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Dominant currency pricing in international trade of services

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Abstract
We analyze, for the first time, how firms choose the currency in which they price transactions in international trade of services and investigate, using direct evidence, whether the US dollar (USD) plays a dominant role in services trade. Drawing on a new granular dataset on extra-European Union exports of Portuguese firms broken down by currency, we show that currency choices in services trade are active firm-level decisions. Firms that are larger and rely more on inputs priced in foreign currencies are less likely to use the domestic currency to export services. Importantly, we show that the USD has a dominant role as a vehicle currency in trade of services – but to a lesser extent than in trade of goods – and that this is not just due to differences in the geography of trade. An external validity test based on macro data available for Portugal and six other European countries confirms this finding. In line with predictions from recent theoretical models, our results are consistent with the lower prevalence of USD in services trade arising from a lower openness of services markets and a stronger reliance of services on domestic inputs.

JEL: F14, F31, F41

Keywords: dominant currency paradigm, international trade, services.

Non-technical summary

When selling a product to foreign markets, exporters can use the currency of their home country, that of the destination country, or a third "vehicle" currency. This decision plays a fundamental role in international economics. Related research has shown that the US dollar (USD) exchange rate is a major source of swings in global trade in goods–a "dominant currency pricing" (DCP) phenomenon–since most goods traded internationally are invoiced and sticky in USD.

Yet it is also key to look at dominant currency pricing in international trade in services for several reasons. First, global trade in services is big–accounting for about a quarter of global gross trade flows and for around 40% in terms of value-added trade. Second, global trade in services is growing fast, unlike global trade in goods which–possibly due to headwinds from a backlash against globalization and risks of geoeconomic fragmentation–might have peaked. Third, and relatedly, the future of globalisation might be in trade in intermediate services–as progress with digitech lowers technological barriers to such trade across borders.

But perhaps the main reason is that trade in services is conceptually different from trade in goods. Indeed, services are a flow and hence not storable. Moreover, many services are characterized by network externalities, tight regulation and natural or policy barriers to entry. Finally, unlike exporters of goods, which often intensively use intermediate inputs internationally traded, services often include lower shares of imports and higher shares of domestic inputs, which tend to be priced in the producer's currency.

Our paper is the first, to our best knowledge, that analyzes how firms choose the currency in which they price transactions in international trade of services and that examines whether dominant currency pricing differs between trade in goods and services using direct evidence– hitherto unavailable–on patterns of currency choices in international transactions in services compared to goods.

First, we use a novel micro dataset with finely grained information about currency choices of Portuguese firms in extra-European Union (EU) transactions of services. This new dataset, from Banco de Portugal, comprises information disaggregated by firm, type of service, country or origin or destination, and time periods, which can be combined with a large set of firm-level characteristics. Second, we use a novel macro data set with aggregate information about currency choices of exporters/importers in Portugal and six other countries (Belgium, Bulgaria, Czech Republic, Italy, Latvia and Slovakia) to/from extra-EU destinations. This new dataset, collected by the European Central Bank, comprises information on the currency of import and export of services, disaggregated by country and type of service.

Our main empirical analysis focuses on the micro data for Portuguese firms. We explore which factors determine currency choices in their exports of services and their relative importance. We show that firm-level factors play a central role in the decision to choose between the domestic currency (the euro) and a foreign currency using a variance decomposition exercise – a finding consistent with theoretical

models pointing to currency choice as an active-firm level decision. We then explore the role of firm-level determinants identified by these models and find significant evidence that the mechanisms they discuss are relevant not only for trade in goods but also for trade in services. We find that larger firms, which tend to exhibit stronger strategic complementarities in price setting, are more likely to use foreign currencies in their exports of services. We also find that firm-exposure to foreign-currency imports is significantly associated with the choice of foreign currencies to price exports of services. This suggests that – notwithstanding the fact that trade in services tends to rely less on imported inputs than trade in goods – strategic complementarities in price setting and real hedging motives emphasized in extant theoretical models are consistent with patterns observed in the services data.

Our central finding is on DCP and the role of the USD in international trade of services, however. We find strong evidence in favour of the hypothesis that the use of the USD as a vehicle currency in international transactions in services is extensive –but systematically lower than in international transactions of goods, and that this is not just due to effects arising from differences in the geography of trade.

We tease out the underlying mechanisms and show that differences in use of the USD in services relative to goods decline in more open services sectors and in those where labour (instead of intermediates) accounts for smaller shares of production costs. This chimes with predictions of models according to which lower reliance on imported inputs weakens the role of input-output linkages and thereby coordination on one currency, such as the USD. It is also consistent with the prediction that, as market openness declines, lower shares of suppliers in destination markets are foreign, hence making it less likely that exporters coordinate on a vehicle currency.

As an external validity test, we complement these findings with evidence from macro data on seven EU countries. Here, too, we find that DCP in USD is systematically lower in trade in services than in goods and that use of the EUR (for Belgium, Italy, Latvia, Portugal and Slovakia) or the domestic currency (for Bulgaria and the Czech Republic) is relatively more important – and that this is not just due to differences in the geography of services vs goods trade. This suggests that the evidence obtained from the micro data on Portuguese firms on the extent of DCP and the underlying mechanisms is not a figment of a particular country-case study but a more general phenomenon.

These findings have implications for policy and future research. For instance, it is established in the literature that widespread USD pricing in goods trade affects meaningfully the relationship between nominal exchange rates and other nominal and real variables, and therefore optimal policies. So, if the USD is less dominant in services trade because of different characteristics of services and services markets, this should translate into different impacts of shocks in services relative to goods trade. As economies diversify their exports to services, their sensitivity to shocks and optimal policies may change, as a result.

1. Introduction

When selling to foreign markets, exporters can use the currency of their home country, that of the destination country, or a third "vehicle" currency.[1] This decision plays a fundamental role in international economics. It has important implications for the elasticity of trade volumes to exchange rate fluctuations, pass-through of exchange rate movements to prices, optimal monetary and exchange rate policies in open economies and the international role of currencies (see e.g. Corsetti and Pesenti 2005; Devereux and Engel 2007; Gopinath *et al.* 2010; Bahaj and Reis 2020; Auer *et al.* 2021).[2]

Related research has shown that it is the US dollar (USD) exchange rate that determines swings in global trade – a "dominant currency pricing" (DCP) phenomenon – since most goods traded internationally are invoiced and sticky in USD, as stressed inter alia by Gopinath (2015), Gopinath *et al.* (2020a), Boz *et al.* (2022) and Gopinath and Itskhoki (2022). Work on dominant currency pricing has almost exclusively focused on trade in goods. One reason is that data on patterns in invoicing currency for trade in services are "virtually nonexistent" (Adler *et al.* 2020) – unlike those for trade in goods.

Yet it is important to look at dominant currency pricing in international trade in services for several reasons. First, global trade in services is big. It accounts for about a quarter of global gross exports (see Figure B.1) and around 40% in terms of value-added (Gopinath *et al.* 2020b). Second, global trade in services is growing fast, unlike global trade in goods which – possibly due to headwinds from a backlash against globalization and risks of geoeconomic fragmentation – might have peaked (Baldwin 2022b). The Covid19 pandemic led to temporary declines in travel and transport services, as Figure B.2 shows, but other commercial services (such as IT, consulting, communication, legal and financial services) have grown unabated and faster than trade in goods. Third, and relatedly, the future of globalisation might be in trade in intermediate services – as progress with digitech lowers technological barriers to such trade across borders (Baldwin 2022a).[3]

But perhaps the main reason is that trade in services is conceptually different from trade in goods, as Francois and Hoekman (2010), Adler *et al.* (2020) and Gopinath *et al.* (2020b) stress. Therefore, a conjecture is that optimal currency

1. Using the exporter's (or producer) currency in exports is known in the literature as producer currency pricing (PCP), while using the importer's currency is known as local currency pricing (LCP) and using a third currency is known as vehicle currency pricing (VCP).

2. From a microeconomic perspective, currency choice determines who bears exchange rate risk between the importer and exporter, how performance of firms in foreign markets is impacted, as well as firms' cash flows and profits (see e.g. Bacchetta and Van Wincoop 2005).

3. Other reasons put forward (see e.g. Baldwin 2022b) are that export capacity in emerging markets is not as significant a limiting factor in services as it is in goods, since every economy has a workforce that is already producing intermediate-service tasks; and that demand is not a limiting factor either since firms in advanced economies spend large sums on intermediate services – some of which could be provided by foreign-based workers.

choice of exporters – and with it the extent of DCP – is potentially different between trade in goods and services (Gopinath *et al.* 2020b). Indeed, services are a flow and hence not storable – their exchange often requires proximity between suppliers and consumers (a phenomenon typically known as the "proximity burden" – now being alleviated by digitech). Moreover, many services are characterized by network externalities (telecommunications, finance, transportation), tight regulation (communications, insurance, professional services), and natural or policy barriers to entry. This suggests that market power is potentially stronger than in trade in goods and that the share of local (vs foreign) competitors in services markets is potentially higher. To the extent that strategic complementarities in price setting across firms determine invoicing currency choice, as predicted by theory (e.g. Mukhin 2022), patterns in invoicing might appreciably differ between trade in goods and services. Finally, unlike exporters of goods, which often use intermediate inputs internationally traded, services often include lower shares of imports and higher shares of domestic inputs, which tend to be priced in the producer's currency. In turn, production costs of services might be less sensitive to exchange rate movements than production costs of goods, thereby reducing incentives of exporter of services to invoice in currencies other than their own.

Our paper is the first, to our best knowledge, that analyzes how firms choose the currency in which they price transactions in international trade of services and that examines whether dominant currency pricing differs between international trade in goods and services using *direct* evidence – hitherto unavailable – on patterns of currency choices in international transactions in services compared to goods.

First, we use a novel micro dataset with finely grained information about currency choice of Portuguese firms in extra-European Union (EU) transactions of services. This new dataset, from Banco de Portugal, comprises information on the currency of imports and exports of services, disaggregated by firm, type of service, country or origin or destination, and time period, which can be combined with a large set of firm-level characteristics. Second, we use a novel macro data set with aggregate information about currency choice of exporters in Portugal and six other countries (Belgium, Bulgaria, Czech Republic, Italy, Latvia and Slovakia) to extra-EU destinations. This new dataset, from the European Central Bank, comprises information on the currency of import and export of services, disaggregated by country and type of service.

Our main empirical analysis focuses on the micro data for Portuguese firms. We explore which factors determine currency choices in their exports of services and their relative importance. We show that firm-level factors play a central role in the decision to choose between the domestic currency (the euro, EUR) and a foreign currency using a variance decomposition exercise – a finding consistent with theoretical models pointing to currency choice as an active-firm level decision (Engel 2006; Gopinath *et al.* 2010; Amiti *et al.* 2022; Mukhin 2022). We then explore the role of firm-level determinants identified by these models and find significant evidence that the mechanisms they discuss are relevant not only for trade in goods but also for trade in services. We find that larger firms, which tend

to exhibit stronger strategic complementarities in price setting – as suggested e.g. by Amiti *et al.* (2019) – are more likely to use foreign currencies in their exports of services. We find that firm-exposure to foreign-currency imports is another significant determinant of currency choices for exporters of services. This suggests that – notwithstanding the fact that trade in services tends to rely less on imported inputs than trade in goods – strategic complementarities in price setting and real hedging motives emphasized in extant theoretical models (e.g. Amiti *et al.* 2022; Mukhin 2022), are consistent with patterns observed in services data.

Our central finding is on DCP and the role of the USD in international trade of services, however. We find strong evidence in favour of the hypothesis that the use of the USD as a vehicle currency in international transactions in services is extensive – but systematically *lower* than in international transactions in goods (by 8 percentage points on average). We tease out the underlying mechanisms and show that differences in use of the USD in services relative to goods decline in more open services sectors and in those sectors where labor (instead of intermediates) account for smaller shares of production costs. This chimes with predictions of models (as e.g. Mukhin 2022) according to which lower reliance on imported inputs weakens the role of input-output linkages and thereby incentives to coordinate on one currency, such as the USD. It is also consistent with the prediction that, as market openness declines, lower shares of suppliers in destination markets are foreign, hence making it less likely that exporters coordinate on a vehicle currency.

As an external validity test, we complement these findings with evidence from macro data on seven countries. Here, too, we find that DCP in USD is systematically lower in trade in services than in goods and that use of the EUR (for Belgium, Italy, Latvia, Portugal and Slovakia) or the domestic currency (for Bulgaria and the Czech Republic) is relatively more important. This suggests that the evidence obtained from the micro data on Portuguese firms on the extent of DCP and the underlying mechanisms is not a figment of a particular country-case study but a more general phenomenon.

Importantly, we provide evidence that allows to refute that differences in the geography of trade between services and goods simply explain our findings. First, we rule out compositional effects, that is that differences in the use of currencies reflect differences in trade partners in services vs. goods trade. In addition, we show that our findings are not explained by higher shares of intra-EU trade in services relative to goods – a feature which coupled with the existence of fixed costs of using multiple currencies, could explain a lower prevalence of the USD in extra-EU trade. We show that intra-EU trade shares are, in fact, higher for goods than for services in our sample of countries – perhaps because of stronger presence of intra-EU production chains in goods relative to services.

Our paper is linked to three strands of literature. Closest to our paper is the study of Gopinath *et al.* (2020b), who estimate the exchange rate elasticity of bilateral trade in services for a panel of over 200 countries and 11 sectors between 1995 and 2017. They find that trade in services is responsive to both bilateral and USD exchange rates, which suggests that producer currency pricing (PCP) and

DCP are each widely used in trade of services – and that PCP is perhaps more prevalent than DCP – in contrast with trade in goods. One key difference between this paper and ours is that our evidence on DCP is direct and based on actual data on the currency composition of trade of services. In the absence of comparable data, Gopinath *et al.* (2020b) provide indirect evidence and infer the existence of PCP and DCP by estimating the strength of the response of imports in importer currency to bilateral and/or USD exchange rates.

Our paper adds to the recent literature on the dominant currency paradigm (e.g. Gopinath 2015; Gopinath *et al.* 2020a; Boz *et al.* 2022; Gopinath and Itskhoki 2022; Amiti *et al.* 2022; Mukhin 2022) and on vehicle currency pricing (e.g. Goldberg and Tille 2008, 2016; Chung 2016). Our main distinctive feature is to shift the analysis away from merchandise trade to trade in service – which is relevant given the conceptual differences between goods and services and the limited evidence available on the hypothesis that the extent of DCP could be different for services.

Finally, the paper is related to recent studies that have leveraged transaction-level data combined with firm-level characteristics (Chung 2016; Goldberg and Tille 2016; Devereux *et al.* 2017; Crowley *et al.* 2020; Auer *et al.* 2021; Amiti *et al.* 2022) to identify determinants of invoicing currency decisions. To our knowledge we are the first to explore these determinants in services trade.

The remaining of the paper is organized as follows. Section 2 describes the micro dataset on Portuguese firms. Section 3 explores which factors shape firms' currency choices. Section 4 compares DCP in USD in services and goods trade. Section 5 provides an external validity test of our findings on DCP using the macro data. Section 6 offers concluding remarks.

2. Micro-data on Portuguese firms

Our empirical analysis benefits from a new dataset with finely grained information about the currencies used by Portuguese firms in their international transactions of services. This confidential dataset is maintained by the Statistics Department of Banco de Portugal, and covers services transactions between residents and non-residents entities, in accordance with the IMF Balance of Payments Manual (IMF 2016). The database reports the firm identifier, classification of service, country of origin or destination, time period (month and year), the amount of the transaction (in the original currency and in EUR) and the currency used in the transaction. Information for travel and tourism flows is not available. Types of services are defined according to the Extended Balance of Payments Services (EBOPS) 2010 classification, as detailed in the first two columns of Table B.1. A similar dataset is available for goods transactions (general merchandise according to the aforementioned IMF Balance of Payments Manual). A breakdown by type of good is not available.

All observations have information on the currency used, and both intra-EU and extra-EU trade are covered. The statistical reporting is mandatory and

regulated by law (Banco de Portugal 2018), and there is no reporting threshold applying specifically to international transactions of services or goods. But there is a reporting threshold based on the yearly value of all economic and financial operations of a firm with non-residents, considering inflows and outflows, which has to be at least equal to EUR 100,000. The dataset was made available for this paper for the period January 2014–June 2021. We only include observations until December 2019 to remove the period of the Covid pandemic from the sample.

We combine the trade dataset with yearly firm characteristics drawn from the Central Balance Sheet database (Banco de Portugal Microdata Research Laboratory (BPLIM) 2020). That database is constructed from information reported via *Informação Empresarial Simplificada* (IES, Simplified Corporate Information) – a collaborative effort between the Portuguese Ministry of Finance, the Portuguese Ministry of Justice, Statistics Portugal and Banco de Portugal. Under IES, firms provide annual balance-sheet and income statement information, together with a set of firm characteristics, such as the number of employees. Merging the two datasets is straightforward since there is a common firm identifier. We keep transactions of firms that are present in both datasets, and that have both a strictly positive turnover value and a strictly positive number of employees.

Table 1 presents descriptive statistics about the incidence of different currencies in Portuguese services trade. Both in extra-EU and intra-EU trade, the EUR is the most widely used currency, be it on the export or import side. As expected, its share is markedly lower in extra-EU trade than in intra-EU trade. The currency with the second largest share is the USD. In total, in our services trade dataset there are transactions denominated in 132 different currencies.

	Exports	Imports
EUR	49.31	44.45
USD	31.18	40.91
Other	19.51	14.64

(a) Extra-EU trade

	Exports	Imports
EUR	91.06	84.92
USD	5.00	12.41
Other	3.94	2.68

(b) Intra-EU trade

Table 1. Services trade: prevalence of EUR, USD and other currencies (percent)

Notes: Tables (a) and (b) show the shares (in value terms) of the EUR, USD and other currencies in extra-EU and intra-EU Portuguese trade, respectively. Each column sums to 100.

3. Determinants of currency choice in trade of services

3.1. Conceptual framework

To inform the empirical analysis of the determinants of currency choices, we present a conceptual framework that draws on the extant theoretical literature on goods

trade (Engel 2006; Gopinath *et al.* 2010; Amiti *et al.* 2022; Mukhin 2022). Based on the framework, we stress which factors should determine currency choices in international trade, and to what extent one should expect differences between services trade and goods trade.

We focus on the problem of a firm i exporting a given product from Portugal (with currency €) to destination country k with currency k. The profits from exports to that destination are denoted by $\Pi_{ik}(p_{ik}|\Omega)$, where p_{ik} is the log export price expressed in the currency of destination, and Ω is the state of the world. Lower-case letters indicate logarithms of the variables.

The environment for currency choices is characterized by price rigidities. If the firm could set prices flexibly, in every state of the world it would choose the desired price $\tilde{p}_{ik}$ given by $\tilde{p}_{ik} = \arg\max_{p_{ik}} \Pi_{ik}(p_{ik}|\Omega)$. The desired price can be written in terms of any currency l as $\tilde{p}^l_{ik} \equiv \tilde{p}_{ik} + e_{lk}$, where e_{lk} is the bilateral exchange rate between currency l and the currency of the destination country.

The firm pre-sets price $\bar{p}^l_{ik}$ in currency l before state Ω is observed. Three pricing paradigms can be used. First, the firm can price transactions in EUR (producer currency pricing, PCP). Second, it can price in the importer's currency (local currency pricing, LCP).[4] Third, it can use a third currency, say currency v (vehicle currency pricing, VCP). In each case, the realized price in destination currency (p_{ik}) conditional on non-price-adjustment will be:

$$p_{ik} = \begin{cases} \bar{p}^{€}_{ik} + e_{k€} & \text{under PCP} \\ \bar{p}_{ik} & \text{under LCP} \\ \bar{p}^{v}_{ik} + e_{kv} & \text{under VCP} \end{cases} \tag{1}$$

where $e_{k€}$ is the bilateral exchange rate between currency k and the EUR, while e_{kv} is the bilateral exchange rate between currency k and currency v.

A well-know theoretical result in the literature is that the currency choice problem $\arg\max_l \mathbb{E}\,\Pi_k(\bar{p}^l_{ik} + e_{kl}|\Omega)$ is equivalent to $\arg\min_l var(\tilde{p}^l_{ik})$. That is, the currency choice problem is equivalent to determining the currency in which the desired price is least volatile. Therefore, PCP will be chosen if the desired price tracks closely $e_{k€}$, or in other words the desired price is stable in EUR. LCP will be chosen if the desired price is stable and does not track any exchange rate. Currency v will be chosen if the desired price tracks closely e_{kv}, that is, if the desired price is stable in currency v.

In a broad class of monopolistic and oligopolistic models (Amiti *et al.* 2019), the desired price in destination currency can be written as a linear combination of the firm's marginal cost and its competitors' prices in the destination currency:

$$\tilde{p}_{ik} = (1-\alpha)(mc_i + e_{k€}) + \alpha p_k \tag{2}$$

4. In transactions with countries whose currency is the EUR, PCP and LCP coincide. This is taken into account in the empirical analysis.

α captures strategic complementarities in price setting across firms, so that the desired price of an exporter depends not only on its marginal costs but also on the prices of competitors in the destination market. It follows that the stronger are strategic complementarities (i.e. the higher is α), the more likely it is that the firm favors using the competitors' currency. To the extent that competitors price in foreign currencies, this favors use of those currencies. This strategy keeps the firm's relative price – and thereby market shares – stable in the presence of exchange shocks.

Larger firms tend to exhibit greater strategic complementarities (Amiti *et al.* 2019). They tend to charge higher markups and actively adjust them to ensure stable market shares. In contrast, smaller firms tend to charge low markups and hence have limited adjustment margins. Therefore, larger firms should be more likely to use foreign currencies in their exports, regardless of the product that they export. That is, everything else constant, larger exporters of services should be more likely to use foreign currencies to price exports (Prediction 1).

The firm's marginal cost can be written as a weighted sum of local wages (w_i) and prices of intermediates (p_i):

$$mc_i = (1 - \varphi)w_i + \varphi p_i \tag{3}$$

Moreover, the aggregate price index (p_i) can be written as a weighted sum of the prices of locally produced goods (p_{ii}) and imported goods (p_i^I):

$$p_i = (1 - \gamma)p_{ii} + \gamma p_i^I \tag{4}$$

It then follows that the more the firm relies on local inputs (labor and locally produced intermediates), the more the firm's desired price tracks the costs of those local inputs. As the costs in question are typically stable in producer currency, then the firm is more likely to price in EUR. Alternatively, the more the firm relies on internationally sourced inputs, the more the desired price tracks the cost of those foreign inputs. If the costs in question are stable in a foreign currency, then the firm is less likely to price its exports in EUR. This mechanism should also not depend on specifics of exported products – therefore not on whether the firm exports services or goods. As a result, the more an exporter of services relies on imported inputs in foreign currencies, the more likely will he/she use foreign currencies to price exports (Prediction 2). This strategy coordinates pass-through into export prices with co-movements in marginal costs, thus providing real hedging.

According to this conceptual framework, the two key determinants shaping currency choices in goods trade, and for which, for example, Amiti *et al.* (2022) provide systematic empirical evidence – firm size and exposure to foreign currencies in imported inputs – should also shape currency choices in services trade. However, this does not mean that we should expect similar prevalence of alternative pricing strategies in aggregate services and goods trade data. For example, a less important role of input-output linkages in services may result in lower prevalence of foreign currencies in services exports. In the next subsections, we focus on the determinants

of firm's currency choice. The implications for the share of the USD in aggregate services and goods trade are explored in section 4.

3.2. Variance decomposition

We now consider a variance decomposition exercise that quantifies the relative importance of different forces as determinants of heterogeneity in currency choices in services exports. Our aim is to understand whether what matters more to explain patterns of variation in the data is "who is the exporting firm", "what is the destination country", "what is the service that is being exported" or "what is the time period".

Initially, we focus on the decision between using the EUR or a foreign currency (PCP or not) – a decision for which the conceptual framework presented in the previous subsection provides more clear predictions. Moreover, we focus on extra-EU exports, where the role of the EUR is less prevalent (Table 1). The analysis is extended to VCP (namely using the USD) and LCP in subsection 3.4.

To decompose the patterns of variation in the data, we start with the following model:

$$NonEuro_{fcpt} = \gamma_f + \varphi_c + \omega_p + \rho_t + \varepsilon_{fcpt} = \sum_{i=1}^{5} C^i_{fcpt} \tag{5}$$

$NonEuro_{fcpt}$ is a dummy variable equal to 0 if firm f exports service p to country c in month-year t in EUR, and 1 if it uses another currency. γ_f, φ_c, ω_p and ρ_t are firm, country, service, and month-year fixed effects, respectively. Equation 5 considers five distinct sources of variance in our dependent variable: firm permanent heterogeneity (γ_f), country permanent heterogeneity (φ_c), service permanent heterogeneity (ω_p), time heterogeneity (ρ_t) and unexplained random variations (ε_{fcpt}).

Our aim is to estimate the contribution of each component to variations in the currency dummy ($NonEuro_{fcpt}$). Omitting subscripts for simplicity, we use the following decomposition:[5]

$$\frac{\sum_{i=1}^{5} \widehat{cov}(NonEuro, C^i)}{\widehat{V}(NonEuro)} = \frac{\bar{\hat{\gamma}}|_{NonEuro=1}}{1-p} + \frac{\bar{\hat{\varphi}}|_{NonEuro=1}}{1-p} + \frac{\bar{\hat{\omega}}|_{NonEuro=1}}{1-p} + \frac{\bar{\hat{\rho}}|_{NonEuro=1}}{1-p} + \frac{\bar{\hat{\varepsilon}}|_{NonEuro=1}}{1-p} \tag{6}$$

where p is the share of observations with $NonEuro = 1$.

5. We adapt to our binary dependent variable setting the procedure followed by Torres *et al.* (2018) to measure the contribution of worker, firm, and job title characteristics to wage variation.

This decomposition has an intuitive interpretation. For example, if the average of the firm fixed effects for the subsample where $NonEuro = 1$ is the same as for the overall sample (and thus is, zero), then the contribution of that component is zero. The contribution will be higher, the higher the average of the estimated fixed effects for the $NonEuro = 1$ subsample. See Appendix A.1 for more details and a full derivation of the decomposition.

The estimated contributions for each component of Equation 6 are presented in the first bar of Figure 1a. In Figure 1a, we also present the results obtained when we make an analogous exercise omitting each set of fixed effects at a time. Figure 1b provides a similar quantification exercise where $NonEuro_{fcpt}$ is regressed on one set of fixed effects at a time; here we consider not only firm, country, product and time fixed effects, but also firm-country, firm-product and country-product fixed effects.

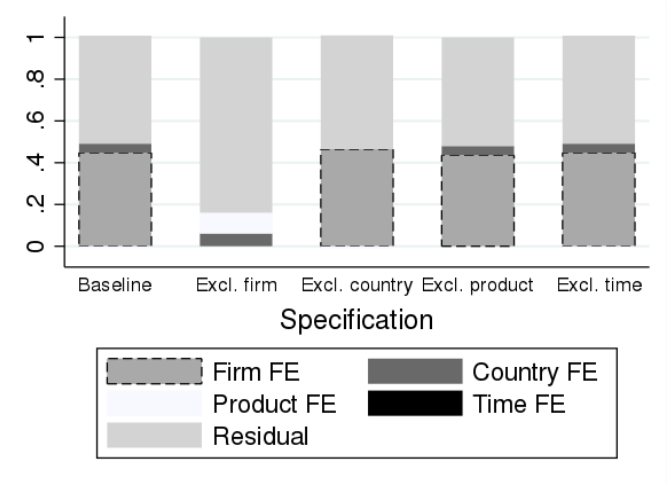
This set of results highlights the key role that firm heterogeneity plays in explaining the variation in currency choices in the data. Firm fixed effects account for almost half of the variance of $NonEuro_{fcpt}$ in the baseline specification and in the specification restricted to such firm fixed effects. Moreover, comparing the baseline specification with the one without firm fixed effects, it is clear that the introduction of firm fixed effects shrinks substantially the residual. Accordingly, the results point to a central role played of firm-level differences as key determinants of the variation in currency choices. Moreover, they are consistent with the conceptual framework presented in section 3.1, where the currency choice is an active firm-level decision.

3.3. Firm-level determinants

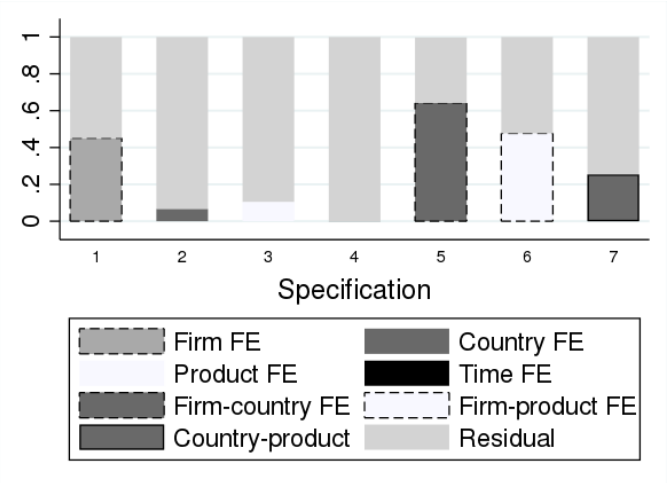
We now explore the role of firm size and exposure to inputs in foreign currencies (Predictions 1 and 2) as determinants of a firm's currency choice. To proxy for firm size, we use the average turnover over the sample period. Figure 2a illustrates how the choice between using the EUR and a foreign currency correlates with this proxy. In line with the mechanisms discussed above, the share of currencies other than the EUR is larger for larger firms.[6]

As for the role of the import intensity of the firm in foreign currencies, Figure 2b shows how it is correlated with use of the EUR relative to other currencies. Import intensity in foreign currencies is computed as the ratio of the import value of the firm (of goods and services) in currencies other than the euro, divided by the firm's variable costs. The latter are obtained from income statements and comprise expenditures with employees, costs of goods sold and materials consumed and supplies from external services. We split firms into five categories. The first

6. The systematic relationship between firm size and currency choice is less clear for imports than exports (Figure B.3). Since the firm size is correlated with several firm characteristics, the evidence in turn suggests that the currency choice in services trade is less an active firm-level decision on the import side, corroborating qualitatively similar results for goods trade in Amiti *et al.* (2022).



(a) Baseline model and alternative specifications which exclude one set of fixed effects at a time

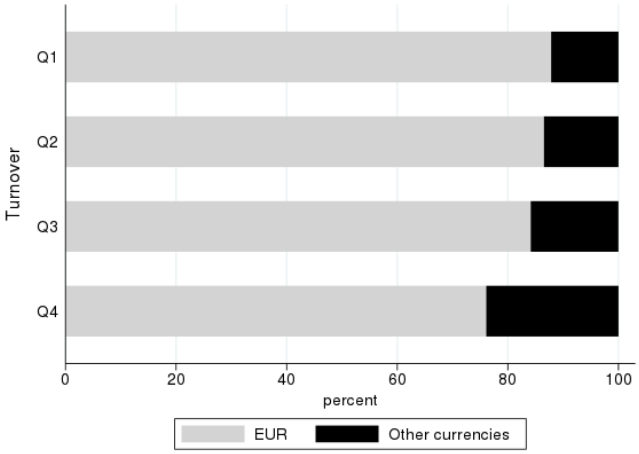


(b) Alternative specifications with one set of fixed effects at a time

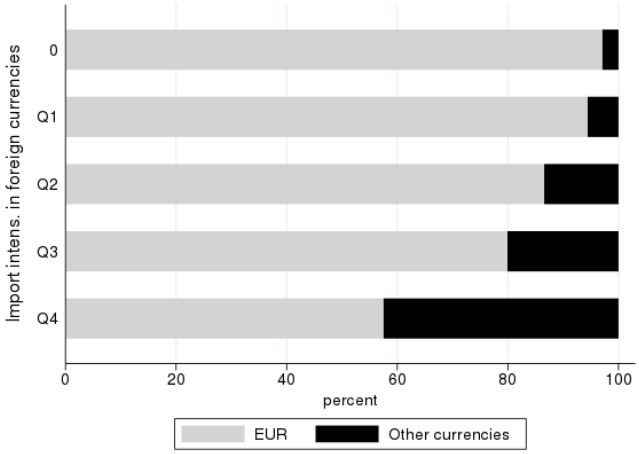
Figure 1: Contributions to the variation of $NonEuro_{fcpt}$ in extra-EU services exports

Notes: The figure shows the contributions of different components to the variance of *NonEuro*, which is a dummy variable equal to 0 if the transaction is priced in EUR, and 1 if it is priced in another currency. In panel (a), the first bar shows the contributions of each component in the baseline model detailed in equation 6. Subsequent bars exclude firm, country, product and time fixed effects one at a time, respectively. Panel (b) shows the contribution of firm, country, product, time, firm-country, firm-product and country-product fixed effects, respectively, in models where only one of these fixed effects is considered at a time.

category comprises firms for which intensity in foreign currencies is equal to zero. The remaining four categories split firms into four quartiles ranked by average



(a) Currency choices and firms' size



(b) Currency choices and firms' import intensity in foreign currencies

Figure 2: Currency choices in extra-EU services exports and firm-level determinants

Notes: Figure (a) shows the average share of the EUR and other currencies (in count terms) in extra-EU services exports across firms categorized into different quartiles (Q) based on firm size. Firm size is approximated by the average turnover of each firm over the sample period. Figure (b) shows the average share of the EUR and other currencies (in count terms) across different quartiles of import intensity in foreign currencies. The category "0" encompasses firms with zero import intensity ratio in foreign currencies, while the remaining four categories divide the remaining firms into four quartiles. Import intensity in foreign currencies is calculated as the average ratio of each firm's import value in currencies other than the euro, divided by the firm's variable costs.

import intensity in foreign currencies over the sample period. We then plot the share of the EUR and of the other currencies in extra-EU services exports for each

category. Use of foreign currencies in services exports increases monotonically with import intensity in foreign currencies. It is particularly large for the firms in the last quartile. In line with Prediction 2, this evidence suggests that real hedging may play an important role in shaping currency choices in services exports even though services are less intensive in foreign inputs than goods.

Following this illustrative evidence, we investigate formally the role of firm size and import intensity in foreign currencies in shaping currency choices in services exports. We estimate the regression:

$$NonEuro_{fcpt} = \beta_1 S_f + \beta_2 I_f^X + FE_{pc} + FE_t + \varepsilon_{fcpt} \quad (7)$$

As before, $NonEuro_{fcpt}$ is a dummy variable equal to 0 if firm f exports service p to country c in month-year t in EUR, and 1 if the firm uses another currency. S_f is firm size proxied with the log of firm employment, turnover or export value (of goods and services). I_f^X is the above-mentioned measure of import intensity in foreign currencies. FE_{pc} are product-country fixed effects, and FE_t are time (month-year) fixed effects.

Table 2a presents the estimation results of Equation 7. The coefficients on the different measures of firm size are positive and significant. That is, larger firms are more likely to price their services exports in foreign currencies and less likely to price them in EUR, in line with Prediction 1. Import intensity in foreign currencies is also positively and strongly associated to use of foreign currencies in services exports, in line with Prediction 2. When we consider import intensity of the firm in EUR instead, we no longer obtain a statistically significant coefficient. Overall, these results suggest that firm size and the firm's import intensity in foreign currencies shape decisions of using the EUR or a foreign currency. These results are in line with patterns documented by earlier literature (e.g. Chung 2016; Amiti *et al.* 2022) for goods trade.

3.4. Use of VCP vs. LCP

In the previous subsection, we studied the forces shaping the use of a foreign currency versus the exporter's currency (EUR). Now we explore the decision between using the local currency (LCP) or a vehicle currency (VCP).

To make this distinction, we focus on the sample of extra-EU services export transactions not priced in EUR. Moreover, we focus on export destinations that do not have the EUR or the USD as local currencies.[7] In this sample, 81% of the services transactions are conducted in USD, 18% in the destination currency and only 1% in other currencies.

Our dependent variable is now USD_{fcpt} – a dummy variable equal to 1 if firm f exports service p to country c in month-year t in USD, and 0 if it

7. Information about the currency(ies) of each country was obtained from ISO currency codes: `https://www.iso.org/iso-4217-currency-codes.html`.

	(1)	(2)	(3)	(4)
S_f (ln turnover)	0.014**			
	(0.006)			
S_f (ln employees)		0.017**		
		(0.007)		
S_f (ln exports)			0.016***	0.041***
			(0.006)	(0.016)
I^X_f	1.304***	1.311***	1.253***	
	(0.167)	(0.161)	(0.156)	
$I^€_f$				-0.034
				(0.042)
Product-country FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
No. of observations	314491	314491	314491	314491
Adjusted R2	0.345	0.346	0.346	0.280

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

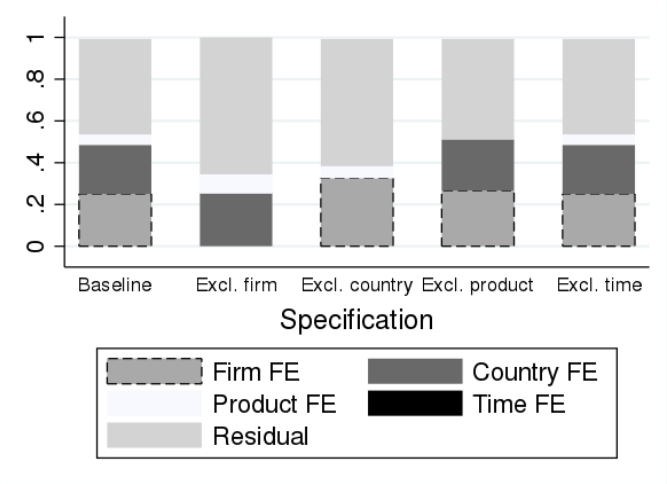
Table 2. Currency choices in extra-EU exports (EUR vs foreign currencies): firm-level determinants

Notes: The table shows estimates from a linear model. The dependent variable is a binary variable, taking the value of 0 if the transaction is priced in EUR, and 1 if it is priced in another currency. S represents the average firm size over the sample period, proxied by the natural logarithm of firm employment (in column 1), turnover (in column 2), or export value (in column 3). I^X denotes the average import intensity in foreign currencies, winsorized at the 99th percentile. This is computed as the ratio of the import value of the firm in currencies other than the euro, divided by the firm's variable costs. $I^€$ represents the average import intensity in euros, winsorized at the 99th percentile, calculated as the ratio of the import value of the firm in euros, divided by the firm's variable costs. Standard errors are clustered at the firm level.

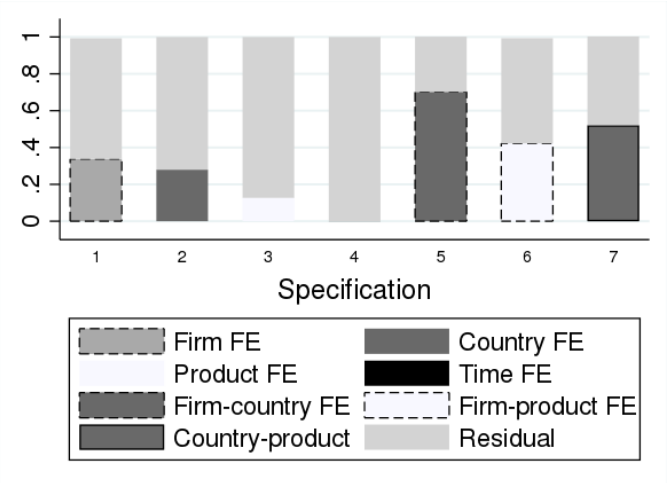
uses another currency. The decomposition of the variation in USD_{fcpt} into firm, country, product and time components is shown in Figure 3. While for the choice between the EUR and a foreign currency the contribution of country fixed effects was relatively small compared to firm fixed effects (Figure 1), the contribution of country fixed effects is larger for the choice between the local currency and a vehicle currency – 23% of the total variation in USD_{fcpt} in the baseline specification.

We then estimate an equation analogous to Equation 7, except that now our dependent variable is USD_{fcpt}. For the import intensity of the firm, we now include in the numerator the value of imports in USD rather than the value of imports in foreign currencies.

The results are presented in the first column of Table 3. The coefficient of firm size is negative, in contrast to the results for the EUR vs. foreign currency decision. That is, larger service exporters use more the local currency relative to the USD.



(a) Baseline model and alternative specifications which exclude one set of fixed effects at a time



(b) Models with one set of fixed effects at a time

Figure 3: Contributions to the variation of USD_{fcpt} in extra-EU services exports

Notes: The figure shows the contributions of different components to the variance of *USD*, which is a dummy variable equal to 0 if the transaction is priced in USD, and 1 if it is priced in another currency. The sample of export transactions considered in both panels excludes transactions priced in EUR and transactions with destination countries that have the EUR or USD as local currencies. In panel (a), the first bar shows the contributions of each component in the baseline model detailed in equation 6. However, in this case, the dependent variable is *USD*. Subsequent bars exclude firm, country, product and time fixed effects one at a time, respectively. Panel (b) shows the contribution of firm, country, product, time, firm-country, firm-product and country-product fixed effects, respectively, in models where only one of these fixed effects is considered at a time.

This pattern is consistent with the conceptual framework of section 3.1. Owing to stronger strategic complementarities, we expect larger firms to use more local currencies to synchronize their prices with those of local competitors. As to the import intensity in USD, we find a positive and significant coefficient, as expected. That is, importing in USD favors using the USD for exporting services.

In addition to firm-level determinants, and given the relatively large role of country-fixed effects in the VCP vs. LCP decision, we also consider macroeconomic determinants in our regression explicitly. In the conceptual framework presented in section 3.1, macroeconomic factors can be incorporated as an additional fixed cost associated to the use of a currency (Amiti *et al.* 2022), which should not depend on the specific product traded.

To incorporate macroeconomic factors in the regression, we replace the product-country fixed effects by product fixed effects and a number of country-level observables. The results are presented in columns 2-4. In column 2, we add as regressors country income and inflation, measured by average GDP per capita and average CPI inflation over the sample period (from the World Bank's World Development Indicators). In column 3, we include the inverse of the transactions costs of exchanging the country's currency, proxied by the ratio of the country's currency turnover in global foreign exchange markets to the EUR turnover in those markets, and a measure of exchange rate volatility. Turnover in foreign exchange markets is obtained from the BIS Triennial Survey of Foreign Exchange and Derivatives, and we use the average of the 2013, 2016 and 2019 shares.[8] Exchange rate volatility is measured by the volatility of the country's exchange rate against the EUR, where the exchange rates were obtained from the Bundesbank's exchange rate statistics. Finally, in column 4 we include a dummy variable for countries that have an exchange rate anchored to the USD. The list of exchange rate arrangements is obtained from the IMF database of the Annual Report on Exchange Arrangements and Exchange Restrictions.

The likelihood of pricing services transactions in USD is higher (and statistically significant) for countries with higher CPI inflation, higher exchange rate volatility, lower turnover of the currency in foreign exchange markets, and in countries that use the USD as an exchange rate anchor. These results about the role of macroeconomic determinants in services exports complement similar patterns documented for goods trade in earlier literature (e.g. Chung 2016; Goldberg and Tille 2016).

4. Dominant currency pricing in USD – services vs. goods trade

Having established that currency choice in international trade of services is an active firm-level decision as well as the determinants of this decision, we now

8. Currencies not listed in the survey are given a zero share.

	(1)	(2)	(3)	(4)
S_f (ln exports)	-0.016***	-0.018***	-0.020***	-0.018***
	(0.006)	(0.006)	(0.006)	(0.006)
I^{USD}_f	0.342***	0.257***	0.264***	0.273***
	(0.099)	(0.083)	(0.080)	(0.082)
ln GDP per capita$_c$		-0.008		
		(0.028)		
CPI inflation$_c$		0.005***		
		(0.002)		
Exch. rate volatility$_c$			0.205**	
			(0.094)	
Currency turnover$_c$			-0.360*	
			(0.210)	
USD arrangement$_c$				0.138***
				(0.052)
Product-country FE	Yes	No	No	No
Product FE	No	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
No. of observations	46924	44642	44642	44642
Adjusted R2	0.513	0.137	0.147	0.145

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3. Currency choices in extra-EU exports (USD vs local currency): firm-level and macroeconomic determinants

Notes: The table shows estimates from a linear model. The sample excludes export transactions priced in EUR and transactions with destination countries that have the EUR or USD as local currencies. The dependent variable is a binary variable, taking the value of 1 if the transaction is priced in USD, and 0 if it is priced in another currency. *S* represents the average firm size over the sample period, proxied by the natural logarithm of firm export value. I^{USD} denotes the average import intensity in USD, winsorized at the 99th percentile. This is computed as the ratio of the import value of the firm in USD, divided by the firm's variable costs. In columns 2-4, the sample is restricted to observations have non-missing data for all country-level dependent variables and countries whose average inflation rate is below the 99th percentile. *ln GDP per capita* represents the average GDP per capita (in natural logarithm) over the sample period, *CPI inflation* denotes the average inflation rate, *Exch. rate volatility* measures the volatility of the country's exchange rate against the EUR, *Currency turnover* indicates the average ratio of the country's currency turnover in global foreign exchange markets to the EUR turnover, and *USD arrangement* is a binary variable equal to 1 for countries with a currency arrangement linked to the USD, and 0 otherwise.

examine whether dominance of the USD for international trade in goods extends to services. We draw on the insights from Mukhin (2022)'s model of equilibrium currency choice and make predictions about the relative use of USD pricing in

services trade versus goods trade. We then confront those predictions to our data on Portuguese firms, and provide and external validity exercise using macro data for seven EU countries.

4.1. Theoretical background

Drawing on the conceptual framework of Section 3.1, it can be shown that strategic complementarities in currency choices and input-output linkages may give rise to an equilibrium with exporters coordinating on the use of a dominant currency (Mukhin 2022). If price linkages are strong enough, firms will want to synchronize their currency choices with those of their suppliers and competitors, and coordinate on a vehicle currency.

As coordination arises due to input-output linkages and price complementarities with foreign firms, it can be shown that vehicle currency pricing is more likely (i) the higher the share of intermediates in production, and (ii) the higher the share of foreign competitors (vs. local competitors) in a given market (Mukhin 2022). Intuitively, a higher share of intermediates strengthens input-output linkages. When markets are more open, so that a significant fraction of suppliers in destination markets come from abroad, the optimal price of exporters is no longer stable in either the producer currency or local currency, and coordination on a vehicle currency becomes more likely. In particular, the USD is likely to play a dominant vehicle currency role because of the large size of the US economy, widespread use of the USD as an exchange rate anchor, and path dependence.

Those results indicate that while at the firm-level the determinants of currency choice in services and goods trade may be largely similar (Predictions 1 and 2), in equilibrium we may observe a different prevalence of the USD in services and in goods trade. Namely, to the extent that the degree of openness of markets in services is lower than in goods (e.g. Imbs and Pauwels 2020), for example due to stronger home bias or regulatory barriers, and to the extent that that local wage costs represent a higher share of production costs in services than in goods (e.g. Bobeica *et al.* 2019), one should observe a lower prevalence of USD pricing in services trade than in goods trade (Prediction 3). Moreover, if these two mechanisms are relevant in explaining possible differences in prevalence of the USD in services trade relative to goods trade, the differences in question should be more limited (i) in services for which local wages represent a smaller share of production costs and (ii) in more open markets (Prediction 4).

In the subsequent empirical analysis, we test Predictions 3 and 4. We start by presenting descriptive statistics about the use of different pricing paradigms in trade in services versus trade in goods, and we compare the share of USD pricing. We then evaluate whether there is systematically lower prevalence of the USD in services trade relative to goods trade across country-year pairs. Finally, we test whether such a differential prevalence of the USD also holds in services for which wages typically account for a low share of production costs and in markets where import penetration is high.

4.2. Evidence from Portuguese exports

We start by providing descriptive statistics on the extent of the use of the USD as a vehicle currency in services vs. goods exports. We split export transactions according to the three pricing paradigms schemes discussed in Section 3.1: producer currency pricing (PCP) if the transaction is in EUR; local currency pricing (LCP) if the transaction is in the currency of the destination country; and vehicle currency pricing (VCP) if the transaction is conducted in a third-country currency. For transactions in EUR with countries whose currency is the euro, PCP and LCP coincide (PCP/LCP). In transactions where VCP is used, we distinguish between use of the USD as a vehicle currency (VCP – USD) versus use of other currencies (VCP – Other).

Table 4 presents the prevalence of the alternative pricing strategies in Portugal's extra-EU exports. Importantly, the share of VCP-USD is lower in services than in goods trade by around 10 percentage points, which is consistent with Prediction 3. But that prediction cannot be validated only with this descriptive evidence, however. One reason is that the geography of trade may be a confounder, driving differences in the prevalence of different pricing strategies in services and goods exports.

	Services	Goods
PCP	49.03	59.31
LCP	30.52	10.47
PCP/LCP	0.28	0.24
VCP - USD	20.07	29.84
VCP - Other	0.09	0.15

Table 4. Services and goods exports: prevalence of different pricing strategies (percent)

Notes: The table shows the shares (in value terms) of different pricing strategies: producer currency pricing (PCP), local currency pricing (LCP) and vehicle currency pricing (VCP). PCP/LCP refers to exports in EUR to countries whose currency is the EUR. VCP in USD (VCP – USD) is distinguished from VCP in other currencies (VCP – Other). Each colum sums to 100.

Therefore we test formally whether there is a systematic lower prevalence of VCP-USD in services relative to goods exports, accounting for heterogeneity in the geography of trade. We start by aggregating firm-level exports at the product-country-year level. We then compute the share of the USD in each product-country-year triplet, and estimate the following regression:

$$ShareUSD_{pct} = \beta Service_p + \gamma_{ct} + \varepsilon_{pct} \tag{8}$$

$ShareUSD_{pct}$ is the share of export value of product p to country c in year t denominated in USD. $Service_p$ is a dummy variable equal to 1 if product p is a service (i.e. belongs to one of the service categories detailed in the first two columns of Table B.1) and 0 if it is a good (i.e. is classified as general merchandise in our database). γ_{ct} are country-year fixed effects. Thus, we focus on the variation

in the share of the USD across products within country-year pairs, and explore whether that share is systematically lower for services exports than for goods exports. Standard errors are clustered at the country level. We consider exports to all countries, except those whose currency is the USD, since we are interested in the role of the USD as a vehicle currency.

Additionally, to test Prediction 4, we construct empirical proxies for the shares of wages in production costs of different services and for the degree of openness of different services markets. As to the wage shares, we first compute for every Portuguese firm that exports service s the share of labor costs in variable costs. We then compute an average value of that share across firms. As for the openness of the different export markets, we compute the share of imports in each country-sector pair using the OECD inter-country input-output tables (ICIO tables) for 2014. In the ISCIO tables, sectors are defined by two-digit ISIC Rev. 4 industries. We make a conversion to EBOPS services categories, as detailed in Table B.1. We did not find a close match for some service categories. Moreover, the set of countries covered by the ICIO tables is smaller than that of our trade database. As a result, we could only compute these proxies for a subset of the observations. We only keep services triplets for which we could compute these proxies, which account for 75% of total services exports.

In our analysis, we evaluate to what extent there is a meaningful difference in the share of USD in goods exports versus services exports when the wage share of those services is below the 25th percentile and/or when service-destination openness is above the 75th percentile. We focus on extreme values of these two proxies to account for plausibly large measurement errors.

The results are reported in Table 5. The first column presents the estimation of Equation 8. We obtain a negative and highly significant coefficient on the $Service_p$ dummy, consistent with lower prevalence of the USD in services than in goods exports of about 8 percentage points (Prediction 3). The second to fourth columns build on that specification by interacting $Service_p$ with the above-described proxies for the wage share and for the degree of openness of markets. The p-values of tests in the bottom of the table show that in services with relatively low wage shares and/or in highly open services markets, the null hypothesis of no statistically significant difference in the prevalence of the USD in services exports relative to goods exports cannot be rejected. These results are consistent with Prediction 4, suggesting that differences in the cost structure of services vs. goods trade and in openness across markets go a long way towards explaining the differential prevalence of the USD in services exports relative to goods exports.

Overall, the analyses presented in this section document a systematic use of the USD in services trade, albeit to a lesser extent than in goods trade. Our results are consistent with models pointing to lower openness of services markets and a stronger reliance of services in domestic inputs as main mechansims underlying these differences.

	(1)	(2)	(3)	(4)
$Service_p$ (S)	-0.077***	-0.103***	-0.094***	-0.115***
	(0.022)	(0.021)	(0.022)	(0.021)
$Service_p$ * Low Wage $Share_p$ (S*W)		0.083***		0.079***
		(0.013)		(0.012)
$Service_p$ * High $Openness_{pc}$ (S*O)			0.060***	0.047***
			(0.017)	(0.016)
Country-year FE	Yes	Yes	Yes	Yes
No. of observations	10541	10541	10541	10541
Adjusted R2	0.120	0.145	0.126	0.148
Test S+S*W=0 (p-value)		0.4273		
Test S+S*O=0 (p-value)			0.2077	
Test S+S*W+S*O=0 (p-value)				0.6931

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5. Share of exports in USD: services vs. goods

Notes: The table shows estimates from a linear model. The sample excludes countries whose currency is the USD. The dependent variable is the share of exports in USD. *Service* is a binary variable, taking the value of 1 if the product is a service, and 0 if it is a good. *Low Wage Share* is a binary variable, taking the value of 1 if the share of wages in the production costs of the service is low (below the 25th percentile), and 0 otherwise. *High Openness* is a binary variable, taking the value of 1 if the openness of the service sector in the destination country is high (above the 75th percentile), and 0 otherwise. The bottom rows show p-values for statistical tests that the sum of the coefficients in the respective column is equal to zero. Standard errors are clustered at the country level.

4.3. External validity with macro data for seven EU countries

Sceptics would argue that the evidence obtained from Portuguese data on the extent of dominant currency pricing in USD and the underlying mechanisms is a figment of a particular country-case study – not a more general phenomenon. Therefore, as an external validity test, we complement these findings with evidence from a new macro dataset on Portugal and six other countries: Belgium, Bulgaria, Czech Republic, Italy, Latvia, and Slovakia. This new dataset, from the European Central Bank, comprises information on the currency of import and export of services, disaggregated by type of services in 2020 (see appendix A.2 for more details on the data). To make comparisons with goods trade, we rely on Eurostat's macro data on international trade in goods by invoivcing currency.

Figure 4 shows the breakdown down of 2020 exports vis-à-vis extra-EU trading partners priced in USD and EUR, distinguishing between transactions of goods (left panel) and services (right panel). The figure makes clear that on average roughly half of extra-EU exports of goods are priced in euros against close to 30% in dollars, which is not too far off global trends (Boz *et al.* 2022). For extra-EU exports of services, however, the average share the USD is markedly lower – less than 20% – whereas that of the EUR is commensurately higher– at almost 70%.

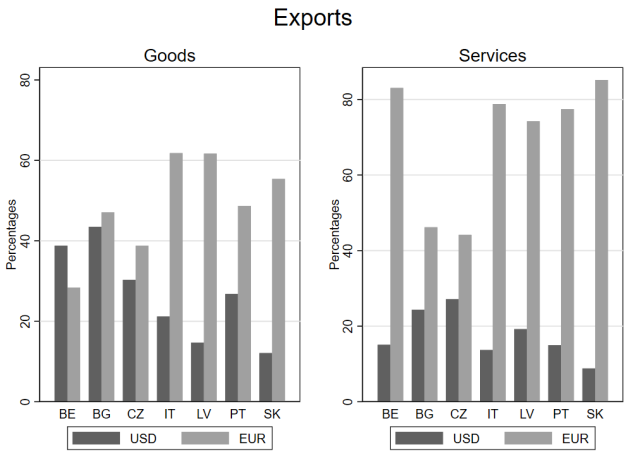


Figure 4: Breakdown by currency of exports of selected countries

Notes: The figure shows the breakdown of 2020 extra-EU exports priced in USD and EUR for Belgium (BE), Bulgaria (BG), Czech Republic (CZ), Italy (IT), Latvia (LV), Portugal (PT) and Slovakia (SK) distinguishing between transactions in goods (left panel) and services (right panel).

Figure B.4 shows that those patterns hold not only for exports, but also imports. Similar patterns hold if one zooms in on manufacturing goods – which shows that results do not just reflect the high prevalence of the USD in oil, commodity and primary goods –as well as if one excludes travel services – which is important to make sure that the findings in question do not just reflect pricing in currencies of source and destination countries of travel.[9]

Next, we estimate the shares of producer currency pricing (PCP), local currency pricing (LCP) and dominant currency pricing (DCP) in both exports and imports. In the absence of dyadic data, we make the following assumptions to estimate the shares in question. As regards exports, we identify PCP as the share of EUR exports in the exports of euro area countries (Belgium, Italy, Latvia, Portugal and Slovakia) and the share of local currency exports of non-euro area EU countries (Bulgaria and Czech Republic). We identify DCP in EUR as the share of EUR exports in the exports of Bulgaria and Czech Republic because we look at extra-EU transactions.

For each of the seven countries, and for each service category, we identify LCP in US dollars as equal at most to the bilateral share of exports to the US because we assume that up to 100% of exports to the US are priced in US dollars, in line with earlier literature on DCP in trade in goods (see e.g. Gopinath *et al.* 2010), in other words:

9. The corresponding figures are not shown to save space but are available from the authors upon request.

$$LCP_{USD} = \min(Share_{USD}, Share_{USexports}) \quad (9)$$

In turn, DCP in US dollars is identified as the share of US dollar exports in excess of the bilateral share of exports to the US, or in other words:

$$DCP_{USD} = \max(0, Share_{USD} - Share_{USexports}) \quad (10)$$

The residual is exports priced in an unidentified pricing paradigm. The shares of PCP, LCP and DCP for imports can be identified similarly. The only difference is that LCP (not PCP) is now the share of EUR imports in the imports of euro area countries (Belgium, Italy, Latvia, Portugal and Slovakia) and the share of local currency imports of non-euro area EU countries (Bulgaria and Czech Republic); and that PCP (not LCP) in US dollars is equal at most to the bilateral share of imports from the US; the rest of the definitions is unchanged.

Armed with these definitions, we can now turn to the evidence on each pricing paradigm. Figure 5 shows that, for extra-EU exports of goods, LCP in US dollars (light green bars) and DCP in US dollars (dark green bars) are often substantial – averaging 27% – which is unsurprising and in line with standard estimates. What is remarkable though is that this is much less the case for services: the combined light and dark green bars are smaller pointing to smaller importance of US dollar-LCP and DCP – of about 18% on average, or 9 percentage points less than goods. Imports tell a similar story: LCP and DCP in US dollars are important for goods as well, but much less for services (see Figure B.5). And the pattern holds not only in aggregate, but also across most categories of exports and imports of services.[10]

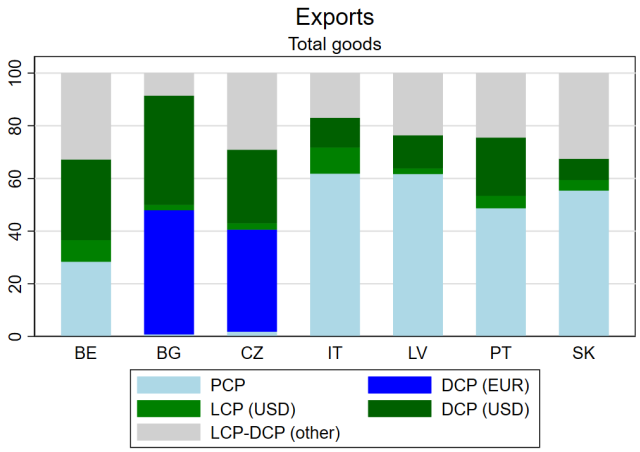
Another way to see the point is in Figure 6 which plots in the left panel the share of dominant currency pricing in US dollars in exports of goods (on the y-axis) against the share of dominant currency pricing in US dollars in export of services (on the x-axis). The right panel does the same for imports. That countries scatter above the 45-degree line (shown as a light grey line) testifies to the fact that the share of DCP in US dollars is quasi systematically higher for goods than for services.

Overall, the evidence based on macro data suggests that the results obtained from the micro data on Portuguese firms on the extent of DCP and the underlying mechanisms are not a figment of a particular country-case study but a general phenomenon.

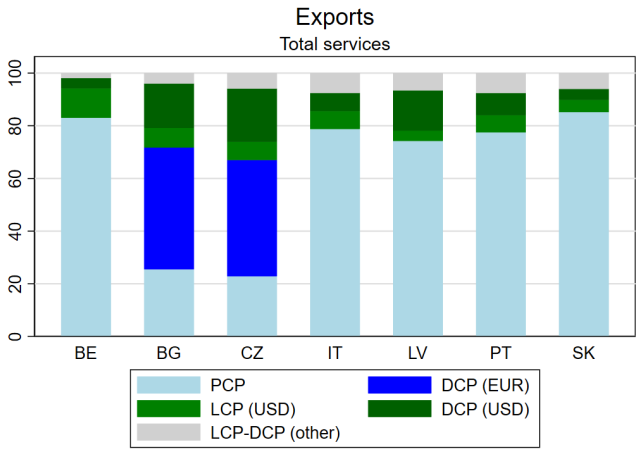
4.4. Robustness: geography of services vs. goods trade

Sceptics would argue that our findings might be due to composition effects – that trade partners systematically differ for trade in goods relative to trade in services. In section 4.2, we account for that using country-year fixed effects in our regressions. A similar exercise is not possible with the macro data as we do not observe the partner

10. The corresponding figure is not shown to save space but is available from the authors upon request.



(a) Exports of goods



(b) Exports of services

Figure 5: Estimates of alternative pricing paradigms

Notes: The figure shows our estimates of alternative pricing paradigms for extra-EU exports of goods and services of Belgium (BE), Bulgaria (BG), Czech Republic (CZ), Italy (IT), Latvia (LV), Portugal (PT) and Slovakia (SK) in 2020, including producer currency pricing (PCP), local currency pricing (LCP) and dominant currency pricing (DCP) in EUR and USD.

country. This notwithstanding, we provide two pieces of evidence that support the view that our findings are not driven by compositional effects.

The first piece of evidence against composition effects is that although the US accounts for similar shares as a source or destination of trade in goods and services,

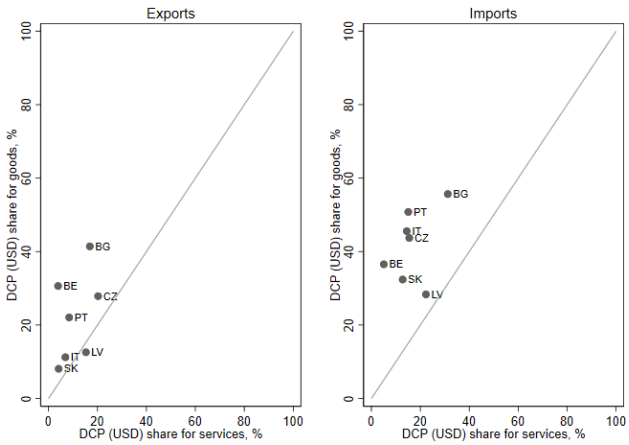


Figure 6: Dominant currency pricing in US dollar–Goods vs. Services

Notes: The figure plots in the left panel the share of dominant currency pricing in USD in extra-EU exports of goods (on the y-axis) against the share of dominant currency pricing in USD in export of services (on the x-axis) of Belgium (BE), Bulgaria (BG), Czech Republic (CZ), Italy (IT), Latvia (LV), Portugal (PT) and Slovakia (SK) in 2020. The right panel does the same for imports. The 45-degree line is shown as a light grey line.

the US dollar is used much less for pricing services than for goods, as Figure B.6 shows.

The second piece of evidence against composition effects is provided in Figure B.7. Differences in the prevalence of the USD in trade in services relative to trade in goods could arise from the fact that our sample of countries trade more services with destination and source countries in the EU's neighbourhood that tend to use the EUR disproportionately more for invoicing – in line with the euro's regional role which contrasts with the US dollar's, which is global. But Figure B.7 shows that this is unlikely to be the case. The left panel of the figure plots the difference between the EUR shares of exports of services and of exports of goods vis-à-vis extra-EU trading partners (on the y-axis) against the difference between the shares of exports of services and of exports of goods destined to EU neighbours (on the x-axis) for our sample.[11] The corresponding differences for imports are shown in the right panel. The 45-degree line is shown as a light grey line. The figure makes apparent that countries tend to use the EUR disproportionately more in transactions of services than goods compared to what trade with EU neighbours would predict.

11. We define neighbours as countries geographically adjacent to the EU in the spirit of the concept of "Euro time zone" whereby use of the EUR is strongest in the immediate geographical vicinity of the euro area (see Mazzaferro *et al.* (2002)), including Albania, Algeria, Belarus, Bosnia, Egypt, Georgia, Iceland, Israel, Lebanon, Libya, Moldova, Norway, Russia, Serbia, Switzerland, Syria, Turkey, Ukraine, and the United Kingdom.

In other words, composition effects are unlikely to explain the larger role of the USD in services trade.

A different geography of services trade could also interact with potential fixed costs involved in use of multiple currencies and explain the lower prevalence of the USD in extra-EU services trade. In particular, if there is a fixed cost involved with the use of multiple currencies, firms may choose to stick to the same currency across multiple markets (Amiti *et al.* 2022). This currency is likely to be the EUR (instead of the USD) if a large share of firm's trade occurs within the EU, where the EUR has a dominant role. If intra-EU trade is more important in services than in goods trade, this could hence be an explanation for the lower prevalence of the USD in services trade. We provide two pieces of evidence against this conjecture. First, using the Portuguese micro data, we show in Table B.2 that there is not a statistically significant relationship between a firm's share of exports to the EU and the likelihood of using VCP-USD in extra-EU exports. Second, in Table B.3 we show that, in fact, intra-EU trade shares are higher on average for goods than for services in our set of countries (about $+8$ percentage points for exports and about $+6$ percentage points for imports) – perhaps because of stronger presence of intra-EU production chains in goods relative to services.

5. Conclusions

In this paper, we explored the determinants of currency choices in services trade. We showed that currency choices in services trade are active firm-level decisions. Larger firms – which tend to exhibit greater strategic complementarities – and firms that rely more on inputs priced in foreign currencies are less likely to use the domestic currency to export services. These results indicate that models of currency choices where strategic complementarities and input-output linkages are key elements (Engel 2006; Gopinath *et al.* 2010; Amiti *et al.* 2022; Mukhin 2022) also explain relatively well currency choices in services trade data.

Importantly, we documented novel stylized facts on DCP in USD. We showed that while the USD is also extensively used as a vehicle currency in services trade, its prevalence is systematically lower than in goods trade. This finding is not confined to Portugal but holds in aggregate in six other European countries, some having the EUR as their domestic currency and others not, and is not explained by differences in the geography of trade between goods and services. Consistent with a key role of strategic complementarities and input-output linkages, the difference in the use of the USD in services vs goods trade disappears when services markets are particularly open, so that a significant fraction of suppliers in the destination market are coming from abroad, and in services where intermediates (instead of labor) constitute a large share of labor costs.

Several questions arise naturally from our analysis and may be interesting avenues for future research. For instance, it is established in the literature that a widespread USD pricing in goods trade affects meaningfully the relationship

between nominal exchange rates and other nominal and real variables, and hence optimal policies. So, if the USD is less dominant in services trade because of different characteristics of services and services markets, this should translate into a different impact of shocks in services relative to goods trade. As economies diversify their exports to services, their sensitivity to shocks and optimal policies may change. We leave those questions for future research.

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Appendix A: Background information

A.1. Variance decomposition derivation

$$NonEuro_{fcpt} = \gamma_f + \varphi_c + \omega_p + \rho_t + \varepsilon_{fcpt} = \sum_{i=1}^{5} C^i_{fcpt} \tag{A.1}$$

By definition:

$$\frac{\sum_{i=1}^{5} cov(NonEuro_{fcpt}, C^i_{fcpt})}{V(NonEuro_{fcpt})} \equiv 1 \tag{A.2}$$

Therefore, the contribution of each component can be computed as:

$$\frac{Cov(NonEuro_{fcpt}, C^i_{fcpt})}{V(NonEuro_{fcpt})} = \frac{Cov(NonEuro_{fcpt}, C^i_{fcpt})}{p(1-p)} \tag{A.3}$$

We know that :

$$NonEuro_{fcpt} = p + \widehat{\gamma}_f + \widehat{\varphi}_c + \widehat{\omega}_p + \widehat{\rho}_t + \widehat{\varepsilon}_{fcpt} \tag{A.4}$$

where all fixed effects and the residuals add up to zero and $p = N_1/N$ is the proportion of 1s in $NonEuro_{fcpt}$. Thus (omitting subscripts to simplify notation), we obtain for example that:

$$\widehat{cov}(NonEuro, \widehat{\gamma}) = \frac{\sum NonEuro\widehat{\gamma}}{N} = \frac{N_1}{N}\frac{\sum NonEuro\widehat{\gamma}}{N_1} = p\bar{\widehat{\gamma}}|_{NonEuro=1} \tag{A.5}$$

That is, $\widehat{cov}(NonEuro, \widehat{\gamma})$ is simply the average of the firm fixed effects for the $NonEuro = 1$ case, multiplied by p. The contribution of each component to the variation of $NonEuro$ can thus be computed as follows:

$$\frac{\sum_{i=1}^{5} \widehat{cov}(NonEuro, C^i)}{\widehat{V}(NonEuro)} = \frac{\bar{\widehat{\gamma}}|_{NonEuro=1}}{1-p} + \frac{\bar{\widehat{\varphi}}|_{NonEuro=1}}{1-p} + \frac{\bar{\widehat{\omega}}|_{NonEuro=1}}{1-p} + \frac{\bar{\widehat{\rho}}|_{NonEuro=1}}{1-p} + \frac{\bar{\widehat{\varepsilon}}|_{NonEuro=1}}{1-p} \tag{A.6}$$

A.2. Macro data on 7 European countries

For goods transactions, data breaking down extra-EU trade by invoicing currency are readily available via customs declarations. Compilation of similar data for services transactions are, in contrast, considerably more difficult to obtain.

To fill that gap, and following-up on an initiative by the European Central Bank, a pilot exercise was conducted in the context of the European Business Statistics regulation. Such a pilot exercise was conducted in 2021, with the participation of seven countries (Belgium, Bulgaria, Czech Republic, Italy, Latvia, Slovakia and Portugal).

Data collection in the pilot exercise included collection of data on imports and exports of services broken down by currency (EUR, GBP, USD, JPY, CNY, and national currency if not the EUR, and other currencies) vis-a-vis selected counterparts (extra-euro area, intra-EU 27, extra-EU 27, total) across the 12 major categories of services according to the extended balance of payments services classification (EBOPS). The resulting dataset constitutes a unique, granular dataset for 7 countries on invoicing currency patterns in various categories of services with many details across several dimensions.

Compilation practices differ across categories of services. Therefore, widespread use of multiple (mostly fragmented) data sources to collect statistics on trade in services inevitably involves a certain degree of estimation by statisticians. Inclusion of invoicing currency information may be more feasible for services items that rely primarily on survey data.

In most cases, national compilers of the participating countries were able to combine their data sources for services and provide information on invoicing currency patterns for the vast majority of the EBOPS items, with a few exceptions. Estimations for travel services relied in some reporting countries (e.g. Belgium, Slovakia) on the geographic direction of trade. Hence for all travel services exports the invoicing currency is the EUR; for travel imports it is the currency of the destination of travel (i.e. imports from the US are estimated to be invoiced in US dollars).

One way to assess the quality of the data is to consider their completeness across various dimensions, and in particular the extent according to which series were either not reported or submitted with values of zero. Having said this, reporting missing/zero values may be perfectly plausible given the granular nature of the dataset. Italy, for example, collects data on all ISO currencies in its surveys. In fact, the proportion of series with no or zero value ranges across reporters from 20% for Italy to 61% for Latvia. There is a concentration of missing or zero values among specific invoicing currencies: 60% of the missing/zero value series are accounted for the Japanese yen and Chinese renminbi (each accounting for 30%). At the other end of the spectrum, the EUR and US dollar only account for 2% and 7%, respectively, of the missing or zero series. Moreover, in terms of type of services with missing/zero values the largest numbers are found for government services (SL) accounting for 14% and manufacturing services (SA, 11%). Also for these

services it seems plausible that trade does not take place vis-à-vis all counterparts in each currency. Thus, overall it appears that the submitted data were rather complete and give a comprehensive picture of invoicing patterns in services.

Appendix B: Additional figures and tables

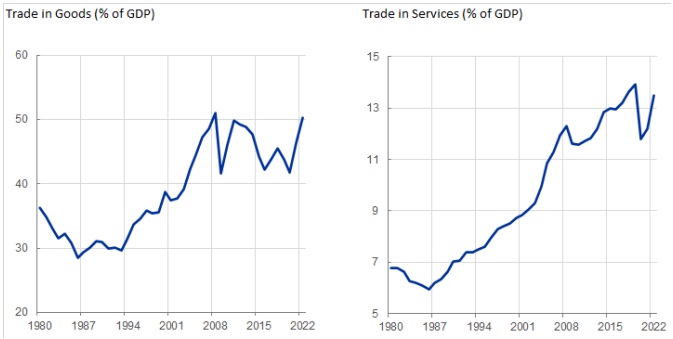


Figure B.1: Share of international trade in goods and in services in global GDP (%)

Notes: Authors' calculations using World Bank and World Trade Organization data.

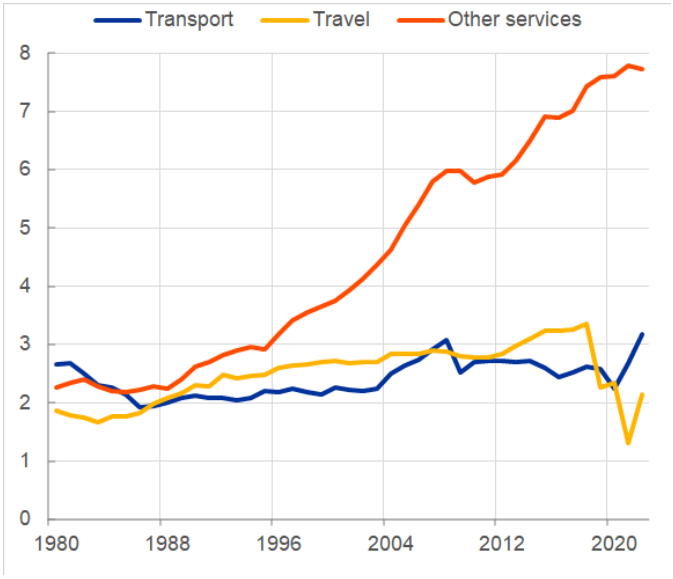


Figure B.2: Share of international trade in services in global GDP broken down by type (%)

Notes: Authors' calculations using World Bank and World Trade Organization data.

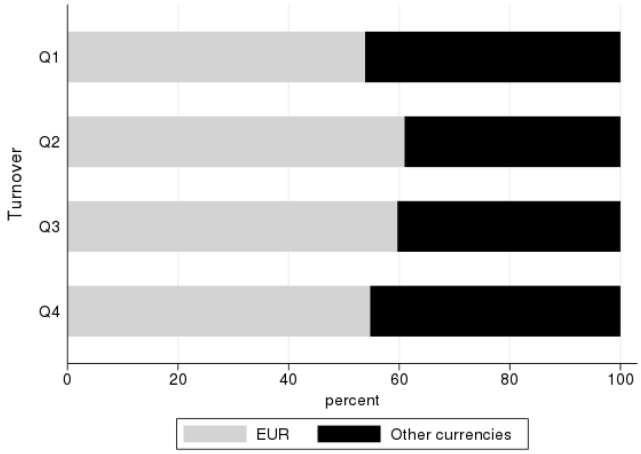


Figure B.3: Currency choices in extra-EU services imports and firm's size

Notes: The figure shows the average share of the EUR and other currencies (in count terms) in extra-EU services imports across firms categorized into different quartiles (Q) based on firm size. Firm size is approximated by the average turnover of each firm over the sample period (2014-19).

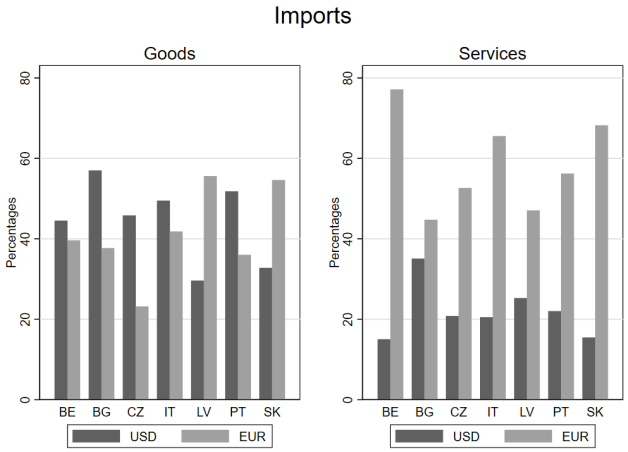
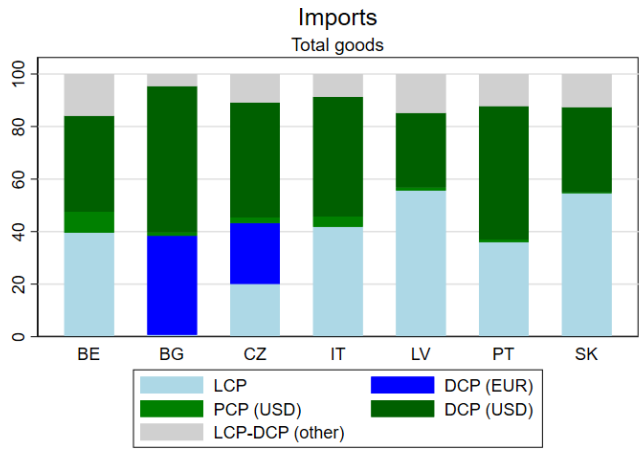
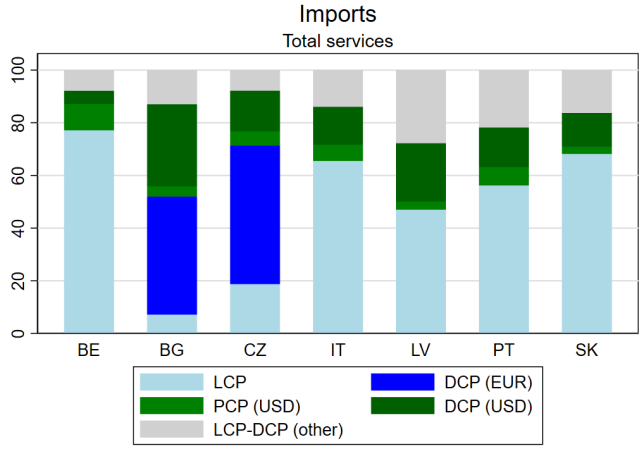


Figure B.4: Breakdown by currency of imports of selected countries

Notes: The figure shows the breakdown of 2020 extra-EU imports priced in USD and EUR for Belgium (BE), Bulgaria (BG), Czech Republic (CZ), Italy (IT), Latvia (LV), Portugal (PT) and Slovakia (SK) distinguishing between transactions in goods (left panel) and services (right panel).



(a) Imports of goods



(b) Imports of services

Figure B.5: Estimates of alternative pricing paradigms

Notes: The figure shows our estimates of alternative pricing paradigms for extra-EU imports of goods and services of Belgium (BE), Bulgaria (BG), Czech Republic (CZ), Italy (IT), Latvia (LV), Portugal (PT) and Slovakia (SK) in 2020, including producer currency pricing (PCP), local currency pricing (LCP) and dominant currency pricing (DCP) in EUR and USD.

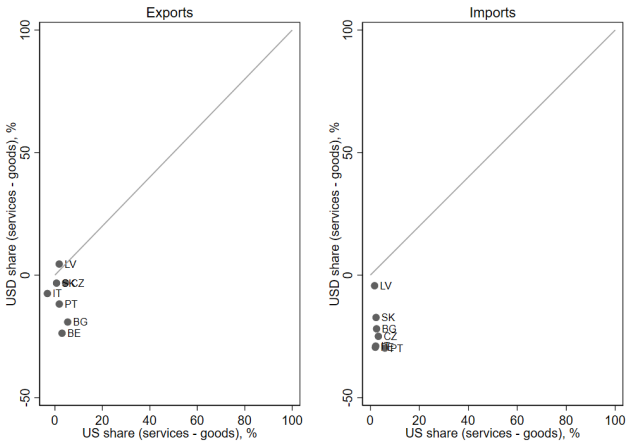


Figure B.6: Evidence against composition effects: role of exports to the US

Notes: The left panel of the figure plots the difference between the shares of extra-EU exports of services and of exports of goods priced in USD (on the y-axis) against the difference between the shares of exports of services and exports of goods destined to the US (on x-axis) for Belgium (BE), Bulgaria (BG), Czech Republic (CZ), Italy (IT), Latvia (LV), Portugal (PT) and Slovakia (SK) in 2020. The corresponding differences for imports are shown in the right panel. The 45-degree line is shown as a light grey line.

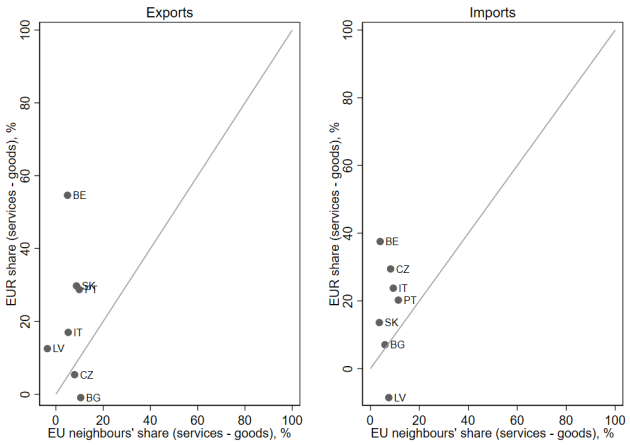


Figure B.7: Evidence against composition effects: partners in the EU's neighbourhood

Notes: The left panel of the figure plots the difference between the shares of extra-EU exports of services and extra-EU exports of goods priced in EUR (on the y-axis) against the difference between the shares of exports of services and of exports of goods destined to EU neighbours (on the x-axis) for Belgium (BE), Bulgaria (BG), Czech Republic (CZ), Italy (IT), Latvia (LV), Portugal (PT) and Slovakia (SK) in 2020. The corresponding differences for extra-EU imports are shown in the right panel. EU neighbours include Albania, Algeria, Belarus, Bosnia, Egypt, Georgia, Iceland, Israel, Lebanon, Libya, Moldova, Norway, Russia, Serbia, Switzerland, Syria, Turkey, Ukraine, and the United Kingdom. The 45-degree line is shown as a light grey line.

EBOPS	Description	ISIC Rev.4
SB	Maintenance and repair services	33
SC11	Sea transport - passenger	50
SC12	Sea transport - freight	50
SC13	Sea transport - other	50
SC21	Air transport - passenger	51
SC22	Air transport - freight	51
SC23	Air transport - other	51
SC3A	Space transport	51
SC3B1	Rail transport - passenger	49
SC3B2	Rail transport - freight	49
SC3B3	Rail transport - other	49
SC3C1	Road transport - passenger	49
SC3C2	Road transport - freight	49
SC3C3	Road transport - other	49
SC3D1	Inland waterway transport - passenger	50
SC3D2	Inland waterway transport - freight	50
SC3D3	Inland waterway transport - other	50
SC3E	Pipeline transport	49
SC3F	Electricity transmission	
SC4	Postal and courier services	53
SE1	Construction abroad	41
SE2	Construction in the reporting economy	41
SF1	Direct insurance	65
SF2	Reinsurance	65
SF3	Auxiliary insurance services	65
SF4	Pension and standardized guarantee services	65
SG1	Financial services	64
SH1	Franchises and trademarks licensing fees	
SH3	Licenses for the use of outcomes of research and development	
SH41	Licenses to reproduce and/or distribute audio-visual products	
SH42	Licenses to reproduce and/or distribute other products	
SI1	Telecommunications services	61
SI2	Computer services	62
SI3	Information services	63
SJ111	Provision of research and development services	72
SJ112	Sale of proprietary rights arising from research and development	72
SJ12	Other research and development services	72
SJ211	Legal services	69
SJ212	Accounting, auditing, bookkeeping, and tax consulting services	69
SJ213	Business, management consulting and public relations services	70
SJ22	Advertising, market research, and public opinion polling services	73
SJ311	Architectural services	71
SJ312	Engineering services	71
SJ313	Scientific and other technical services	71
SJ321	Waste treatment and de-pollution	38
SJ322	Services incidental to agriculture, forestry and fishing	
SJ323	Services incidental to mining, and oil and gas extraction	
SJ33	Operating leasing services	77
SJ34	Trade-related services	
SJ35	Other business services n.i.e.	
SK1	Audio-visual and related services	59
SK21	Health services	86
SK22	Education services	85
SK23	Heritage and recreational services	90-94
SK24	Other personal services	

Table B.1. EBOPS service categories and conversion to ISIC Rev. 4 divisions

	(1)
I^{USD}_f	0.363***
	(0.104)
S_f (ln exports)	-0.017***
	(0.006)
EU export share$_f$	0.057
	(0.054)
Product-country FE	Yes
Time FE	Yes
No. of observations	46924
Adjusted R2	0.513

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table B.2. Currency choices in extra-EU exports (USD vs local currency): role of the share of exports to the EU

Notes: The table shows estimates from a linear model. The sample excludes export transactions priced in EUR and transactions with destination countries that have the EUR or USD as local currencies. The dependent variable, S_f and I_f^{USD} are defined in Table 3. *EU export share* represents the ratio of the firm's exports to EU countries over total exports. Standard errors are clustered at the firm level.

	Goods - Services (intra-EU), p.p.	
	Exports	Imports
Belgium	0.5	8.5
Bulgaria	12.1	6.2
Czech Republic	18.5	2.3
Greece	16.9	10.5
Italy	-5.7	-0.4
Latvia	1.6	10.0
Portugal	9.8	15.6
Slovakia	9.7	-5.7
Sample	7.9	5.9
All EU	5.4	7.9

Table B.3. Share of intra-EU trade in goods vs services trade

Source: Eurostat – Balance of payments by country – annual data (BPM6) for the year 2021.

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