country sample without European countries (columns (4) and (8)).

Several observations stand out. First, consistent with the theory, in all country and time samples the share of homogeneous goods exports and imports is associated with greater US dollar invoicing.

Second, in the full country samples (columns (1), (2), (5) and (6)), backward GVC integration is negatively associated with US dollar invoicing, which is inconsistent with the theory. A possible explanation is that this result is driven by a disproportionately large number of European countries in our sample.[10] Indeed, Figure 4 shows that the possibility that the finding that greater backward GVC integration is associated with greater use of the euro is driven disproportionately by European countries would also be consistent with the observation that backward GVC integration has been particularly great in Europe. Indeed, when the country samples exclude EA or European countries altogether, the negative association between US dollar invoicing and backward GVC integration disappears; we explore this further below in Section 2.7.

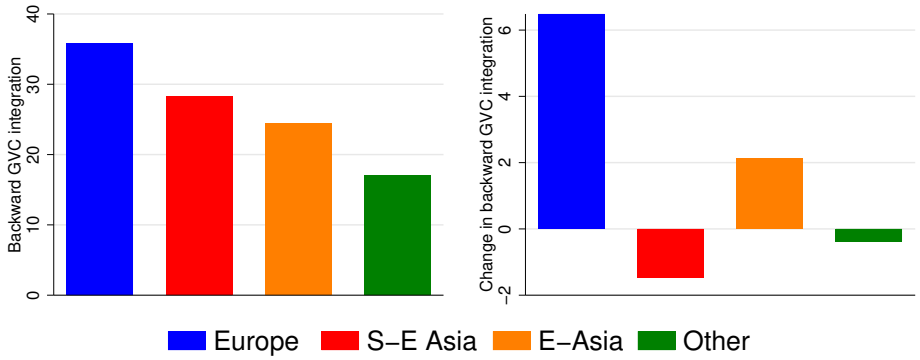
Third, changes in trading-partners composition are also systematically related to invoicing currency shares. In particular, greater export exposure to the US is associated with higher US dollar invoicing. Interestingly, greater export exposure to the EA is also associated with higher US dollar invoicing shares. On the other hand, greater import exposure to the EA is associated with lower US dollar invoicing shares. Surprisingly, greater import exposure to the US is associated with lower US dollar invoicing shares.

Finally, exchange rate valuation effects in the recording of invoicing data also seem to be relevant in the data, as an appreciation of country i's currency against the US dollar (euro) is associated with an increase (decline) in the US dollar invoicing share, at least qualitatively; that the coefficient estimates for the exchange rate are not very precise may be due to the time fixed effects in the regression, which absorb much of the common variation in US dollar and euro exchange rates across countries.

Analogous to Table 1 for US dollar invoicing shares, Table 2 reports the results from the regression of Equation (1) for the euro invoicing shares. Again several observations stand out. First, as a mirror image to the findings for the US dollar, euro invoicing shares are lower for countries with higher shares of homogeneous goods in their trade.

[10]Note also that the country sample does not include Mexico and has but a single observation for Canada, the two most important countries in the American value chain. Also, the country sample does not include some countries that figure prominently in the Asian value chain (see Asian Development Bank, 2019), namely China, Hong Kong SAR, Laos, Singapore, and Vietnam.

Figure 4: GVC integration levels and changes for selected regional aggregates



Note: The figure displays the average level of and change in backward GVC integration, from 1990 to 2018, as measured by the vertical specialisation index of Hummels et al. (2001) (see also Belotti et al., 2020). The data are from the UNCTAD-EORA database. "Europe" includes EU countries in addition to Albania, Bosnia and Herzegovina, Belarus, Iceland, Moldova, Northern Macedonia, Montenegro, Norway, Serbia, Switzerland, and Ukraine. Southeast Asia includes Cambodia, Indonesia, Macao SAR, Malaysia, and Thailand; East Asia includes Japan, South Korea, Mongolia, and Taiwan.

Table 1: Regression results for US dollar invoicing shares

	Exports				Imports			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Share of homogeneous goods in total X/M	0.27***	0.38***	0.33***	0.20**	0.35***	0.37***	0.28***	0.39***
	(0.00)	(0.00)	(0.00)	(0.03)	(0.00)	(0.00)	(0.00)	(0.00)
Own/trading-partner backward GVCP	-0.33*	-0.66***	0.04	0.12	-1.02*	-1.39**	-0.33	-1.10
	(0.08)	(0.01)	(0.77)	(0.12)	(0.08)	(0.01)	(0.67)	(0.39)
Share of X/M to/from US in total X/M	0.76***	0.70***	0.74***	1.00***	-0.09	-0.34**	-0.30**	-0.19*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.30)	(0.05)	(0.03)	(0.10)
Share of X/M to/from EA in total X/M	0.10*	0.17**	0.24***	0.26***	-0.58***	-0.58***	-0.23*	0.03
	(0.06)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)	(0.06)	(0.84)
Bil. nom. FX against USD (+ is appreciation)	0.31	0.53	0.40	-0.22	0.58*	0.56*	0.65**	0.60
	(0.45)	(0.18)	(0.36)	(0.56)	(0.07)	(0.05)	(0.04)	(0.21)
Bil. nom. FX against EUR (+ is appreciation)	-0.33	-0.55	-0.40	0.25	-0.60*	-0.59**	-0.68**	-0.68
	(0.43)	(0.17)	(0.36)	(0.51)	(0.06)	(0.05)	(0.03)	(0.16)
Within R-squared	0.30	0.31	0.34	0.56	0.22	0.19	0.16	0.24
Observations	938	995	662	417	1012	1078	735	472
Countries	89	89	71	54	94	94	76	56

Note: The dependent variable is the share of countries' exports (columns (1) to (4)) and imports (columns (5) to (8)) invoiced in US dollars. The table reports results for the baseline sample (columns (1) and (5)), the full time sample starting from 1990 already (columns (2) and (6)), a country sample without EA countries (columns (3) and (7)), and a country sample without European countries (columns (4) and (8)). Inference is based on Driscoll-Kraay robust standard errors. p-values are reported in parentheses below the point estimates, and * (**) [***] indicates statistical significance at the 10% (5%) [1%] significance level. Country and time fixed fixed effects are included in all regressions.

Table 2: Regression results for euro invoicing shares

	Exports				Imports			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Share of homogeneous goods in total X/M	-0.14***	-0.17***	-0.13***	-0.06***	-0.16**	-0.13*	-0.03	0.01
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.07)	(0.70)	(0.62)
Own/trading-partner backward GVCP	0.47***	0.50***	0.06	0.08	0.48	0.83*	-0.46	0.29
	(0.01)	(0.00)	(0.57)	(0.43)	(0.17)	(0.05)	(0.15)	(0.36)
Share of X/M to/from US in total X/M	0.05	0.10	0.17**	0.07	-0.02	0.20	0.12	-0.14*
	(0.43)	(0.14)	(0.03)	(0.23)	(0.79)	(0.18)	(0.27)	(0.08)
Share of X/M to/from EA in total X/M	0.30***	0.23***	0.19***	0.11***	0.64***	0.67***	0.37***	0.25***
	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Bil. nom. FX against USD (+ is appreciation)	-0.02	0.03	-0.07	0.06	-0.14	0.10	-0.20	-0.26
	(0.92)	(0.91)	(0.73)	(0.60)	(0.32)	(0.60)	(0.13)	(0.21)
Bil. nom. FX against EUR (+ is appreciation)	0.04	-0.01	0.07	-0.07	0.14	-0.09	0.21	0.28
	(0.86)	(0.97)	(0.71)	(0.56)	(0.30)	(0.63)	(0.11)	(0.17)
Within R-squared	0.37	0.43	0.41	0.24	0.29	0.31	0.27	0.27
Observations	945	998	664	419	1012	1074	729	466
Countries	87	87	69	52	93	93	75	55

Note: The dependent variable is the share of countries' exports (columns (1) to (4)) and imports (columns (5) to (8) invoiced in euro. The table reports results for the baseline sample (columns (1) and (5)), the full time sample starting from 1990 already (columns (2) and (6)), a country sample without EA countries (columns (3) and (7)), and a country sample without European countries (columns (4) and (8)). Inference is based on Driscoll-Kraay robust standard errors. p-values are reported in parentheses below the point estimates, and * (**) [***] indicates statistical significance at the 10% (5%) [1%] significance level. Country and time fixed effects are included in all regressions.

Second, also as a mirror image to the findings for the US dollar, in the the full country samples greater backward GVC integration is associated with higher euro invoicing shares; the result again disappears in the country samples without EA and European countries.

Third, greater trade exposure to the EA is robustly associated with higher euro invoicing shares. In case of exports, surprisingly, there is also a mild positive association with exposure to the US; for imports, the association between US exposure and euro invoicing is quite sensitive to the country and time sample.

Finally, the exchange rate coefficient estimates are generally not informative, but qualitatively plausible when they are at least somewhat more precisely estimated; again, this finding may be due to the time fixed effects in the regression.

2.7 GVC integration and the role of the euro

In order to explore in more detail the role of cross-border input output linkages, we include in Equation (1) interaction terms between countries' backward GVC integration and the share of their trade accounted for by the US and the EA. The results for the marginal effect of backward GVC integration on countries' export invoicing shares are reported in Figure 5. The left-hand side panels present results for the US dollar

invoicing shares, and the right-hand side panels for euro invoicing shares. The top row presents results for the full country sample, the middle row for the non-EA country sample, and the bottom row for the non-European country sample. The point estimate of the marginal effect evaluated at different values of countries' export shares accounted for by the US/EA is depicted by the black solid lines. The blue dashed lines indicate 90% confidence bands, and the red dashed-dotted lines indicate kernel density estimates of countries' export shares accounted for by the US/EA. The underlying regression results are reported in Table C.1 in Appendix C.

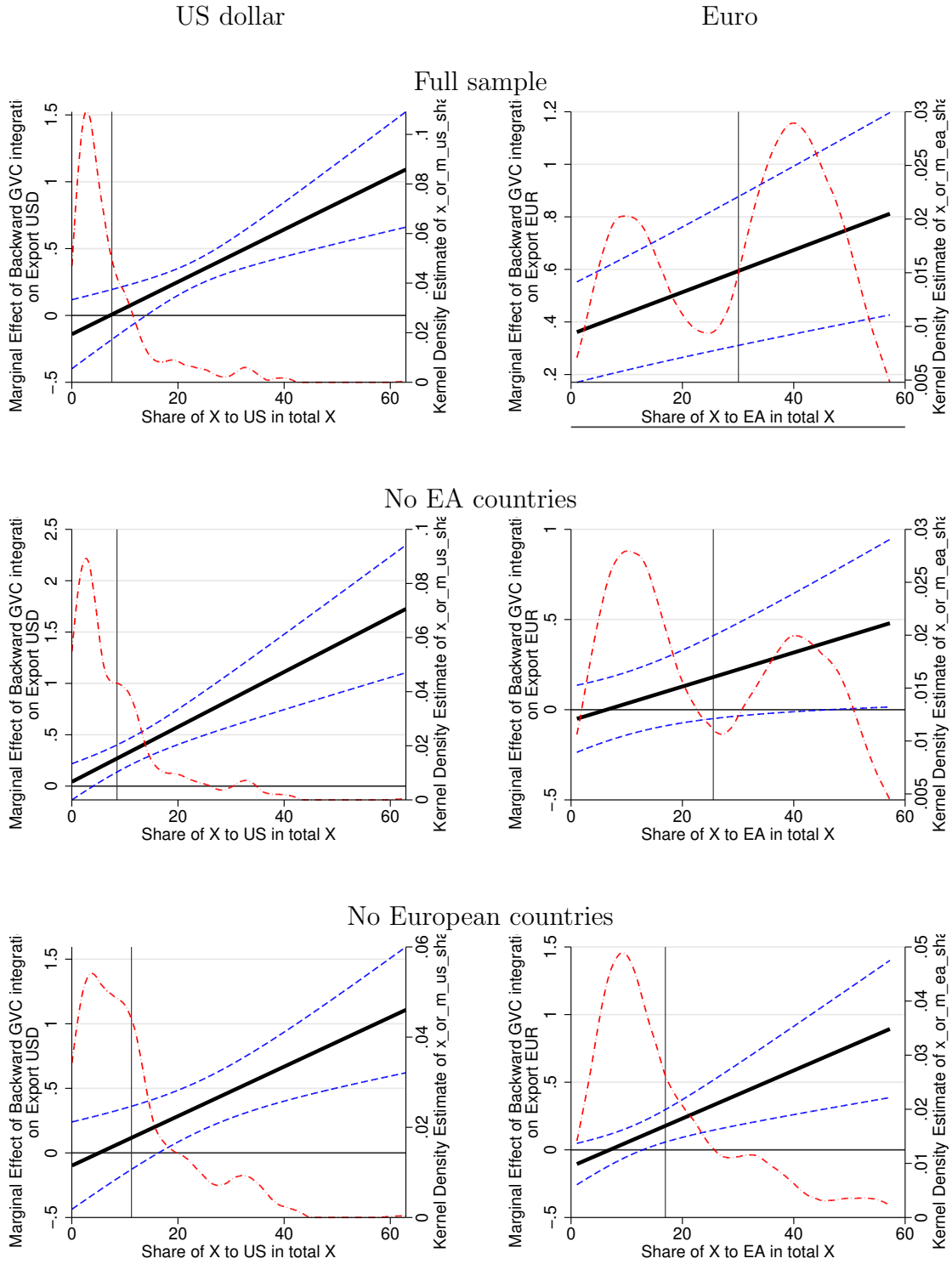
The results shown in Figure 5 indicate that greater backward GVC integration is generally associated with higher US dollar and euro invoicing shares when countries are more exposed to the US and the EA, respectively. In turn, Figure B.3 in Appendix B shows that greater backward GVC integration is generally associated with lower US dollar and euro invoicing shares only when countries are more exposed to the EA and the US, respectively. This clarifies the inconclusive findings from Tables 1 and 2, which did not indicate evidence for a systematic association between GVC integration and invoicing currency patterns across country samples. In fact, the results shown in Figure 5 suggest that GVC integration does generally not favour the use of the US dollar or the euro in trade invoicing, but that which currency is used depends on the degree of trade integration with the US and the EA.

2.8 Summary

Our findings contrasting the invoicing currency patterns for the US dollar and the euro can be summarised as follows. First, our findings confirm theoretical predictions in that the US dollar is the dominant vehicle currency used due to strategic complementarities in price setting in export markets. Second, we find that shifting trade patterns in terms of the relative role of different trading partners affect relative US dollar/euro invoicing patterns. In particular, as a greater share of countries' overall trade is accounted for by the US or the EA, the share of their trade invoiced in US dollar or in euro generally increases. And third, backward GVC integration fosters the use of the US dollar or the euro especially when countries' exports are particularly exposed to the US or the EA.

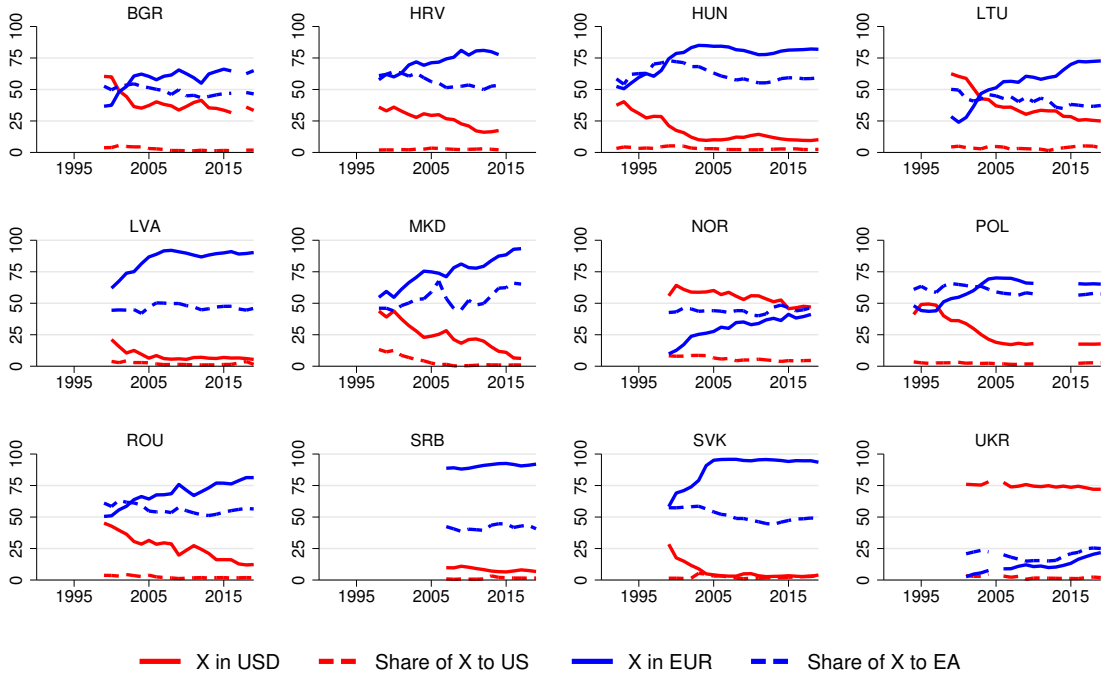
Hence, our analysis suggests that the euro has limited the US dollar's dominant role through the euro area's importance in global trade and its involvement in cross-border value chains. In this context, it is interesting to point to the impressive increase of euro invoicing in several European countries shown in Figure 6, that is consistent with the continuous deepening of European integration. Simialrly, it is interesting to point to the important role of Europe—especially contrasted with North America—

Figure 5: Marginal effects GVC integration on US dollar and euro export invoicing for different values of export exposure to the US and the EA



Note: The figure presents the marginal effects of GVC integration on US dollar and euro invoicing from Table C.1. The solid black line indicates the point estimate, the dashed blue lines 90% confidence bands, and the red dash-dotted lines kernel density estimates of the distribution of the share of countries' total exports/imports accounted for by exports to/imports from the US/EA.

Figure 6: Evolution of invoicing and export shares for selected European countries



Note: The figure plots the evolution of US dollar (solid blue lines) and euro export (solid red lines) invoicing shares as well as US (dashed red lines) and EA (dashed blue lines) export shares.

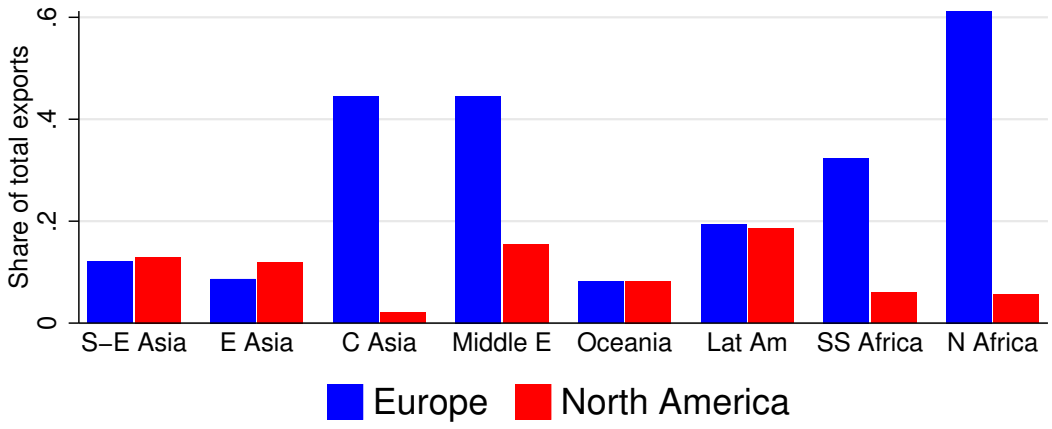
as a destination for countries' exports shown in Figure 7. Going forward, in order to preserve the euro's role as an invoicing currency, deepening European integration, enhancing the role of Europe in global trade and fostering GVCs seems to be crucial.

3 Policies: The renminbi as a new challenger to the US dollar (and the euro)?

3.1 Background on renminbi internationalisation

Since the beginning of the 1990s, China has grown in terms of economic size and has become a major player in international trade. As it is set to become the biggest economy in the world, the question whether the renminbi could become another—potentially more successful—challenger to the US dollar is natural. In contrast to the internationalisation journeys of the US dollar and the euro which were primarily driven by market forces, renminbi internationalisation has so far been a government-driven process. In particular, China's authorities have adopted several initiatives to foster the

Figure 7: Export shares accounted for by Europe and North America



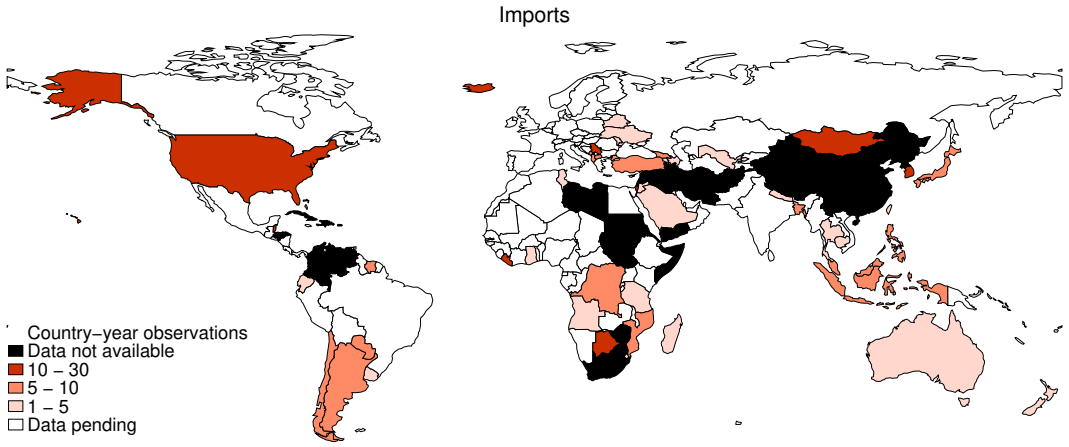
Note: The figure displays the share of goods exports of the countries in a specific region that are accounted for by exports to /imports from Europe and North America. "S-E Asia" stands for Southeast Asia, "E Asia" for East Asia, "C Asia" for Central Asia, "Middle E" for Middle East, "LatAm" for Latin America, "SS Africa" for Sub-Saharan Africa, and "N Africa" for North Africa. We only consider countries which are also used in the regressions. The data are taken from the IMF Direction of Trade Statistics. The shares are very similar if we consider all countries for which there is data in the IMF Direction of Trade Statistics.

internationalisation of its currency (Chen and Cheung, 2011; Frankel, 2012; Prasad, 2016). One such initiative has aimed strengthening the renminbi's role as a settlement currency in China's trade through the 'Pilot Programme of RMB Settlement of Cross-border Trade Transactions'. Another has been the establishment of swap lines with the PBoC.

3.2 Stylised facts on renminbi invoicing shares

The publicly available data set of Boz et al. (2020) contains only information on US dollar, euro and home currency invoicing shares. In this paper we make use of a so far not yet used/publicly available part of the data set of Boz et al. (2020) that includes renminbi invoicing shares. As the data collection of Boz et al. (2020) focused on the US dollar and the euro, information on renminbi invoicing shares are available only for a subset of 47 countries in case of exports and 52 countries in case of imports. Figure 8 presents the country coverage of renminbi invoicing shares, and the left-hand side panel in Figure 9 its evolution over time. The right-hand side panel in Figure 9 shows the evolution of the median renminbi invoicing share across countries over time. While at least for imports it has been increasing over time, in absolute terms renminbi invoicing remains at very low levels. An important caveat here is that the data set

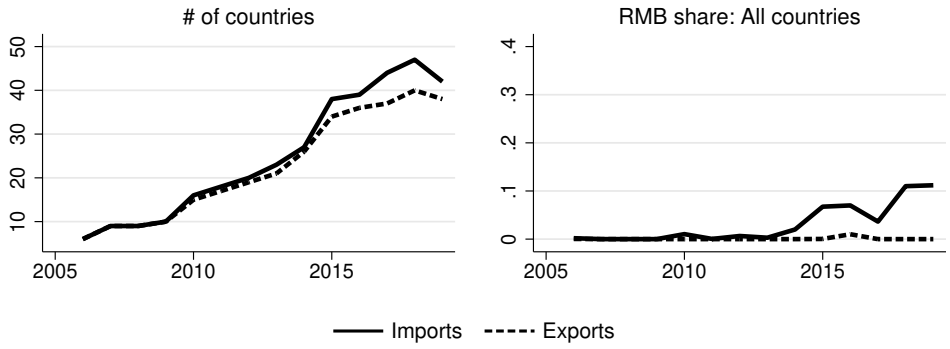
Figure 8: Country coverage of renminbi import invoicing data



Note: See the note to Figure 1.

does not include China, as well as a few Asian countries such as Vietnam, Hong Kong, Singapore, and Lao, for which we would plausibly expect greater renminbi shares. For example, China's exports settled in renminbi are in the order of 15%.

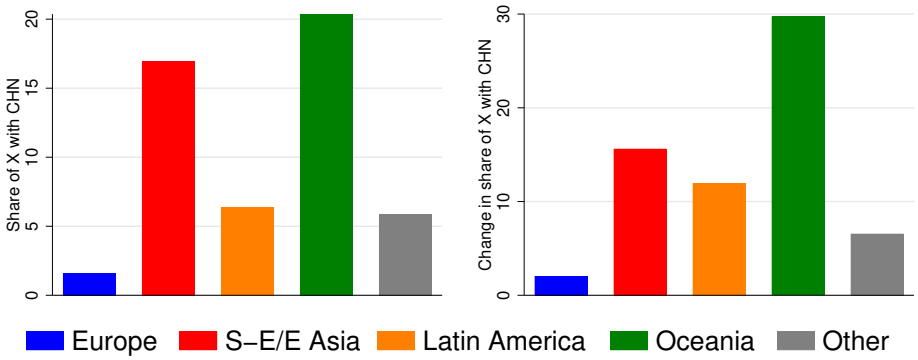
Figure 9: Evolution of renminbi invoicing share availability



Note: The figure depicts the evolution of the number of countries for which renminbi invoicing data is available (right-hand side panel) and the median renminbi invoicing share over time (right-hand side panel). Data for Mongolia are not included to avoid distortions.

Against the background of our findings from the previous section, we first explore whether growing exposures to trade with China have given rise to increasing renminbi invoicing. Thereafter, we consider the effects of the establishment of swap lines with the People's Bank (PBoC) of China as a particular policy initiative that aims at fostering the international use of the renminbi. Along the way, we also explore whether increasing use of the renminbi in trade invoicing has occurred at the expense of the US dollar and the euro.

Figure 10: Shares of trade with China in levels and changes for selected regional aggregates



Note: The figure shows the average level and change in the share of countries' exports accounted for by China for the 1999-2019 period, where "S-E/E Asia" stands for "Southeast Asia and East Asia". The data are from the IMF Direction of Trade Statistics.

3.3 Does renminbi invoicing take off as trade exposures to China grow?

Figure 10 documents that China has become a more important trading partner for many countries, most notably for those in Southeast/East Asia, Latin America, and Oceania.

Table 3 reports results of regressions for the share of countries' trade invoiced in US dollar, euro, non-US dollar/non-euro and renminbi that include the share of countries' exports/imports accounted for by China. The regressions in Table 3 use data only from 2011, as this is when China expanded the 'Cross-border Trade RMB Settlement Pilot Project' initiated originally in 2008 to trade with countries in the whole world.[11]

For exports and on average across all observations, the results suggest that as countries' experienced an increase in their exposure to China the share of their exports invoiced in renminbi increased slightly, although this is not estimated very precisely (column (4)). At the same time, these countries also experienced a strong increase in the share of their exports invoiced in US dollar (column (1)). The increase in US dollar and renminbi invoicing as countries' experienced an increase in their exposure to China has occurred at the expense of other non-US dollar/non-euro currencies (column (3)).

[11] We drop export invoicing data for Mongolia to preclude that one country has a disproportionate effect on the results. Specifically, in Mongolia the share of exports invoiced in renminbi increased from essentially zero in 2007 to 30% in 2013, oscillating somewhat after that. Also, the share of Mongolia's total goods exports destined to China accounted for around 90% from 2010. Not surprisingly, regression results including data from Mongolia indicate greater use of the renminbi as countries' trade exposure to China grows.

For imports, while estimated even less precisely, the results are qualitatively similar for the renminbi and the US dollar (columns (5) and (8))). The increase in US dollar and renminbi invoicing has come at the expense of the euro (column (6)). Table C.2 in Appendix C reports the results when the country sample is restricted to that of the renminbi regressions in columns (4) and (8); the results are overall robust, with those for the euro being reinforced. The nonetheless limited power in the results in Tables 3 and **??**ay stem from regional heterogeneities, which we explore next.

Table 3: Regression results for the role of the increase in exports to/imports from China for invoicing currency patterns

	Exports				Imports			
	(1) USD	(2) EUR	(3) Other	(4) RMB	(5) USD	(6) EUR	(7) Other	(8) RMB
Share of M from CH in total M	0.14***	-0.03	-0.09*	0.02	0.08	-0.13**	0.06	0.05
	(0.00)	(0.64)	(0.06)	(0.10)	(0.44)	(0.04)	(0.60)	(0.16)
Within R-squared	0.14	0.19	0.05	0.20	0.29	0.37	0.07	0.22
Observations	505	510	510	180	556	552	552	225
Countries	84	83	83	35	92	91	91	47

Note: The dependent variable is the share of countries' exports invoiced in US dollars (columns (1) and (2)), in euro (columns ((3) and (4)), in currencies other than the US dollar and the euro (columns ((5) and (6)), and in renminbi (columns (7) and (8)). Inference is based on Driscoll-Kraay robust standard errors. p-values are reported in parentheses below the point estimates, and * (**) [***] indicates statistical significance at the 10% (5%) [1%] significance level. Country and time fixed effects are included in all regressions. The coefficient estimates for the share of homogeneous goods in total trade, GVC integration, exchange rates and trade shares are not reported to save space.

Table 4 reports results from regressions in which we interact the share of trade accounted for by China with regional dummy variables. For exports, the results in Table 4 reveal that the increase in renminbi invoicing as countries experienced an increase in their exposure to China reported in Table 3 stems from Oceanian countries only. In contrast, the increase in US dollar invoicing reported in Table 3 has been fairly broad based across regions, including even Europe (column (1)). Allowing for regional heterogeneities reveals that euro invoicing has also changed in the face of countries' increasing exposure to China. In particular, euro invoicing shares have declined almost across the board, even for European countries (column (2)).

For imports, the results are similar to those for exports in that US dollar invoicing has generally increased and euro invoicing decreased as countries experienced an increase in their exposure to China (columns (5) and (6)). Similarly, renimnbi invoicing again increased in Oceanian countries, but for imports also in case of Southeast/East Asian countries (column (8)). One important difference in the results for imports relative to exports is that European countries in fact exhibited an increase in euro invoicing as they experienced an increase in their exposure to China, and that this oc-

curred at the expense of the US dollar and other currencies. Table C.3 in Appendix C again reports the results when the country sample is restricted to that of the renminbi regressions in columns (4) and (8); the results are again overall robust.

Table 4: Regression results for the role of the increase in exports to/imports from China for invoicing currency patterns across regions

	Exports				Imports			
	(1) USD	(2) EUR	(3) Other	(4) RMB	(5) USD	(6) EUR	(7) Other	(8) RMB
Share of M from CH in total M								
x S-E/E Asia dummy	0.32*	-0.33*	0.04	-0.01	0.70**	-0.44***	-0.26	0.25*
	(0.08)	(0.05)	(0.77)	(0.82)	(0.01)	(0.00)	(0.26)	(0.06)
x Europe dummy	1.41**	-0.71**	-0.71**	-0.01**	-0.22*	0.53***	-0.31***	-0.00
	(0.02)	(0.03)	(0.03)	(0.03)	(0.09)	(0.00)	(0.00)	(0.93)
x Latin America dummy	0.21**	-0.11	-0.07	0.01	0.28	-0.59***	0.31	-0.02**
	(0.02)	(0.13)	(0.25)	(0.69)	(0.25)	(0.00)	(0.13)	(0.01)
x Oceania dummy	0.21**	-0.13*	-0.09	0.11**	1.28	-0.66***	-0.71	0.15***
	(0.05)	(0.07)	(0.43)	(0.05)	(0.12)	(0.00)	(0.46)	(0.00)
x Sub-Saharan Africa dummy	-0.02	0.21*	-0.18**	0.00	-0.15	-0.05	0.19	0.01
	(0.75)	(0.08)	(0.05)	(0.97)	(0.59)	(0.69)	(0.45)	(0.39)
x Other region dummy	-0.45	0.15	0.32	0.01	-0.16	-0.03	0.19	-0.00
	(0.15)	(0.39)	(0.15)	(0.52)	(0.12)	(0.54)	(0.12)	(0.82)
Within R-squared	0.19	0.21	0.09	0.27	0.32	0.40	0.10	0.38
Observations	505	510	510	180	556	552	552	225
Countries	84	83	83	35	92	91	91	47
Countries in groups	9/35/10/ 3/10/17	9/35/10/ 3/10/16	9/35/10/ 3/10/16	8/5/8/ 2/4/8	10/38/10/ 4/12/18	10/38/10/ 3/12/18	10/38/10/ 3/12/18	10/8/7/ 2/8/12

Note: The dependent variable is the share of countries' exports invoiced in US dollars (columns (1) and (2)), in euro (columns ((3) and (4)), in currencies other than the US dollar and the euro (columns ((5) and (6)), and in renminbi (columns (7) and (8)). Inference is based on Driscoll-Kraay robust standard errors. p-values are reported in parentheses below the point estimates, and * (**) [***] indicates statistical significance at the 10% (5%) [1%] significance level. Country and time fixed effects are included in all regressions. The coefficient estimates for the share of homogeneous goods in total trade, GVC integration, exchange rates and trade shares are not reported to save space. The last row provides information on the number of countries for which the regional dummy variable equals unity in the regression in each column in the order they appear in the rows in the main part of the regression table.

In sum, the results indicate that the emergence of China as a major player in the global trade landscape has been associated with shifts in invoicing currency patterns. Renminbi invoicing has increased along countries' strengthening trade ties with China, in particular in Oceanian and Southeast/East Asian countries. At the same time, this has not challenged the role of the US dollar, which has in fact exhibited an increase in invoicing shares as countries experienced an increase in their exposure to China. Overall, the increasing use of renminbi and US dollar has come at the expense of the euro and other currencies.

3.4 Do PBoC swap lines foster renminbi invoicing?

3.4.1 Background and theory

China's authorities have also made efforts to foster use of the renminbi in trade settlement indirectly. In particular, the PBoC has signed renminbi-denominated bilateral swap agreements with other central banks with the stated objective to facilitate renminbi trade settlement (see People's Bank of China, 2012).[12]

A renminbi swap line is an agreement between the PBoC and a foreign central bank enabling it to borrow renminbi. For example, consider the case of an Egyptian firm in need of renminbi to settle imports from China discussed in detail by the Central Bank of Egypt (see Central Bank of Egypt, 2017, CBE). First, the CBE and the PBoC activate the currency swap, after which each party puts its local currency swap fund at the account within itself and under the name of the counterparty: The CBE provides the PBoC with EGP by opening an account on behalf of China in EGP, and the PBoC provides in exchange renminbi by opening an account on behalf of the CBE. Second, an Egyptian importer applies for a renminbi loan with an Egyptian bank. Third, the Egyptian bank applies to the CBE for a renminbi loan. The CBE then requests the PBoC to transfer the renminbi funds from the CBE's account to the Egyptian bank's account with a corresponding bank in China. Fourth, the Egyptian bank directs the corresponding bank in China to transfer the renminbi funds into the Chinese exporter's account. Fifth, the Egyptian importer repays the renminbi loan at its maturity date. The Egyptian bank notifies the CBE of the repayment and transfers the renminbi into the CBE's account within the PBoC through the corresponding bank in China.

The strategy to jump-start the internationalisation of the renminbi through swap lines is backed by theory. In particular, Bahaj and Reis (2020) study a small open-economy model in which firms choose the currency in which to obtain working capital and trade credit, as well as the currency in which they set the price for their sales. Comparing a dominant currency with a challenger vehicle currency, they derive thresholds that a challenger currency must exceed before firms in other countries start using it for their credit and sales. The thresholds depend on the distribution of financing costs in the challenger currency, the relative variances of bilateral exchange rates, and the covariance of domestic input costs with the challenger currency exchange rate. If the thresholds are exceeded, then the challenger currency can achieve vehicle-currency status. In this case, there is a complementarity between the currency choices for credit

[12] In contrast, the objective of US dollar-denominated swap lines maintained by the Federal Reserve is to mitigate US dollar shortages in foreign financial markets in particular in times of severe stress such as the Covid-19 pandemic.

and sales that creates a jumpstart. From a practical perspective, the swap lines of the PBoC represent a cropping of the right tail of the distribution of trade financing costs by providing a backstop, and could hence trigger this mutually reinforcing process.

Since the inception of renminbi internationalisation, China's authorities have gradually loosened their grip on the capital account to allow renminbi funds to flow out of China and thereby develop offshore renminbi markets. However, the remaining limited convertibility of the renminbi implies a lack and a potentially large sensitivity of renminbi offshore funding. Against this background, a PBoC swap line may indeed help overcome such funding shortages and reduce the risk of renminbi liquidity available for trade finance on the offshore market drying up (Song and Xia, 2019; Bahaj and Reis, 2020). The trade-centered nature of these mechanisms is consistent with the fact that the PBoC seems to have established swap lines in particular with countries that have significant trade ties with China (Garcia-Herrero and Xia, 2015; Liao and McDowell, 2015; Lin et al., 2016).[13]

Indeed, using SWIFT settlement data Bahaj and Reis (2020) find that a PBoC swap line PBoC raises the probability that the country uses the renminbi for payments by approximately 20%. Also using SWIFT data on the use of the renminbi in China's exports, Song and Xia (2019) find that the signing of a PBoC swap is associated with a higher share of trade settled in renminbi.

Our analysis complements those of Song and Xia (2019) as well as Bahaj and Reis (2020) along several dimensions. First, we—largely—consider *invoicing* rather than *settlement* data. One practical downside of settlement currency data—apart from not necessarily coinciding with the invoicing currency data—is that larger, more developed economies, are often hubs for international payments, which can lead to double-counting of the same underlying transactions in SWIFT. This may be important, as the model in Bahaj and Reis (2020) makes predictions about the *invoicing* rather than the settlement currency.[14] Second, at least the analysis of Song and Xia (2019) is not linked to theoretical considerations of invoicing currency choice, as they do not control

[13]Information about the actual use of the swap lines is scarce. The PBoC reports such information only sporadically. For example, in People's Bank of China (2011) it was disclosed that only about RMB 30 billion out of the maximum possible amount of RMB 803.5 billion at the time had been used. Similarly, People's Bank of China (2015) reported that as of end-2014 only RMB 96.5 billion out of the maximum possible amount of around RMB 3 trillion at the time had been used. In a non-exhaustive exercise, McDowell (2019) reports several instances of use of nine different countries. He find that in the cases of South Korea, Singapore, Turkey, Russia and Hong Kong the renminbi swap lines were used largely for trade settlement. In contrast, Pakistan, Argentina, Ukraine and Mongolia used it to pay for imports from China which would otherwise be funded in US dollar, or just swapped the renminbi directly into US dollar to pay others.

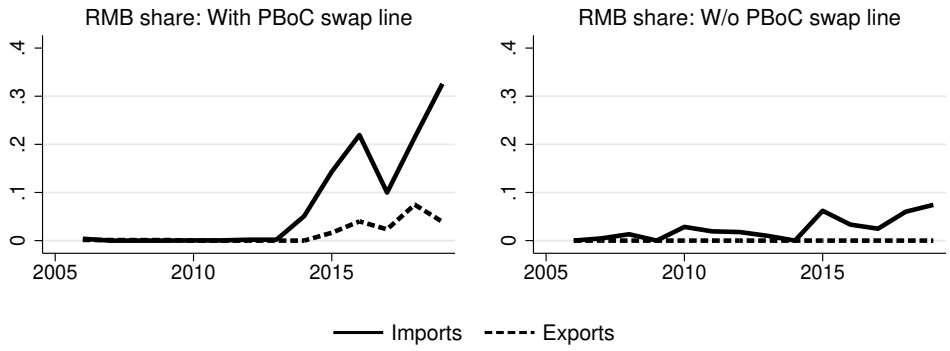
[14]In this context, reference is often made to work that documents that invoicing and settlement currency coincide. However, this evidence stems from specific advanced economies, and it is not clear if it generalises to emerging economies (e.g. Friberg and Wilander, 2008, for the case of Sweden).

for countries' exposure to strategic complementarities in price setting and their GVC integration. And Song and Xia (2019) focus on renminbi settlement in *bilateral* trade with China, while we are interested in the use of the renminbi as a vehicle currency more broadly. Most importantly, in contrast to Bahaj and Reis (2020) as well as Song and Xia (2019) we also explore whether increasing use of the renminbi has come at the expense of the US dollar and/or the euro.

3.4.2 Evidence on the effect of PBoC swap lines on renminbi invoicing

Table A.2 provides the list of the 41 PBoC swap lines at the end of 2019.[15] Note that Table A.2 also provides information about the availability of data on renminbi invoicing for these countries.

Figure 11: Evolution of renminbi invoicing shares for countries with and without PBoC swap line



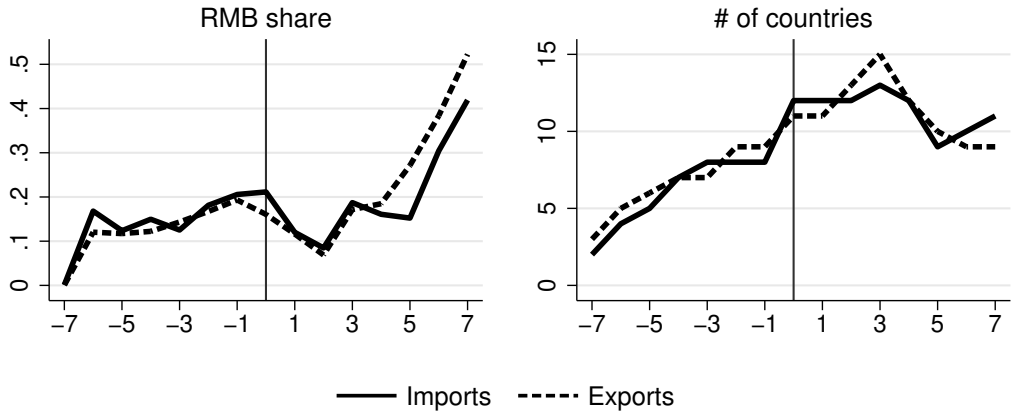
Note: The figure depicts the evolution of the median renminbi invoicing share separately for countries which established a swap line with the PBoC (left-hand side panel) and for those that did not (right-hand side panel). Data for Mongolia are not included to avoid distortions.

Figure 11 shows that renminbi invoicing increased noticeably more visibly in countries which established a PBoC swap line at some point. Analogous to Figure 7 in Bahaj and Reis (2020), the left-hand side panel in Figure 12 suggests that renminbi invoicing picked up noticeably *after* the establishment of swap lines with the PBoC. Of course, a caveat here is that the number of countries for which this is shown is small and differs over horizons (see the right-hand side panel in Figure 12). Nevertheless, Figures 11 and 12 provide at least circumstantial evidence that the establishment of PBoC swap lines may have increased renminbi invoicing.

Columns (1) and (4) in Table 5 report results from regressions for the share of exports/imports invoiced in renminbi in which we include a dummy variable that equals

[15]The swap lines typically have a three-year maturity and are renewable, although some of them were not renewed at their expiration. For our purposes we however do not distinguish between active and expired swap lines.

Figure 12: Evolution of renminbi invoicing shares after establishment of a PBoC swap line



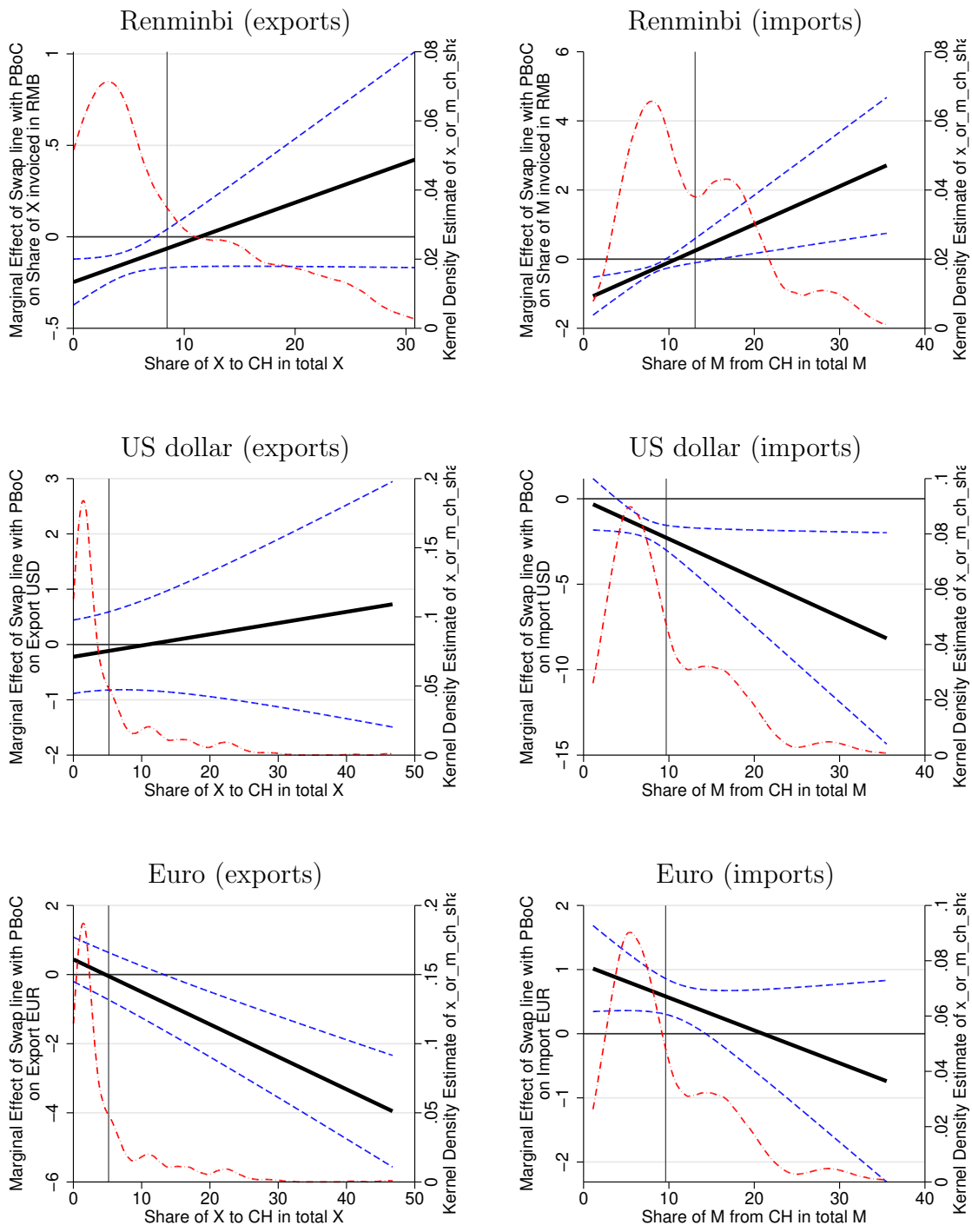
Note: The figure depicts the evolution of the mean renminbi invoicing share over time around the establishment of a swap line with the PBoC (indicated by the vertical line) in the left-hand side panel, and the number of countries for which the median is calculated in the right-hand side panel. The horizontal axis indicates years prior and after the establishment of a PBoC swap line.

unity starting from the year in which a country has signed a swap line with the PBoC.[16] The estimates in columns (1) and (4) are rather imprecise. In columns (2) and (5) we additionally include an interaction term between the PBoC swap line dummy and the share of countries' total exports/imports accounted for by exports to/imports from China. The results suggest that the establishment of a PBoC swap line has been associated with an increase of renminbi invoicing for countries which were strongly exposed to China, especially in case of imports. The panels in the top row in Figure 13 plot the marginal effects of PBoC swap lines for different of countries' trade shares accounted for by China.

One concern might be reverse causality. In particular, it could be that renminbi use in a given country increases due to some other factor besides the new policy and the country signs a swap line with the PBoC as a result of this increased demand for renminbi. However, to the extent that countries are relatively homogeneous, the time fixed effects we include in the regressions control for common trends in the adoption of the renminbi and the expansion of the swap lines. The country-fixed effects similarly deal with time-invariant country characteristics that make a country more likely to both use the renminbi in invoicing and establish a swap line with the PBoC. This still leaves the possibility of region-specific trends in renminbi use that could be correlated with the establishment of a PBoC swap line: To proxy for these we control for neighbouring

[16] We run the regressions underlying the results reported in Table 5 on data for the time period since 2007—i.e. one year prior to the establishment of the first PBoC swap line (see Table A.2)—rather than 2011 as in Tables 4 and 3.

Figure 13: Marginal effects PBoC swap lines on invoicing currency choice



Note: The figure presents the marginal effects of PBoC swap lines on renminbi invoicing from Table 5 (columns (2) and (5)) and Table 6. The results for exports are shown in the left-hand side column, and those for imports in the right-hand side column. The solid black line indicates the point estimate, the dashed blue lines 90% confidence bands, and the red dash-dotted lines kernel density estimates of the distribution of the share of countries' total exports/imports accounted for by exports to/imports from China.

Table 5: Regression results for the role of PBoC swap lines for renminbi invoicing

	Exports			Imports		
	(1)	(2)	(3)	(4)	(5)	(6)
Swap line with PBoC	-0.05	-0.25***	-0.13**	0.02	-1.19***	-1.06***
	(0.50)	(0.01)	(0.05)	(0.92)	(0.01)	(0.00)
x share of X/M accounted for by China		0.02	0.00		0.11**	0.11***
		(0.14)	(0.68)		(0.03)	(0.01)
Within R-squared	0.20	0.23	0.38	0.19	0.35	0.61
Observations	213	213	210	262	262	259
Countries	35	35	34	47	47	46
Effect of PBoC swap line for high CHN exposure		0.11 (0.52)	−0.06 (0.70)		1.03* (0.07)	1.07*** (0.01)

Note: The dependent variable is the share of countries' exports (columns (1) to (3)) and imports (columns (4) to (6)) invoiced in renmimbi. Inference is based on Driscoll-Kraay robust standard errors. p-values are reported in parentheses below the point estimates, and * (**) [***] indicates statistical significance at the 10% (5%) [1%] significance level. Country and time fixed effects are included in all regressions. The coefficient estimates for the share of homogeneous goods in total trade, GVC integration, exchange rates and trade shares are not reported to save space. The last row provides the marginal effects of PBoC swap lines on renmninbi invoicing shares, evaluated at 'high' exposure of countries' exports to/imports from China. 'High' exposure refers to the mean plus one standard deviation of the cross-country distribution of export/import shares accounted for by China. The marginal effects are plotted in the top row of Figure 13.

countries' PBoC swap lines [to be done].

One can also think of other non-trade related capital flows that lead to increased renminbi payments thanks to policies distinct from but correlated with the establishment of PBoC swap lines (Bahaj and Reis, 2020). The swap lines are often signed as part of a package of joint policies between China and the counterparty country, and it is possible that these other policies are what spurred the use of the renminbi. To address this issue, as in (Bahaj and Reis, 2020), we add to the regressions interactions with three additional measures of China's foreign economic policy as controls, namely whether a country has a renminbi clearing bank, whether it has a free trade agreement with China, and—to account for the Belt and Road Initiative—how large the infrastructure investment flows from China as ratio of GDP are. The results are reported in columns (3) and (6) in Table 5 and are consistent with those from columns (2) and (5), at least for imports.

Finally, we again explore whether the positive association between PBoC swap lines and the use of renminbi invoicing has occurred at the expense of the US dollar and/or the euro. To do so, we run regressions analogous to those underlying the results in Table 5 for the renminbi also for the US dollar, the euro and other currencies. The results are reported in Table 6. The corresponding marginal effects for the US dollar and euro invoicing are shown in the middle and bottom rows in Figure 13. The results suggest that the increase in renminbi invoicing for countries with large trade exposure to China associated with the establishment of PBoC swap lines has generally occurred

Table 6: Regression results for the role of PBoC swap lines for renminbi invoicing: All currencies

	Exports				Imports			
	(1) USD	(2) EUR	(3) Other	(4) RMB	(5) USD	(6) EUR	(7) Other	(8) RMB
Swap line with PBoC	-0.22	0.44	-0.38	-0.25***	-0.07	1.07**	-1.01	-1.19***
	(0.59)	(0.28)	(0.32)	(0.01)	(0.95)	(0.03)	(0.16)	(0.01)
x share of X/M accounted for by China	0.02	-0.09***	0.07**	0.02	-0.23	-0.05	0.28**	0.11**
	(0.47)	(0.00)	(0.03)	(0.14)	(0.12)	(0.21)	(0.02)	(0.03)
Within R-squared	0.21	0.18	0.25	0.23	0.27	0.33	0.14	0.35
Observations	680	686	686	213	750	747	746	262
Countries	84	83	83	35	93	92	92	47
Effect of PBoC swap line for high CHN exposure	0.02 (0.97)	−0.67 (0.19)	0.44 (0.37)	0.11 (0.52)	−3.74*** (0.01)	0.26 (0.33)	3.46*** (0.01)	1.03* (0.07)

Note: The dependent variable is the share of countries' exports (columns (1) to (4)) and imports (columns (5) to (8)) invoiced in US dollar (columns (1) and (5)), in euro (columns (2) and (6)), in currencies other than US dollar and euro (columns (3) and (7)) and in renminbi (columns (4) and (8)). Inference is based on Driscoll-Kraay robust standard errors. *p*-values are reported in parentheses below the point estimates, and * (**) [***] indicates statistical significance at the 10% (5%) [1%] significance level. Country and time fixed effects are included in all regressions. The coefficient estimates for the share of homogeneous goods in total trade, GVC integration, exchange rates and trade shares are not reported to save space. The last row provides the marginal effects of PBoC swap lines on renmninbi invoicing shares, evaluated at 'high' exposure of countries' exports to/imports from China. 'High' exposure refers to the mean plus one standard deviation of the cross-country distribution of export/import shares accounted for by China. The marginal effects are plotted in Figure 13.

at the expense of the US dollar in case of imports and the euro in case of exports. Table C.4 in Appendix C and Figure B.4 in Appendix B document that these findings are very similar when the sample is constrained to countries for which we have renminbi data.

3.5 Summary

Our findings suggest that while renminbi invoicing has been increasing over the last couple of years it still remains at a very low level. The observed increase in renminbi invoicing has occurred in particular as countries experienced an increase in their trade exposure to China. Moreover, the increase has been particularly strong in specific regions, namely in Oceania and Southeast/East Asia. In these cases, the increase in renminbi invoicing has occurred largely at the expense of the euro; interestingly, in these cases US dollar invoicing has increased alongside with the renminbi. Extrapolating these findings implies that if China further strengthens its role for global trade, renminbi invoicing will expand further. Lastly, our evidence suggests that specific policy initiatives aimed at fostering the use of the renminbi may prove to be successful: The establishment of PBoC swap lines with countries whose trade is particularly exposed to China was associated with increases in renminbi invoicing, in this case both at the expense of the US dollar and the euro.

4 Conclusion

[to be written.]

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A Additional Tables

Table A.1: Invoicing currency data overview

Country	Code	Range	Type	Source	Comment
North Africa					
Algeria	DZA	2001-10	invoicing	Customs Authority	Exports only for 2003-04; 2001 for euro not available due to lack of legacy currency information from Lafarguette (2015) (2003-2004 Exports; Imports: 2001-2010)
Egypt	EGY	2010-19	invoicing	Central Bank of Egypt	
Morocco	MAR	2006-16	invoicing	Ministry of Planning and Economics	
Tunisia	TUN	1995-2001, 2010-19	invoicing	Banque Centrale de Tunisie	1995-2001 from Kamps (2006), US dollar data until 2018, euro data until 2019
Sub-Saharan Africa					
Angola	AGO	2016-19	invoicing	National Bank of Angola	
Benin	BEN	2016-19	invoicing	Central Bank of West African Currency Union	Data part of the West African Currency Union aggregate excluding Cote d'Ivoire and Senegal
Botswana	BWA	2003-19	invoicing	Statistics Botswana	
Burkina Faso	BFA	2016-19	invoicing	Central Bank of West African Currency Union	Data part of the West African Currency Union aggregate excluding Cote d'Ivoire and Senegal
Cote d'Ivoire	CIV	2016-19	invoicing	Central Bank of West African Currency Union	
Democratic Republic of Congo	COD	2014-19	invoicing	Banque Centrale du Congo	
Eswatini	SWZ	2016-18	invoicing	Central Bank of Eswatini	
Ghana	GHA	2017-19	settlement	Bank of Ghana	
Gambia	GMB	2012-16	invoicing	Central Bank of The Gambia, Gambia Revenue Authority	only exports
Guinea-Bissau	GNB	2016-19	invoicing	Central Bank of West African Currency Union	Data part of the West African Currency Union aggregate excluding Cote d'Ivoire and Senegal
Liberia	LBR	2000-19	invoicing	Central Bank of Liberia	Liberian trade invoiced exclusively in US dollars according to Central Bank of Liberia. We assume such practice has been the case since 2000
Madagascar	MDG	2015-18	invoicing	Banque Centrale de Madagascar	
Malawi	MWI	2014-19	settlement	Reserve Bank of Malawi	
Mali	MLI	2016-19	invoicing	Central Bank of West African Currency Union	Data part of the West African Currency Union aggregate excluding Cote d'Ivoire and Senegal
Mauritius	MUS	2009-19	invoicing	Bank of Mauritius	
Mozambique	MOZ	2011-19	invoicing	Banco de Moçambique	
Niger	NER	2016-19	invoicing	Central Bank of West African Currency Union	Data part of the West African Currency Union aggregate excluding Cote d'Ivoire and Senegal
Rwanda	RWA	2019	invoicing	National Bank of Rwanda, Rwanda Customs	
Senegal	SEN	2016-19	invoicing	Central Bank of West African Currency Union	
Seychelles	SYC	2015-19	invoicing	Central Bank of Seychelles	Only imports
South Africa	ZAF	2003, 2017-19	invoicing	South Africa Treasury, South African Revenue Service	2003 from Kamps (2006); only exports
Tanzania	TZA	2015-19	invoicing	Bank of Tanzania	

Note: "A1" refers to trade with the rest of the world, "J6" to trade with non-euro area countries, and "V2" to trade with non-EU countries. When data for more than one concept is available for the same time period, priority is given to the A1 series, followed by the J6 series and lastly the V2 series. In these cases, J6 and V2 series are adjusted to refer to trade with the rest of the world assuming that a certain share of intra-EU and intra-euro area trade is invoiced in euros, typically 90% for euro area countries and 60% for non-euro area EU countries. When data are available for different concepts for different, non-overlapping time periods, we perform "continuation-adjustment". In particular, we adjust the V2/J6 series by assuming a euro invoicing share for intra-EU trade such that the transition between the time series is smooth. Finally, when data are available for overlapping time periods but also cover different sub-periods we backpolate and extrapolate based on actual changes, again giving priority to A1, J6 and then V2.

Table A.1: Invoicing currency data overview (continued)

Country	Code	Range	Type	Source	Comment
Togo	TGO	2016-19	invoicing	Central Bank of West African Currency Union	Data part of the West African Currency Union aggregate excluding Cote d'Ivoire and Senegal
Uganda	UGA	2015-19	invoicing	Uganda Revenue Authority	only imports
Central Asia					
Armenia	ARM	2015-19	invoicing	Armenia State Revenue Commitee	
Azerbaijan	AZE	2012-19	invoicing	Central Bank of Azerbaijan	
Georgia	GEO	2015-19	invoicing	National Bank Of Georgia	
Kazakhstan	KAZ	2013-19	settlement	Eurasian Economic Commission	
Kyrgyz Republic	KGZ	2013-19	settlement	Eurasian Economic Commission, National Bank of Kyrgyz Republic	
Uzbekistan	UZB	2018-19	settlement	Central Bank of the Republic of Uzbekistan	
South Asia					
Bangladesh	BGD	2014-19	settlement	Bangladesh Bank and Bangladesh Export Processing Zones Authority	
India	IND	1991-2000, 2005, 2008-14	invoicing	Reserve Bank of India	Invoicing shares are recorded from June to June, hence not clearly attributable to a single year; 1991-2000, 2005, 2008 from Lafarguette (2015)
Maldives	MDV	2017-20	invoicing	Maldives Customs Service	
Nepal	NPL	2015-20	invoicing	Nepal Rastra Bank	
Pakistan	PAK	2001-03	invoicing	State Bank of Pakistan	Kamps (2006)
South East Asia					
Cambodia	KHM	2015-19	settlement	National Bank of Cambodia	
Indonesia	IDN	1991, 1994-19	invoicing	Bank Indonesia	1991, 1994-2004 from Kamps (2006)
Malaysia	MYS	1995-96, 2013-2019	invoicing, settlement	Treasury Malaysia, Bank Negara Malaysia	invoicing data for 1995-96 from Kamps (2006), settlement data for 2013-2019 from Bank Negara Malaysia
Philippines	PHL	2014-2019	settlement	Bangko Sentral ng Pilipinas	
Thailand	THA	1993-2019	invoicing	Bank of Thailand	
Timor-Leste	TLS	2002-2019	invoicing	Banco Central de Timor-Leste	Trade invoiced exclusively in US dollars according to the Banco Central de Timor-Leste
East Asia					
Japan	JPN	1990-1998, 2000-18	invoicing	Japan Customs	US dollar shares for 1990-1998 from Lafarguette (2015)
Macao	MAC	2015-19	invoicing	Monetary Authority of Macao	
Mongolia	MNG	2006-19	invoicing	Central Bank of Mongolia	
South Korea	KOR	1990, 1992-2019	settlement	Statistics Korea	1990 from Lafarguette (2015)
Taiwan	TWN	2016-19	invoicing	Taiwan Customs Administration	
Middle East					
Israel	ISR	1999-2002, 2004-2007, 2010, 2012-2019	invoicing	Israel Central Bureau of Statistics	
Jordan	JOR	2018-19	invoicing	Jordan Customs	
Kuwait	KWT	2013-19	settlement	Central Bank of Kuwait	
Saudi Arabia	SAU	2018-19	invoicing	General Authority for Statistics	
Turkey	TUR	1996-2018	invoicing	Turkish Statistical Institute	

Note: "A1" refers to trade with the rest of the world, "J6" to trade with non-euro area countries, and "V2" to trade with non-EU countries. When data for more than one concept is available for the same time period, priority is given to the A1 series, followed by the J6 series and lastly the V2 series. In these cases, J6 and V2 series are adjusted to refer to trade with the rest of the world assuming that a certain share of intra-EU and intra-euro area trade is invoiced in euros, typically 90% for euro area countries and 60% for non-euro area EU countries. When data are available for different concepts for different, non-overlapping time periods, we perform "continuation-adjustment". In particular, we adjust the V2/J6 series by assuming a euro invoicing share for intra-EU trade such that the transition between the time series is smooth. Finally, when data are available for overlapping time periods but also cover different sub-periods we backpolate and extrapolate based on actual changes, again giving priority to A1, J6 and then V2.

Table A.1: Invoicing currency data overview (continued)

Country	Code	Range	Type	Source	Comment
Europe					
Albania	ALB	2010-19	invoicing	Central Bank of Albania	
Austria	AUT	2006, 2008-14, 2016-19	invoicing	ECB, nat. authorities, Eurostat	
Belarus	BLR	2015-19	invoicing	National Statistical Committee	We also have settlement data for 2013-19 from Eurasian Economic Commission, but they differ from the invoicing data for US dollar imports
Belgium	BEL	2000-12, 2014-19	invoicing	ECB, nat. authorities	
Bosnia and Herzegovina	BIH	2010-19	invoicing	Central Bank of Bosnia and Herzegovina	
Bulgaria	BGR	1999-2016, 2018-19	invoicing and settlement	ECB, nat. authorities, Eurostat	1998 from Lafarguette (2015)
Croatia	HRV	1998-14, 2016, 2018	invoicing	ECB, nat. authorities, Eurostat	1998-2000 from Lafarguette (2015)
Cyprus	CYP	2003-14, 2016-19	invoicing	ECB, nat. authorities, Eurostat	
Czech Republic	CZE	1999-2019	invoicing	ECB, nat. authorities	
Denmark	DNK	1999-2004, 2010, 2012, 2014, 2016, 2018	invoicing	ECB, nat. authorities, Eurostat	
Estonia	EST	1999-2014, 2016-19	invoicing	ECB, nat. authorities, Eurostat	
Finland	FIN	2006, 2010, 2012, 2014, 2016-19	invoicing	ECB, nat. authorities, Eurostat	
France	FRA	1999-2019	invoicing	ECB, nat. authorities	
Germany	DEU	2002-07, 2009-19	invoicing	ECB, nat. authorities, Eurostat	
Greece	GRC	2001-19	invoicing	ECB, nat. authorities	
Hungary	HUN	1992-2014, 2016-19	invoicing	ECB, nat. authorities	
Iceland	ISL	1998-2019	invoicing	Statistics Iceland	
Ireland	IRL	2006-14, 2016-19	invoicing	ECB, nat. authorities, Eurostat	
Italy	ITA	2001-12, 2014, 2016	settlement before 2010, invoicing after 2010	ECB, nat. authorities, Eurostat	
Latvia	LVA	2000-19	invoicing	ECB, nat. authorities	
Lithuania	LTU	1999-2019	invoicing	ECB, nat. authorities	
Luxembourg	LUX	2000-14, 2016-19	invoicing	ECB, nat. authorities, Eurostat	
Malta	MLT	2010, 2012, 2014, 2016, 2018-19	invoicing	Eurostat	
Moldova	MDA	2017-18	invoicing	National Bank of Moldova	We also have settlement data for 2014-18 from National Bank of Moldova, but they differ from the invoicing data for US dollar and euro exports
Montenegro	MNE	2010-19	settlement	Central Bank of Montenegro	
Netherlands	NLD	1998-2002, 2006, 2010, 2012, 2014, 2016, 2018-19	invoicing	ECB, nat. authorities, Eurostat	
Northern Macedonia	MKD	1998-17	invoicing	State Statistical Office	1998-2001 from Kamps (2006), 2002-2012 from Lafarguette (2015)
Norway	NOR	1999-18	invoicing	Statistics Norway	
Poland	POL	1994-2010, 2012, 2014, 2016-19	invoicing	ECB, nat. authorities, Eurostat	
Portugal	PRT	2000-19	invoicing	ECB, nat. authorities	
Romania	ROU	1999-2019	invoicing	ECB, nat. authorities	
Russia	RUS	2008-19	settlement	Central Bank of Russia	
Serbia	SRB	2002-03, 2007-19	invoicing	National Bank of Serbia	2002-03 from Lafarguette (2015)
Slovenia	SVN	2000-01, 2003-14, 2016-19	invoicing	ECB, nat. authorities, Eurostat	
Slovakia	SVK	1999-2019	invoicing	ECB, nat. authorities	

Note: "A1" refers to trade with the rest of the world, "J6" to trade with non-euro area countries, and "V2" to trade with non-EU countries. When data for more than one concept is available for the same time period, priority is given to the A1 series, followed by the J6 series and lastly the V2 series. In these cases, J6 and V2 series are adjusted to refer to trade with the rest of the world assuming that a certain share of intra-EU and intra-euro area trade is invoiced in euros, typically 90% for euro area countries and 60% for non-euro area EU countries. When data are available for different concepts for different, non-overlapping time periods, we perform "continuation-adjustment". In particular, we adjust the V2/J6 series by assuming a euro invoicing share for intra-EU trade such that the transition between the time series is smooth. Finally, when data are available for overlapping time periods but also cover different sub-periods we backpolate and extrapolate based on actual changes, again giving priority to A1, J6 and then V2.

Table A.1: Invoicing currency data overview (continued)

Country	Code	Range	Type	Source	Comment
Spain	ESP	1998-2014, 2016-18	invoicing	ECB, nat. authorities, Eurostat	
Sweden	SWE	2010-19	invoicing	ECB, nat. authorities	
Switzerland	CHE	2012-19	invoicing	Federal Customs Administration	
Ukraine	UKR	2001-04, 2006-19	settlement	National Bank of Ukraine	2001-04 taken from Lafarguette (2015); we also have invoicing data for 2015-19 from State Customs Service of Ukraine
United Kingdom	GBR	1999-2002, 2010-18	invoicing	ECB, nat. authorities, Eurostat, HM Revenue & Customs	
Oceania					
Australia	AUS	1997-2016	invoicing	Australian Bureau of Statistics	
Fiji	FJI	2016-19	invoicing	Fiji Revenue and Customs Services	
New Zealand	NZL	2004-19	invoicing	Stats NZ	
Solomon Islands	SLB	2015-19	settlement	Central Bank of Solomon Islands	Only US dollar
Latin America and Caribbean					
Argentina	ARG	2010-19	invoicing	National Institute of Statistics and Census	
Bahamas	BHS	2009-18	invoicing	Central Bank of The Bahamas	
Belize	BLZ	2000-19	invoicing	Central Bank of Belize	for exports only 2017-19
Brazil	BRA	2000-12, 2017-18	settlement, invoicing	Banco Central do Brasil, Ministry of Foreign Trade	Data for 2000-12 from Lafarguette (2015)
Chile	CHL	2004-19	invoicing	Chile Customs	
Colombia	COL	2007-18	invoicing	Banco de la República	Exports only
Costa Rica	CRI	2005-19	invoicing	Banco Central de Costa Rica, Direccion General de Aduanas	
Ecuador	ECU	2015-19	invoicing	Banco Central del Ecuador, National Customs Service of Ecuador	
Guyana	GUY	2019	invoicing	Guyana Revenue Authority	only imports
Paraguay	PRY	2014-2019	invoicing	Customs	
Peru	PER	2009-18	invoicing	Banco Central de Reserva del Peru	Only imports
Suriname	SUR	2010-19	invoicing	Central Bank of Suriname	
Uruguay	URY	2015-19	invoicing	Customs Authority of Uruguay	
North America					
Canada	CAN	2001	invoicing	Murray and Powell (2002)	from Kamps (2006), only US dollar exports
United States	USA	2003-18	invoicing	Bureau of Labour Statistics	

Note: "A1" refers to trade with the rest of the world, "J6" to trade with non-euro area countries, and "V2" to trade with non-EU countries. When data for more than one concept is available for the same time period, priority is given to the A1 series, followed by the J6 series and lastly the V2 series. In these cases, J6 and V2 series are adjusted to refer to trade with the rest of the world assuming that a certain share of intra-EU and intra-euro area trade is invoiced in euros, typically 90% for euro area countries and 60% for non-euro area EU countries. When data are available for different concepts for different, non-overlapping time periods, we perform "continuation-adjustment". In particular, we adjust the V2/J6 series by assuming a euro invoicing share for intra-EU trade such that the transition between the time series is smooth. Finally, when data are available for overlapping time periods but also cover different sub-periods we backpolate and extrapolate based on actual changes, again giving priority to A1, J6 and then V2.

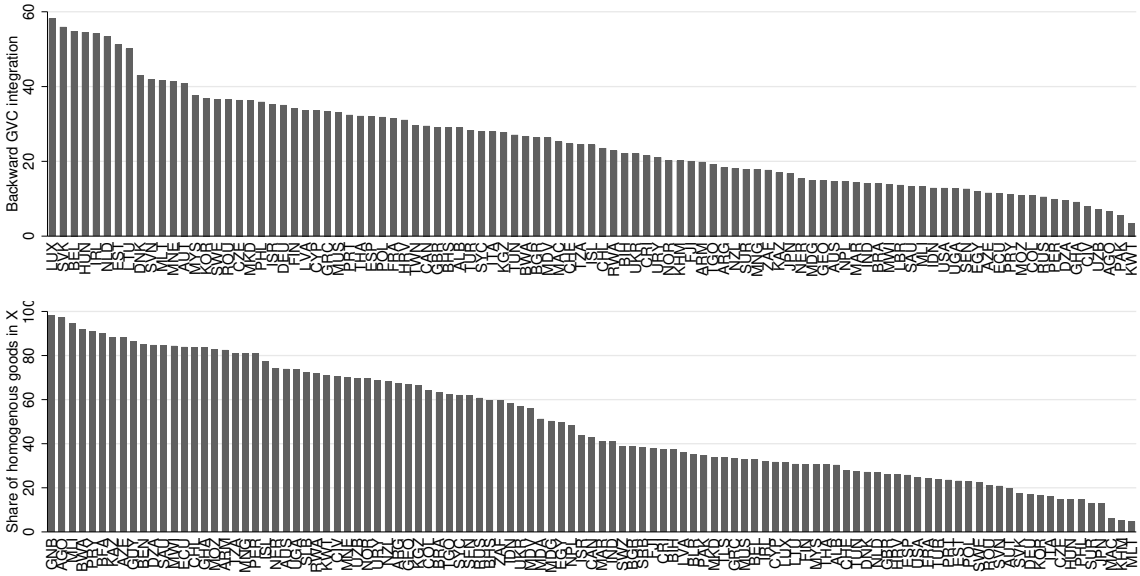
Table A.2: List of People's Bank of China renminbi swap lines

Country	Date first signed	Notional amount (RMB bil.)	RMB invoicing data since
South Korea	12/2008	180	1995
Hong Kong	1/2009	200	
Malaysia	2/2009	80	2013
Argentina	3/2009	70	2010
Belarus	3/2009	20	2015 (only imports)
Indonesia	3/2009	100	2014 imports, 2011 exports
Iceland	6/2010	3.5	2007
Singapore	7/2010	150	
New Zealand	4/2011	25	2003 exports, 2017 imports
Uzbekistan	4/2011	0.7	2018 (only imports)
Mongolia	5/2011	5	2006
Kazakhstan	6/2011	7	
Pakistan	12/2011	10	
Thailand	12/2011	70	2015
United Arab Emirates	1/2012	35	
Turkey	2/2012	10	2012 imports, 2014 exports
Australia	3/2012	200	2012
Ukraine	6/2012	15	2015
Brazil	3/2013	190	
United Kingdom	6/2013	200	
Albania	9/2013	2	2010
Hungary	9/2013	10	
Euro area	10/2013	350	
Switzerland	7/2014	150	
Sri Lanka	9/2014	10	
Russia	10/2014	150	
Canada	11/2014	200	
Qatar	11/2014	35	
Nepal	12/2014	n.a.	2015
Armenia	3/2015	1	2015 (only imports)
Suriname	3/2015	1	2010
South Africa	4/2015	30	
Chile	5/2015	22	2010 imports, 2013 exports
Georgia	9/2015	n.a.	2010
Tajikistan	12/2015	3	
Morocco	5/2016	10	
Serbia	6/2016	1.5	2007
Egypt	12/2016	18	
Nigeria	5/2018	15	
Japan	10/2018	200	2013
Macao	12/2019	20	2000

Note: The table lists the People's Bank of China's renminbi swap lines. The data is taken from Direction Générale du Trésor (2018) as well as Bahaj and Reis (2020), augmented by Nepal and Georgia for which amounts were not disclosed, as well as Macao. For the regressions, we code the dummy variable indicator as unity for a given year when the swap line was first signed until June of that year. We do not consider whether the swap line has expired and/or whether it has been renewed.

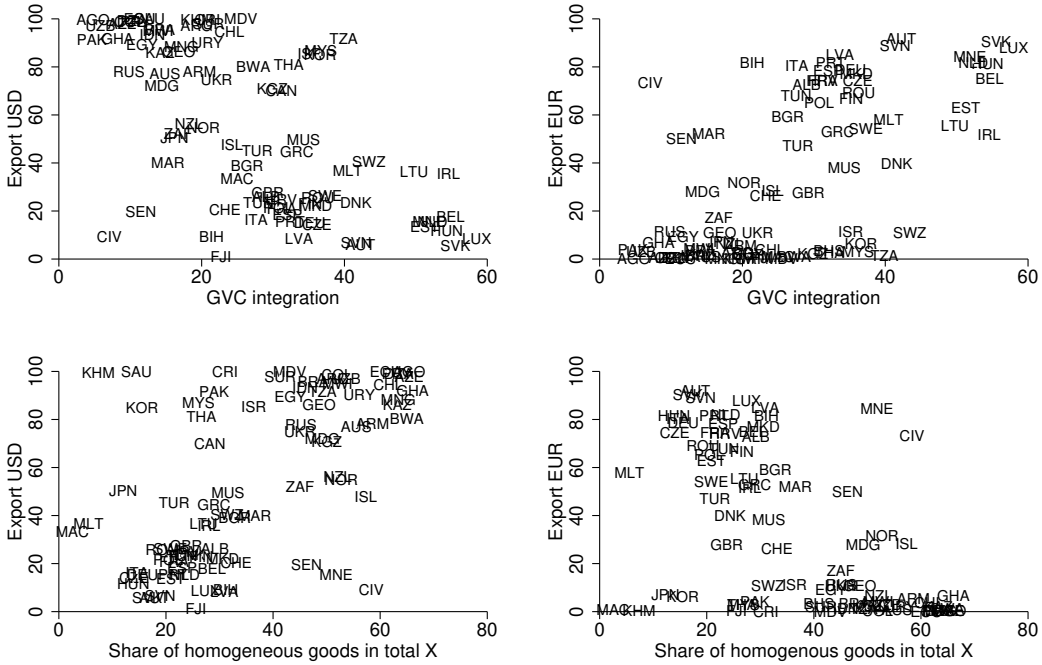
B Additional figures

Figure B.1: Average levels of backward GVC integration and the share of homogeneous goods in total exports for different values of export exposure to the EA and the US



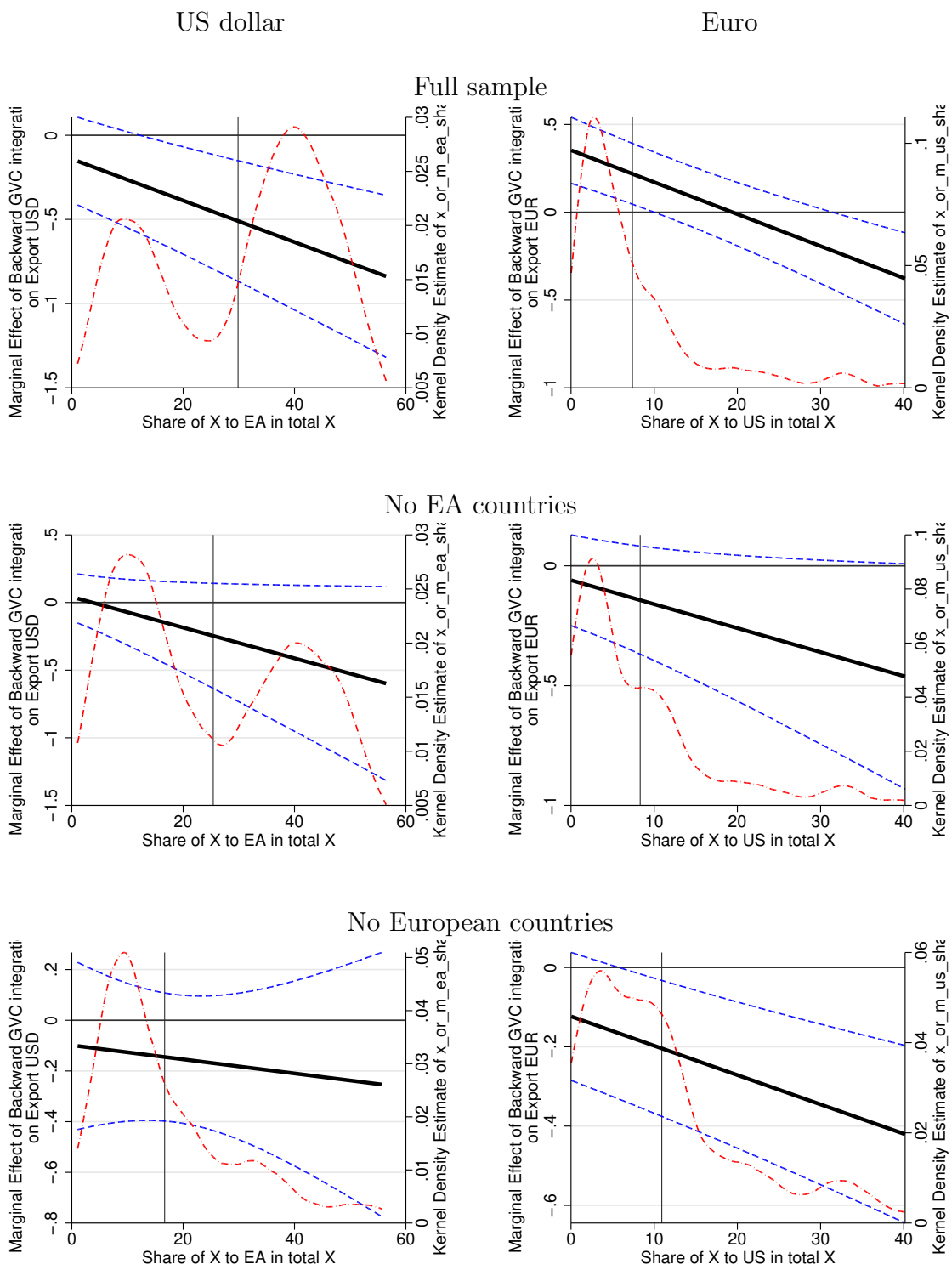
Note: The upper panel shows the average backward GVC integration as measured by the vertical specialisation index of Hummels et al. (2001) (see also Belotti et al., 2020); the lower panel shows the share of homogeneous goods in countries' exports as measured by the classification of Rauch (1999). The data, which give average levels for 1999–2019, are from the UNCTAD-EORA database and United Nations COMTRADE.

Figure B.2: Correlation between backward GVC integration, the share of homogeneous goods in exports, and US dollar/euro invoicing shares across countries



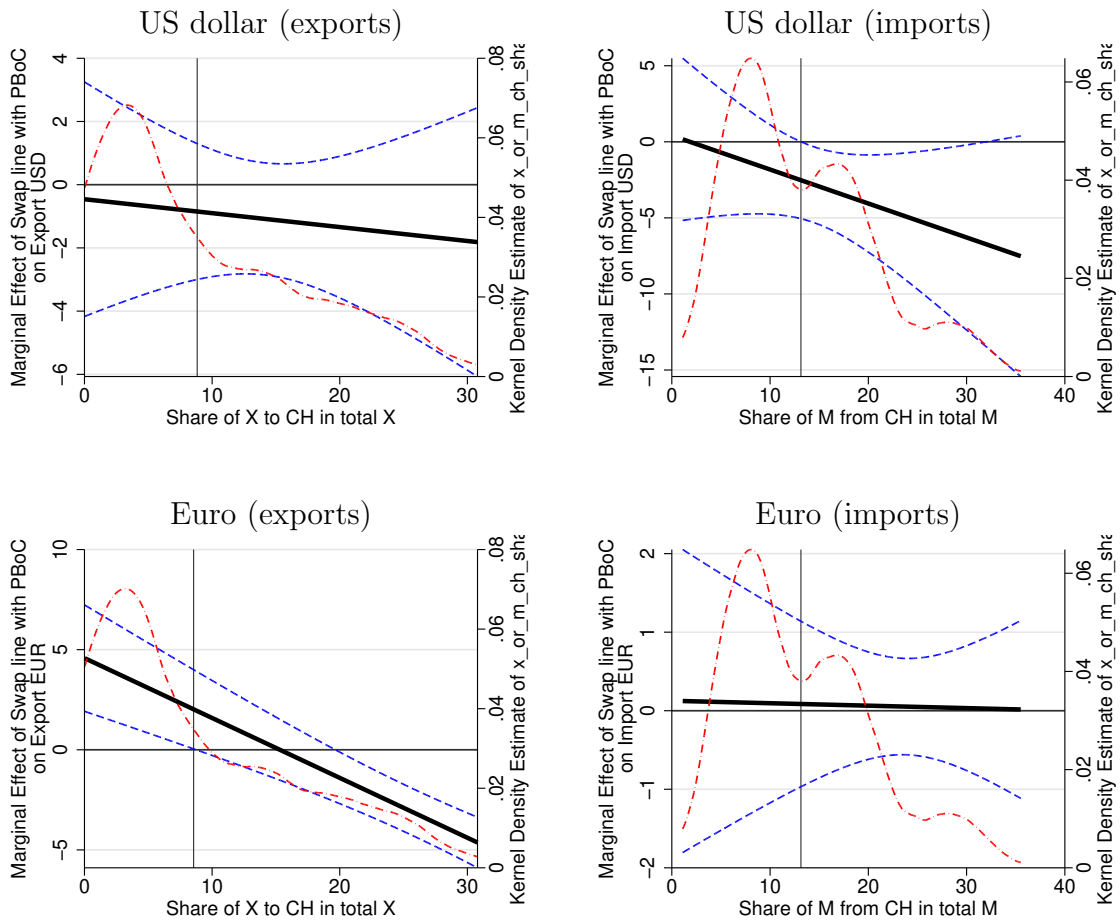
Note: The panels show unconditional cross-sectional correlations between backward GVC integration, the share of homogeneous goods in exports, and US dollar/euro invoicing shares. The data are averaged over time.

Figure B.3: Marginal effects GVC integration on US dollar and euro export invoicing



Note: The figure presents the marginal effects of GVC integration on US dollar and euro invoicing from Table C.1. The solid black line indicates the point estimate, the dashed blue lines 90% confidence bands, and the red dash-dotted lines kernel density estimates of the distribution of the share of countries' total exports/imports accounted for by exports to/imports from the EA/US.

Figure B.4: Marginal effects PBoC swap lines on invoicing currency choice for the renminbi country sample



Note: The figure presents the marginal effects of PBoC swap lines on renminbi invoicing from Table 5 (columns (2) and (5)) and Table 6. The results for exports are shown in the left-hand side column, and those for imports in the right-hand side column. The sample is restricted to countries for which there is renminbi invoicing data. The solid black line indicates the point estimate, the dashed blue lines 90% confidence bands, and the red dash-dotted lines kernel density estimates of the distribution of the share of countries' total exports/imports accounted for by exports to/imports from China.

C Additional Regression Tables

Table C.1: Regression results for the role of GVC integration in export invoicing currency patterns: Interactions with the share of exports accounted for by the US and the EA

	USD				EUR			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Share of homogeneous goods in total X	0.27***	0.26***	0.29***	0.16*	-0.14***	-0.13***	-0.12***	-0.06***
	(0.00)	(0.00)	(0.00)	(0.07)	(0.00)	(0.00)	(0.00)	(0.00)
Backward GVC integration	-0.33*	-0.14	0.04	-0.10	0.47***	0.35***	-0.06	-0.12
	(0.08)	(0.38)	(0.70)	(0.64)	(0.01)	(0.01)	(0.61)	(0.22)
x share of X to the US in total X		0.02***	0.03***	0.02**		-0.02***	-0.01*	-0.01***
		(0.01)	(0.00)	(0.01)		(0.00)	(0.10)	(0.00)
x share of X to the euro area in total X		-0.01***	-0.01	-0.00		0.01***	0.01*	0.02**
		(0.00)	(0.11)	(0.71)		(0.01)	(0.10)	(0.01)
Within R-squared	0.30	0.32	0.37	0.57	0.37	0.38	0.42	0.28
Observations	938	938	662	417	945	945	664	419
Countries	89	89	71	54	87	87	69	52

Note: The dependent variable is the share of countries' exports invoiced in US dollars (columns (1) to (4)) and euro (columns ((5) to (8)). Inference is based on Driscoll-Kraay robust standard errors. *p*-values are reported in parentheses below the point estimates, and * (**) [***] indicates statistical significance at the 10% (5%) [1%] significance level. Country and time fixed effects are included in all regressions. Regressions in columns (3) and (7) do not include euro area countries, and regressions in columns (4) and (8) do not include European countries. The marginal effects are plotted in Figure 5.

Table C.2: Regression results for the role of the increase in exports to/imports from China in invoicing currency patterns for the renminbi country sample

	Exports				Imports			
	(1) USD	(2) EUR	(3) Other	(4) RMB	(5) USD	(6) EUR	(7) Other	(8) RMB
Share of M from CH in total M	0.19***	-0.09	-0.13**	0.02	-0.03	-0.14***	0.17	0.05
	(0.01)	(0.13)	(0.01)	(0.10)	(0.90)	(0.00)	(0.51)	(0.16)
Within R-squared	0.29	0.25	0.15	0.20	0.35	0.35	0.16	0.22
Observations	172	177	177	180	222	222	222	225
Countries	35	34	34	35	46	46	46	47

Note: The dependent variable is the share of countries' exports invoiced in US dollars (columns (1) and (2)), in euro (columns ((3) and (4)), in currencies other than the US dollar and the euro (columns ((5) and (6)), and in renminbi (columns (7) and (8)). The sample is restricted to countries for which there is renminbi invoicing data. Inference is based on Driscoll-Kraay robust standard errors. *p*-values are reported in parentheses below the point estimates, and * (**) [***] indicates statistical significance at the 10% (5%) [1%] significance level. Country and time fixed effects are included in all regressions. The coefficient estimates for the share of homogeneous goods in total trade, GVC integration, exchange rates and trade shares are not reported to save space.

Table C.3: Regression results for the role of the increase in exports to/imports from China for invoicing currency patterns across regions for the renminbi country sample

	Exports				Imports			
	(1) USD	(2) EUR	(3) Other	(4) RMB	(5) USD	(6) EUR	(7) Other	(8) RMB
Share of M from CH in total M								
x S-E/E Asia dummy	0.67**	-0.59***	-0.14	-0.01	0.44	-0.33**	-0.11	0.25*
	(0.01)	(0.01)	(0.44)	(0.82)	(0.30)	(0.02)	(0.79)	(0.06)
x Europe dummy	1.28	-1.38	0.02	-0.01**	0.35	0.70	-1.06***	-0.00
	(0.31)	(0.27)	(0.89)	(0.03)	(0.33)	(0.13)	(0.01)	(0.93)
x Latin America dummy	0.21	-0.04	-0.14	0.01	0.17	-0.18**	0.02	-0.02**
	(0.27)	(0.65)	(0.38)	(0.69)	(0.21)	(0.04)	(0.91)	(0.01)
x Oceania dummy	0.22	-0.18*	-0.08	0.11**	0.60***	-0.76***	0.16	0.15***
	(0.23)	(0.10)	(0.45)	(0.05)	(0.00)	(0.00)	(0.22)	(0.00)
x Sub-Saharan Africa dummy	0.05	0.16	-0.24**	0.00	-0.29	-0.11	0.40	0.01
	(0.41)	(0.14)	(0.03)	(0.97)	(0.43)	(0.13)	(0.22)	(0.39)
x Other region dummy	-0.11	-0.22	0.28	0.01	-0.62	0.29	0.34	-0.00
	(0.75)	(0.25)	(0.26)	(0.52)	(0.25)	(0.12)	(0.38)	(0.82)
Within R-squared	0.33	0.31	0.18	0.27	0.38	0.39	0.20	0.38
Observations	172	177	177	180	222	222	222	225
Countries	35	34	34	35	46	46	46	47
Countries in groups	8/5/8/ 2/4/8	8/5/8/ 2/4/7	8/5/8/ 2/4/7	8/5/8/ 2/4/8	10/8/7/ 2/7/12	10/8/7/ 2/7/12	10/8/7/ 2/7/12	10/8/7/ 2/8/12

Note: The dependent variable is the share of countries' exports invoiced in US dollars (columns (1) and (2)), in euro (columns ((3) and (4)), in currencies other than the US dollar and the euro (columns ((5) and (6)), and in renminbi (columns (7) and (8)). The sample is restricted to countries for which there is renminbi invoicing data. Inference is based on Driscoll-Kraay robust standard errors. p-values are reported in parentheses below the point estimates, and * (**) [***] indicates statistical significance at the 10% (5%) [1%] significance level. Country and time fixed effects are included in all regressions. The coefficient estimates for the share of homogeneous goods in total trade, GVC integration, exchange rates and trade shares are not reported to save space. The last row provides information on the number of countries for which the regional dummy variable equals unity in the regression in each column in the order they appear in the rows in the main part of the regression table.

Table C.4: Regression results for the role of PBoC swap lines for renminbi invoicing: All currencies for the renminbi country sample

	Exports				Imports			
	(1) USD	(2) EUR	(3) Other	(4) RMB	(5) USD	(6) EUR	(7) Other	(8) RMB
Swap line with PBoC	-0.46	4.58**	-5.22***	-0.25***	0.41	0.13	-0.54	-1.19***
	(0.84)	(0.02)	(0.01)	(0.01)	(0.91)	(0.92)	(0.83)	(0.01)
x share of X/M accounted for by China	-0.04	-0.30***	0.35**	0.02	-0.22	-0.00	0.23	0.11**
	(0.76)	(0.00)	(0.02)	(0.14)	(0.32)	(0.95)	(0.25)	(0.03)
Within R-squared	0.54	0.26	0.61	0.23	0.36	0.32	0.28	0.35
Observations	202	208	208	213	258	258	258	262
Countries	35	34	34	35	46	46	46	47
Effect of PBoC swap line for high CHN exposure	−1.19 (0.31)	−0.33 (0.71)	0.54 (0.62)	0.11 (0.52)	−4.13* (0.06)	0.06 (0.88)	4.06** (0.05)	1.03* (0.07)

Note: The dependent variable is the share of countries' exports (columns (1) to (4)) and imports (columns (5) to (8)) invoiced in US dollar (columns (1) and (5)), in euro (columns (2) and (6)), in currencies other than US dollar and euro (columns (3) and (7)) and in renminbi (columns (4) and (8)). The sample is restricted to countries for which there is renminbi invoicing data. Inference is based on Driscoll-Kraay robust standard errors. p-values are reported in parentheses below the point estimates, and * (**) [***] indicates statistical significance at the 10% (5%) [1%] significance level. Country and time fixed effects are included in all regressions. The coefficient estimates for the share of homogeneous goods in total trade, GVC integration, exchange rates and trade shares are not reported to save space. The last row provides the marginal effects of PBoC swap lines on renminbi invoicing shares, evaluated at 'high' exposure of countries' exports to/imports from China. 'High' exposure refers to the mean plus one standard deviation of the cross-country distribution of export/import shares accounted for by China. The marginal effects are plotted in Figure B.4.