International sanctions and the dollar: Evidence from trade invoicing

Antoine Berthou[1]

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ABSTRACT

This paper shows that international sanctions can undermine the role of the US dollar in trade invoicing. The analysis is based on the episode of international sanctions targeting Russia after the invasion of regions of Ukraine in 2014. While European sanctions increased trade costs for firms located in the EU and conducting transactions with Russia, sanctions imposed by the United States affected firms located in third countries due to the extra-territoriality of the US law. This created an incentive to diversify away from the US dollar to avoid these sanctions when exporting to target countries such as Russia. The empirical exercise relies on detailed customs data for France with information on the currency of invoicing by transaction. Following the start of the Western sanctions on Russia in 2014, the propensity of French exporters to invoice their contracts in US dollars decreased. Estimation results highlight the role played by (i) strategic complementarities between firms, (ii) the diversification of Russian foreign reserves, (iii) US secondary sanctions targeting exports of dual-use goods, and (iv) threats of US secondary sanctions faced by exporters' banks.

Keywords: Dollar dominance, Currency Invoicing, International Sanctions.

JEL classification: F10, F14, F44.

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NON-TECHNICAL SUMMARY

The US dollar is widely recognized as the major vehicle currency for invoicing international transactions. According to Gopinath and Itskhoki (2021), the US dollar represents more than half of global export invoicing. For European countries, the US dollar represents about 40% of their aggregate exports and imports extra-EU, while this share tends to be quite stable over time (Boz et al., 2022).

The dominant role of the US dollar in international transactions invoicing is, however, increasingly debated, in the context of the emergence of large economic powers potentially offering alternatives in terms of invoicing and reserve currencies. The increased use of international sanctions in the foreign policy toolbox of the United States and its Western allies has also reignited the debate on the dominant role of the US dollar in the international financial system. As direct and secondary sanctions implemented by the US administration increase the risks of holding assets or invoice transactions in US dollars, this generates an incentive by targeted countries and third parties to diversify away from the US dollar for international payments.

This paper investigates whether international sanctions may reduce the dominance of US dollar invoicing in international transactions. In the analysis, we explore this question in the context of the first Russian invasion of Ukraine, using firm-level information about the export activity of French firms during the period 2011-2020. The analysis mainly relies on firm-level information about the currency denomination of individual transactions by French exporters to Russia and other destinations outside the European Union.

Figure. Impact of international sanctions on US dollar invoicing in Russia by French exporters.
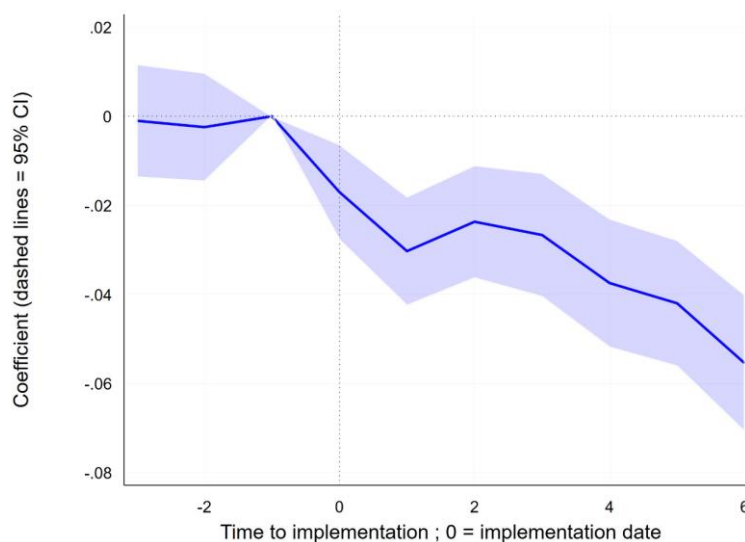
Note: Results from the estimation based on a sample of continuing French exporters in Russia. The solid line corresponds to the estimation coefficient by year. The shaded area corresponds to the 95% confidence interval. Values on the horizontal axis correspond to the years since the implementation of the sanctions. Values on the vertical axis correspond to the estimation coefficient and can be interpreted as the change in percentage points relative to the pre-sanctions period (-0.06 implies a decline of USD invoicing in French exports to Russia by 6 percentage points).

Estimation results confirm that consecutive to the implementation of sanctions in 2014, the propensity to invoice exports in US dollars by French firms to Russia declined. In quantitative terms,

we find that the shock due to the sanctions decreased the propensity to invoice in US dollars by about 4 percentage points six years after the start of the sanctions.

We find evidence for different transmission channels. The reduction of US dollar invoicing by French exporters in Russia is partly explained by the reduction in the market share of US exporters in Russia, in particular during the period starting in 2016 when US sanctions were strengthened. The role played by the market share of competitors in a destination market highlights the role played by strategic interactions between firms, which contributes to promote the dominance of the vehicle currency (the US dollar) as large firms have an incentive to set their prices in the same currency.

We then find evidence that changes in the composition of international reserves by the central bank of Russia reduced the incentive for private firms in Russia to hold US dollars and contributed to the decline of the importance of USD invoicing in our estimations.

Finally, we provide evidence of the importance of the US secondary sanctions in driving our results. The decline in the propensity by French exporters to invoice their exports to Russia in USD is indeed stronger in dual-use goods (i.e., goods that can be used for both civilian and military applications) that were particularly targeted by US sanctions. We also find evidence that French banks contributed to the decline of USD invoicing by their clients as they sought to avoid being targeted by US secondary sanctions.

Conséquences des sanctions internationales sur le rôle du dollar dans la facturation des échanges

RÉSUMÉ

Cet article évalue les conséquences des sanctions internationales sur le rôle du dollar américain dans la facturation des échanges commerciaux. L'analyse est basée sur l'épisode des sanctions internationales visant la Russie après l'invasion de régions de l'Ukraine en 2014. Tandis que les sanctions européennes ont augmenté les coûts de transaction pour les entreprises situées dans l'UE et effectuant des transactions avec la Russie, les sanctions imposées par les États-Unis ont affecté les entreprises situées dans des pays tiers en raison de l'extraterritorialité de la loi américaine. Cela a incité les entreprises à se détourner du dollar américain pour éviter ces sanctions lorsqu'elles exportent vers des pays cibles tels que la Russie. L'exercice économétrique présenté dans cet article s'appuie sur des données douanières détaillées pour la France, révélant notamment la monnaie de facturation par transaction. Nous montrons qu'après le début des sanctions occidentales contre la Russie en 2014, la propension des exportateurs français à facturer leurs contrats en dollars américains a diminué. Nos résultats mettent en évidence le rôle joué par (i) les interactions stratégiques entre entreprises, (ii) la diversification des réserves de change russes, (iii) les sanctions secondaires américaines ciblant les exportations de biens à double usage, et (iv) les menaces de sanctions secondaires américaines auxquelles sont confrontées les banques des exportateurs.

Mots-clés : rôle international du dollar, monnaies de facturation, sanctions internationales.

1 Introduction.

The US dollar is widely recognized as the major vehicle currency for invoicing international transactions. Gopinath and Itskhoki (2021) show that the US dollar represents more than half of global export invoicing. For European countries, the US dollar represents about 40% of their aggregate exports and imports extra-EU, while this share tends to be quite stable over time (Boz et al., 2022). The dominance of the US dollar in global trade can be explained by complementarities in goods and asset markets.[1] It has implications for the reaction of trade prices to exchange rate shocks and can generate a disconnect between exchange rates and macroeconomic variables (Gopinath et al., 2010; Corsetti et al., 2022; Boz et al., 2022; Amiti et al., 2022; Chen et al., 2022; Berthou and Schmidt, 2022). It has implication for the implementation of monetary policy and the global financial cycle (Egorov and Mukhin, 2020).

Against this backdrop, the increased use of international sanctions in the foreign policy toolbox of the United States and its Western allies – particularly in the context of the Russian invasion of Ukraine – has reignited the debate on the dominant role of the US dollar in the international financial system.[2] As direct and secondary sanctions implemented by the US administration increase the risks of holding assets or invoice transactions in US dollars, this generates an incentive by targeted countries and third parties to diversify away from the US dollar for international payments.

In this paper, we ask whether international sanctions can backfire and change the relative importance of US dollar invoicing in international transactions. We explore this question in the context of the first Russian invasion of Ukraine, during the period 2014-2020. The analysis mainly relies on firm-level information about the currency denomination of individual transactions by French exporters to Russia and control destinations. The empirical setting allows to identify the impact of US sanctions on transactions between a target country exposed to US sanctions (Russia) importing from a third country (France) exposed to secondary sanctions. To the best of our knowledge, this is the first paper addressing this question, while existing papers have been focusing on the reaction of trade volumes.

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[1]We detail in the literature review the identified channels behind the US dollar dominance.

[2]See for instance the interview of Gita Gopinath in a Financial times article "Russia sanctions threaten to erode dominance of US dollar, says IMF", published 31 March 2022.

Following the Russian invasion of Crimea and the Eastern regions of Ukraine by 2014, international sanctions targeting Russia were *progressively* phased-in. These sanctions were coordinated by a Western coalition including among others the United States and the European Union. Sanctions targeted both entities (e.g. companies, Gov. agencies), individuals and certain categories of goods such as military equipment, dual-use goods or equipment for deep-water exploration. Russia retaliated by using more classical trade policy instruments targeting imports in the agri-food sector in particular. After 2014, Western sanctions were strengthened in different occasions, for instance in 2017 and 2018 after Russia was accused of interfering with US 2016 elections, in 2019 after the 2018 Donbass elections, or in 2018 and 2019 following the Sergey Skripal poisoning. Importantly, European sanctions were loose enough to allow the continuation of export activity by European firms, even for sensitive products such as dual-use goods.

The analysis relies on French customs data that detail, from 2011 to 2020 and for each extra-EU transaction, product and destination, the value in euros, the quantity, and the currency of invoicing. The data focuses on extra-EU exports for which this information is available; it is similar to the data for Belgium that has been used in the work by Amiti et al. (2022), or data for the United Kingdom by Crowley et al. (2020) and Chen et al. (2022).

Using this data, we examine the evolution of the propensity by French exporters to invoice their exports to Russia in US dollar before and after the progressive phasing-in of the sanctions in 2014.[3] We start by providing descriptive evidence on the evolution of trade invoicing over time. In this exercise, we account for the role played by changes in the composition of exporters, as small exporters tend to invoice more exports in their home currency (the euro) but are also very volatile in terms of export participation. We then run an event study to examine the effect of sanctions on USD invoicing over time. The effect of sanctions is estimated year-by-year using a linear probability model. The empirical model controls (using appropriate fixed effects) for the propensity to invoice different products in USD, and for firm-product-specific (productivity) shocks.

In the most restrictive estimations, we use the heterogeneity across products (dual-use goods) and across firms (link to sanctioned banks) to identify the effects of US secondary sanctions on USD invoicing in Russia, while controlling for channels related to

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[3]We also provide some descriptive evidence on euro and ruble invoicing.

the macroeconomic adjustment in Russia (e.g. exchange rate, oil and gas prices) using country-time fixed effects .

We test four main transmission channels of US sanctions on exporters propensity to invoice in US dollars:

1. The role of strategic complementarities: As US sanctions progressively reduced the US share in Russian imports, it also reduced the incentive of French competitors of US firms to invoice their exports to Russia in dollars.

2. The role of the currency composition in RU foreign reserves, which affected the liquidity in US dollars in Russia especially by 2018, and the capacity to pay imports in the dominant currency ;

3. The effect of US secondary sanctions through the lens of US dollar invoicing in dual-use goods categories where US sanctions were progressively strengthened;

4. The funding side of US secondary sanctions: Here we explore the behavior of exporters linked to a French bank that was sanctioned around 2014 by the US administration for conducting operations in US dollar in countries under US sanctions.

Consistently with the results presented in previous work (Crozet et al., 2021), we find that the export probability to Russia and the export value by French firms (conditional on exporting after the sanctions started to be implemented) decreased after 2014.

Estimation results confirm that consecutive to the implementation of sanctions in 2014, the propensity to invoice exports by French firms to Russia in US dollars declined. We find no pre-trend in this event study for the propensity of French exporters to invoice in US dollars. In quantitative terms, we find that the shock due to the sanctions decreased the propensity to invoice in US dollars by about 4 percentage points six years after the start of the sanctions.

We then explore the transmission channels listed above.

Firstly, we find evidence for the role of strategic complementarities in US dollar invoicing. Our estimations confirm that the drop in US dollar invoicing in French exports to Russia is stronger in HS4 product categories where the United States has before the invasion in 2014 a higher share in Russian imports. This result is consistent with the drop in the US

market share in Russia reducing the incentive to set prices in US dollars. Importantly, we find that this effect is stronger among larger French exporters, which are more likely to strategically interact with their competitors.

Secondly, we run a new empirical exercise where we control for the currency composition of international reserves in each destination country. The data detail the share of USD, EUR, GBP, and JPY in each central bank's reserves. Controlling for reserves composition leads to a weaker reaction of US dollar invoicing to sanctions on Russia by 2014, but the sanctions continue to have a significant negative impact on US dollar invoicing.

Thirdly, we rely on a list of "dual-use goods" as defined by the European commission and that we can match to our data using product codes. These dual-use goods identify product categories that may have for instance a military usage. In the United States, a similar list of products (without concordance to usual product codes) exists under the Export Administration Regulations (EAR), which is handled by the Bureau of industry and Security of the US Department of Commerce. We rely on the EU list, which we can match with our data and offers a list of products being potentially "exposed" to the risk of sanctions. We augment the empirical model by including an interaction term between the Russia-sanctions dummy by 2014 and a dummy variable identifying dual-use goods. Estimation results indicate that the reduction in the propensity to invoice in US dollars is more pronounced in dual-use goods. This result remains valid when we saturate the model on the demand-side by including destination-by-time fixed effects, thus controlling for the role played by macroeconomic channels as discussed above.

Finally, we rely on the French credit register that we match with the French customs data to identify exporters' relations to a large French banking group that was sanctioned by the US administration in 2014 for having conducted financial transactions in US dollars with countries under sanctions. Our results indicate that the clients of this large banking group reacted more strongly to the sanctions by 2014 on Russia in terms of US dollar use for transactions with Russia.

Overall, our results show that while the US dollar continues to represent a dominant share of currency invoicing in international transactions, the implementation of international sanctions on target countries can motivate firms in target countries and in third countries to diversify away from the US dollar in order to avoid sanctions. This mechanism comes on top of the direct impact through the composition of reserves and through the change

in the US market share in target countries (strategic complementarities effect).

Literature review.

Different reasons have been provided to explain the dominance of the US dollar in international trade invoicing since at least the second World War, and despite the decline of the United States in global GDP over time. The US dollar dominance involves both micro and macro determinants. Rey (2001) and Bacchetta and van Wincoop (2005) emphasize the role played by strategic complementary between firms operating in the same market, while Goldberg and Tille (2009) and Goldberg and Tille (2016) examine the role of the market power and bargaining between the exporter and the importer, which complements macroeconomic factors such as exchange rate volatility. Novy (2006) highlights the hedging motive when firm-level costs are paid in a foreign currency. Amiti et al. (2022) develop an integrated framework, which accounts for both the currency composition of imported inputs, as well as strategic complementary between firms. Gopinath and Stein (2021) develop a theory where a currency's role as a unit of account for invoicing is complementary to its role as a safe store of value.

The future role of the US dollar in the international financial system remains however very much debated, in the light of the rising share of China and other emerging economies, and the declining share of the United States in Global GDP. Arslanalp et al. (2022) document the progressive decline in the share of the US dollar in international reserves, to the benefit of the Chinese renminbi and other smaller reserve currencies. Mukhin (2022) develops a models with strategic complementary and input-output linkages across firms where the invoicing choice is endogenous. Predictions from the calibrated model indicate that the US dollar can remain a dominant currency despite the declining share of the United States in the global economy. Bahaj and Reis (2020) shows that the signature of swap lines with the People's Bank of China increases the propensity to use the renminbi for international payments. Georgiadis et al. (2021) show that the rise of China in the global economy had an ambiguous impact on the US dollar: The rising share of China in global trade actually strengthened the international role of the US dollar, while currency swap lines of the PBOC increased the propensity to invoice in renmbinbi as in Bahaj and Reis (2020).

Against this background, there is now an important policy debate about whether global

fragmentation in relation to geopolitical tensions between the United States and other large countries such as China or Russia could undermine the international role of the US dollar. James et al. (2022) discuss how international sanctions can undermine the role of the US dollar as a reserve currency. Mamonov et al. (2022) examine the consequence of sanctions starting in 2014 on Russian sanctioned banks. Itskhoki and Mukhin (2022) and Lorenzoni and Werning (2022) discuss the effects on the exchange rate. Finally, there is wide evidence that international sanctions are detrimental to international trade flows from / with sanctioned countries (Ahn and Ludema, 2020; Crozet and Hinz, 2020; Crozet et al., 2021; Hinz and Monastyrenko, 2022).

Our contribution is at the cross-roads of the literature on (i) the economic effects of sanction and (ii) the determinants of the US dollar dominance. In our paper, we study the impact of the economic sanctions against Russia. US-based sanctions on Russia increased the risks for firms (and banks) located in a third country to be targeted by US secondary sanctions when conducting transactions with Russian counterparts. We show that greater French exporters increased the use of the local currency (ruble) when they continued exporting to Russia. We provide evidence that three mechanisms amplified the decline of USD invoicing: (i) Strategic complementarities due to the decline of the US market share in Russia; (ii) the diversification of foreign reserves in Russia outside US dollar; (ii) US secondary sanctions targeting exporters of dual-use goods; (iii) US secondary sanctions targeting exporters' banks when the US dollar is used in foreign transactions.

The paper is organized as follows. In Section 2 we present a description of the sanctions against Russia and the implications of the extraterritoriality of the US law vis-à-vis USD invoicing. In section 3 we present some descriptive evidence regarding trade patterns and the composition of currency invoicing among French exporters in Russia. Section 4 presents our baseline estimation results. Section 5 details the transmission mechanisms. Section 6 concludes.

2 Sanctions and the extraterritoriality of the US law: Implications for US dollar invoicing.

2.1 The rise of international sanctions as a foreign policy tool

International sanctions have become an important tool for Governments' foreign policy. As depicted in Figure 1 using data from the Global Sanctions Database (Felbermayr et al., 2020), they are now implemented more frequently and by a large number of countries since the 1990's. These sanctions can take different forms including restrictions on trade flows, financial sanctions, travel restrictions, or controls of arms and military equipment.[4] They seek to influence foreign Governments policy without direct conflict. With the start of the Russian war of aggression on Ukraine in February 2022, the question of the economic impact of international sanctions has received an increasing degree of attention. An important aspect of this discussion has focused on its consequences for the international financial system, and the dominant role of the US dollar.

Figure 1: International sanctions (World, number of.)

(a) All sanctions   (b) by category
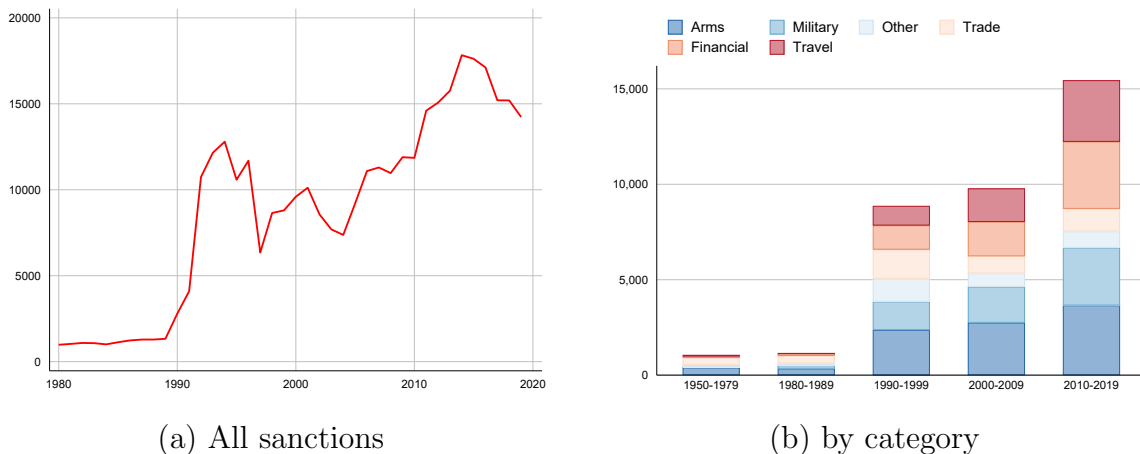
Source: Global Sanctions DataBase (Felbermayr et al., 2020). These sanctions do not include classical trade instruments such as import tariffs.

The wide use of international sanctions as a policy instrument indeed creates new risks

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[4]In the GSDB database, sanctions associated with international trade restrictions differ from classical trade policy such as tariffs or anti-dumping measures.

in terms of global fragmentation. Among possible economic consequences, international sanctions can modify the geography of international trade and financial flows, and can lead to the constitution of trading blocks. They can also affect the exchange rate and the value of foreign assets, through valuation effects but also through assets freezing. Finally, they have consequences for the architecture of the global financial system and the international role of the US dollar, as diversifying away from the US dollar may help to circumvent US sanctions. Importantly, international sanctions implemented by the US administration expose firms from third countries to penalties when they are conducting operations in the target country. This is due to the well-known extraterritorial nature of the US law and the related US secondary sanctions, which, combined with the dominant role of the US dollar as a vehicle currency in international transactions, provides an important lever for foreign policy by the US administration. The implementation of international sanctions by the US administration could foster the use of alternative currencies for international payments or in the composition of international reserves.

2.2   Nature of the sanctions

International sanctions targeting Russia started to be implemented in March 2014, after the invasion by Russia of parts of Ukraine, by a Western coalition of countries including in particular the United States and the European Union.

The nature of the sanctions implemented by the Western coalition has taken different forms. They targeted Russian foreign assets, entities (e.g. defense-related, energy, financial institutions), individuals or sectors (e.g. military, dual-use goods, extraction equipment). They also introduced restrictions on transactions ranging from goods to financial transactions, and targeted Russian banks.

2.3   EU sanctions

Importantly, EU sanctions in 2014 did not prevent French firms from exporting to Russia, even for sensitive products. For instance, dual-use goods could still be exported to Russia: (i) if the contract was passed before 2014, or (ii) if the buyer is not military (Council regulation (EU) No 833/2014 of 31 July 2014). However, EU sanctions increased the complexity to export to Russian counterparts, which is equivalent to a rise in trade costs.

We therefore have a first testable implication that will guide our empirical exercise:

- International sanctions introduced by the European Union on transactions with Russian entities increased transaction costs and reduced the propensity to export to Russia by French firms.

2.4   US sanctions

On the other hand, US sanctions do apply *directly* to US nationals and entities, but they can also impact *indirectly* foreign entities conducting activities with sanctioned countries, as soon as the US dollar is used in the transaction. This relates to "secondary sanctions" in the US law, which can be applied to foreign nationals.

The role of the US dollar for the foreign policy of the United States is made clear in a report published by the US congress: "De-dollarization efforts in China and Russia" (Congressional Research Service, July 2021). "*The dominance of the US dollar in cross-border transactions allows the United States unique visibility and levers of influence through policy measures such as financial sanctions that impede access to the US financial system or use of US dollar in international trade. Sanctions, imposed for foreign policy or national security objectives, restrict access to US payments and financial system, which is generally needed to process dollar transactions.*". Over the past decade, the report illustrates that the currency composition of Russian exports to BRICS countries has changed following in particular the implementation of international sanctions after the invasion of Crimea.

For firms located in a third country (such as French firms), but also financial intermediaries such as exporters' banks, using the US dollar as the invoicing currency for transactions with sanctioned countries is risky as it exposes them to financial penalties by the US secondary sanctions. This motivates our second testable implication:

- International sanctions introduced by the United States and targeting Russian entities increased the risks for firms located in third countries of being targeted by US secondary sanctions whenever they use the US dollar as a means of payments. These sanctions reduced the propensity to export to Russia by French firms, but also the use of US dollars in transactions among continuing exporters.

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2.5   Strengthening of sanctions over time

Since March 2014, international sanctions on Russia have been progressively strengthened over time. In particular, the US administration introduced new sanctions after the Russian interference in US elections, or the poisoning of Serguei Skripal and his daughter (March 2018).

These actions triggered a series of reactions from the US administration that progressively reinforced its arsenal of sanctions on Russia, especially by 2017. This process is well described in a report published by the Congressional research service of the United States of America: "US sanctions on Russia" (updated in January 2022).

- August 2017: Countering America's Adversaries Through Sanctions Act of 2017 (CAATSA), which includes as Title II the Countering Russian Influence in Europe and Eurasia Act of 2017 (CRIEEA).

- August 2018: CBW (Chemical and Biological Weapons control act of 1991) triggered

- November 2018: the State Department informs Congress that it "could not certify that Russia met the required conditions" and intends "to proceed in accordance with the terms of the CBW Act, which directs the implementation of additional sanctions".

- August 2019: Treasury issues a directive (the "CBW Act Directive") specifying that the latter measures prohibits U.S. banks from "lending non-ruble denominated funds to the Russian sovereign" or participating "in the primary market for non-ruble denominated bonds issued by the Russian sovereign".

   Export licenses to Russian state-owned or state-funded enterprises for goods controlled for their dual-use chemical and biological applications became subject to a "presumption of denial" policy.

The report additionally describes that from 2018, the Treasury Department appeared ready to enforce CRIEEA-mandated secondary sanctions on persons that continued to conduct transactions with a sanctioned Russian firm. This followed new sanctions on Rusal, a global aluminum firm. It concludes that in reaction, the Russian government

started to reduce the share of dollar-denominated assets in its sovereign wealth fund, and developed alternative payment systems that are not centered on the dollar.

To illustrate the strengthening of sanctions on Russia by the US administration, we conducted a Google search using an Rstudio algorithm (gtrendsR), in order to view the importance of topics reclated to EU and US sanctions over time. We relied on two sets of strings: "European sanctions Russia" and "US sanctions Russia", focusing on the period 2012 to 2020, i.e. before the Russian aggression on Ukraine in February 2022. We tested different alternatives for the sequence of strings, using alternatively, e.g., "US sanctions Russia" or "United States sanctions Russia".

The results from this search is reported in Figure . It clearly shows the relevance of these two topics around the time of the invasion of Crimea and the Eastern regions of Ukraine in 2014, for both EU and US sanctions on Russia. However, while the topic for European sanctions rapidly dissipates already in 2015 and in the following years, we can see clearly a strong renewal of the interest in US sanctions on Russia in Google searches from 2017, i.e. at the time when the arsenal of US sanctions on Russia was strengthened.

Figure 2: Google search results for European vs. US sanctions on Russia
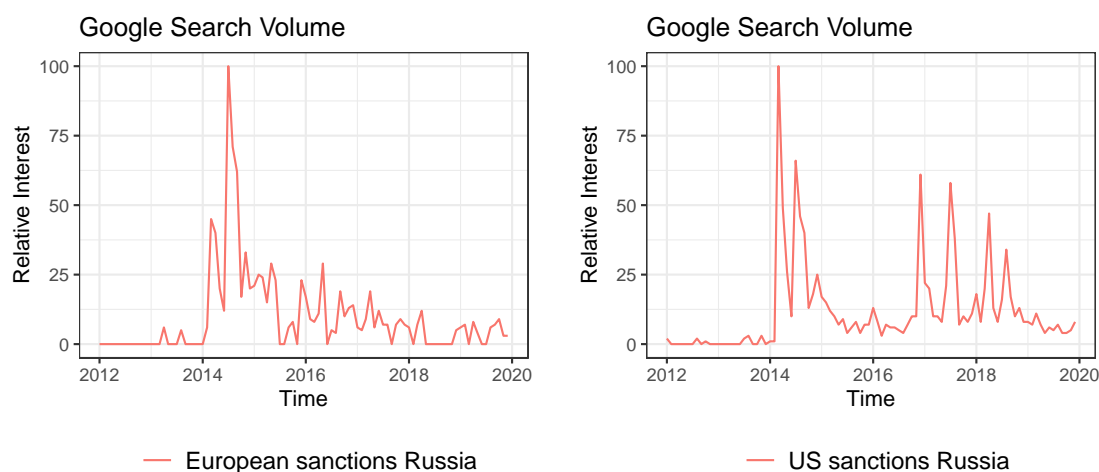
This observation helps us to formalize a third testable implication that will guide our empirical analysis:

- As the US sanctions on Russia were progressively strengthened over time, we should

observe that the negative impact on USD invoicing in French transactions to Russia also increased progressively over time (in absolute terms).

3 Descriptive statistics

3.1 Trade patterns

The following graphs indicate different patterns of French exports to Russia following the first war in Ukraine and the implementation of sanctions starting in 2014:

- We first have a sharp decline in the number of transactions (firm-product trade flows) as well as in total exports to Russia (Figure 3).

- The share of Russia in French total exports was about 5% before the sanctions and is reduced to about 3% in 2020. We observe a similar drop in the number of transactions and this decline is persistent (Figure 4).

- The number of French firms exporting to Russia declines rapidly after 2014 but the average size of exporters, measured by their total extra-EU exports before 2014, increases (Figure 5), meaning that smaller exporters are more likely to withdraw.

All these results signal a change in the composition of French exporters in Russia after the start of the sanctions, with small exporters exiting the Russian market, while larger ones remain. Importantly, we know from previous work (Amiti et al., 2022) that the size of exporters is very much related to their propensity to invoice in a foreign currency. This implies that we will need to control for these composition effects in the rest of the analysis.

3.2 Currency invoicing

We report in Figure 6 the exact composition of currencies in French total exports to Russia. On average over the period, about 40% or more of total exports to Russia is invoiced in euro, an other 40% or more is invoiced in rubles, and the remaining 15% is invoiced in dollars. Interestingly, the share of the euro in percentage of the total number of

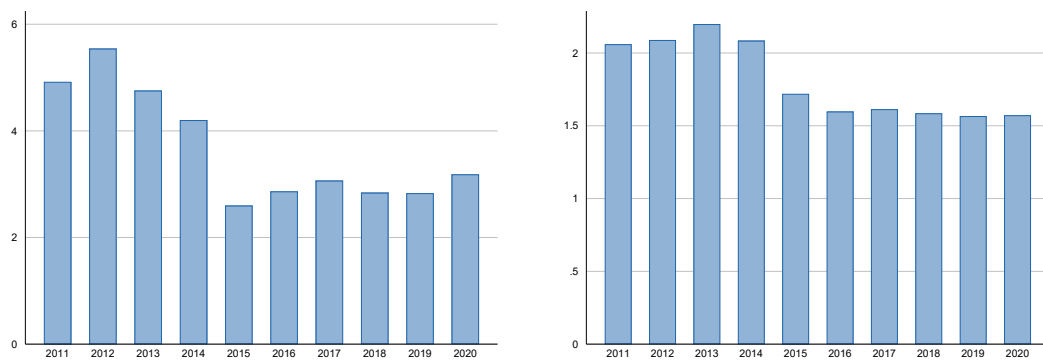Figure 3: French total exports to Russia

(a) Ln total exports

(b) Ln nb. transactions

Note: French customs data, extra-EU.

Figure 4: Russia in total extra-EU French exports

(a) Total exports

(b) Nb. transactions

Note: French customs data, extra-EU.

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Figure 5: The changing composition of exporters
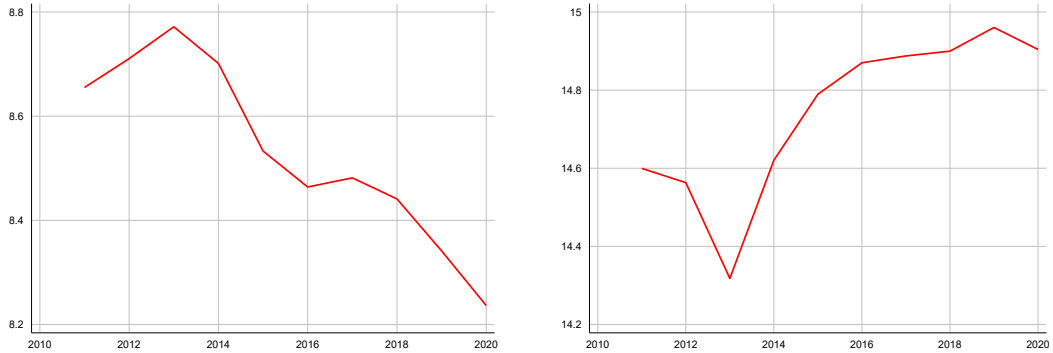
(a) Ln nb. exporters

(b) Ln average exporter size

Note: French customs data, extra-EU.

transactions is much higher and represented more than 80% of transaction-level invoicing in 2011 when our data start. It declined sharply by 2014 when sanctions started to be implemented.

Figure 6: Share of currencies in French exports to Russia
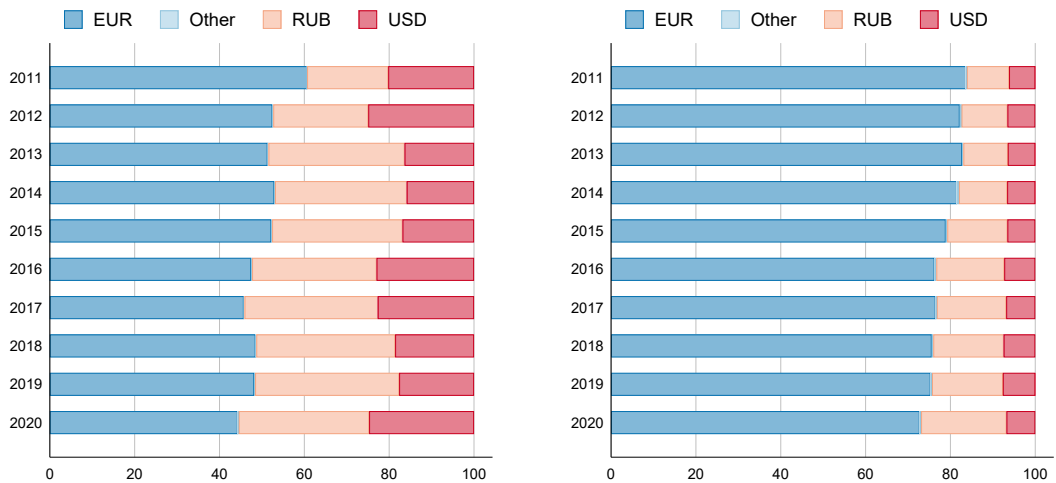
(a) % of total exports

(b) % of transactions

Note: French customs data, extra-EU.

As shown in previous graphs, changes in the composition of exporters were important by the start of the war and sanctions, so we need to disentangle what comes from the

selection of exporters and what is due to real changes in the propensity to invoice in different currencies.

To do this, we replicate the analysis but focus only on the set of transactions that are continuously exported to Russia during the period covered by our data (2011-2020). This reduces substantially our sample of observations, but allows to have a better idea of the "treatment" implied by the sanctions. The three graphs reported in Figure 7 show that (1) the US dollar share declined; (2) the euro share declined as well; and (3) this was compensated by an increase in the share of ruble in transactions.

Figure 7: Share of currencies in French exports to Russia (continuing transactions)

| (a) % of dollar | (b) % of euro | (c) % of ruble |

Note: French customs data, extra-EU. Firms continuously exporting to Russia during the period 2011-2020.

4 Impact of sanctions

4.1 Event study: Trade

We ask two questions: (1) How were trade flows impacted by the sanctions; (2) How did the USD share in French exports' invoicing to Russia evolve. Compared with the descriptive analysis presented in the previous sections, the econometric analysis will control for a broad set of structural factors related to the characteristics of trade flows per firm, product and destination. We will control also for product-level shocks over time that are not specific to a destination (e.g. global product-specific supply or demand shocks), and for firm-level shock (such as productivity shocks).

We start by estimating two empirical models where export patterns are explained by a set of Russia-time dummies around the time of the sanctions on Russia in 2014, with time values ranging from -2 to +6; 0 being the time of first "implementation" of the sanctions. In these two models represented in Equations 1 and 2, the two dependent variables are either $\mathbb{1}^X_{fpjt}$ (this is a linear probability model) or $\Delta \ln V_{fpjt}$, the log variation of the export value between year t and year t-1. γ_{fpj} is a fixed effect controlling for structural firm-product-destination characteristics, and θ_{fpt} is a firm-product-time fixed effect controlling for common shocks across destinations. With this specification, we therefore aim at identifying a factor that is specific to Russia around the time of the sanctions, controlling for characteristics of each individual in the panel.

For this estimation, we rely on two destinations: Russia and the United States. Russia is the "treated" destination. The United States is the largest destination in our French extra-EU exports database. This choice is mainly motivated by the analysis on currencies: we need a benchmark country that is relatively stable in terms of currency invoicing patterns. For instance, China is not a good benchmark country as the patterns of currency invoicing in that destination has been changing over time during the period of the analysis (2011-2020). Other emerging economies may have decided to use alternative vehicle currencies or local currencies in the context of the increased implementation of international sanctions by the United States.

$$\mathbb{1}^X_{fpjt} = \sum_{t=-2}^{t=6} Russia_{jt} + \gamma_{fpj} + \theta_{fpt} + \epsilon_{fpjt} \tag{1}$$

$$\Delta \ln V_{fpjt} = \sum_{t=-2}^{t=6} Russia_{jt} + \gamma_{fpj} + \theta_{fpt} + \epsilon_{fpjt} \tag{2}$$

The results from this event study are reported in Figure 8. The graph in panel (a) indicate a sharp decline in the export probability to Russia over the time period considered, by about 3 percentage points after 6 years. Note that this empirical specification controls for firm-destination-product fixed effects and the treatment effect should be interpreted within this dimension over time, with firm progressively removing some of their products form the Russian market.

The graph in panel (b) shows that the growth rate of firm-level exports declines sharply in

the year of implementation (2014) and also in the following year (by 0.4 log points) when
we have a full year of sanctions. Two and three years after the start of the implementation,
there is a small catch-up of export values, but overall the losses in the first two years of
implementation are not made-up and the trade loss is persistent.

Figure 8: Event graph: Impact of 2014 sanctions on Russia on firm-level exports
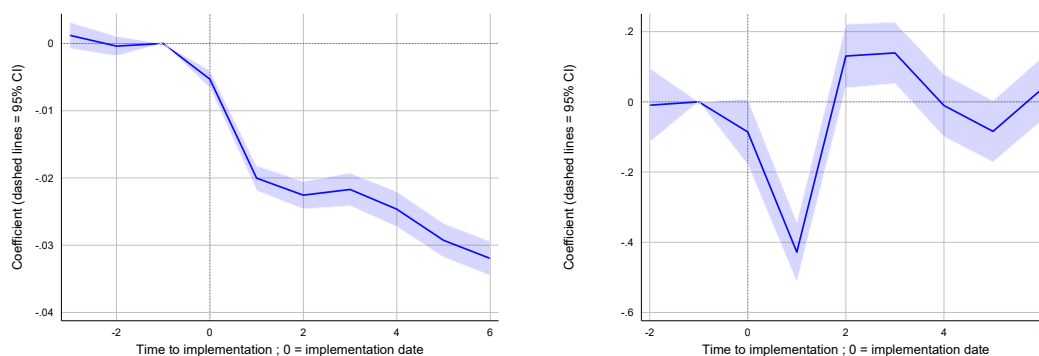
(a) Export probability (t)   (b) Log change in exports (t / t-1)

Note: French customs data, extra-EU. Treated destination: Russia; Control destination: United States.
Standard errors clustered by destination-product (HS6).

To compete the analysis, we report in Tables 1 and 2 the average treatment effect based
on a model where the dependent variable is now a dummy equal to on if the destination
is Russia, by 2014. The empirical specification is very similar to the one presented in
Equations 1 and 2.

For the linear probability model with the dependent variable "Export dummy (fpjt)",
we provide the estimations for different subsamples of observations and fixed effects.
In the first two columns (1) and (2), we use firm-product time fixed effects as well as
destination fixed effects. This allows to track the impact of the sanctions on Russia in
terms of export probability both between and within firms (i.e. the selection of firms in
the Russian market and the selection of products within firms). In columns (3) and (4)
we control for firm-product-destination fixed effects instead of destination fixed effects
(we still control for firm-destination-time fixed effects) and the interpretation of the linear
probability model is therefore within firms exporting to Russia and between products. For
each estimation, we keep either the full sample of products or conversely manufacturing
products only, which de facto eliminates agricultural and agri-food product that were
targeted by Russian sanctions. We also estimate the model over two periods: 2011-2020

for the full sample, and 2012-2016 in a specification where we focus on a shorter period, two years before and after the start of the sanctions.

Estimation results provided in Table 1 show that the impact of the sanctions on export probability is the largest in the estimations reported in column (1) and (2) in the top panel, i.e. when the set of fixed effects allows to identify selection within and across firms. Estimation results are similar when we exclude agriculture, food products and energy products. The effect is quantitatively weaker when we focus on a shorter time period, which indicates that the sanctions progressively implemented after 2014 continued to reduce the export probability until the end of the sample.

Table 1: Impact of sanctions: Export probability

	(1)	(2)	(3)	(4)
Dep. var.		Export dummy (fpjt)		
Destinations		RU+US		
Exporters	All	All	All	All
Products	All	Manuf.	All	Manuf.
Period		2011-2020		
RU sanctions (2014)	-0.026^a	-0.026^a	-0.021^a	-0.020^a
	(0.001)	(0.001)	(0.001)	(0.001)
R^2	0.57	0.57	0.85	0.84
Obs.	11380452	10258564	8,181,086	7,266,138
Period		2012-2016		
RU sanctions (2014)	-0.016^a	-0.016^a	-0.016^a	-0.016^a
	(0.001)	(0.001)	(0.001)	(0.001)
R^2	0.57	0.57	0.87	0.86
Obs.	5,651,068	5,115,748	3,566,744	3,160,448
j-FE	Yes	Yes	No	No
fpj-FE	No	No	Yes	Yes
fpt-FE	Yes	Yes	Yes	Yes

Note: Significance levels: ^{a} p<0.01, ^{b} p<0.05, ^{c} p<0.1. Treated destination: Russia; Control destination: United States. Standard errors clustered by destination-product (HS6). Standard errors clustered by destination-product (HS6).

We report the estimation results for the log variation of exports in Table 2. Estimation results are reported for all or continuous exporters, and relies on different samples of destinations (all destinations, OECD destinations and Russia, US and Russia). In all estimations we conclude that sanctions had a negative effect on French exports to Russia. Estimation results remain unchanged when we focus on manufacturing goods (unreported estimations).

Table 2: Impact of sanctions: Firm-level exports

	(1)	(2)	(3)	(4)	(5)
Dep. var.		Ln Export (fpjt) - Ln Export (fpjt-1)			
Destinations	All	RU+OECD		RU+US	
Exporters	All	All	Conti.	All	Conti.
Period			2011-2020		
RU sanctions (2014)	-0.128^a	-0.157^a	-0.156^a	-0.059^b	-0.095^a
	(0.015)	(0.017)	(0.019)	(0.027)	(0.029)
R^2	0.35	0.44	0.43	0.62	0.62
Obs.	2,963,571	999,602	680,848	81,112	57,634
Period			2012-2016		
RU sanctions (2014)	-0.214^a	-0.249^a	-0.246^a	-0.138^a	-0.160^a
	(0.016)	(0.018)	(0.022)	(0.030)	(0.033)
R^2	0.38	0.47	0.46	0.63	0.62
Obs.	1,451,444	474,890	333,296	40,344	27,682
fpj-FE	Yes	Yes	Yes	Yes	Yes
fpt-FE	Yes	Yes	Yes	Yes	Yes

Note: Significance levels: ^{a} p<0.01, ^{b} p<0.05, ^{c} p<0.1. Column (1): all exporters and destinations; Column (2): all exporters, exports to Russia or OECD countries; Column (3): continuing exporters-and-destinations (10-years), exports to Russia or OECD countries; Column (4): all exporters, exports to Russia or the United States; Column (5): continuing exporters-and-destinations (10-years), exports to Russia or the United States; Column (6):Top 500 exporters in the United States, exports to Russia or the United States.

4.2 Event study: Currency invoicing

To identify in a cleaner way the effects of international sanctions on currency invoicing in Russia, we estimate the specification reported in Equation 3. Dollar_{fpjt} is a USD invoicing dummy variable. γ_{fpj} is a firm-by-destination-by-product fixed effect, θ_{fpt} is a firm-by-product-by-time fixed effect, and ϵ_{fpjt} is the error term. As in the previous estimations, standard errors are clustered by destination and HS6 product.

$$\text{Dollar}_{fpjt} = \sum_{t=-2}^{t=6} Russia_{jt} + \gamma_{fpj} + \theta_{fpt} + \epsilon_{fpjt} \tag{3}$$

Results from the estimation are reported in Figure 9, panel a, with the estimated coefficient and the 95% confidence interval. The propensity to invoice in US dollars is found to decline by about 4 percentage points after six years of sanction.

In a robustness exercise, we rely on a sample of firms that continuously export in each destination for a period of 10 years. This allows us to address the composition effect mentioned earlier in the paper, which has a strong impact on invoicing currency compo-

sition. The results are very similar when we keep in the sample only exporters exporting continuously for 10 years in a row (Figure 9, panel b): The USD invoicing propensity by French exporters operating in Russia declines by four to six percentage points after six years. Importantly, we find no pre-trend for the US dollar invoicing patterns. We also find equivalent results when we have all extra-EU OECD countries in the control group.

Figure 9: Event graph: probability to invoice in USD following sanctions in 2014 in Russia
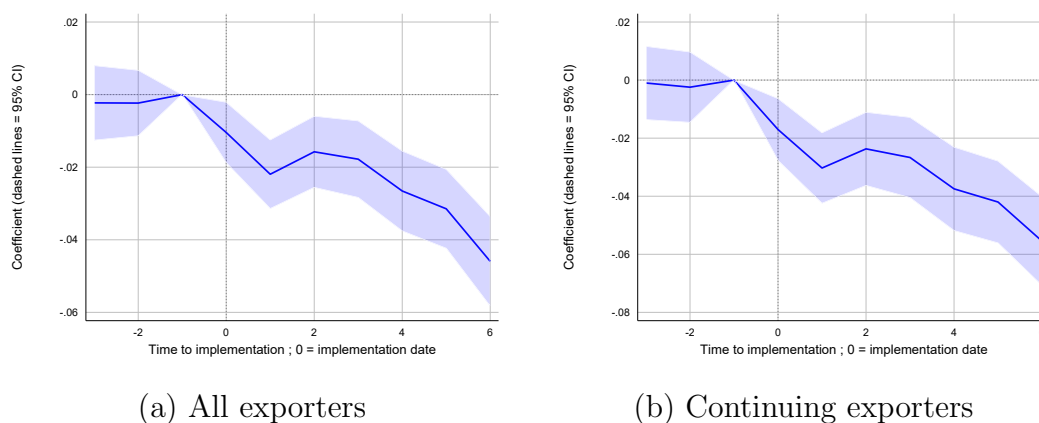
(a) All exporters   (b) Continuing exporters

Note: French customs data, extra-EU. Treated destination: Russia; Control destination: United States. Standard errors clustered by destination-product (HS6). Continuing exporters: We keep exporters exporting exactly 10 years in treatment and control destinations.

We complete the analysis by estimating the average treatment effect of sanctions on currency invoicing. Estimation results for dollar invoicing, euro invoicing and ruble invoicing, are reported in Table 3. For each currency, we provide the results from a regression where all exporters are included, and the results from a regression only for exporters being 10 consecutive years on the Russian market. The results are based on keeping only the United States in the reference group of destinations. Results confirm that the sanctions produced a change in the composition of currencies in French exports to Russia, post 2014. If we refer to the results for continuing exporters, we find that the share of US dollar invoicing declined by about 3 pp., the share of euro declined by about 1 pp., and the share of ruble increased by about 4 pp. after the implementation of the sanctions in 2014.

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Table 3: Impact of sanctions: Currency invoicing

	(1)	(2)
Dep. var.	Dollar	
Exporters	All	Conti.
Period	2011-2020	
RU sanctions (2014)	-0.021^a	-0.031^a
	(0.004)	(0.005)
R^2	0.93	0.93
Obs.	136,586	87,388
Period	2012-2016	
RU sanctions (2014)	-0.015^a	-0.023^a
	(0.004)	(0.005)
R^2	0.95	0.95
Obs.	62,148	39,148
fpj-FE	Yes	Yes
fpt-FE	Yes	Yes

Note: Significance levels: ^{a} p<0.01, ^{b} p<0.05, ^{c} p<0.1.. Standard errors clustered by destination-product (HS6). Treated destination: Russia; Control destination: United States. *Conti.* stands for continuing exporters: exporters exporting exactly 10 years in treatment and control destinations.

5 Mechanisms

5.1 Strategic complementarities

In this section, we test for the role of strategic complementarities in shaping invoicing patterns across export destinations and product markets. Amiti et al. (2022) show that the decision to invoice in euro or a different currency for Belgian exporters depends on strategic complementarities between firms. Small firms are more likely to invoice their exports in their home currency (Producer Currency Pricing, PCP) whereas large firms are more likely to invoice in the currency of the importer or in a vehicle currency (Local currency Pricing, LCP, or Dominant Currency Pricing, DCP). In markets where competitors use DCP pricing, individual exporters are also likely to invoice their exports in US dollars.

Western sanctions affected progressively the market share of Western nations in the Russian market. Figure 10 shows that the US export market share in Russia (measured as the share of Russian imports from the United States in each HS4 product category – in the graph taken as a simple average) progressively declined over time. The decline of the US market share in Russia, however, did not start when Russia invaded Crimea.

It started to decline by 2016 onward, which corresponds to the period of new sanctions being implemented by the US Government. For the top 10% of HS4 products in terms of US exports performance, the market share declined from more than 10% to about 8% in 2020. The average US export market share in Russia (across HS4 products) declined from about 4% before the Russian invasion to about 3% in 2020.

Figure 10: US export market share in Russia (by HS4 product)
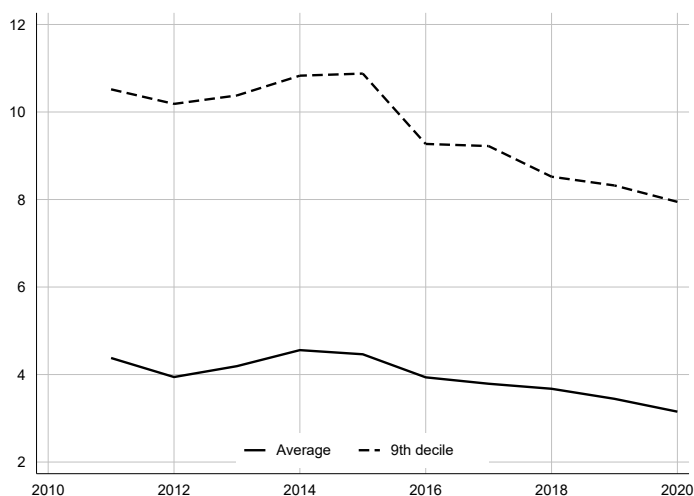
Source: Authors' calculations, CEPII-BACI dataset

5.1.1 The role of Changes in the US market share over time

We first present in this section an empirical analysis where we relate the propensity of French exporters to invoice their exports in US dollars in Russia to the changes in the US market share over time in HS4 product categories. We use the heterogeneity in terms of the US export market share in Russia, in the cross section of products and over time, to identify the role of strategic complementarities in terms of US dollar invoicing. Given the dominant role of the US dollar in international transactions, most of US exports is invoiced in US dollars.

We expect that in product categories where the US market share is high, large French exporters should invoice more their exports in US dollars as they compete in this market with other large US firms. We also expect that the decline in the US market share over

time should have reduced the propensity by French exporters to invoice in US dollars.

We start the analysis with a simple econometric specification where Russia is the only destination. The decision of French firms to invoice their exports to Russia in US dollars is explained by the US export market share in the same HS4 product category in Russia and in each year, by the size of the French exporter (measured by its market share in French total exports in each year), and by an interaction term between the two variables (US market share in Russia × exporter size). Standard errors are clustered by HS4-product and year (not by destination here as there is only one destination in this alternative specification: Russia). The estimation relies on firms operating ten years on the Russian market through exporting, which allows controlling for composition effects due to changes in export participation following the introduction of the sanctions.

$$
\begin{aligned}
\text{Dollar}_{fpt}^{RU} = \ & \alpha_1 \text{US market share}_{HS4,t}^{RU} \\
& + \alpha_2 \text{US market share}_{HS4,t}^{RU} \times \ln \text{Size}_{ft} \\
& + \alpha_3 \ln \text{Size}_{ft} + \gamma_{fp} + \theta_t + \epsilon_{fpt}
\end{aligned}
\tag{4}
$$

Where Dollar_{fpt}^{RU} is a dummy variable which equals one when the US dollar is used as the invoicing currency, and zero otherwise. US market share$_{HS4,t}^{RU}$ is the US market share in each HS4 and year in Russian Imports. Size_{ft} is the relative size of the exporter in French total exports. γ_{fp} is a firm-product fixed effect. θ_t is a year dummy variable. ϵ_{fpt} is the error term clustered by destination-product-year. In this specification, Russia is the only destination.

Estimation results reported in Table 4 confirm that French exporters tend to invoice more their exports in US dollars in Russia when the United States' exporters have a larger market share. This effect appears stronger among larger exporters, which are more likely to strategically interact with other very large exporters in the destination market. This result, which is obtained by considering only one destination (Russia), implies that the reduction in the US market share in Russian imports, in each HS4 product by 2016, led to a decline in the propensity of French firms to invoice their exports in US dollars.

In an alternative estimation, the econometric model fully controls for firm-year fixed effects. In this estimation, the fixed effects fully absorb the role of exporters' size and therefore control for any productivity shock at the firm level. In this new estimation,

the role of strategic complementarities, proxied by the market share of US exporters, is confirmed.

Table 4: Strategic complementarities and USD invoicing: the role of US market share

	(1)	(2)
Dep. var.	Dollar invoicing	
Destinations	Russia	
US market share (HS4, by year)	0.231^a	0.268^b
	(0.080)	(0.118)
... $\times$ ln Exporter size	0.028^a	0.029^b
	(0.009)	(0.013)
ln Exporter size	0.006^a	
	(0.002)	
R^2	0.85	0.91
Obs.	88,760	86,234
fp-FE	Yes	Yes
Year-FE	Yes	No
ft-FE	No	Yes

Note: Russia is the only destination market. Estimation sample is restricted to French exporters surviving 10 years in the Russian market. The dependent variable *Dollar* takes the value equal to one if the dollar is used by the exporter as the invoicing currency, and zero otherwise. The exporter size is measured as its share in total French exports in each year. The US share in Russian imports is measured by HS4 and year. Standard errors are clustered by HS4-product and year. Significance levels: ^{a} p<0.01, ^{b} p<0.05, ^{c} p<0.1.

5.1.2 The role of sanctions in products where US firms dominate

A different way to test for the role of strategic complementarities is to augment our baseline model with an interaction term between the sanctions dummy on Russia and the US market share per HS4 product.

Our baseline empirical specification is a difference-in-difference estimation, where French exports to Russia and control destinations are compared before and after sanctions started to be implemented in 2014. Compared with the baseline econometric specification, we add two interaction terms: (1) between the sanctions dummy and the ex-ante US export market share in Russia; (2) between the sanctions dummy and the exporter size. Last, we also add a triple interaction term to take into account the combined effect of operating in an HS4 market in Russia dominated by US firms, for large versus small French exporters. We expect that strategic complementarities should be stronger among large French exporters.

$$\text{Dollar}_{fpjt} = \quad \alpha_1 \text{Russia}_{j,Post2014} + \gamma_{fpj} + \theta_{fpt} + \epsilon_{fpjt}$$
$$+ \alpha_2 \quad ... \times \text{US market share}_{HS4,pre2014}^{RU}$$
$$+ \alpha_3 \quad ... \times \ln \text{Size}_{ft} \tag{5}$$
$$+ \alpha_4 \quad ... \times \text{US market share}_{HS4,pre2014}^{RU} \times \ln \text{Size}_{ft}$$

Table 5: Strategic complementarities and USD invoicing: Sanctions and US market share

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. var.				Dollar		
Destinations	Russia + United States			Russia + OECD		
RU sanctions (2014)	-0.021^a	0.041^b		-0.005^b	-0.008	
	(0.005)	(0.016)		(0.002)	(0.007)	
... × US market share (HS4, pre-2014)	-0.303^a	-1.946^a	-1.946^a	-0.217^a	-0.794^a	-0.791^a
	(0.091)	(0.395)	(0.394)	(0.045)	(0.164)	(0.163)
... × US M.S. × ln Exporter size		-0.219^a	-0.220^a		-0.075^a	-0.074^a
		(0.049)	(0.049)		(0.019)	(0.019)
... × ln Exporter size		0.008^a	0.009^a		-0.001	-0.001
		(0.002)	(0.002)		(0.001)	(0.001)
R^2	0.93	0.93	0.93	0.88	0.88	0.88
Obs.	87,364	87,364	87,364	1,037,978	1,037,978	1,037,978
fjp-FE	Yes	Yes	Yes	Yes	Yes	Yes
fpt-FE	Yes	Yes	Yes	Yes	Yes	Yes
jt-FE	No	No	Yes	No	No	Yes

Note: Destinations are Russia and a set of control countries. Estimation sample is restricted to French exporters surviving 10 years in destination markets. The dependent variable *Dollar* takes the value equal to one if the dollar is used by the exporter as the invoicing currency, and zero otherwise. The exporter size is measured as its share in total French exports in each year. The US share in Russian imports is measured by HS4 before the implementation of the sanctions. Standard errors are clustered by destination, HS4-product and year. Significance levels: ^{a} p<0.01, ^{b} p<0.05, ^{c} p<0.1.

Estimation results are reported in Table 5. Results confirm that Russian sanctions had a negative impact on the propensity to invoice French exports in US dollars. This effect is stronger in product markets where the United States has a larger market share (the interaction term between the sanctions dummy and the ex-ante US export market share in Russia is significantly negative). The role of strategic complementarities is also stronger in this estimation for larger French exporters (the coefficient on the triple interaction term is also significantly negative), confirming the results obtained in the previous specification where Russia was the only destination.

These results are robust to including destination-time fixed effects in the empirical specification (columns 3 and 6). Destination-time fixed effects control for the overall macroeconomic adjustment including exchange rates or oil prices, and all the identification relies

on the heterogeneous adjustment between firms and products. This is therefore a cleaner specification in terms of identification. We obtain similar results when the control destination is composed of several OECD countries instead of the United States only.

5.2 Controlling for the role of international reserves

We test here for the additional role played by the changes in the currency composition of central bank reserves in Russia after the implementation of the sanctions. We use the data collected by Ito and McCauley (2020) from various sources, as it details publicly the currency composition of reserves country by country, unlike the IMF COFER database. As the threat of new sanctions on Russia increased, the central bank progressively reduced the share of US dollars in its foreign reserves, with an important step taken in 2018 where the US dollar share declines to about 20% from more than 40% (Figure 11). This is an important shift, which reduced the availability of the US dollar for international payments made by Russian firms.

Figure 11: Russia: Composition of international reserves
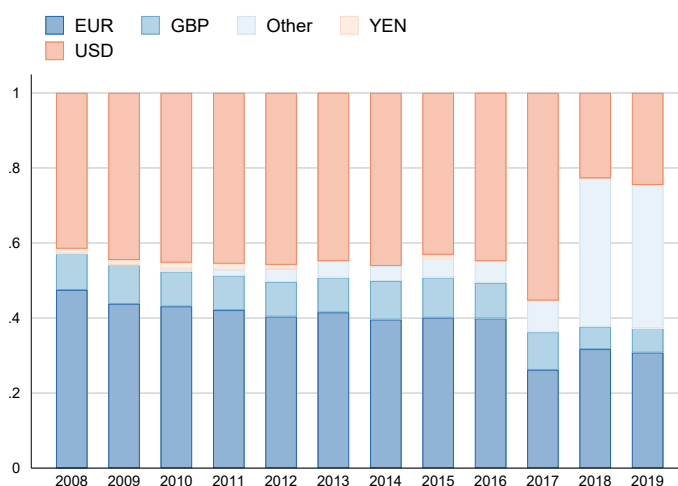
Source: This graph shows the evolution of the currency composition of reserves by the central bank of Russia. It relies on data collected by Ito and McCauley (2020).

To test for this additional channel, we augment the econometric model presented in Equation 5 by including a control variable for the share of the USD in the reserves of the

Bank of Russia. For this new estimation, the last data point in time is for the year 2019, as 2020 is not yet available in the data published by Ito and McCauley (2020).

Estimation results are reported in Table 6. The coefficient on the RU sanctions variable remains significantly negative in the first column corresponding to the baseline specification over the period 2011-2019, and also in the second column where the control for USD reserves is included. USD reserves is positively associated with US dollar invoicing in French exports, confirming that restricting the USD liquidity in Russia also reduces the capacity of Russian operators to pay for their imports in US dollars. Importantly, the results reported in columns 3 and 4 of the table confirm the role played by strategic complementarities in shaping the response of French exporters in Russia following the implementation of sanctions.

Table 6: Strategic complementarities and USD invoicing: controlling for international reserves

	(1)	(2)	(3)	(4)
Dep. var.		Dollar		
Period		2011-2019		
RU sanctions (2014)	-0.028^a	-0.025^a	0.050^a	0.046^a
	(0.004)	(0.004)	(0.017)	(0.017)
... × US market share (HS4, pre-2014)			-1.759^a	-1.759^a
			(0.404)	(0.404)
... × US M.S. × ln Exporter size			-0.200^a	-0.199^a
			(0.051)	(0.051)
... × ln Exporter size			0.009^a	0.009^a
			(0.002)	(0.002)
International reserves in USD		0.060^a	0.060^a	
		(0.015)	(0.015)	
R^2	0.93	0.93	0.93	0.93
Obs.	76,846	76,846	76,830	76,830
fpj-FE	Yes	Yes	Yes	Yes
fpt-FE	Yes	Yes	Yes	Yes

Note: Destinations are Russia and a set of control countries (United States). Estimation sample is restricted to French exporters surviving 10 years in destination markets. The dependent variable *Dollar* takes the value equal to one if the dollar is used by the exporter as the invoicing currency, and zero otherwise. International reserves data are from Ito and McCauley (2020). Standard errors are clustered by destination, HS4-product and year. Significance levels: ^{a} p<0.01, ^{b} p<0.05, ^{c} p<0.1.

5.3 Sector heterogeneity: The role of dual-use goods.

Western sanctions on Russia after the 2014 aggression on Ukraine targeted more specifically goods that an have a direct or indirect military use. In the United States in par-

ticular, those sanctions were strengthened over time. For this reason, we expect that the effect of secondary sanctions is stronger in dual-use goods compared to other categories of goods.

In our empirical analysis, we use a classification that identifies specifically goods that can have a dual-use, i.e. civil or military, for the identification of the impact of sanctions on trade with Russia and currency invoicing. The European Commission has established a list of such goods, for which there exists a specific regulation for exports, and for which there may exist a ban on exports in certain circumstances. Importantly, the ban can target specifically a product, an entity, a person, or a combination of those. And the list of sanctioned products, entities or persons in a given partner country can evolve over time. Importantly for our analysis, the European Commission publishes a detailed list of products listed as "dual use goods" and this list has a mapping with the Combined Nomenclature of the European customs.

European sanctions are detailed in COUNCIL REGULATION (EU) No 833/2014 of 31 July 2014 "concerning restrictive measures in view of Russia's actions destabilizing the situation in Ukraine". The regulation on exports of dual-use goods exported to Russia is specified in article 2. It prohibits selling dual-use goods for military use or end-users in Russia. However, it specifies that those goods can still be exported when the end-user is not military, or when the contract was concluded before 1st August 2014. It follows that dual-use goods can still be exported by French companies to Russia, under certain conditions, after August 2014.

Similar restrictions selling dual-use goods to Russia were implemented by the US administration by 2014. In the United States, these sanctions are handled by the Bureau of Industry and Security of the US Department of Commerce. The list – Export Control Classification Number (ECCN) on the Commerce Control List (CCL) – has no mapping with product codes in the customs data and there is no easy match. For restrictions on dual-use goods, *"The Department of Commerce's BIS denies export licenses for military, dual-use, or energy-related goods to designated end users, most of which also are subject to Treasury-administered sanctions"* (Congressional research service, "US sanctions on Russia" Updated January 18, 2022). These restrictions on dual-use goods exports were strengthened by the US administration after the poisoning of Serguei Skripal and his Daughter. Importantly, these US sanctions have an extraterritorial dimension mean-

ing that firms and banks using the US dollar with sanctioned countries are expected to comply with the US regulation.

For the analysis, we will use the most recent list of dual-use goods provided by the European Commission, in order to identify those products that are eligible to possible sanctions.

5.3.1 Effect on trade.

We start by investigating the effect of sanctions on exports to Russia in dual-use goods relative to other types of goods. The empirical specification is similar to the main empirical model for trade. We add an interaction term between the $Russia_j \times Post2014$ dummy variable, and a dummy variable identifying dual-use goods categories. Importantly, other types of goods in agriculture and food industry were subject to sanctions by Russian authorities. We therefore provide estimation results for all goods or manufacturing goods only. For the estimation of the linear probability model, we rely on two alternative sets of fixed effects so as to identify the overall impact on selection between and within firms across products, or the within-firms effect only.

Estimation results for the linear probability model are provided in Table 7. Estimation results indicate that sanctions had a more negative impact on the probability to export dual-use goods to Russia only in the specification where we focus on manufacturing goods outside agriculture and food, and when the equation introduces firm-product time and destination fixed effects, but not firm-product-destination fixed effect (i.e. when the model allows selection between firms). In the more demanding specification in terms of fixed effects, where firm-product-destination fixed effects are included, we find no specific impact of the sanctions on dual-use goods exports.

This result is not completely surprising, since the European 2014 sanctions were quite loose and allowed a large share of the goods to keep being exported. Our results indicate though that in dual-use goods sectors, some firms were forced to stop exporting more to Russia because of the sanctions.

We report in Table 8 the results for the log variation of firm-level exports. In each estimation, the interaction term between the time of the Russian sanctions and the dual-use goods dummy is negative, meaning that exports of dual-use goods seem to suffer more

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Table 7: Impact of sanctions: Export probability and dual use goods

	(1)	(2)	(3)	(4)
Dep. var.		Export dummy (fpjt)		
Destinations		RU+US		
Exporters	All	All	All	All
Products	All	Manuf.	All	Manuf.
Period		2011-2020		
RU sanctions (2014)	-0.022^a	-0.018^a	-0.024^a	-0.023^a
	(0.004)	(0.002)	(0.001)	(0.001)
... $\times$ Dual use goods	-0.013	-0.021^a	0.009^a	0.008^a
	(0.010)	(0.005)	(0.002)	(0.002)
R^2	0.57	0.57	0.85	0.84
Obs.	11380452	10258564	8,181,086	7,266,138
j-FE	Yes	Yes	No	No
fpj-FE	No	No	Yes	Yes
fpt-FE	Yes	Yes	Yes	Yes

Note: Destinations are Russia and a set of control countries (United States). The dependent variable "Export dummy (fpjt)" takes the value equal to one if a French exporter exports a product p to destination j in year t, and zero otherwise. Standard errors are clustered by destination, HS4-product and year. Significance levels: [a] $p<0.01$, [b] $p<0.05$, [c] $p<0.1$.

after 2014. However, the effect is not statistically significant, or only weakly significant in the second column. As discussed above, this can be explained by the fact that European sanctions by 2014 were not a ban on dual-use goods exports, it simply introduced more restrictions.

Table 8: Impact of sanctions: Firm-level exports and dual use goods

	(1)	(2)	(3)	(4)
Dep. var.		Ln Export (fpjt) - Ln Export (fpjt-1)		
Destinations		RU+US		
Exporters	All	All	Conti.	Conti.
Products	All	Manuf.	All	Manuf.
Period		2011-2020		
RU sanctions (2014)	-0.038	-0.005	-0.073^c	-0.075^c
	(0.036)	(0.037)	(0.038)	(0.040)
... $\times$ Dual use goods	-0.066	-0.098	-0.068	-0.065
	(0.065)	(0.066)	(0.072)	(0.073)
R^2	0.62	0.63	0.62	0.62
Obs.	81,112	76,122	57,634	55,644
fpj-FE	Yes	Yes	Yes	Yes
fpt-FE	Yes	Yes	Yes	Yes

Note: Destinations are Russia and a set of control countries (United States). The dependent variable is the log variation of exports by firm f, product p, to destination j in year t. *Conti* corresponds to continuing exporters to destination j over 10 years. Standard errors are clustered by destination, HS4-product and year. Significance levels: [a] $p<0.01$, [b] $p<0.05$, [c] $p<0.1$.

5.3.2 Effect on invoicing

We test here if international sanctions on Russia starting in 2014 had a stronger impact on USD invoicing in dual use goods categories. We augment the econometric model presented in Equation 5 and include an interaction term between the Russia-2014 dummy variable and the product-specific dummy variable that identifies specifically dual-use goods: $RU2014 \times Dual\ use\ goods$. The empirical specification controls for the role of strategic complementarities that leads French firms exporting to Russia to invoice more in US dollars in HS4 products where the United States has a higher export market share. For this estimation, we rely on the set of exporters exporting continuously 10 years. Standard errors are clustered by destination, product and year. In columns (2), (4) and (6), the estimated equation introduces destination-time fixed effects (controlling for macroeconomic adjustments), so all the identification relies on the interaction term $RU2014 \times Dual\ use\ goods$.

Estimation results for the invoicing choice are reported in Table 9. The estimation results confirm that the use of the US dollar declined after sanctions started being implemented in 2014. This effect is stronger for dual use goods (the interaction term is significantly negative), even when destination-year fixed effects are introduced in the specification and all the identification relies on the interaction term (column (2)). This result is consistent with the strong focus of US sanctions on dual use goods, particularly after the poisoning of Serguei Skripal and the interference in the US elections. These estimations are confirmed in columns (3) to (6) where the estimation additionally controls for the role of strategic complementarities. This is consistent with the role played by the extraterritorial nature of US sanctions in undermining US dollar invoicing in Russia after 2014.

We complete this analysis by providing, in Figure 12, the results of an estimation where the effect of sanctions on Russia for dual-use goods is estimated over time. Compared with the previous estimation, we now have a Russia-year dummy variable, which is interacted with the variable identifying dual-use goods. The dependent variable is the dummy variable for US dollar invoicing. We proceed with two different estimations. In the first graph, we use only the United States in the control group of destinations. In the second graph, we use instead all OECD countries.

Estimation results clearly show that the negative effect of sanctions on Russia on USD invoicing by French exporters is (i) negative as in previous estimations and more so for

Table 9: Impact of sanctions: Dual use goods, firms exporting 10 years in Russia

Dep. var.	(1)	(2)	(3)	(4)	(5)	(6)
				Dollar		
RU sanctions (2014)	-0.023^a		0.041^b		0.046^a	
	(0.004)		(0.016)		(0.016)	
... × Dual use goods	-0.025^a	-0.025^a			-0.018^b	-0.018^c
	(0.009)	(0.009)			(0.009)	(0.009)
... × US market share (HS4, pre-2014)			-1.946^a	-1.946^a	-1.855^a	-1.858^a
			(0.395)	(0.394)	(0.398)	(0.398)
... × US M.S. × ln Exporter size			-0.219^a	-0.220^a	-0.214^a	-0.214^a
			(0.049)	(0.049)	(0.049)	(0.049)
... × ln Exporter size			0.008^a	0.009^a	0.008^a	0.009^a
			(0.002)	(0.002)	(0.002)	(0.002)
R^2	0.93	0.93	0.93	0.93	0.93	0.93
Obs.	87,388	87,388	87,364	87,364	87,364	87,364
fjp-FE	Yes	Yes	Yes	Yes	Yes	Yes
fpt-FE	Yes	Yes	Yes	Yes	Yes	Yes
jt-FE	No	Yes	No	Yes	No	Yes

Note: Destinations are Russia and a set of control countries (United States). Estimation sample is restricted to French exporters surviving 10 years in the Russian market. The dependent variable *Dollar* takes the value equal to one if the dollar is used by the exporter as the invoicing currency, and zero otherwise. The exporter size is measured as its share in total French exports in each year. The US share in Russian imports is measured by HS4 before the implementation of the sanctions. Standard errors are clustered by destination, HS4-product and year. Significance levels: ^{a} p<0.01, ^{b} p<0.05, ^{c} p<0.1. .

dual-use goods; (ii) gets stronger over time in absolute terms for dual-use goods. This result is consistent with the strengthening of sanctions on Russia over time by the US administration, especially after the interference in US elections, and the poisoning of Serguei Skripal.

Figure 12: Impact of sanctions: Dual use goods, firms exporting 10 years in Russia
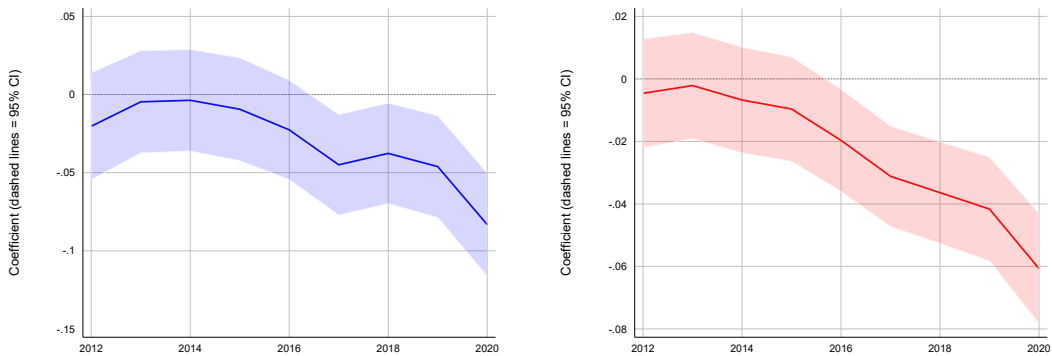
(a) Control group : USA   (b) Control group : OECD

Note: French customs data, extra-EU.

5.4   Firm heterogeneity: bank-to-firms relations

In a last exercise, we explore the funding side of US dollar invoicing. In 2014, one large French banking group was sanctioned by the United States administration for failing to comply on US sanction targeting Sudan and other regimes. The reason for this penalty was that these transactions were denominated in dollars. This creates an extraterritorial purpose for US-based secondary sanctions. The French banking group was then condemned to a multi-billion financial sanction by US authorities.

Our analysis relies on data from the French credit registry, which allows linking each bank to exporters via outstanding credit links. We create a dummy variable that equals one for exporters linked to that banking group, and zero otherwise. This variable is interacted with our main variable of interest. We also introduce an interaction with firm size (total exports) as a control. Because firms may have changed their banks around the timing of the event, we restrict the period for the estimation around the period 2012-2016, so two years before and after the event in 2014. Given that this period of time is characterized by relatively stable US market share in Russian imports, we do not control for the role of strategic complementarities.

Results are presented in Table 10. It shows that the negative impact of sanctions on US dollar invoicing by 2014 in Russia is largely driven by clients of this very large banking group. In the first column where the estimation relies only on the sample of clients from this large sanctioned banking group, the econometric exercise estimates a significantly negative coefficient on the RU sanctions 2014 dummy, whereas the coefficient remains non-significant in the second column. In the subsequent estimations that rely on the full sample of exporters and where the sanctions dummy is interacted with a second dummy variable that identifies the clients of the sanctioned French banking group, the coefficient on the interaction term is significantly negative. This confirms that the effect of international sanctions on the propensity to invoice exports in US dollars can be transmitted by banks to their clients. This result supports our assumption that US secondary sanctions and the extraterritoriality of the US law can undermine the role of the US dollar when US sanctions target a specific country.

Table 10: Sanctions on Russia and currency invoicing: The role of firm heterogeneity (2012-16)

	(1)	(2)	(3)	(4)	(5)	(6)
Banks	Sanctioned	Not-sanctioned		All		
Exporters		All			Conti	
Dep. var.			Dollar			
RU sanctions (2014)	-0.024^a	-0.005	-0.004		-0.036	
	(0.005)	(0.007)	(0.027)		(0.044)	
... × Sanctioned Bank			-0.020^a	-0.020^a	-0.022^b	-0.022^b
			(0.007)	(0.007)	(0.009)	(0.009)
... × ln exporter size			0.000	0.000	0.001	0.001
			(0.002)	(0.002)	(0.002)	(0.002)
R^2	0.95	0.94	0.95	0.95	0.95	0.95
Obs.	32,144	18,030	62,148	62,148	39,148	39,148
fjp-FE	Yes	Yes	Yes	Yes	Yes	Yes
fpt-FE	Yes	Yes	Yes	Yes	Yes	Yes
jt-FE	No	Yes	No	Yes	No	Yes

Note: French firm-level exports to Russia or the United States in 2012-2016. The dependent variable *Dollar* takes the value equal to one if the dollar is used by the exporter as the invoicing currency, and zero otherwise. The exporter size is measured as its share in total French exports in each year. Standard errors are clustered by destination, HS4-product and year. Significance levels: ^{a} p<0.01, ^{b} p<0.05, ^{c} p<0.1.

6   Conclusion

In this paper, we presented the first evaluation of the effects of international sanctions on US dollar invoicing in international trade. The analysis is conducted using detailed information on international transactions of French exporters with foreign countries, which details in particular the currency of transaction. While international sanctions by the EU have introduced new trade costs faced by French exporters to Russia and are expected to reduce the export value as well as the probability to export, US sanctions have an additional effect on the invoicing currency in US dollars, which is explained by the extraterritoriality of the US law.

We show that following the implementation of sanctions targeting Russia after the invasion of Crimea and the Eastern regions of Ukraine, French exporters reacted by (i) exporting less to Russia or reducing their probability to export; and (ii) reducing the probability to invoice their export contracts in US dollars. The results detailed in the analysis emphasize the role played by different transmission mechanisms: Strategic complementarities between firms, the decline in central bank reserves in US dollars, and US secondary sanctions being particularly important in dual-use goods categories but also

being transmitted by the financial sector to exporters.

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