Renminbi rising? Exporters' response to China's currency internationalization[*]

Sonali Chowdhry[†]

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Abstract

This paper investigates the heterogeneous responses of exporters to policy reforms undertaken by the People's Bank of China to internationalize the Renminbi (RMB). Using detailed customs data from France for the initial years of these reforms (2011-2017), it documents several novel stylized facts on RMB adoption, highlighting both the growth and extreme skewness in RMB's uptake across firms and varieties. It further examines various mechanisms underpinning self-selection into RMB and proposes a novel channel that strongly predicts RMB adoption. This channel exploits information on firms' invoicing currency strategies in existing markets and is observed to be a valid instrument for RMB adoption. Leveraging this new instrument, the paper shows that invoicing in RMB significantly boosted exports for varieties sold to China. Overall, the findings suggest that early RMB adoption, although limited across firms, provided an important competitive edge when exporting to China.

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[†]*Affiliation:* German Institute for Economic Research & Kiel Institute for the World Economy. Email: schowdhry@diw.de. *Address:* Mohrenstrasse 58, Berlin 10117, Germany.

1 Introduction

In January 2012, the Chinese Renminbi (RMB) ranked twentieth amongst the world's currencies that are used most actively for global payments. A decade later, it stood fourth in the list after overtaking the Japanese Yen.[1] The rise in RMB use within this period overlaps with a series of reforms undertaken by the People's Bank of China (PBoC) designed to "steadily and carefully promote the internationalization of the RMB".[2] This paper exploits detailed customs data from France, one of the leading RMB clearing hubs within the Eurozone, in order to examine the effect of these internationalization reforms on the invoicing currency choice and export performance of firms selling to China.[3]

The study of firms' invoicing currency behaviour is important in numerous respects. First, the choice of invoicing currency is not exogenous but rather the outcome of firms' profit optimisation problem. It therefore constitutes an important margin of adjustment that is available to firms. Second, the choice of invoicing currency has significant distributional consequences. When pricing in the local currency of the destination, exporters bear the risk of exchange rate fluctuations. That exchange rate risk is transferred to consumers if exporters invoice their goods in the home (producer) currency. At the macroeconomic level, the choice of invoicing currency affects exchange rate pass-through into prices (Boz, Gopinath, and Plagborg-Møller, 2019) and the international transmission of shocks (Corsetti et al., 2007). Finally, from a policy perspective, there is a growing interest from central banks such as the PBoC to promote their currencies for cross-border settlements. Studying firm-level responses to these policies reveals the extent to which such efforts can successfully incentivize firms to switch their invoicing currencies.

With detailed information from France on firms' invoicing currency choices over 2011-2017, the paper reports several novel stylized facts regarding the early adoption of RMB. The first stylized fact concerns the striking growth in France's RMB-denominated monthly exports to China, from €2.3 million in January 2011 to €145 million by December 2017. These RMB-denominated exports accounted for more than a third of the total increase in French exports to China between 2011 and 2017. Despite this sharp increase, the global use of RMB by French exporters remained narrow as nearly 99% of all RMB-denominated exports were directed only towards China during this time period. Hence, RMB did not displaced either the Euro (EUR) or the US Dollar (USD) as the preferred invoicing currency of French exporters selling to other markets over 2011-2017.

Second, RMB usage shows a high degree of concentration with old varieties (those exported to China in previous years) capturing more than 75% of RMB exports in any given year. In contrast, first-time exporters to China rarely choose the RMB. Further disaggregation of RMB

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[1]For further details, see the SWIFT RMB Tracker Document Centre. Link: https://bit.ly/3tdYNIX

[2]These broad goals are also reflected in China's latest 14th Five-Year Plan for 2021-2025. For the complete (translated) document, see Murphy (2021).

[3]For further details on RMB payments within Europe, see Kärnfelt (2020).

invoicing reveals considerable granularity. RMB invoicing firms are few and even within this set, multi-product firms that invoice several products in RMB account for more than 90% of total RMB exports to China.

Drawing upon these stylized facts, the paper then reveals key drivers of firms' selection into RMB adoption. This includes channels such as operational hedging, the fixed costs of currency management and strategic complementarity which have been suggested by existing literature in order to analyse firm invoicing in established currencies such as the USD. In addition to the above mechanisms, the paper proposes a novel channel driving RMB use when it becomes newly available to foreign firms for settling their cross-border transactions.

This channel connects the selection of a specific variety (or firm-product combination) into invoicing in RMB in China, to the use of local currencies when the same variety is exported to other destinations. This is motivated by the fact that more than 75% of RMB-invoiced varieties exported to China over 2011-2017 were also sold in other markets in their respective local currencies. In the baseline specification, such local currency pricing of a given variety elsewhere corresponds to a 5.7 percentage point increase in the probability of RMB adoption in China. Furthermore, the likelihood of RMB invoicing in China is magnified for varieties which have greater experience of being exported in local currencies in other destinations. This suggests that firms may prefer to invoice certain products in local currencies across their markets but were constrained from doing so in China until the RMB internationalization reforms.

The next stage of analysis builds upon this key observation that local currency pricing in other markets is a significant predictor for RMB adoption. This novel channel is then used to instrument for selection into RMB and to determine its causal impact on firm exports to China. Such causal estimates of invoicing choice on trade flows are scarce in the literature given the high degree of stability in invoicing patterns. This paper addresses the crucial gap by exploiting time variation and firm heterogeneity in RMB invoicing during the initial years of China's currency reforms alongside the novel instrument of firms' local currency pricing in other destinations. Tests of over-identifying restrictions further confirm the validity of instruments. Based on these results, the two-stage least squares (TSLS) regressions show that invoicing in RMB increases exports of a given variety in China by 73.8% and exported quantity by nearly 50%. In contrast, there is no statistically significant change in export prices. This effect of RMB use on export sales is indicative of a substantial competitive advantage of invoicing in local currency in China.

Overall, this paper i) documents new stylised facts on firm heterogeneity in the adoption of a newly available currency (RMB); ii) proposes a novel mechanism driving selection into RMB invoicing and; iii) provides new causal estimates on the impact of RMB invoicing on export revenues in China. The remainder of this paper is structured as follows. Section 2 briefly describes prior research on firms' invoicing currency behaviour and highlights the paper's contribution to this rapidly growing literature. Section 3 outlines important milestones in China's gradual

liberalization of the RMB and discusses the motivations underlying this shift in China's currency policy. Section 4 describes the structure of French customs data and the different stylized facts concerning RMB invoicing. Following this, Section 5 analyses various mechanisms driving the selection into RMB invoicing. The causal impact of RMB invoicing on firm exports are reported in Section 6. Finally, Section 7 concludes with policy implications and suggested avenues for future research.

2   Contributions to related literature

This paper contributes to several strands of research. First, it adds new firm-level evidence to recent empirical work on the aggregate effects of China's RMB promotion policies. This includes Bahaj and Reis (2022) who investigate the impact of establishing swap lines with the PBoC on RMB usage. By exploiting bilateral country-level data from the SWIFT Institute on cross-border payments, they estimate that swap lines led to a 14 percentage point increase in the probability of a country transacting in RMB. Boz, Casas, et al. (2022) assemble an alternative dataset that provides information on the share of different invoicing currencies in aggregate exports and imports of 115 countries over 1990-2019. Unlike SWIFT, this country-level panel data focuses on invoicing rather than payments and is not altered by the presence of international payment hubs. With this data, the authors find high degree of stability in the the share of trade invoiced in USD or EUR. However, they do observe increasing use of RMB in African economies given their growing trade with China. With similar data, Georgiadis et al. (2021) also find that PBoC swap lines have increased RMB invoicing in countries that trade more intensively with China, with adverse effects on USD and EUR invoicing.

This paper contributes to the above literature on the rise in RMB usage in three different respects. First, it shifts the analysis of RMB invoicing from the country-level to the firm-level and does so for a major EU economy. It documents the rich heterogeneity across firms in RMB adoption that is masked by previously used aggregate data. Second, the use of firm-level data reduces potential threats to identification resulting from endogeneity at the country-level between trade flows and the signing of swap lines with China. Third, firm-level data enables us to investigate whether RMB invoicing had a causal impact on the revenues and prices of exporters to China. In doing so, this paper adds to firm-level evidence provided by Messer (2020) on the impact of foreign currency risk on exports. While Messer (2020) focuses on the impact of switching to the home currency on exports of Brazilian firms, this paper focuses on the impact of switching to the destination currency i.e. RMB, on French firm exports to China.

More broadly, this paper also contributes to the established literature on firm-level heterogeneity in invoicing behaviour. For instance, Amiti, Itskhoki, and Konings (2020) use Belgian customs data to demonstrate that invoicing currency choice is an active firm-level decision, but more

so for exporting than importing. Using customs data from France, Barbiero (2020) highlights heterogeneity in firm-level invoicing currency choice even within the same country-industry pair with larger firms invoicing in multiple currencies as they trade with more countries. In contrast, this paper focuses on providing new empirical evidence on firm behaviour when a currency becomes newly available for invoicing.

Existing literature also suggests numerous mechanisms that underpin invoicing currency choices of the firm. Amiti, Itskhoki, and Konings (2020) provide evidence that firms are more likely to invoice their exports in a given currency if they also import inputs in that currency and if competing firms within the same industry-destination pair invoice in that currency. This paper's focus on exporters also aligns with their benchmark model wherein exporting firms choose the optimal currency and importers respond by adjusting quantities. Using transaction-level customs data from the UK, Crowley, Han, and Son (2020) document an additional channel that determines firms' invoicing currency choice. Focusing on the dominance of USD, they analyse the role played by prior currency experience of the firm. In their data, firms are more likely to invoice in USD when exporting to a new destination if they have persistently used USD in existing markets. This channel emerges from their theoretical model which features increasing returns to scale associated with the fixed costs of currency management. This paper builds upon Crowley, Han, and Son (2020) by instead examining firms' prior experience of invoicing in local currencies in other markets as a novel channel underpinning RMB adoption.

The underlying idea for this channel is that firms are more likely to adopt the RMB when exporting to China for products that they already invoice in local currencies to other destinations. This 'local currency use channel' can be rationalised if firms face high levels of competition from local sellers or if demand is highly sensitive to exchange rate risk or if it provides convenience in settling transactions with buyers. Under these various conditions, firms may prefer to invoice certain products in local currencies in all their markets but were constrained from doing so in China until the RMB internationalization reforms. In suggesting this novel channel, the paper contributes to earlier research on local currency invoicing by firms. The findings from this literature show that firms are more likely to invoice in the currency of their export destination if they are multi-national corporations (Ito, Koibushi, et al., 2021), have transactions that are large in terms of absolute size (Goldberg and Tille, 2016), can hedge at low costs against exchange rate risks using forward contracts (Ito, Koibuchi, et al., 2010) and have increased access to hedging instruments such as derivatives (Lyonnet, Martin, and Mejean, 2022).

Overall, this paper provides a detailed examination of the initial uptake of the RMB following the PBoC's internationalisation reforms, highlighting key stylized facts and mechanisms that drove the currency's early adoption by foreign firms as well as their impact on export performance. These findings additionally complement recent work that documents growing use of RMB invoicing but in a context of geoeconomic fragmentation of the global economy. For instance,

Chupilkin et al. (2023) use customs data to show an increase in RMB use by Russian firms following the country's invasion of Ukraine in 2022. However, with data from 2011-2017, this paper sheds light on RMB adoption prior to the escalation of such geopolitical conflicts and rising trade tensions between USA, EU and China.

3 Policy context

Since joining the World Trade Organization (WTO) in 2001, China has become a major trading economy. By 2009, it was the world's largest goods exporter accounting for 9.6% of global merchandise exports and surpassing other leading exporters such as Germany (8.9%), USA (8.4%) and Japan (4.7%). Unlike these nations however, China's domestic currency remained peripheral to international capital markets due to the numerous restrictions around its use.

Several factors however motivated a shift in China's policy towards RMB promotion and internationalization. As suggested by Eichengreen and Xia (2019), the first factor was the need to lower transaction costs for Chinese firms and to promote their international competitiveness. The second was to enhance China's financial stability by decreasing dependence of domestic exporters and importers on the USD. Third, China hoped to reduce asymmetries in global financial markets by creating a multipolar system of international currencies that would include the RMB. Finally, symbolic reasons relating to prestige and reputation also played an important role in the push towards RMB internationalization. This section provides a brief overview of the key milestones of this RMB reform process over the time period of French customs data (2011-2017).

The first important step toward reform was undertaken in July 2009, when the PBoC launched a pilot programme to promote the use of the RMB for trade settlements. The scope of this pilot scheme was quite limited however, with RMB settlements restricted to five cities from mainland China in addition to Hong Kong, Macau and members of the ASEAN bloc.[4] In July 2010, the scheme was expanded to cover 20 pilot areas. In these areas, only firms which were recognised as Mainland Designated Enterprises (MDEs) could settle in RMB but now with any country in the world. The purpose of creating such a list of MDEs was to control and monitor the number of Chinese firms dealing in RMB. Obtaining this status also imposed administrative costs on firms. Despite these limitations, the pilot scheme helped foster the use of RMB in Asia and established Hong Kong as the main offshore RMB center.

The most significant expansion occurred later in February 2012 when Chinese authorities issued the *Circular Yinfa [2012] No. 23*. This new Circular permitted all firms in China to settle in RMB unless they were blacklisted due to serious violations of tax or trade laws. With this new regulation, China's RMB liberalization therefore moved from a positive to a negative list

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[4]The five mainland cities included were Shanghai, Guangzhou, Shenzhen, Dongguan and Zhuhai.

approach. By eliminating the earlier requirement that firms be designated as MDEs, the Circular expanded the number of firms eligible to trade in RMB.

More recently, China has taken additional measures to promote the RMB. PBoC signed several swap agreements with Central Banks, including the European Central Bank (ECB) in 2013, to increase the liquidity of RMB and provide RMB lending of last resort to foreign firms Bahaj and Reis (2022). This swap arrangement had a maximum size of RMB 350 billion and EUR 45 billion and was the second largest swap line signed by the PBoC at the time, following South Korea (RMB 360 billion). In 2016, the RMB was also included within the International Monetary Fund (IMF) basket of Special Drawing Rights (SDR), providing further boost to the currency's international reputation as a suitable vehicle for trade transactions. The addition of RMB to the SDR is notable considering that the last change had only been in 1999 when the EUR replaced the German mark and French franc in the IMF's currency basket. Looking at the currency composition of official foreign exchange reserves held worldwide, the share of RMB-denominated assets also increased from virtually zero in 2010 to approximately 2% in 2020.[5] While these developments have eased several constraints on RMB use, the reform process is still ongoing. This is clearly reflected in China's 14th Five Year Plan (2021-2025), one of whose stated objectives is to "strengthen the construction of the RMB cross-border payment system".

Since these reforms were motivated primarily by China's domestic concerns, they can be considered as exogenous shocks to individual exporting firms in France. In particular, the removal of strict eligibility criteria surrounding RMB use in 2012 and the ECB's swap line agreement with PBoC in 2013 enlarged the set of invoicing currencies available to EU firms trading with China. Moreover, such an expansion in currency choices for a major trade partner is a relatively rare occurrence that has not been investigated by prior literature on invoicing currency. By permitting exporters to also invoice their products in RMB, these reforms potentially altered firms' transaction costs and their competitiveness in China's local markets. In the following sections, I turn toward customs data from France in order to investigate the extent to which these currency promotion policies have succeeded in fostering the use of RMB by exporting firms and the impact of switching to RMB on their export outcomes. Besides the availability of rich customs data, France makes for an ideal choice for examining RMB adoption given its position as an important country within the Eurozone for RMB clearing by value.

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[5]Latest data from 'Currency Composition of Official Foreign Exchange Reserves (COFER) Database', IMF. Link:https://bit.ly/3Cs6O1o

4 Data and stylized facts

4.1 Customs data

To examine heterogeneity in RMB invoicing across firms, I exploit detailed customs data from France from 2000-2017 (dataset DGDDI, 2018).[6] This data provides information on exports and imports of a firm (f), disaggregated by destination or source country (d), product (p) and time (t). In addition to the merchandise value in Euros, the dataset contains information on the quantities traded. Moreover, each firm is assigned a unique identifier ('SIREN') and product codes are harmonized to the 6-digit HS 1992 classification.

The main variable of interest, i.e. invoicing currency (c), is reported only from 2011 onwards and is restricted to trade with non-EU economies.[7] Therefore, the majority of empirical analysis in this paper will rely on customs data spanning 2011-2017. However, data on firm-level trade flows for preceding years spanning 2000-2010 is useful for tracking the export histories of French firms and varieties.

In all, the customs data used in subsequent analysis includes information on the universe of French firms' extra-EU trade flows over 2011-2017. It covers approximately 250,000 firms that invoice in more than 120 unique currencies, trade in more than 4600 products and with 205 non-EU partner countries. Focusing on exporters in Table 1, we find that the top 100 firms alone account for 48% of total French exports. They also exhibit substantial diversification across destinations and products. Moreover, these firms invoice in multiple currencies, even with a given product. In comparison, the smallest exporters typically invoice in just one currency. Therefore, there is ample heterogeneity in invoicing currencies both across and within firms over this time period.

Table 1: Summary statistics for extra-EU exports (2011-2017)

	Top 100	100-1000	Others
Share in total exports	0.48	0.29	0.23
Mean # destinations per firm	83.76	52.54	4.57
Mean # products per firm	281.34	130.42	8.55
Mean # currencies per firm	11.01	5.14	1.18
Mean # currencies per firm-product	2.74	1.84	1.2
Mean # currencies per firm-product-destination	1.15	1.11	1.03

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[6]The transaction level customs data that support the findings of this study is covered by statistical secrecy and can be accessed only through a previous authorization of the French Custom Administration. The customs data is from the DGDDI (Direction Générale des Douanes et Droits Indirects – a directorate of the French Ministry of Finance). The authorization is granted by the "Comité du secret" of the CNIS (Conseil National de l'Information Statistique). The link to procedures for getting access to the data is: https ://www.comite-du-secret.fr/.

[7]The Customs agency of France does not collect invoicing currency data for intra-EU trade. Moreover, data on extra-EU trade flows does not identify the other transacting partner. Therefore analysis of potential variation in RMB invoicing across and within buyer-supplier relationships is not feasible.

4.2 Stylized facts on RMB adoption

By exploiting the customs data described in the previous section, I document three key stylized facts relating to heterogeneity of RMB invoicing by French exporting firms. I first explore the growth of RMB invoicing over time in comparison to the USD and EUR before turning to the decomposition of this RMB growth along various margins. I then examine how RMB exports are distributed across firms and provide preliminary evidence of firm selection into RMB invoicing. Finally, I show that RMB invoicing even varies within firms that exported multiple products to China over 2011-2017.

Stylized fact 1. *Strong growth in RMB-denominated exports to China*

Across 2011-2017, nearly 99% of all RMB-denominated exports from France were directed towards China. The remaining 1% of exports in RMB were to Hong Kong and Japan. Therefore, RMB was rarely used as a vehicle currency by French exporters serving other destinations during this time period. Its availability therefore did not displace either the EUR or USD as the preferred invoicing currency in French exports globally.[8]

Nevertheless, RMB-denominated exports from France to China grew significantly as shown in Figure 1. While the value of (monthly) RMB exports to China stood at €2.3 million in January 2011, this increased to approximately €145 million by December 2017. This increase is notable in terms of shares as well. While the EUR and USD remained dominant, the share of RMB in monthly French exports to China grew from less than 1% to 10% by the end of 2017. Moreover, these RMB-denominated exports accounted for more than a third (€1.77 billion) of the total increase (€4.97 billion) in French exports to China when comparing 2011 to 2017.

In Figure 2, I decompose this growth in RMB exports to China into i) growth in the number of RMB invoicing firms; ii) growth in RMB invoiced products; iii) growth in RMB exports per variety (firm-product pair) and; iv) growth in density i.e. share of all possible firm-product combinations which have positive RMB exports. For each year, I depict the growth rates in all these margins relative to 2011. Looking at 2017, the data shows nearly 700% growth in the number of RMB-invoicing exporters relative to 2011 with a 560% growth in the number of product products invoiced in RMB. In comparison, growth rates are moderate in the number of EUR (22.15%) or USD (2.18%) invoicing firms and EUR (10.21%) or USD (3.83%) invoiced products.[9] This descriptive evidence clearly indicates that the growth in RMB exports is driven by the extensive rather than the intensive margin. Thus, an increasing number of firms adopted RMB for a widening range of products exported to China.[10]

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[8]On average across the years 2011-2017, EUR and USD denominated exports account for 51.2% and 40.15% of total extra-EU French exports, respectively.

[9]See Figure 5 in Appendix B.

[10]For the sectoral distribution of these RMB exports, see Figure 6 in Appendix B.

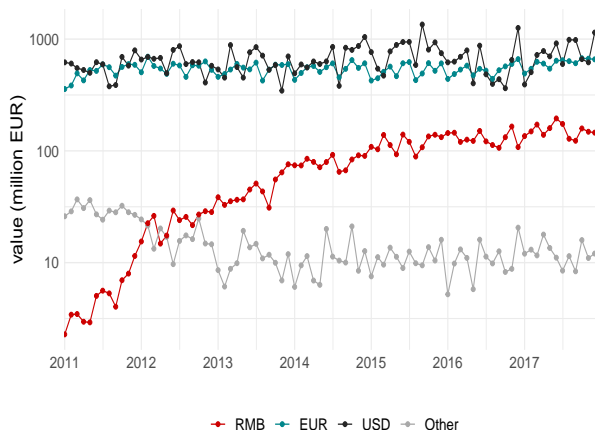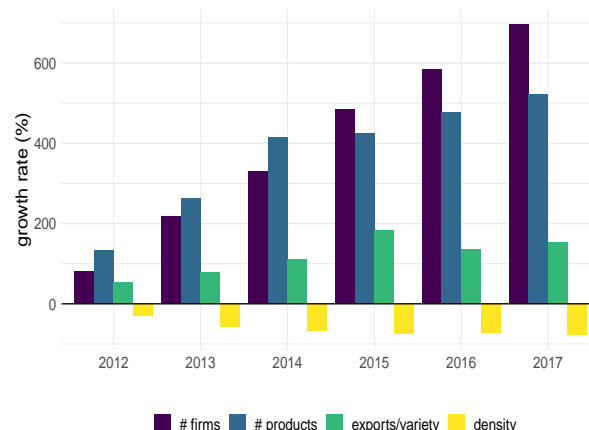**Figure 1:** Monthly French exports to China

Figure 2: Margin decomposition

Note: Figure 1 plots monthly exports from France to China over 2011-2017 on a logarithmic scale. Exports are then disaggregated by invoicing choice – RMB, EUR, USD and any other currency. Figure 2 displays the growth in RMB exports to China (relative to 2011) along multiple margins following the decomposition strategy proposed by Bernard et al. (2009).

Stylized fact 2. *RMB invoicing is highly concentrated*

As shown previously, growth in RMB over 2011-2017 is driven predominantly by the extensive margin. This leads us to the next question of whether the extensive margin comprises of firms that are new exporters to China or just new to invoicing in RMB. To examine this, I make use of the long time panel of customs data spanning 2000-2017 which allows me to determine the export history of a given firm-product combination up until its first year of invoicing in RMB. Since the use of RMB for settling transactions was limited to ASEAN member nations before 2011, we can reasonably assume that the first year of a French firm invoicing in RMB in the data corresponds to the actual first year of RMB adoption by the firm.

With information on export histories, I further decompose the extensive margin into i) varieties that were exported to China atleast once prior to the first year of exporting in RMB ('old firm w/ old product'); ii) firms that had exported to China previously but now introduce a new product to the market which is invoiced in RMB ('old firm w/ new product') and; iii) new firms that invoiced in RMB in their first year of exporting products to China ('new firm-product'). Figure 3 shows this decomposition for RMB-denominated exports both in terms of value (left) and the number of exported varieties (right).

This exercise reveals a high degree of skewness in RMB exports, with old varieties capturing more than 75% of the total value in any given year. Old varieties also account for the majority of all firm-product combinations that are exported in RMB, although this share declines gradually from 77.5% in 2011 to 41.8% in 2017. This decline coincides with the growth of old firms invoicing new products in RMB. While such varieties accounted for 21% of all RMB varieties in

Figure 3: Decomposition of the extensive margin

Note: The horizontal axes display the year in which a given variety is first exported to China in RMB. These varieties are further differentiated into three categories by their prior exporting experience in China. The vertical axes display the share of each category in the value of France's RMB exports (left) and number of exported varieties (right).

2011, their share surpassed 50% by 2017. In sharp contrast, first-time exporters to China rarely choose the RMB as can be seen by their negligible shares in total RMB exports (0.5%) and RMB varieties (1.4%).

To further examine this skewness in RMB exports, Table 2 provides an informative snapshot from 2017 on how RMB exports are distributed across French firms selling to China. The first three columns indicate the number of products exported by the firm globally, to China and to China in RMB. By splicing the data in this manner, the table reveals three key facts. First, RMB invoicing is seen to be a relatively rare occurrence, with only 207 firms invoicing in this currency (rows iv - vii). Together, they account for less than 2% of all firms exporting to China in 2017. However, these RMB adopters are relatively large, with their collective exports to China standing at approximately 17% of total French exports to China. This second fact suggests that there is considerable granularity in RMB invoicing.

When looking at the set of RMB adopters, we note that firms which invoice multiple products in RMB account for more than 90% of total RMB exports (row iv). This leads to our third observation that RMB exports are highly skewed even within the set of RMB-invoicing firms. The intensity of RMB usage of these firms is also high, with the average exporter amongst them invoicing 64.3% of its total exports to China in RMB.

Taken together, Figure 3 and Table 2 indicate that RMB usage is highly concentrated. Therefore, firms which invoice in this newly available currency are few in number, have prior experience of exporting to China, account for a substantial share of total French exports to China and tend to export multiple products in RMB. Figure 7 in Appendix B also shows that RMB-invoicing

firms are larger in terms of global exports when compared to firms that never adopt the RMB. They serve more destinations, have wider product scope and also invoice in multiple currencies globally. These superior characteristics of RMB firms provide preliminary evidence of self-selection mechanisms that may be underpinning the adoption of RMB.

Table 2: RMB exports by firm type: Snapshot for 2017

	Global	China	RMB	# Firms	Share (%)	China exports	Share (%)	RMB exports	Share (%)	RMB intensity
(i)	>1	>1	0	5937	47.71	14405.43	78.62	0.00	0.00	0.00
(ii)	1	1	0	1650	13.26	165.06	0.90	0.00	0.00	0.00
(iii)	>1	1	0	4649	37.36	697.99	3.81	0.00	0.00	0.00
(iv)	>1	>1	>1	128	1.03	2453.22	13.39	1661.63	90.84	64.35
(v)	>1	>1	1	48	0.39	576.57	3.15	159.18	8.70	22.91
(vi)	>1	1	1	26	0.21	18.26	0.10	4.63	0.25	81.59
(vii)	1	1	1	5	0.04	6.56	0.04	3.65	0.20	90.61

Note: The table above disaggregates RMB exports to China in 2017 across firms. These firms are grouped into seven different categories, shown in each row, based on the number of products they export globally (column 1), to China (column 2) and to China in RMB (column 3). Subsequent columns document the number of firms under each category, their overall exports to China (across currencies) and exports to China in RMB (in millions). Alongside these values, the corresponding shares are also reported. The final column shows the share of RMB exports in total firm exports to China, averaged across firms within each category.

Stylized fact 3. *RMB invoicing varies across products within firms*

We learnt from Table 2 that firms which invoice multiple products in RMB dominate overall RMB exports from France to China. This prompts an investigation of whether RMB usage potentially varies across products within a RMB-invoicing firm. In order to examine this internal adjustment of the firm, I modify the product vector approach introduced by Fontagné, Secchi, and Tomasi (2018). In their paper, the authors construct ordered vectors of products which are exported by the firm globally (global product vector) and the subset of products exported by the firm to any given destination (local product vectors). Measures of string distances between these global and local product vectors enables them to evaluate the sparsity, fickleness and stability of export decisions made by multi-product firms.

Analogous to this approach, I construct ordered vectors of products which are exported by the firm to China (China product vector) and which are exported by the firm to China in RMB (RMB product vector). The string distance between them reveals the heterogeneity in RMB usage within the firm. For this exercise, I focus on firms that export multiple products to China, at least one of which is in RMB. For these firms, I construct two types of standard string distance measures, namely, the Levenshtein distance and the Bray-Curtis distance. Both these measures capture the extent of dissimilarity between product vectors.

The Levenshtein measure ranges from zero (identical vectors) to one (disjoint vectors) and reflects similarities in the size of product baskets exported to China and those exported to China

Figure 4: String distances between China and RMB product vectors

(a) Levenstein distance **(b)** Bray-curtis distance
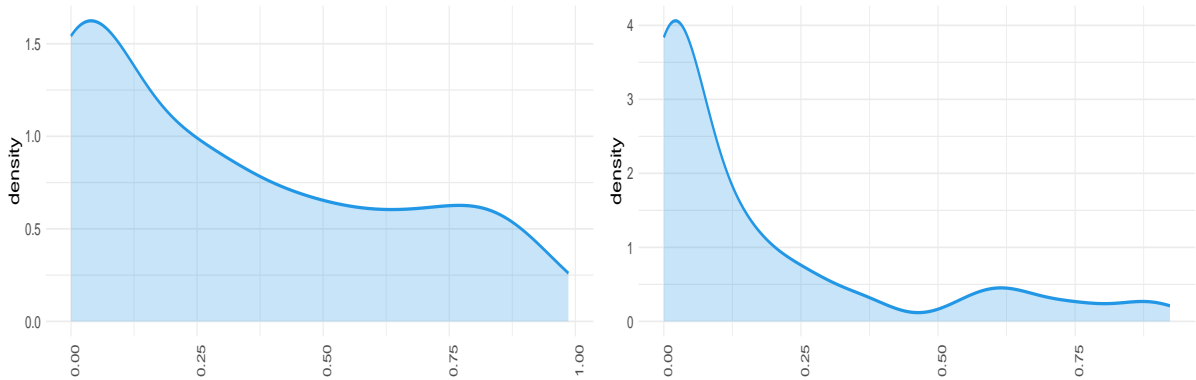
Note: The figures above are density plots of string distances measured between two ordered vectors: the vector of products exported to China and the vector of products exported to China in RMB. These string distances reflect how the RMB product vector can be transformed into the China product vector based on (i) the number of additions, deletions or replacements in Figure 4a and; ii) the distribution of export shares in Figure 4b.

in RMB. The Bray-Curtis measure also ranges from zero (disjoint vectors) to one (identical vectors) and reflects differences in the *shape* of these vectors.[11] Plotting these measures in Figure 4 reveals that there are many firms for which RMB invoicing is only partial as reflected by the range of intermediate values lying between zero and one. Since firms export 33 products to China on average, the mean Levenshtein distance indicates that 11 changes are typically required to transform their RMB product vector into the China product vector. Therefore, there is selection within the firm regarding which products are exported to China in RMB.

5   Selection into RMB invoicing

Building on descriptive evidence provided in Section 4, I now examine various channels driving selection into RMB invoicing. The first channel corresponds to the firm's hedging behaviour. Here, I examine whether a firm importing in RMB in a given month also invoices its exports in RMB. By reducing currency mismatch in its cash flows in this manner, the firm can synchronise changes in input costs with export prices and lower the exchange rate risk.[12]

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[11] When product vectors are coded as a sequence of zeroes and ones, the Levenshtein distance can be calculated as the number of steps (eg. replacement, addition, deletion) required to transform the RMB product vector into the China product vector. This measure is then normalized by the total number of products exported by the firm to China minus one. When the vectors are defined using product export shares instead, the Bray-Curtis measure can be computed to reflect differences in the shape (distribution of elements). For further details on the construction of these measures, refer to Appendix A and Fontagné, Secchi, and Tomasi (2018).

[12] Other forms of such operational hedging by the firm include geographical diversification of export markets and suppliers. These hedging practices are distinct from financial hedging which entails the use of derivative instruments. For more details, see Döhring et al. (2008)

The second channel highlights the role of fixed costs of currency risk management incurred by firms. These fixed costs can arise from gathering experience in currency monitoring to setting up internal departments or purchasing services that can track the company's currency exposure. Here, I test whether firms that are large, diversified and experienced exporters are more likely to adopt the RMB for settling transactions since they may have already incurred the fixed costs associated with currency management. The third channel relates to the competitive dynamics among French exporters. Specifically, I analyse whether competitors' size within the same 4-digit industry classification affects the likelihood of an exporter adopting RMB. For instance, firms might leverage RMB invoicing to improve their competitive positioning vis-à-vis larger French exporters when selling to China.

In addition to the above three channels, I propose a novel fourth mechanism that can underpin the rise in RMB invoicing by French exporters. This channel exploits existing information in the customs dataset on the choice of invoicing currency of the exporter in all other extra-EU destinations. If local currency invoicing emerges as the optimal strategy of the firm in these other markets, it can increase the likelihood of the firm invoicing in RMB when it becomes available for exporting to China. The data also reaffirms this prior. I observe that on average in any given year, more than 75% of RMB-invoiced varieties were also exported to other destinations in their local currency (see Figure 8 in Appendix B). This local currency mechanism is partially analogous to the channel proposed by Crowley, Han, and Son (2020) who show that firms use USD for invoicing exports to new markets when they have used it persistently in their existing markets.

In the following section, I jointly examine these four mechanisms and their role in driving RMB invoicing by French exporters over 2011-2017. As shown previously, firms invoicing multiple products in RMB account for the vast majority of total RMB-denominated exports to China during this period (Table 2). These multi-product RMB exporters also vary their invoicing strategies across the product basket (Figure 4). This suggests that there is selection into RMB at both the inter and intra-firm level. In light of these results, the baseline regression for selection into RMB is specified at the level of a variety or firm-product combination. This has the additional advantage of being able to control for unobserved firm-product and product-time characteristics with corresponding fixed effects. For robustness, I also report selection into RMB at the aggregated firm level in Table 10 in Appendix C. Results are qualitatively similar to the baseline.

5.1 Estimation results

The baseline specification for selection into RMB invoicing is shown in equation (1) where the subscripts f, p and t denote the exporting firm, HS-6 digit product and month respectively. Since RMB invoicing is used only when firms trade with China, the specification drops the destination dimension and focuses only on exports to China. The dependent variable is RMB_{fpt} which

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takes the value of one for varieties that are invoiced in RMB when exported to China and zero otherwise.

$$RMB_{fpt} = \alpha\text{RMB import share}_{ft} + \sum_{k=1}^{\mathcal{K}} \beta^k\text{Currency management}_{ft}^k$$

$$+ \delta\log(\text{competitor size})_{fpt} + \gamma\text{local currency use}_{fpt} \tag{1}$$

$$+ \theta_{fp} + \theta_{pt} + \epsilon_{fpt}$$

I now turn to the construction of variables corresponding to the various mechanisms described previously. The first channel on firms' operational hedging is captured by the share of a firm's global imports in that period that are denominated in RMB. The second channel on a firm's capacity to cover the fixed costs of currency management is captured by a series of firm-time varying characteristics such as the log of its global export revenues (excluding China), its geographical diversification, size of product basket and months of experience gained in exporting outside the EU. The third channel on firms' competitive positioning is captured by the average size of other firms from France that are exporting within the same 4-digit industry to China in that period. Finally, a novel fourth channel is included in the specification as a dummy that takes the value of one if the same variety is also exported to other destinations in the same month in the local currencies of those destinations.[13]

Alongside these variables, equation (1) includes fixed effects to reduce risks of omitted variable bias. Firm-product fixed effects control for time-invariant factors such as the exporter's product-specific capability or market knowledge. Product-time fixed effects additionally control for possible demand-side shocks that affect all exporters. These fixed effects also account for fluctuations in aggregate macroeconomic conditions such as GDP growth, inflation or exchange rates in China that may further alter the choice of invoicing currencies.

Overall, identification of coefficients in equation (1) relies on time variation in currency choice across and within firm-product combinations. It is feasible to do so within this setting since the availability of RMB introduced changes in invoicing behaviour of firms which otherwise exhibits a high degree of stability in established currencies such as the USD or EUR. As an additional robustness check, I also include firm-time fixed effects to account for any unobservable supply-side shocks. Note however that the inclusion of these fixed effects prevents the identification of coefficients for the operational hedging and currency management channel that are similarly defined at the firm-time level.

Table 3 reports the results for selection of exported varieties into RMB invoicing. Here, column (1)

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[13]Exports in USD to the US are excluded given its unique status as an international reserve currency.

corresponds to the baseline specification whereas column (2) reports estimates after introducing additional firm-time fixed effects. In column (1), we observe that a 1% increase in the share of RMB in a firm's global imports translates into a 0.18 percentage point increase into RMB invoicing for exports. This is a first confirmation of the evidence provided by previous literature on the role of operational hedging in invoicing decisions of the firm.

Looking at the other channels, we find a marginal negative effect in the likelihood of RMB invoicing for firms with more months of experience exporting outside the EU – which may arise from the cost of switching established currency management practices. Other variables corresponding to competitor sizes and firm-time characteristics do not show any statistically significant effects on RMB adoption.

Interestingly, results show that the fourth channel of local currency invoicing in exports to other markets is a strong predictor of RMB adoption. Specifically, the probability of RMB invoicing for a given variety increases by 5.7 percentage points if a firms exported the same variety to any other destination in its respective local currency. This positive effect remains statistically significant even with the inclusion of more demanding firm-time fixed effects under column (2).

Moreover, this particular local currency mechanism continues to be significant even when aggregating all variables to the firm-time level (see Table 10 in Appendix C). With both firm and time fixed effects included, we observe that the use of local currency in other destinations is associated with a 1.9 percentage point higher likelihood of a firm invoicing at least one of its products in RMB when exporting to China. As an additional robustness check, equation (1) is also estimated with Logit (see Table 11 in Appendix C). Note that in doing so, the sample shrinks by more than 90%, since all varieties that are never or are always exported in RMB are dropped. However, even in this case, the usage of local currency elsewhere is found to be a positive and statistically significant predictor of a variety's adoption of RMB.

Relative to other mechanisms, the local currency channel emerges as the only potential instrument for investigating the causal impact of RMB adoption on exports to China. First, it is seen to strongly predict RMB invoicing, thereby satisfying the relevance criterion. Second, it is plausibly insulated from demand shocks in China, which supports the exogeneity criterion. This is in contrast to other channels such as hedging practices, competitor sizes and firm characteristics which are likely to be correlated to firms' export outcomes in China. Since local currency use in the rest of the world may be a viable instrument for RMB invoicing, the subsequent analysis focuses on exploring the relevance of this channel across product characteristics.

Table 3: Selection of varieties into RMB

Dependent Variable:	RMB_{fpt}	
Model:	(1)	(2)
RMB import share	0.185***	
	(0.057)	
log(size)	0.001	
	(0.003)	
log(#destinations)	-0.005	
	(0.004)	
log(#products)	0.004	
	(0.004)	
log(extra-EU experience)	-0.033**	
	(0.017)	
log(competitor size)	0.067	-0.007
	(0.071)	(0.012)
local currency use	0.057**	0.023***
	(0.023)	(0.006)
product x time	✓	✓
firm x product	✓	✓
firm x time		✓
Observations	663,516	663,516
R^2	0.825	0.951

Note: The table reports estimation results following the specification outlined in equation (1). The dependent variable takes the value of one for varieties (firm-product combinations) that are invoiced in RMB when exported to China in a given month and zero otherwise. Columns vary in the set of fixed effects included, with the baseline specification reported in column (1). Standard errors are clustered by firm and product. Significance codes: ***: 0.01, **: 0.05, *: 0.1

Table 4: Interactions with product characteristics

Dependent Variable:		RMB_{fpt}	
Characteristic:	GVC	Rauch	RCA
Model:	(1)	(2)	(3)
local currency use	0.110**	0.019***	0.037*
	(0.049)	(0.007)	(0.019)
local currency use x characteristic	-0.017*	0.050*	0.016***
	(0.010)	(0.026)	(0.006)
product x time	✓	✓	✓
firm x product	✓	✓	✓
Observations	656,937	613,949	663,186
R^2	0.825	0.827	0.825

Note: The dependent variable takes the value of one for varieties (firm-product combinations) that are invoiced in RMB when exported to China and zero otherwise. Each column features interactions between a given product characteristic and an indicator variable for local currency use in other destinations (excluding the US). Regressions include all other controls from equation (1) alongside firm $\times$ product and product $\times$ time fixed effects. Standard errors are clustered by firm and product. Significance codes: ***: 0.01, **: 0.05, *: 0.1

5.2 Examining the local currency channel

I now proceed towards a closer examination of the local currency channel which is a potential candidate for instrumenting RMB adoption in China. To the baseline specification, I therefore include an additional term where the dummy for local currency use in the rest of the world is interacted with various product characteristics (Table 4). These interaction terms will serve to illustrate how the local currency channel operates. Product characteristics include i) an industry-level measure of upstreamness at the HS-4 digit for China (Antràs and Chor, 2018); ii) a dummy if a product is differentiated following the Rauch (1999) classification and; iii) the revealed comparative advantage of China within the given HS-6 digit product and time period. By interacting the local currency channel with such measures, I can examine whether the nature of the product amplifies or dampens this mechanism.

Results are reported in Table 4. Looking at coefficients on the interaction term, we find that the use of local currencies in other markets corresponds to higher RMB adoption in China in products that are relatively downstream, differentiated and in which China has a comparative advantage. This indicates that exporters may be using the RMB when selling products that are more consumer-facing and for which there is tougher competition from Chinese firms.

I next investigate whether the salience of the local currency channel changes with the dependency of a given variety on exporting to China. To do so, I estimate the baseline over samples split by quartiles of export dependency. Results are reported in Table 5. Comparing columns (1)-(4), the likelihood of RMB invoicing is seen to progressively increase with a rising share of China

Table 5: Export dependency on China

Dependent Variable:		RMB_{fpt}		
Dependency:	Q1	Q2	Q3	Q4
Model:	(1)	(2)	(3)	(4)
local currency use	0.021*	0.027***	0.116**	0.158**
	(0.011)	(0.008)	(0.051)	(0.062)
product x time	✓	✓	✓	✓
firm x product	✓	✓	✓	✓
Observations	269,619	269,664	269,600	269,502
R^2	0.867	0.936	0.919	0.844

Note: The dependent variable takes the value of one for varieties (firm-product combinations) that are invoiced in RMB when exported to China and zero otherwise. Columns report coefficients from estimating equation (1) over samples split by quartiles of the variety's export dependency on China. Regressions include all other controls from equation (1) alongside firm × product and product × time fixed effects. Significance codes: ***: 0.01, **: 0.05, *: 0.1

in a given variety's global exports. Interpreted differently, the use of local currencies in other destinations translates into a 15.8 percentage point jump in RMB invoicing for the most China-dependent varieties and 2.1 percentage point increase for the least dependent. It indicates that as firms become more embedded in the Chinese market, they may be adopting the RMB to minimize transaction costs and maintain stable prices relative to local sellers.

The analysis so far has focused on whether the contemporaneous use of local currency in exports to the rest of the world increases the probability of RMB adoption. I now build on these results by investigating the role of prior experience in local currency invoicing and the intensity of local currency use. The former is measured as the cumulative number of time periods over which the variety has been invoiced in local currencies in its exports to the rest of the world until t. The latter is defined as the share of global transactions in a given variety and time period that are invoiced in local currencies.[14] The results are reported in Table 6 where column (1) reports the baseline while columns (2)-(3) additionally show coefficients on the new variables.

The results indicate that an additional month of experience in exporting in local currencies elsewhere corresponds to 0.4 percentage point increase in RMB adoption. Adoption is also higher by 4.8 percentage points with a 1% increase in the share of export transactions invoiced in local currencies globally. Together, these results affirm that the local currency channel is a relevant instrument for RMB adoption in China.

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[14]The data for China and the US are excluded in the construction of these variables.

Table 6: Frequency of local currency invoicing

Dependent Variable: Model:	RMB_{fpt} (1)	(2)	(3)
local currency use	0.057** (0.023)		
local currency experience		0.004*** (0.001)	0.004*** (0.001)
share of local currency transactions			0.048* (0.027)
product x time	✓	✓	✓
firm x product	✓	✓	✓
Observations	663,516	663,516	663,516
R^2	0.825	0.832	0.832

Note: The dependent variable takes the value of one for varieties (firm-product combinations) that are invoiced in RMB when exported to China and zero otherwise. Column (1) repeats the coefficient on the local currency channel from the baseline specification for comparison. Columns (2)-(3) report coefficients from replacing the local currency use dummy with the experience (number of months) over which the variety has been invoiced in local currencies in its exports to the rest of the world until time t and the share of global transactions in that variety which are invoiced in local currencies. Regressions include all other controls from equation (1) alongside firm $\times$ product and product $\times$ time fixed effects. Standard errors are clustered by firm and product. Significance codes: ***: 0.01, **: 0.05, *: 0.1

6   Impact of RMB invoicing on exports

Section 5 provided evidence of the various mechanisms driving selection of varieties into RMB invoicing. Accounting for this selection, what impact might RMB invoicing have on export outcomes of French firms selling to China? To examine this issue, I exploit the novel channel of local currency use that emerged previously as a candidate instrumental variable for RMB adoption.

The proposed IV strategy therefore exploits the fact that RMB invoiced varieties tend to be priced in local currencies even when exported to other destinations. Moreover, there is no clear rationale why buyers in China would have a strong preference for varieties that are sold elsewhere in the local currencies of those markets. With these features, the local currency channel can be considered a reasonable candidate to instrument for RMB adoption in China. This novel IV has not been exploited in prior research and can address the lack of causal estimates of invoicing choice on trade flows in the literature.

Based on this identification strategy, equation (2) is estimated. Here, the dependent variable is log Y_{fpct}. This corresponds to the log of export revenues, quantity (in kilos) or prices (ratio of export revenue to quantity) of a given firm (f) selling to China, in a given product (p), currency (c) and month (t).

$$\log \mathrm{Y}_{fpct} = \mathrm{RMB}^{IV}_{fpct}\Phi + \mathbf{Z}_{ft}\Gamma + \lambda\log(\text{exchange rate})_{ct} + \theta_{fp} + \theta_{pt} + \epsilon_{fpt} \qquad (2)$$

The main variable of interest, RMB adoption, is a dummy that takes the value of one if the given transaction is invoiced in RMB and zero otherwise. Since export outcomes may themselves influence RMB invoicing, this variable is further instrumented with local currency use defined at the firm-product level. Moreover, instead of using only the dummy for whether the variety is exported to other destinations in local currencies, I exploit information at the variety level on the (i) prior experience of local currency invoicing and; (ii) share of global transactions that are invoiced in local currencies. This approach provides a key advantage – with two instruments and a single endogenous regressor, one can conduct tests for over-identifying restrictions and assess the validity of instruments used.[15].

The specification also controls for two additional channels from equation (1), corresponding to competitor sizes and firm-time characteristics – as captured by the vector $\mathbf{Z}_{ft}$. To account for exchange rate risks, equation (2) further includes the log of monthly exchange rates between all reported currencies and the USD, provided by the IMF's Exchange Rate Archives. In addition to these controls, the specification also includes firm-product and product-time fixed effects to reduce risks of omitted variable bias.[16]

At the transaction-level, we observe flows ranging from less than €10 (such as in plastic products) to more than €400 million (such as large aircraft). These extreme values may bias estimates, therefore the baseline sample is trimmed by dropping the bottom and top 5% of transactions. As a result, we only keep transactions whose value exceeds €35 or is lower than €240,000.[17] Table 7 reports the baseline results for the two-stage least-squares (TSLS) estimations alongside test statistics for the validity of IVs. Causal interpretation of the coefficients relies on the assumption that local currency invoicing in foreign destinations is orthogonal to unobserved shocks faced by the variety in China.

We begin by analysing the test statistics reported for the TSLS estimations in Table 7. Both the F-test and Wald test statistics for the first stage regression are seen to be quite high, indicating that the regressions do not suffer from a weak instruments problem. This is also confirmed by the positive and statistically significant coefficients on the instruments seen in the first stage regression (reported in Table 12 in Appendix C). Moreover, the Wu-Hausman test rejects the null hypothesis, indicating that the OLS estimates would be biased due to endogeneity in the explanatory variable (RMB invoicing). Finally, the Sargan test (or Hansen test of over-identifying

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[15]Note that both these instruments were seen to be relevant predictors of RMB adoption in Table 6.

[16]The inclusion of additional firm-time fixed effects creates issues for both the relevance and the validity of instruments likely due to over-fitting. For further details, see Table 15 in Appendix C.

[17]As a further robustness check, Table 13 in Appendix C also reports coefficients from the full sample that includes the outlier transactions. Compared to the baseline, results are seen to be qualitatively similar but with inflated coefficient sizes.

restrictions) does not reject the null hypothesis at either the 1% and 5% significance levels in any of the models, indicating that the instruments are valid and not correlated with the error term in equation 2. Together, these tests lend credence to the causal interpretation of the TSLS estimates.

Table 7: Causal impact of RMB invoicing: TSLS approach

Dependent Variables: Model:	log(exports) (1)	log(quantity) (2)	log(price) (3)
RMB	0.553***	0.403**	0.150
	(0.178)	(0.200)	(0.104)
product x time	✓	✓	✓
firm x product	✓	✓	✓
Observations	704,152	704,152	704,152
R^2	0.572	0.752	0.842
F-test (1st stage), RMB	11,682.869	11,682.869	11,682.869
Wald (1st stage), RMB	50.606	50.606	50.606
Wu-Hausman	31.611	9.395	12.885
Wu-Hausman, p-value	0.000	0.002	0.000
Sargan	1.327	3.194	1.762
Sargan, p-value	0.249	0.074	0.184

Note: Columns report second-stage regression results following the specification outlined in equation (2). The dependent variable corresponds to the log of export revenues, quantity (in kilos) or prices (ratio of export revenue to quantity) of a given firm (f) selling to China, in a given HS 6-digit product (p), currency (c) and month (t). Here, RMB adoption is instrumented with two variables: (i) prior experience of local currency invoicing and; (ii) share of global transactions that are invoiced in local currencies at the variety level. All regressions include controls for firm-time characteristics, competitor sizes and exchange rates. Standard errors are clustered by firm and product. Significance codes: ***: 0.01, **: 0.05, *: 0.1

Looking at the TSLS estimates across columns (1)-(3), we find that invoicing in RMB raises firm exports by 73.8%, driven by a nearly 50% increase in exported quantity. Interestingly, there is no statistically significant change in export prices from invoicing in RMB.[18] The magnitude of these effects implies that the adoption of RMB contributed towards notable increases in a variety's exports, possibly driven by increased competitiveness of the firm relative to local counterparts.

I next compare the above results with OLS estimates reported in Table 8. Here, RMB invoicing is also seen to have a positive and statistically significant impact on a given variety's exports to China. However, the effects are substantially smaller. Adopting RMB corresponds to a rise in export revenues by 17.8%, driven by growth in exported quantities for the variety. Compared to TSLS regressions, OLS estimates are therefore downward biased. This is likely a consequence of reverse causality as firms with growing exports may be better placed to adopt RMB invoicing – a

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[18]For coefficients on all other control variables, see Table 14 in Appendix C. Here, export prices are seen to be affected only by movements in monthly exchange rates.

relationship that OLS cannot properly disentangle.

Table 8: OLS estimations

| Dependent Variables: | log(exports) | log(quantity) | log(price) |
Model:	(1)	(2)	(3)
RMB	0.164***	0.168***	-0.004
	(0.056)	(0.061)	(0.028)
product x time	✓	✓	✓
firm x product	✓	✓	✓
Observations	704,152	704,152	704,152
R^2	0.572	0.752	0.842

Note: The dependent variable corresponds to the log of export revenues, quantity (in kilos) or prices (ratio of export revenue to quantity) of a given firm (f) selling to China, in a given HS 6-digit product (p), currency (c) and month (t). Columns report OLS results without instrumenting for RMB adoption. All regressions include controls for firm-time characteristics, competitor sizes and exchange rates. Standard errors are clustered by firm and product. Standard errors are clustered by firm and product. Significance codes: ***: 0.01, **: 0.05, *: 0.1

Even after instrumenting for RMB invoicing and the inclusion of a rich set of fixed effects, selection into RMB may still play a role. To exclude this possibility, I further restrict the sample by retaining only those firms that were already exporting to China prior to 2011. This drops any firm that began exporting into China following the RMB reforms. The TSLS results from this modification are reported in Table 9. For this set of 'older' exporters, RMB invoicing of a given variety in China results in nearly 93% increase in exports. As before, this growth is driven by a strong rise in exported quantity (67%). In a final step, I introduce additional firm-time fixed effects to the specification outlined in equation (2). Results of the second stage are reported in Table 15 of Appendix C. With the inclusion of these more demanding fixed effects, there is an increased risk of using weak IVs (as reflected in low values of the F-test statistic) that are also invalid (with rejection of the Sargan null hypothesis).

Table 9: Impact of RMB invoicing: Excluding entrant firms

Dependent Variables: Model:	log(exports) (1)	log(quantity) (2)	log(price) (3)
RMB	0.657***	0.515**	0.142
	(0.181)	(0.202)	(0.107)
product x time	✓	✓	✓
firm x product	✓	✓	✓
Observations	638,590	638,590	638,590
R^2	0.569	0.748	0.839
F-test (1st stage), RMB	10,493.573	10,493.573	10,493.573
Wald (1st stage), RMB	48.129	48.129	48.129
Wu-Hausman	51.992	21.799	10.900
Wu-Hausman, p-value	0.000	0.000	0.001
Sargan	2.654	2.637	0.071
Sargan, p-value	0.103	0.104	0.791

Note: The dependent variable corresponds to the log of export revenues, quantity (in kilos) or prices (ratio of export revenue to quantity) of a given firm (f) selling to China, in a given HS 6-digit product (p), currency (c) and month (t). Columns report second-stage regression results following the specification outlined in equation (2). Relative to the baseline, the sample is restricted by retaining only those firms that were already exporting to China prior to 2011. Standard errors are clustered by firm and product. Significance codes: ***: 0.01, **: 0.05, *: 0.1

7   Conclusion

This paper exploits highly disaggregated customs data from France in order to examine the impact of China's RMB reforms on individual firms' invoicing behaviour. It is the first paper that analyses the strong selection into RMB adoption at the firm-level and that provides novel evidence on the (positive) causal impact of RMB invoicing on export performance. In doing so, it contributes to the vibrant literature on the rich heterogeneity in firms' invoicing currency choice and existing research on the impact of RMB internationalization that relies on aggregate payments or invoicing data at the country-pair level.

The results in this paper suggest that China's RMB internationalization policies have had positive but limited effects on the invoicing behaviour of exporting firms in France. The majority of firms continue invoicing in USD or EUR when exporting to China, especially those that newly enter the market. To expand currency usage, PBoC promotion policies should therefore target the unique obstacles faced by small and new exporters eg. in accessing RMB-denominated trade finance and managing exchange rate fluctuations. The results also reveal that USD dominance is difficult to challenge, particularly in its usage as a vehicle invoicing currency for exports to third markets.

Despite the limited early adoption of RMB following the PBoC reforms, firms that invoiced in RMB saw strong sales growth when exporting to China. This growth was driven exclusively by

increased export volumes rather than prices. Additionally, firms tended to invoice in RMB for products that were relatively downstream, differentiated, and where China held a comparative advantage, suggesting that RMB use conferred a significant competitive edge. However, identifying the precise source of this advantage—such as reduced transaction costs, expansion to new buyers, or price stability relative to local suppliers — remains beyond the scope of this paper due to data limitations.

This points towards several avenues that remain open for future research. Further work can investigate the extent to which RMB invoicing changes when firms' buyers or suppliers are themselves trading with China. Information on the other side of the transaction is not available for extra-EU exports in the case of France but such buyer-supplier customs data can shed light on RMB use within regional value chains centred around China. Since data on firms' invoicing currency only begins from 2011 in France, future research can also examine RMB adoption in other countries where customs data potentially report longer currency histories that predate China's RMB reforms. Such research can further add to our understanding of the RMB's evolving role in global trade and financial markets.

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A String distance measures

A.1 Levenshtein distance

Consider a hypothetical firm exporting five different product products to China, two of which are invoiced in RMB. In this scenario, each element of the firm's China product vector (CPV) takes the value of one whereas elements in the RMB product vector (RPV) take the value of one or zero depending on whether the corresponding product is invoiced in RMB or not. Then the (normalized) Levenshtein distance between these two vectors is 3/4. The numerator reflects the number of changes that are required to transform the RPV into the CPV and the denominator reflects the normalization (maximum length of product vectors minus one).

$$CPV_{ft} = \begin{pmatrix} 1 \\ 1 \\ 1 \\ 1 \\ 1 \end{pmatrix} \qquad RPV_{ft} = \begin{pmatrix} 1 \\ 0 \\ 1 \\ 0 \\ 0 \end{pmatrix}$$

A.2 Bray-Curtis similarity index

Consider the same hypothetical firm exporting five different product products to China, two of which are invoiced in RMB. In contrast to before, the CPV and RPV are now defined based on product export shares as shown below.
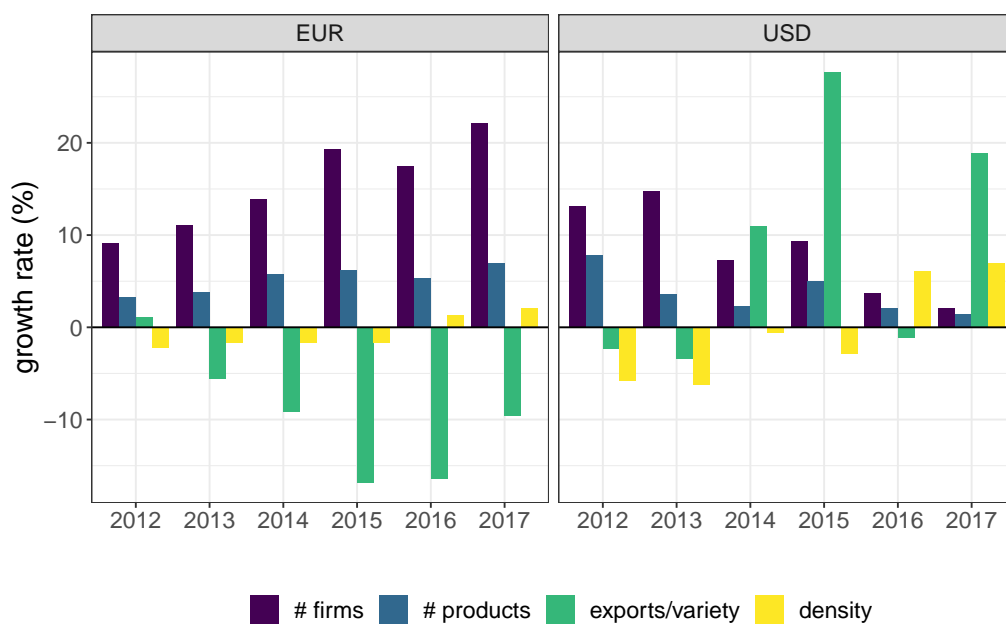
$$CPV_{ft} = \begin{pmatrix} 0.1 \\ 0.5 \\ 0.2 \\ 0.1 \\ 0.1 \end{pmatrix} \qquad RPV_{ft} = \begin{pmatrix} 0.7 \\ 0 \\ 0.3 \\ 0 \\ 0 \end{pmatrix}$$

Then the corresponding Bray-Curtis similarity index is calculated as follows:

$$BC = 1 - \frac{|0.1-0.7|+|0.5-0|+|0.2-0.3|+|0.1-0|+|0.1-0|}{(0.1+0.5+0.2+0.1+0.1)+(0.7+0+0.3+0+0)} = 1 - 0.7 = 0.3$$

B Further descriptive statistics

Figure 5: Margin decomposition of growth in EUR and USD-denominated exports to China

Note: Figures above display the growth in EUR-denominated and USD-denominated exports to China (relative to 2011) along multiple margins following the decomposition strategy proposed by Bernard et al. (2009).

Figure 6: RMB penetration in exports to China by sector
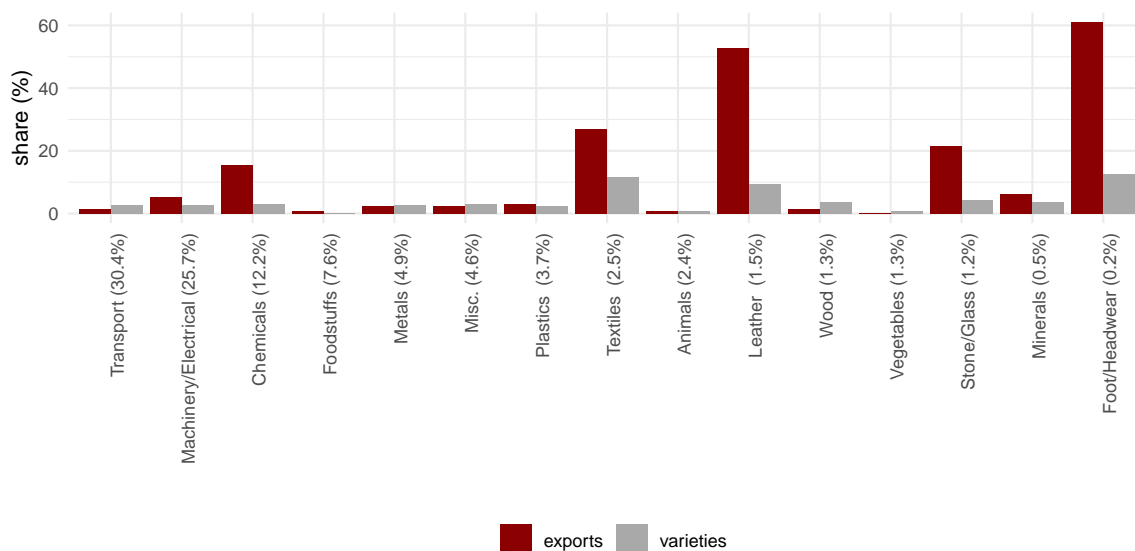
Note: The figure above shows the share of total export value (red) or varieties (grey) in a given sector that is invoiced in RMB over 2011-2017. Sectors are arranged from left to right in decreasing order of their share in France's aggregate exports to China over the same time period.

Figure 7: Kernel density distributions: RMB vs non-RMB invoicing firms
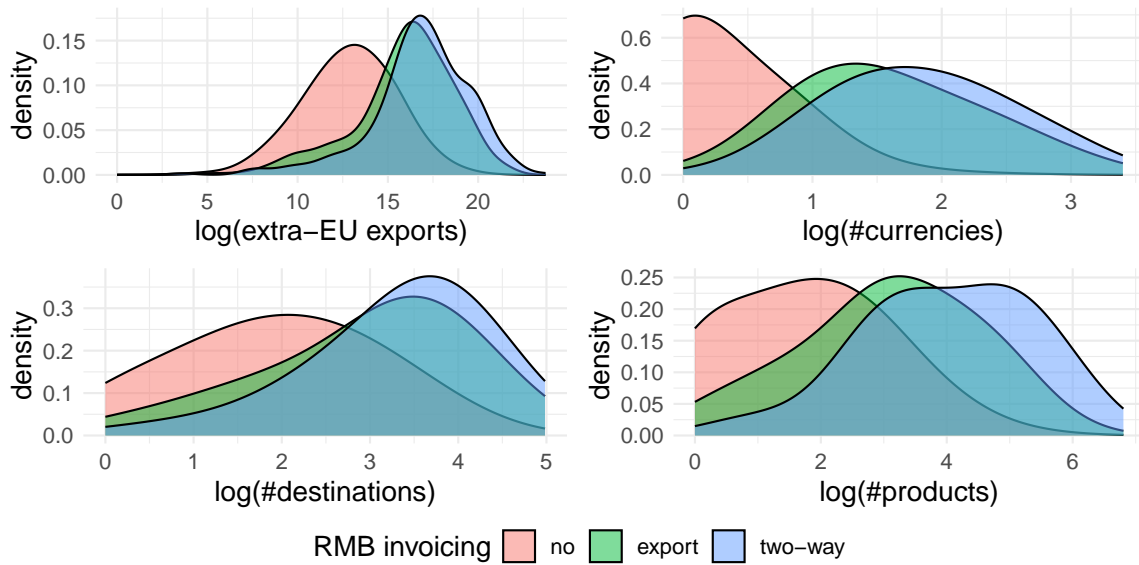
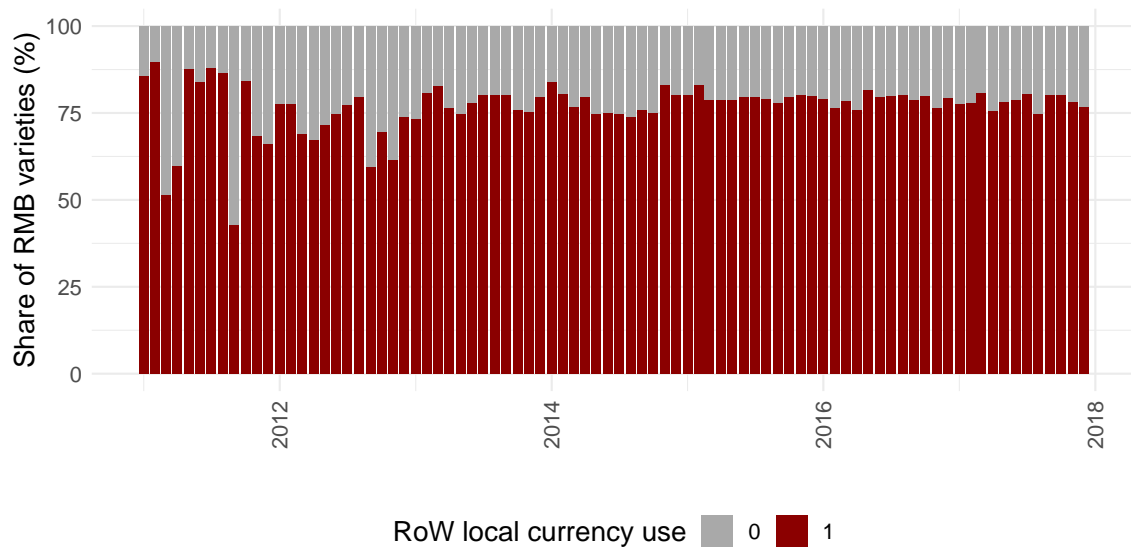*Note:* The figure above displays kernel density plots for firms that i) never traded in RMB (red); ii) only exported in RMB (green) and; iii) exported and imported in RMB (blue) over 2011-2017.

Figure 8: Invoicing strategies in other markets for varieties invoiced in RMB in China

Note: The figure above shows the share of RMB-invoiced varieties exported to China in any given month which are also invoiced in local currencies when exported to other extra-EU destinations (in red) or not (in grey).

C Additional robustness checks

Table 10: Selection of exporting firms into RMB invoicing

| Dependent Variable: | RMB_{ft} | |
Model:	(1)	(2)
RMB import share	0.284***	0.156***
	(0.063)	(0.040)
log(size)	0.002**	0.000
	(0.001)	(0.000)
log(#destinations)	-0.009***	-0.003**
	(0.003)	(0.001)
log(#products)	0.013***	0.003**
	(0.003)	(0.001)
log(extra-EU experience)	0.000	-0.010**
	(0.001)	(0.004)
log(competitor size)	-0.798	-0.615
	(0.885)	(0.406)
local currency use	0.078***	0.019***
	(0.010)	(0.005)
firm		✓
time	✓	✓
Observations	265,468	265,468
R^2	0.082	0.582

Note: The table reports estimation results when all variables outlined in equation (1) are defined at the aggregated firm-time level instead of the firm-product-time level. Thus, the dependent variable takes the value of one for firms that invoice at least one product in RMB when exporting to China in a given month and zero otherwise. Columns vary in the set of fixed effects included. Standard errors are clustered by firm and time. Significance codes: ***: 0.01, **: 0.05, *: 0.1

Table 11: Selection into RMB with Logit

| Dependent Variable: | RMB_{fpt} |
Model:	(1)
RMB import share	10.563***
	(2.719)
log(size)	0.439
	(0.333)
log(#destinations)	-0.393
	(0.731)
log(#products)	0.603
	(0.480)
log(extra-EU experience)	-4.639*
	(2.568)
log(competitor size)	1.855
	(3.792)
local currency use	2.989***
	(0.575)
product x time	✓
firm x product	✓
Observations	48,011
Pseudo R^2	0.855

Note: The table reports estimation results following the specification outlined in equation (1). In contrast to the baseline reported in Table 3, results here correspond to coefficients from Logit estimations. Note that this shrinks the sample considerably – all varieties that are never or always exported in RMB are dropped. Standard errors are clustered by firm and product. Significance codes: ***: 0.01, **: 0.05, *: 0.1

Table 12: Impact of RMB invoicing – First stage regression

Dependent Variable:	RMB
Model:	(1)
local currency experience	0.003***
	(0.000)
share of local currency transactions	0.153***
	(0.037)
product x time	✓
firm x product	✓
Observations	704,152
R^2	0.768
F-test (1st stage)	11,682.869
Wald (1st stage)	50.606

Note: The table reports the first stage coefficients following the specification outlined in equation (2). The dependent variable corresponds to a dummy for RMB invoicing at the transaction level. Here, RMB adoption is instrumented with two variables: (i) prior experience of local currency invoicing and; (ii) share of global transactions that are invoiced in local currencies at the variety level. The regression includes controls for firm-time characteristics, competitor sizes and exchange rates alongside firm-product and product-time fixed effects. Standard errors are clustered by firm and product. Significance codes: ***: 0.01, **: 0.05, *: 0.1

Table 13: Impact of RMB invoicing – Full sample

Dependent Variables:	log(exports)	log(quantity)	log(price)
Model:	(1)	(2)	(3)
RMB	0.868***	0.667***	0.201**
	(0.196)	(0.209)	(0.102)
product x time	✓	✓	✓
firm x product	✓	✓	✓
Observations	764,761	764,761	764,761
R^2	0.597	0.740	0.834
F-test (1st stage), RMB	12,478.298	12,478.298	12,478.298
Wald (1st stage), RMB	52.118	52.118	52.118
Wu-Hausman	59.925	24.822	20.421
Wu-Hausman, p-value	0.000	0.000	0.000
Sargan	0.012	0.013	0.000
Sargan, p-value	0.912	0.908	0.985

Note: The table reports the first stage coefficients following the specification outlined in equation (2). Relative to the baseline reported in Table 7, outlier transactions are not dropped i.e. the sample includes flows with values below €35 (5th percentile) and exceeding €240,000 (95th percentile). Standard errors are clustered by firm and product. Significance codes: ***: 0.01, **: 0.05, *: 0.1

Table 14: Impact of RMB invoicing – Second-stage with all controls

Dependent Variables: Model:	log(exports) (1)	log(quantity) (2)	log(price) (3)
RMB	0.553***	0.403**	0.150
	(0.178)	(0.200)	(0.104)
log(competitor size)	-0.026**	-0.020	-0.006
	(0.013)	(0.014)	(0.008)
log(size)	0.041***	0.038***	0.003
	(0.006)	(0.006)	(0.003)
log(#destinations)	0.002	-0.006	0.008
	(0.013)	(0.015)	(0.009)
log(#products)	-0.033***	-0.044***	0.011
	(0.010)	(0.012)	(0.007)
log(extra-EU experience)	0.036	0.038	-0.002
	(0.029)	(0.031)	(0.016)
log(exchange rate)	0.013	-0.035	0.047***
	(0.022)	(0.026)	(0.015)
product x time	✓	✓	✓
firm x product	✓	✓	✓
Observations	704,152	704,152	704,152
R^2	0.572	0.752	0.842
F-test (1st stage), RMB	11,682.869	11,682.869	11,682.869
Wald (1st stage), RMB	50.606	50.606	50.606
Wu-Hausman	31.611	9.395	12.885
Wu-Hausman, p-value	0.000	0.002	0.000
Sargan	1.327	3.194	1.762
Sargan, p-value	0.249	0.074	0.184

Note: Columns report second-stage regression results following the specification outlined in equation (2). The dependent variable corresponds to the log of export revenues, quantity (in kilos) or prices (ratio of export revenue to quantity) of a given firm (f) selling to China, in a given HS 6-digit product (p), currency (c) and month (t). Here, RMB adoption is instrumented with two variables: (i) prior experience of local currency invoicing and; (ii) share of global transactions that are invoiced in local currencies at the variety level. Standard errors are clustered by firm and product. Significance codes: ***: 0.01, **: 0.05, *: 0.1

Table 15: Impact of RMB invoicing – Including firm-time fixed effects

| Dependent Variables: | log(exports) | log(quantity) | log(price) |
Model:	(1)	(2)	(3)
RMB	1.886	1.161	0.725
	(3.792)	(4.103)	(2.237)
product x time	✓	✓	✓
firm x product	✓	✓	✓
firm x time	✓	✓	✓
Observations	704,157	704,157	704,157
R^2	0.674	0.814	0.889
F-test (1st stage), RMB	15.859	15.859	15.859
Wald (1st stage), RMB	4.675	4.675	4.675
Wu-Hausman	0.608	0.181	0.265
Wu-Hausman, p-value	0.436	0.670	0.607
Sargan	17.257	24.487	4.527
Sargan, p-value	0.000	0.000	0.033

Note: Columns report second-stage regression results with a modified equation (2) that features additional firm-time fixed effects. The dependent variable corresponds to the log of export revenues, quantity (in kilos) or prices (ratio of export revenue to quantity) of a given firm (f) selling to China, in a given HS 6-digit product (p), currency (c) and month (t). Here, RMB adoption is instrumented with two variables: (i) prior experience of local currency invoicing and; (ii) share of global transactions that are invoiced in local currencies at the variety level. Standard errors are clustered by firm and product. Significance codes: ***: 0.01, **: 0.05, *: 0.1