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The Effect of the Single Currency on Exports: Comparative Firm-level Evidence*

Abstract

We investigate how adopting the euro affects exports using firm-level data from Slovakia and Estonia. In contrast to previous studies, we focus on countries that adopted the euro individually and had different exchange rate regimes prior to doing so. Following the New Trade Theory we consider three types of adjustment: firm selection, changes in product varieties and changes in the average value of the exports that compose the exports of individual firms. The euro effect is identified by a difference in differences analysis comparing exports by firms to the euro area countries with exports to the EU countries that are not members of the euro area. The results highlight the importance of the transaction costs channel related to exchange rate volatility. We find the euro has a strong pro-trade effect in Slovakia, which switched to the euro from a floating exchange rate, while it has almost no effect in Estonia, which had a fixed exchange rate to the euro prior to the euro changeover. Our findings indicate that the euro effect manifested itself mainly through the intensive margin and that the gains from trade were heterogeneous across firm characteristics.

Keywords: international trade, common currency areas, euro adoption, transaction costs, Slovakia, Estonia, firm-level data

JEL Classification: F14, F15

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1. Introduction

Assessment of the potential benefits of adopting the euro or of any currency union relies predominantly on the savings that come from eliminating nominal exchange rate volatility and reducing transaction costs. These savings are expected to lead to higher exports, higher gross domestic product and consequently higher living standards in the economies of the currency union. Introducing currency unions such as the euro area can affect trade through more than one channel. Baldwin et al. (2008) suggest we may consider (1) trade prices being reduced as transaction costs from exchange rate volatility and foreign exchange fall; (2) trade prices being reduced by increased competition; and (3) opportunities opening up for newly traded goods. However, there is no consensus as to which channel has a decisive role for the gains from trade.

The more years pass since the introduction of the single European currency, the more information there naturally is on the impact of this step on international trade. While there is ample macro-level evidence that the euro changeover had a positive impact on trade, micro-level analyses remain limited to a small number of countries. The distribution of gains from trade and the mechanism behind this distribution are still unclear. The aim of this paper is to offer more evidence on the topic using firm-level data. The paper contributes to the literature on the effects of common currency areas on trade by, first, studying two natural experiments where trade costs were reduced but there was no increase in competition from other countries; and, second, by testing the heterogeneous effect of the euro on exports.

The data come from two relatively new euro area members: Slovakia, which joined the common currency area in 2009, and Estonia, which joined in 2011. The difference in differences methodology is applied where the euro adoption effect is identified by firm-level bilateral trade flows to EU countries. The treatment group consists of exports to the euro area countries, while the control group consists of exports to the non-euro area EU countries. The paper asks whether adopting the euro has raised the probability of exports going to a given destination, has increased the number of products for each destination, or has boosted exports to each destination. This approach is used to examine whether the benefits of euro adoption are manifested mostly through the intensive margin or the extensive margin. The incidence of gains from adopting the euro is tested across productivity and size groups, and across other firm characteristics such as age, foreign ownership and financing structure. The unconditional quantile regression technique of Firpo et al. (2009) is applied to study the effect of the euro along the distribution of exports, to test whether the smallest exporters or the largest benefited the most.

The Slovakian and Estonian changeovers to the euro are good case studies for a number of reasons. The large majority of the literature on how the euro affected trade is based on papers that use data from when the euro was introduced in 1999. The euro was introduced by many countries at the same time and transaction costs were reduced for all of them. This meant the introduction of the euro affected trade in two ways, with a positive effect from lower transaction costs and a negative effect from increased competition from other euro area countries. Berthou and Fontagne (2013) control for the competition effect indirectly and find that the euro effect is underestimated when the increased competition is ignored. The advantage of our paper is that we use two cases where the euro was introduced in one country at a time, so that there was no effect of increased competition from other countries.

Our two-country natural experiment study has further advantages. The timing of the effect is concentrated as the euro was introduced for electronic and cash transactions at the same time,

and a much larger control group of EU destination markets is available than when the euro was first introduced. Most importantly, the cases analysed in this paper, Slovakia and Estonia, provide insightful comparative evidence about the channel behind the effects. Slovakia had a floating exchange rate against the euro prior to the changeover, while Estonia had a currency board system with a strict peg to the euro. A result was that Slovakia saw its transaction costs from exchange rate volatility fall but Estonia did not, while both countries benefited from the fall in the transaction costs from foreign exchange. We use these similarities and differences to identify the channel behind the gains. To the best of our knowledge there is only one paper that uses data from recent euro area members to estimate how the euro affects trade, Mika and Zymek (2018), which considers the macro-level but does not ask which channel contributed to the effect and ignores the cross-country variation in the exposure to different channels.

There is a lot of research on how common currency areas affect trade. Abundant macroeconomic studies typically find that a common currency has a positive effect on trade. Many amendments to the gravity type estimates have emerged since Rose (2000) demonstrated generous effects from currency unions to trade. The main contributions are critically reviewed in Baldwin (2006), who concludes that the euro trade effect varies between 5% and 10%, and also in Bun and Klaassen (2007), Baldwin et al. (2008) and Polak (2018), who suggest the effect is even smaller. Baldwin and Taglioni (2007) or Head and Mayer (2014) give evidence on more estimates of the euro effect that are frequently disputable. More recently, Glick and Rose (2015) show that the estimates of the currency union effect are sensitive to the exact econometric methodology and conclude that the euro has a smaller trade effect than other currency unions do. A possible reason for the milder effect could be the deep pre-accession integration in the common market.

Using product-level trade data helps to unveil more of the consequences of a currency union. Baldwin and Nino (2006) provide supportive evidence for the newly traded goods hypothesis. Flam and Nordström (2007) find a stronger trade effect for products that were not exported continuously and confirm the significant and substantial effects on the extensive margin of trade from the introduction of the EMU. Simple stylised facts based on product-level data for the trade of new euro area countries indicate that the euro promotes exports of intermediate or semi-finished products, as shown by Flam and Nordström (2007) or Rotili (2014).

A microeconomic approach offers even more aspects for study than the aggregate or product-level approach does. The theoretical approaches build on Melitz (2003). In his framework a fall in export costs allows smaller and less productive firms to start exporting and increases the value of exports for each firm. Bernard et al. (2011) propose a multi-product model, where a fall in trade costs leads to firm selection into the export market, with an increase in both the number of destinations for each type of product and the range of products exported by firms to a given destination.

As we have access to detailed firm-level trade data, we contribute to the smaller stream of empirical firm-level literature that uncovers processes that are usually hidden in aggregate trade figures. Baldwin et al. (2008) offer the first unconditional evidence of the euro trade effect for France and Belgium and confirm the newly traded goods hypothesis. However, the conditional estimates with a more rigorous approach are not conclusive. Berthou and Fontagne (2008, 2008a and 2013) find the adoption of the euro in France has a statistically significant impact in reducing trade costs. Berthou and Fontagne (2013) show that the euro changeover increased firm-level exports by 5% in France and that the intensive margin dominated the effect. Nitsch and Pisu (2008) estimate the euro trade effect on Belgian exporters. They find no statistically significant effect on total firm-level exports, but find that intra-euro area trade has expanded through new markets and new product margins. De Nardis et al. (2008) find from Italian firm-level data that the euro had no statistically significant

effect on total firm-level exports, but had an effect along the extensive margin of new markets.

There is also no consensus on which type of firm saw its exports increase the most from the changeover to the euro. Berthou and Fontagne (2008a) find that firm efficiency and the composition effect play a role in the decision by firms to export, but the newly traded goods hypothesis is not subject to the presence of the composition effect of firm size. There is evidence that the most productive firms started to export more because of the euro changeover (Berthou and Fontagne (2013)) or that less productive firms started to export more (Nitsch and Pisu (2008)). It has also been found that the exports of the smallest firms increased the most due to the introduction of the euro (Esteve-Perez et al. (2010) and Nitsch and Pisu (2008)).

We find that adopting the euro had a statistically significant and strong economic impact on exports for Slovakia, but almost no effect for Estonia. For Slovakia we find that the changeover to the euro increased exports by 14% and that the intensive margin dominated the effect. One possible explanation for this larger effect is that we are studying countries that adopted the euro separately and not in a big group of countries, and so no adverse competition effect from other countries emerges. We claim that the main mechanism behind the effect is the reduction of transaction costs from the exchange rate volatility that exporters were exposed to in Slovakia but not in Estonia. It is also found that the gains from trade from the reduced transaction costs are distributed heterogeneously across firms. More productive firms benefit the most from the reduced transaction costs. These findings provide empirical evidence on theoretical models like that of Melitz (2003), as we confirm the prediction that reduced trade costs contribute to more concentrated distribution of productivity. We also find that the exports of smaller exporters increased the most after the changeover to the euro.

The next section provides background to the adoption of the euro in our sample countries and describes the aggregate developments in the exports of goods. A detailed description of the data used in our econometric analyses is available in Section 3. Section 4 describes our methodology. In Section 5 we present the estimation results and robustness tests; and Section 6 concludes.

2. Background and aggregate developments

The introduction of the euro has provided the set-up of a natural experiment for research into how currency unions affect trade. As discussed above, there has been a lot of research into how the adoption of the euro has affected trade, especially at the country level and the aggregate product group level. Baldwin et al. (2008) offer the finding that the introduction of the euro in 1999 increased the trade of euro area countries by 5%. They show a number of channels in action behind this effect.

The main channel is the fall in trade prices that comes from lower transaction costs and increased competition. They conclude that the transaction costs effect cannot be the main channel, because if this effect was the main mechanism it should have led to trade diversion in non-euro area EU countries. However, the trade diversion effect has not found empirical support. The increased competition has been confirmed by many studies, as Baldwin et al. (2008) show that export prices have been converging among euro area countries and outsiders, and Berthou and Fontagne (2013) show that the euro effect increases after increased competition is controlled for.

The second main channel behind the positive trade effect from the euro is shown by Baldwin and Taglioni (2004) to be the newly traded goods channel. They claim that newly traded goods can explain the rise in the volume of trade, but not the rise in trade prices. Baldwin et al. (2008) show that EU firms inside and outside the euro area started to export more goods to the euro area after the euro was introduced.

The sample countries in this study, Slovakia and Estonia, are exposed differently to the reduction of transaction costs caused by the introduction of the euro as they had different monetary policies before they adopted the euro. Slovakia had a fixed exchange rate system in the 1990s and shifted to a managed floating exchange rate with inflation targeting from 1998. The indicative target inflation was gradually lowered towards 2% prior to the accession to the common currency area (Banerjee et al. (2007)). Estonia had a fixed exchange rate system with a currency board from 1992, where the Estonian currency was first strictly pegged to the German mark and from 2002 to the euro (Kroon and Economy (2008)). This implies that the benefits to trade from the removal of exchange rate volatility are different in the two countries and the gains expected in exports should be larger in Slovakia than in Estonia.

Figure 1 presents the exchange rate volatility in our sample countries and other EU countries before and after the adoption of euro. The EU sample is split into two groups, with one group of countries in the euro area during the changeover, and the other of countries outside the euro area during the changeover. This follows the same logic as the difference in differences methodology applied later in the paper for identifying the euro effect on trade. This methodology implies that there is a development over time, the difference, which has no effect on the group of non-euro area countries, but some effect on the group of euro area countries. If the development over time is different in these two groups, as is noted by the second difference in the name of this methodology, we can conclude that the changeover had some effect.

Figure 1 shows that the exchange rate volatility has decreased over time for both the non-euro area countries and the euro area countries. The figure demonstrates that the *difference* between these *differences* is much larger in Slovakia than in Estonia. Estonia does not have any exchange rate volatility with euro area countries prior to accession and the small volatility shown in the figure results from the fixed composition of countries and Slovakia in the treatment group. The exchange rate volatility with the euro area countries has decreased substantially for Slovakia, while there is no reduction in exchange rate volatility with the euro area countries for Estonia if the composition effect is left aside.

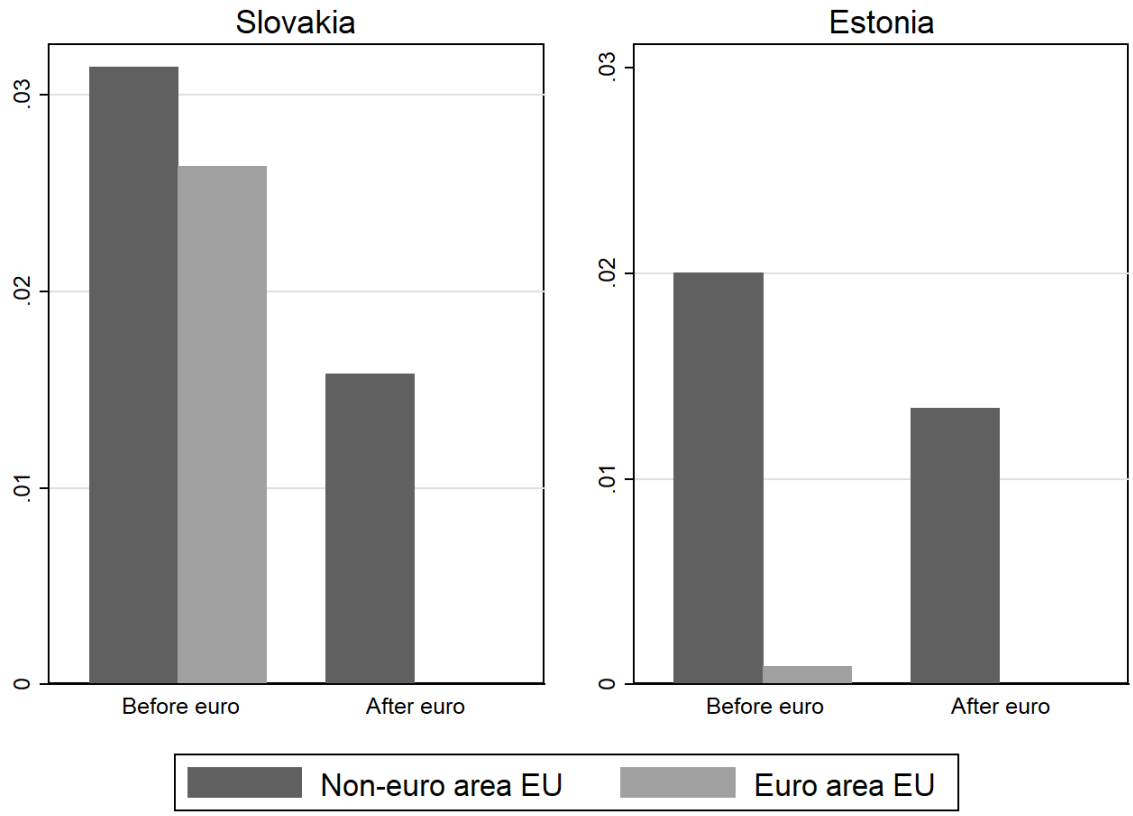

Figure 1. Exchange rate volatility with euro area and non-euro area EU countries, Slovakia 2006-2011, Estonia 2008-2013.

Note: The figure presents the unweighted average of the volatility of exchange rates between the country of origin and partner countries. The exchange rate volatility is calculated as the coefficient of variation of monthly exchange rates in a year. A fixed composition is used for euro area and non-euro area countries and it is based on the list of members at the time of the changeover. As a result, the Slovakian sample of euro area countries contains some years of data from Slovenia, Malta and Cyprus when the euro was not yet used there, and similarly the Estonian sample of euro area countries contains one year of Slovakian data when the euro was not used there.

Source: Authors' calculations based on Eurostat.

Another source of transaction costs is the reduced cost of foreign exchange. The European Commission (1990) estimated that the expected gains from foreign exchange brought by the euro were from 0.1% to 1% of GDP and were higher for small euro area countries like our sample countries. Suster et al. (2006) estimated that total savings on foreign exchange transaction costs in Slovakia may have reached 0.36% of GDP. These savings included financial transaction costs originating from sales and purchases of euros and administrative transaction costs related to foreign currency management, accounting of foreign exchange losses and gains, additional reporting and other costs.

The euro was already a dominant currency in extra-euro area trade before the changeover in Slovakia and Estonia, as around 90% of extra-euro exports were invoiced in euros in Slovakia in 2008 and 50% were in Estonia in 2010 (European Central Bank (2012)). The amount of invoicing in euros increased by 20 percentage points in Estonia after the changeover, while the already high share of invoices in euros was unaffected by the changeover in Slovakia. Unfortunately, there are no public statistics on currency invoicing for intra-euro area trade,

but it is also likely to have been higher in Slovakia than in Estonia[3]. It can be expected that the gain from reduced foreign exchange transaction costs in exports was larger in Slovakia than in Estonia, though both of the countries gained. The reasoning for this is that the drop in transaction costs from foreign exchange was larger in Slovakia than in Estonia, as currencies other than the euro had a minor role in the exports of Slovakian firms, while the exports of Estonian firms were more frequently invoiced in other currencies after the changeover.

The introduction of the euro in 1999 brought innovation in cross-border euro payments, which also reduced the costs of foreign exchange. The Trans-European Automated Real-time Gross settlement Express Transfer system (TARGET) was created in 1999 and Estonia joined it as early as 2006. This system was not used much by Estonian companies before the changeover to the euro in 2011, but it became the main cross-border transaction system after the changeover.[4] Slovakia was using its own system up to the adoption of the euro and then switched directly to TARGET2, the new version of the transfer system that replaced TARGET in 2007.

The findings on the effects of the introduction of the euro suggest that the gains from trade were different across countries and that countries which were more tightly integrated before adopting the euro gained more. Baldwin and Taglioni (2004) propose a model to explain this regularity. They show that countries which have lower trade barriers before the introduction of a common currency have larger expected gains. This implies that countries with close proximity to other euro area countries or which trade a lot with other euro area countries have larger expected gains for exports. Both of the sample countries in this study export the majority of their products to the EU, though Slovakia is more tightly integrated in trade with the EU than Estonia is. Slovakia sent 86% of its exports to the EU before adopting the euro (Eurostat indicator ext_lt_intratrd from 2008) and Estonia sent 69% of its exports to the EU before it adopted the euro (Eurostat indicator ext_lt_intratrd from 2010). Within the EU, Slovakia is again more tightly connected to the euro area, exporting 56% of its EU trade to the euro area, while Estonia exports 46%. Slovakia is a neighbour of one euro area country, Austria, and is close to such large euro area countries as Germany, France and Italy. Estonia has one euro area neighbour Finland, which is also one of its main trading partners, but the rest of Estonia's main trading partners were not in the euro area at the time of the changeover.

This implies that the potential gains for trade from adopting the euro are larger for Slovakia than those for Estonia, and the two main reasons for this are that Slovakia had a floating exchange rate before adopting the euro, and it exports more to the euro area than Estonia does. Table 1 summarises the main channels behind the gains for trade from common currency areas. The three main channels that can reduce transaction costs all have a positive effect on trade. The increased competition channel has a negative effect on trade as export prices are reduced, export markets become more transparent, and product mark-ups are reduced. Unlike when the euro was introduced in 1999, our sample countries did not face increased competition from other countries because they joined the euro area one country at a time. Our sample countries are so small that they cannot affect the equilibrium price-level in the euro area, as Slovakian exports are 1.6% of the total euro area exports the year before the changeover and Estonian exports are 0.3% (Eurostat indicator DS-016894).

[3] The invoice data are available in the confidential customs data for Estonia used in this paper, and 67% of the volume of exports to the euro area was already being invoiced in euros before the euro was adopted in Estonia.
[4] See more about the development of settlement systems in Estonia on the website of the Bank of Estonia at https://www.eestipank.ee/en/payments/development-settlement-systems-estonia.

Table 1. Expected gains ifrom trade from the euro.

Channel of euro impact on trade	Expected direction of the effect	Introduction of the euro in 1999	Changeover to the euro in Slovakia in 2009	Changeover to the euro in Estonia in 2011
Transaction costs from exchange rate volatility	(+)	Strong	Strong	No
Transaction costs from foreign exchange	(+)	Variable	Strong	Medium
Interaction of transaction costs and importance of the euro area in trade prior to accession	(+)	Variable	Strong	Weak
Increased competition from other euro area members	(-)	Strong	No	No

Source: compiled by the authors from related literature.

An aggregate view of the actual development in the new euro area countries does not provide conclusive evidence that introducing the euro has an unconditional effect on euro area trade. Figure 2 compares the developments in the ratio of exports to the euro area to total exports to the EU in countries that have joined the euro area since 2007. The countries did not all adopt the euro at the same time. Slovenia was the first to introduce the single currency in 2007, followed by Cyprus and Malta in 2008. Slovakia joined the euro area in 2009, followed by Estonia in 2011, then Latvia and Lithuania adopted the euro in 2014 and 2015. The unconditional aggregate picture shows no sudden changes or clear common patterns in the intra-euro area export shares of Slovakia, Estonia or other new euro area countries following their introduction of the euro.

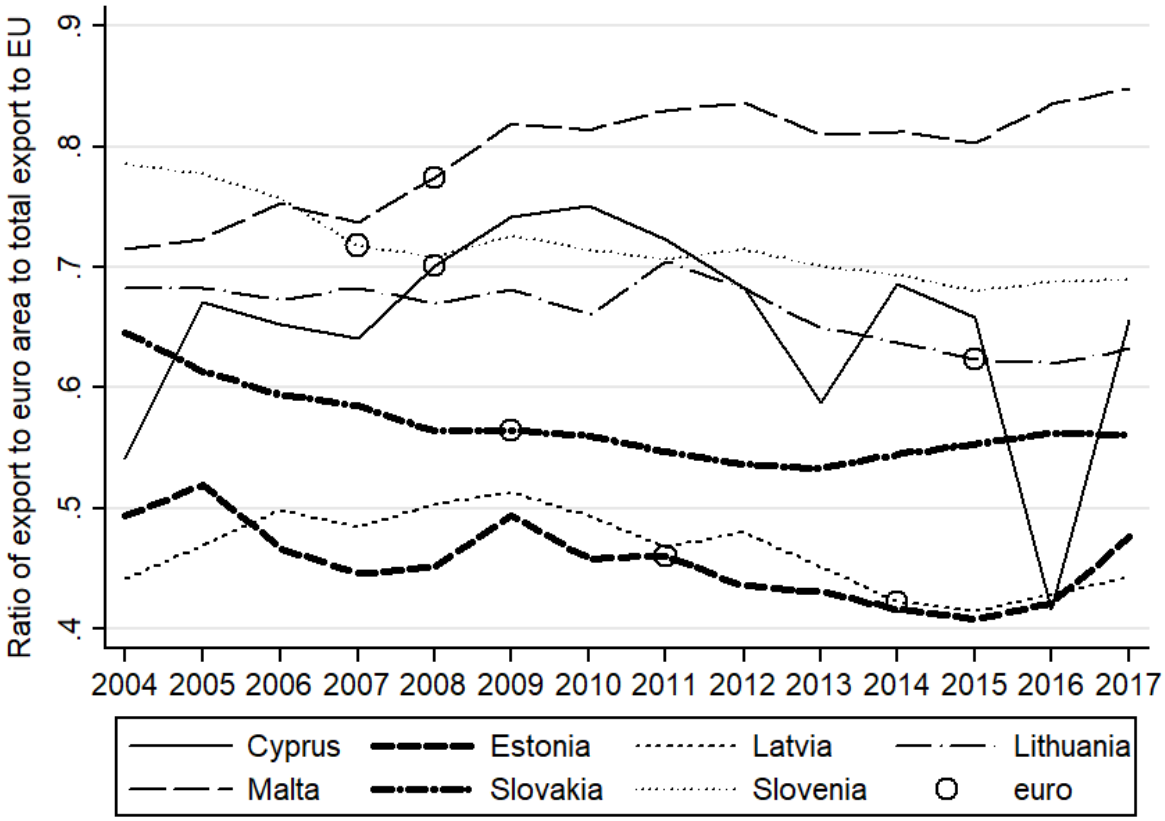

Figure 2. Intra-euro area export share in total exports to EU countries, new euro area members since 2004.

Notes: The circle indicates the year of adoption of the euro. The euro area countries are defined by the time of the euro adoption in each country, so the composition of euro area and non-euro area countries differs across countries, but is not time-varying for each individual country. The bold lines are for our sample countries Slovakia and Estonia.

Source: Authors' calculations based on Eurostat series DS-016894.

3. Data

We use detailed firm-level trade and balance sheet data for Slovakia and Estonia. These two countries represent the new CEE and Baltic euro area countries well in terms of their level of development or trade openness.[5] Like with the original euro area countries, high levels of confidentiality for the detailed transaction data mean that strict data handling rules are required, and these prevent cross-country combination of datasets.[6]

We use customs data on all exporting firms in Slovakia and Estonia, covering the NC8 codes for products, the ISO codes for destination countries and the FOB values of the export flows.

[5] They both represent small, highly open economies. Cyprus and Malta differ significantly in their trade openness based on trade in goods. See Appendix 1 for a more detailed comparison of the new euro countries.

[6] According to Castellani, D. and Koch, A. (2015) firm-level trade data are in general available for all seven new euro area member states except Cyprus, but they are confidential and restrictive accessibility rules make them difficult to access.

The data represent fairly exhaustive information on the exports of the countries analysed, running between 2006 and 2011 for Slovakia and between 2008 and 2013 for Estonia. We aggregate the 8-digit NC codes to actual 6-digit HS codes to ensure better comparability of product codes over time. We also have access to the data on imports, which we use to test whether more import intensive exporters have experienced different effects from the euro. The data are of very high quality as the same administrative data have been used by national statistical institutions to produce official trade statistics.

So that we can study differences in the characteristics of exporters we merge the customs data with commercial register data and firm-level balance sheet data. The commercial register contains information on the date each firm was established, allowing us to calculate the age of each firm, its type of ownership so we can distinguish between foreign and domestic firms, and size-group information based on the number of employees.

The customs and commercial register dataset is combined with the balance sheet data. We use real value added, the real book value of net capital, employment, and material inputs to calculate firm-level total factor productivity (TFP). The TFP is calculated using the GMM-based approach suggested by Wooldridge (2009). The real values are derived using GDP deflators at the 2-digit NACE level. Interest paid and profits are used to derive a debt burden indicator that accounts for any financial situation effect. The balance sheet data are harmonised across countries using an approach that originates from the CompNet microdata project.[7] To ensure better compatibility of the Slovakian and Estonian data, we use a sample of firms with 20 or more employees and firm-destination trade flows that are a thousand euros per year or larger. As exports are highly concentrated we still cover 99% of total exports in Slovakia and 95% in Estonia.

Tables 2 and 3 provide descriptive statistics about all the trade margins and explanatory variables analysed. The descriptive statistics have been provided for the treatment and control group destination countries and for the period before and after the changeover to the euro. There is no evidence that average unconditional trade margins have developed differently for the treatment and control groups, as exports have increased to both of the destination country groups and the increase has been even faster in non-euro area markets. The sample countries are similar in terms of the probability of a firm being an exporter, firm age; though Slovakian firms are somewhat larger than Estonian firms, export larger volumes and participate more tightly in global value chains (the share of foreign owned firms and the share of imports in material costs).

Additional aggregate explanatory data on macroeconomic indicators come from publicly available databases published by the International Monetary Fund and Eurostat. We control for the demand effect using the gross domestic product values of destination countries published in the World Economic Outlook database. The nominal value of GDP in destination countries is used instead of real values as the export data are not deflated either. The import prices of destination countries are added to the analysis and this variable aims to control for competition from third countries (Berthou and Fontagne (2013) control for import prices using this argument). We control for the competitiveness in destination countries by using the real effective exchange rate based on consumer prices.

[7] See Dhyne et al. (2014) for more details on the definition of variables and outlier treatments. This source also discusses the methodology for the TFP calculation.

Table 2. Descriptive statistics of the main variables (EU trade), Slovakia 2006-2011

	Control group: EU non-euro area countries				Treatment group: EU euro area countries			
	Before		After		Before		After	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Share of exporters in each destination (n=86332)	0.519	0.500	0.490	0.500	0.486	0.500	0.471	0.499
Share of exporters in each destination×product (n=632223)	0.265	0.441	0.245	0.430	0.266	0.442	0.257	0.437
Number of HS6 products per destination (n=32991)	5.125	7.200	4.862	7.146	4.963	8.503	4.768	9.289
Average exports per HS6 product in destination (ths. EUR) (n=32991)	394.0	2098.7	539.6	4137.6	589.5	2605.0	774.8	6243.7
Total exports per destination (ths. EUR) (n=32991)	2128.4	15978.5	1733.4	10342.1	3420.7	25437.0	3179.7	27313.1
Firm age (years) (n=32991)	11.6	4.5	13.0	5.0	11.3	4.6	12.8	5.2
Firm employment (n=32991)	381.2	1009.0	315.4	719.8	433.0	1108.4	339.3	779.0
Share of foreign owned firms (n=32991)	0.430	0.495	0.512	0.500	0.486	0.500	0.559	0.497
Firm log(TFP) (n=32991)	-0.049	1.616	-0.023	1.614	-0.282	1.512	-0.214	1.594
Firm debt burden (n=32991)	0.237	0.246	0.207	0.235	0.237	0.243	0.198	0.232
Share of imports in material costs (n=32076)	2.224	3.807	2.355	3.789	3.244	7.920	2.890	6.753

Notes: Foreign owned firms are defined as a binary variable where majority foreign owned firms take the value "1" and the rest "0". The firm debt burden represents interest paid divided by operating profit.
Source: Authors' calculations from Commercial Register and Customs data.

Table 3. Descriptive statistics of the main variables (EU trade), Estonia 2008-2013

	Control group: EU non-euro area countries				Treatment group: EU euro area countries			
	Before		After		Before		After	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Share of exporters in each destination (n=12014)	0.597	0.491	0.634	0.482	0.579	0.494	0.638	0.481
Share of exporters in each destination×product (n=73656)	0.378	0.485	0.450	0.497	0.385	0.487	0.455	0.498
Number of HS6 products per destination (n=5979)	4.1	6.8	5.0	8.2	4.4	8.5	5.2	10.1
Average exports per HS6 product in destination (ths. EUR) (n=5979)	215.6	621.8	268.6	1034.1	372.7	1013.8	498.1	1349.9
Total exports per destination (ths. EUR) (n=5979)	665.0	2124.4	2414.5	37280.0	1025.1	2903.2	1636.7	5391.4
Firm age (years) (n=5496)	13.7	4.1	15.9	5.2	13.5	4.1	15.7	5.2
Firm employment (n=5979)	119.5	193.4	126.1	183.7	123.2	182.5	138.4	210.1
Share of foreign owned firms (n=5359)	0.358	0.480	0.411	0.492	0.375	0.484	0.428	0.494
Firm log(TFP) (n=5727)	-0.061	1.948	0.077	1.855	-0.337	2.004	-0.149	1.906
Firm debt burden (n=5806)	0.143	0.225	0.078	0.155	0.126	0.218	0.072	0.146
Share of imports in material costs (n=5913)	1.425	1.972	1.655	2.259	1.948	9.740	2.127	10.273

Notes: Foreign owned firms are defined as a binary variable where majority foreign owned firms take the value "1" and the rest "0". The firm debt burden represents interest paid divided by operating profit.
Source: Authors' calculations from Commercial Register and Customs data.

4. Methodology

The aim of this paper is to investigate how joining a common currency area affects trade. Following the New Trade Theory we consider three types of adjustment: firm selection to exports; changes in product varieties, which represent extensive margins; and changes in the average value of exports, which represent an intensive margin. The unit of analysis is the trade flow to a particular destination country at the firm level, or firm times destination market.

In the baseline estimation strategy we start with the probability of a firm exporting using a within fixed effect estimator.[8] The dependent variable in these regressions takes the value of 1 if the firm exports to a particular destination market and 0 otherwise.

In the next step, we continue by estimating the effect of the euro on the product margin as the number of products exported for each firm in a destination market, the intensive export margin as the average value of exports of a product for each firm in a destination market, and the total firm exports in a destination market using a fixed effect estimator.

We follow the methodology of Berthou and Fontagne (2013), but in addition to their approach we introduce a dynamic specification where the persistence of the export margin is controlled for, and we introduce industry-specific time trends. The euro effect is identified by a difference in differences style dummy variable that is equal to one during the period following the adoption of the euro if the destination country was a member of the euro area, and zero otherwise. We compare exports to the euro area countries with exports to the remaining non-euro area EU countries, so destination markets outside the EU are removed from the control group to ensure better comparability of the treatment and control groups. The number of EU members was 27 during the sample period, so excluding the home country results in 26 countries, of which 15 were euro area members at the time when Slovakia introduced the euro and 16 at the time when Estonia did so. Only manufacturing firms are used in the estimations as these are responsible for the majority of trade in goods.

The following dynamic specification is applied:

$$TM_{ijt} = \alpha_{ij} + \beta_1 TM_{ijt-1} + \beta_2 Post_t \times EA_{ij} + \beta_3 \log(TFP_{it-1}) + \beta_4 \log(\mathrm{GDP}_{jt}) + \beta_5 \log(\mathrm{REER}_{jt}) + \beta_6 \log(\mathrm{MP}_{jt}) + \tau_t \times sector_k + e_{ijt} \quad (1)$$

where *i* denotes the firm, *j* is the destination country, *t* is the year and *k* the industry. TM_{ijt} stands for the trade margin. Five different trade margins are modelled in this paper: the decision by a firm to export to a destination market; the decision by the firm to export a 6-digit HS product to a destination market; the number of products the firm has in each destination market; the average exports of the firm for each product in a destination; and the total exports of the firm to each destination. The first two types of trade margin are binary variables for whether the firm exports or not. The estimation of equation (1) for these trade margins covers firms that have exported at least once during the sample period. The last three trade margins are continuous variables and are defined only for positive firm-destination-level trade flows. These trade margins have values larger than zero and have been logarithmed. We prefer this two-part approach over the selection model as it has been proven to be robust to endogenous selection and avoids the often fruitless search for instruments that affect the decision to export but not the value of exports (see Drukker (2017) for a formal presentation of these issues and Nitsch and Pisu for a discussion of them). The firm and destination fixed effects are controlled for and are denoted by α_{ij}.

$Post_t \times EA_{ij}$ represents a combination of two dummy variables; $Post_t$ is equal to 1 after the home country joined the euro area (for the period 2009-2011 for Slovakia and 2011-2013 for Estonia), and 0 otherwise; and EA_{ij} is equal to 1 if the destination country was a member of

[8] In contrast to the logit approach, which estimates the effect of independent variables on the probability of the firm changing its status from non-exporter to exporter, meaning it takes into account only information for the firms that change their status (switchers), while the within fixed effect approach keeps all the observations, meaning it takes into account both switchers and non-switchers. The logit model with only switchers in the sample has been estimated for robustness.

the euro area at the time of the changeover, and 0 otherwise. The difference in differences effect of adopting the euro is captured by the coefficient β_2 and has a statistically significant positive value if the common currency area increases the export margin.

The lagged TFP at the firm level controls for the dynamics of firm-level productivity. In order to isolate the effect of the euro from other economic factors we control for a number of macro variables in the destination country: gross domestic product $log(GDP_{jt})$, the real effective exchange rate $log(REER_{jt})$, and import prices $log(MP_{jt})$. GDP is expected to control for demand in the destination country, the real effective exchange rate for price competitiveness in the destination country, and import prices for the potential effect of imports from third countries[9]. Here we follow Berthou and Fontagne (2013), who used the same set of macro controls and lagged TFP. To control for the remaining industry-level developments in export markets, the industry-specific time trends $\tau_t \times sector_k$ are added. The industry-specific time trend also captures possible developments in the domestic economy that can induce firms to export. The standard errors e_{ijt} are clustered at the firm and destination levels and are expected to have conventional properties.

Berthou and Fontagne (2013) disentangle the euro effect into that from the product intensive and product extensive margins by simple decomposition. This paper applies the same approach to test the role of the newly-traded goods channel (Baldwin and Taglioni (2004)) in the effect of the common currency area on trade. This approach first estimates three separate regressions for continuous trade margins as the logarithm of total exports for each destination, the logarithm of the number of products exported to each destination, and the logarithm of the average value of exports for each product in destinations. The total effect on the value of exports is decomposed as follows:

$$\frac{\partial \log(X_{ijt})}{\partial Post_t \times EA_{ij}} = \frac{\partial \log(N_{ijt})}{\partial Post_t \times EA_{ij}} + \frac{\partial \log(\bar{x}_{ijt})}{\partial Post_t \times EA_{ij}} \quad (2)$$

where X_{ijt} denotes total exports to each destination, N_{ijt} the number of products for each destination, and $\bar{x}_{ijt}$ the average value of exports in destinations. The first term on the right hand side of equation (2) captures the effect from the new products exported, or the product extensive margin, and the second term captures that from the average value of exports per product, or the product intensive margin. A large share for the product extensive margin would suggest that the newly-traded goods channel was the main mechanism behind the effect of the euro on exports.

5. Results

5.1. Baseline results and intensive vs extensive margin

The estimation results for equation (1) on all the trade margins are presented in Tables 4 and 5 Our results show the euro has a positive trade effect across all the margins for Slovakia, but only for the probability of exporting for Estonia. The finding that the euro has no statistically significant effect on overall firm-level trade in Estonia but that the decision to export to new destination markets is affected can be related to experimentation in new markets with little export value that does not stand out in the total exports of firms. The euro increased the

[9] The role of industry-level import prices in the destination country has also been tested, but as the results were similar to the ones with country-level import prices, the latter have been used throughout the paper.

probability of exporting into euro area destination markets by 1.7% in Slovakia and by 4.2% in Estonia. These effects are in line with previous findings, like the increase of a couple of per cent from Belgian data (Nitsch and Pisu (2008)). At the product level, the euro increased the probability of a new product being exported to a euro area destination market by 1.9% in Slovakia.[10]

For total exports, we find that adopting the euro had a statistically significant and relatively strong economic impact in Slovakia, but no effect in Estonia. The euro increased the exports of Slovakian manufacturing by 14% (it is calculated as (exp(0.130)-1)×100, because the dependent variable is logarithmed), which is a large effect in comparison to results published on the introduction of the euro in 1999. For example Baldwin (2006) concludes that the feasible macro-level findings for the effect of the euro on trade are between 5% to 10%, while from micro-data, Berthou and Fontagne (2008) find that the euro increased exports by 5%, but Nitsch and Pisu (2008) and de Nardis et al. (2008) find there to be no effect. Our results from the Slovakian data are clearly from the upper bound of feasible effects. The main reason for the large effect in Slovakia is that this country benefited strongly along all the channels that have potential for positive gain, while it did not face increased competition from the other countries.

Our results indicate that the euro effect mainly manifested itself via the intensive margin and only partially via the decision to export new products. The euro effect on average exports of each product is 12% ((exp(0.111)-1)×100) in Slovakia and it accounts for almost 85% of the total increase in exports. This result is in line with the findings of Berthou and Fontagne (2008), who also find the effect of newly traded goods to be less than 20%, while it is in contrast to the findings of Nitsch and Pisu (2008), who find that the euro increased newly traded goods, but that there was no statistically significant effect on overall firm-level trade.

The micro-level control variables have the expected signs, as all the export margins tend to have low persistence[11] and the lagged TFP, if statistically significant, has a positive effect on the trade margin. This gives support to our dynamic specification. Among the macro-level control variables, destination market GDP has a positive effect on the trade margin, while the price competitiveness proxy (REER) and import prices (MP) have varying effects depending on the country and specification.

[10] The panel fixed effects logit model with only the export decision of switchers in the sample shows the euro changeover has an even stronger effect on trade, but the statistical significance is unchanged. In this model the probability of exporting to a new euro area destination increased by 11.3% in Slovakia and 5.7% in Estonia, while the probability of exporting a new product to a euro area destination increased by 14.8% in Slovakia.

[11] For the sake of presentational simplicity, the short-term effects are discussed in this paper. Given the low persistence of trade margins, the long-term effects are quite close to the short-term effects. For the most persistent trade margin, total exports per destination, the short-term effect is 14% and the long-term effect is 18% (exp(0.13/(1-0.228))-1) in the Slovakian sample.

Table 4. The euro effect on firm-level exports, Slovakia 2006-2011, manufacturing firms, within group estimation

	Export decision in each destination	Export decision in each destination×product	Number of products per destination, N_{ijt}	Average export value per product in destination, $\bar{x}_{ijt}$	Total exports per destination, X_{ijt}
Lagged dependent	0.045***	0.041***	0.133***	0.177***	0.228***
	(0.005)	(0.002)	(0.010)	(0.010)	(0.011)
$Post_t \times EA_{ij}$	0.017**	0.019***	0.020	0.111***	0.130***
	(0.007)	(0.002)	(0.014)	(0.030)	(0.032)
$Log(TFP_{ijt-1})$	-0.005	0.005***	0.003	0.029	0.020
	(0.005)	(0.002)	(0.010)	(0.023)	(0.024)
$Log(GDP_{jt})$	0.197***	0.064***	0.124	0.677***	0.742***
	(0.038)	(0.016)	(0.086)	(0.186)	(0.193)
$Log(MP_{jt})$	0.073	0.011	0.098	-0.427*	-0.336
	(0.054)	(0.022)	(0.119)	(0.255)	(0.264)
$Log(REER_{jt})$	-0.185***	-0.084***	-0.158	-0.639**	-0.740***
	(0.054)	(0.021)	(0.118)	(0.254)	(0.267)
Year×sector FE	Yes	Yes	Yes	Yes	Yes
Firm×destination FE	Yes	No	Yes	Yes	Yes
Firm×destination×product FE	No	Yes	No	No	No
Observations	95,987	660,953	35,599	35,595	35,595
No of objects	22,885	148,813	11,446	11,445	11,445
Within R^2	0.015	0.009	0.040	0.067	0.081

Note: Significance levels *10%, **5%, ***1%. Clustered standard errors in parenthesis.
Source: Authors' calculations from the Commercial Register and Customs data.

Table 5. The euro effect on firm-level exports, Estonia 2008-2013, manufacturing, within group estimation

	Export decision in each destination	Export decision in each destination×product	Number of products per destination, N_{ijt}	Average export value per product in destination, $\bar{x}_{ijt}$	Total exports per destination, X_{ijt}
Lagged dependent	0.108***	0.065***	0.183***	0.234***	0.250***
	(0.014)	(0.005)	(0.025)	(0.022)	(0.024)
$Post_t \times EA_{ij}$	0.042**	0.013	0.005	0.002	0.004
	(0.020)	(0.009)	(0.034)	(0.066)	(0.067)
$Log(TFP_{ijt-1})$	-0.000	0.005	-0.020	0.055	0.032
	(0.009)	(0.005)	(0.016)	(0.038)	(0.038)
$Log(GDP_{jt})$	0.006	-0.014	0.126	1.328***	1.433***
	(0.094)	(0.045)	(0.162)	(0.394)	(0.390)
$Log(MP_{jt})$	0.384**	0.298***	0.341	-0.817	-0.471
	(0.160)	(0.080)	(0.318)	(0.642)	(0.642)
$Log(REER_{jt})$	0.477***	0.305***	0.269	-1.552**	-1.279**
	(0.180)	(0.089)	(0.350)	(0.730)	(0.736)
Year×sector FE	Yes	Yes	Yes	Yes	Yes
Firm×destination FE	Yes	No	Yes	Yes	Yes
Firm×destination×product FE	No	Yes	No	No	No
Observations	12898	75547	6311	6311	6311
No of objects	3792	22701	2393	2393	2393
Within R^2	0.044	0.033	0.105	0.100	0.119

Note: Significance levels *10%, **5%, ***1%. Clustered standard errors in parenthesis.
Source: Authors' calculations from the Commercial Register and Customs data.

The introduction of the euro reduced exchange rate volatility in Slovakia but not in Estonia, which suggests that the transaction costs channel from exchange rate volatility is important in the manifestation of gains from common currencies. Another part of transaction costs, those from foreign exchange, were reduced in both of our sample countries. The only similar effect of the euro in the sample countries is on the decision to export, which may be related to the transaction costs from foreign exchange. These findings suggest that transaction costs from exchange rate volatility and from foreign exchange may affect trade margins differently, as foreign exchange is related more to fixed trade costs or the decision to export and exchange rate volatility to variable trade costs or the volume of exports.

There is also support for this speculation from previous firm-level studies on how the euro affects exports. Berthou and Fontagne (2013) find from French data that there is no effect on the decision to export and Nitsch and Pisu (2008) find from Belgian data that the euro

increased the probability of exporting to new destination markets. French firms were more likely to have lower transaction costs from foreign exchange than Belgian firms were, as their currency was used extensively in international payments, while this was not the case for a small country like Belgium. The European Commission (1990) estimated that the expected gains from foreign exchange were 0.1 to 0.2% of GDP for large euro area countries, and up to 1% of GDP for small euro area countries.

In sum, our findings suggest that the transaction costs channel, both from exchange rate volatility and from foreign exchange, was an important mechanism behind the gains from trade due to adoption of the euro. This is not something that has been confirmed from the introduction of the euro, as Baldwin et al. (2008) summarise the literature and conclude that as non-euro area countries in the EU did not face trade diversion after the introduction of the euro, this is evidence that the transaction costs channel was not the main channel. They claim that the main mechanism was increased competition and improved market transparency in euro area countries, and that the newly traded goods channel had a potentially important role. We find that the newly traded goods channel accounted for only 15% of the total increase in trade, while we can exclude the increased competition channel from our empirical set-up and confirm the strong effect from reduced transaction costs.

5.2. Results over firm characteristics

It was shown that the intensive margin has dominated the effect of the euro on exports in our sample countries. This subsection tests whether the effects have been heterogeneous over firm productivity and size, and also over age, ownership and debt. The heterogeneity of the effects has been tested by interacting the treatment dummy with firm characteristics before the euro was adopted. We start with the total factor productivity (TFP), which in theory has been the most important determinant of entry to export markets, but where the empirical findings on effect have been inconclusive. The firms have been divided into four TFP quartiles based on their average TFP three years prior to accession.

The results are shown in Table 6 and 7, where only the treatment dummy and the interaction terms with treatment are presented, as the rest of the coefficients do not differ much from the baseline estimates and are not shown. The overall effect on the value of exports is strongest for the most productive firms from the fourth productivity quartile in Slovakia, while the effect is only weakly statistically significant. The results for Estonia show that it was firms from the second productivity quartile that gained the most from the euro. This also explains why the effect does not show up in total exports, as it was rather less productive firms that started to export.

Berthou and Fontagne (2013) find that the effects were also concentrated in the most productive firms from the fourth productivity quartile, while Nitsch and Pisu (2008) find that less productive firms gained the most.

Table 6. The euro effect over TFP quartiles and firm size groups, Slovakia 2006-2011, manufacturing firms, within group estimation

	Export decision in each destination	Export decision in each destination×product	Number of products per destination, N_{ijt}	Average export value per product in destination, $\bar{x}_{ijt}$	Total exports per destination, X_{ijt}
Regression with TFP quartiles					
$Post_t \times EA_{ij}$	0.022**	0.008**	0.005	0.104**	0.095**
	(0.0108)	(0.004)	(0.019)	(0.043)	(0.044)
$Post_t \times EA_{ij} \times TFP\_q1_i$	-0.023*	0.006	-0.020	-0.079	-0.060
	(0.013)	(0.005)	(0.028)	(0.059)	(0.063)
$Post_t \times EA_{ij} \times TFP\_q3_i$	-0.005	0.013***	0.028	0.029	0.053
	(0.012)	(0.004)	(0.024)	(0.051)	(0.054)
$Post_t \times EA_{ij} \times TFP\_q4_i$	0.004	0.023***	0.044*	0.053	0.097*
	(0.012)	(0.005)	(0.025)	(0.057)	(0.056)
Regression with size groups					
$Post_t \times EA_{ij}$	0.023***	0.023***	0.029*	0.138***	0.157***
	(0.008)	(0.003)	(0.017)	(0.036)	(0.037)
$Post_t \times EA_{ij} \times Size\_1_i$	0.005	-0.004	-0.029	-0.073	-0.054
	(0.012)	(0.005)	(0.029)	(0.066)	(0.066)
$Post_t \times EA_{ij} \times Size\_3_i$	-0.030***	-0.009***	-0.016	-0.052	-0.057
	(0.011)	(0.004)	(0.020)	(0.044)	(0.046)

Note: The table presents only the coefficients of the interaction terms with the treatment variable and productivity or size. The rest of the control variables, not presented, are the same as in the baseline estimations or in equation (1). Two separate regressions are estimated for each trade margin, one with TFP as the interaction term and the other with size as the interaction term. Significance levels *10%, **5%, ***1%. Clustered standard errors in parenthesis.
Source: Authors' calculations from the Commercial Register and Customs data.

Table 7. The euro effect over TFP quartiles and firm size groups, Estonia 2008-2013, manufacturing firms, within group estimation

	Export decision in each destination	Export decision in each destination×product	Number of products per destination, N_{ijt}	Average export value per product in destination, $\bar{x}_{ijt}$	Total exports per destination, X_{ijt}
Regression with TFP quartiles					
$Post_t \times EA_{ij}$	0.111	0.049***	-0.011	0.126	0.114
	(0.029)	(0.012)	(0.056)	(0.105)	(0.098)
$Post_t \times EA_{ij} \times TFP\_q1_i$	-0.122***	-0.083***	-0.109*	-0.221*	-0.320***
	(0.035)	(0.015)	(0.065)	(0.116)	(0.105)
$Post_t \times EA_{ij} \times TFP\_q3_i$	-0.055	-0.027*	0.114*	-0.186	-0.080
	(0.035)	(0.016)	(0.063)	(0.123)	(0.115)
$Post_t \times EA_{ij} \times TFP\_q4_i$	-0.128***	-0.020	0.073	-0.086	-0.017
	(0.038)	(0.016)	(0.071)	(0.124)	(0.113)
Regression with size groups					
$Post_t \times EA_{ij}$	0.036	-0.010	-0.028	0.026	-0.005
	(0.023)	(0.011)	(0.048)	(0.074)	(0.081)
$Post_t \times EA_{ij} \times Size\_1_i$	0.015	0.027*	0.038	-0.029	0.012
	(0.028)	(0.014)	(0.048)	(0.084)	(0.081)
$Post_t \times EA_{ij} \times Size\_3_i$	0.007	0.079***	0.224**	-0.159	0.058
	(0.041)	(0.016)	(0.081)	(0.172)	(0.161)

Note: The table presents only the coefficients of the interaction terms with the treatment variable and productivity or size. The rest of the control variables, not presented, are the same as in the baseline estimations or in equation (1). Two separate regressions are estimated for each trade margin, one with TFP as the interaction term and the other with size as the interaction term. Significance levels *10%, **5%, ***1%. Clustered standard errors in parenthesis.
Source: Authors' calculations from the Commercial Register and Customs data.

A similar exercise is to test whether the effect differed across firm size. Esteve-Perez et al. (2010) claim that only small firms experienced trade gains from the introduction of the euro, a finding that Nitsch and Pisu (2008) confirm. In this paper the firms are divided into three size groups of small firms with 20 to 49 employees, medium firms with 50 to 249 employees and large firms with 250 or more employees. Like in the exercise with productivity, the average firm size three years prior to adoption of the euro is calculated, and from this firms are allocated into three size groups. The results are presented in Tables 6 and 7. Our results differ for various export margins. For Slovakia, where we find the euro has a strong effect on trade, we confirm the previous findings for new destination markets, where smaller firms started to export to new markets after the introduction of the euro. However, the gains over export volumes are quite equally distributed across firm size. The results from the Estonian sample

are mostly statistically insignificant, like in the baseline estimation, while there is some evidence that larger firms entered with new products after the euro was adopted.

Lastly, we test whether the gains from the euro have been distributed equally over other firm characteristics such as firm age, ownership, debt burden and import intensity. There is no theoretical evidence that the reduction in trade costs has a varying effect over these firm characteristics. It is rather that these estimates indicate whether trade costs differ across firms with different characteristics. The results are presented in Tables 8 and 9. The interaction terms with the treatment dummy are mostly statistically insignificant but there is some evidence that younger and foreign owned companies gained more in terms of the product margin. Given the strong presence of foreign direct investment in new EU member states and its contribution to economic growth (e.g. Neuhaus (2006)), it is important to understand how investment reacts to the change in trade costs. Multinational companies are used to operating in many countries at the same time, so they are likely to have incorporated effective procedures for dealing with the costs from exchange rate volatility or foreign exchange and probably face lower transaction costs for trade. Given this it is surprising that for total exports foreign owned companies do not react differently to domestically owned companies to the reduction in trade costs, as contrary to expectations they started to export more new products than domestically owned companies did after the changeover to the euro.

There is also no evidence that larger importers have benefited differently from lower transaction costs. As shown by Amiti et al. (2014), large exporters are usually also large importers, which explains the low pass-through of exchange rate volatility to trade prices. This suggests that exporters with high import intensity would benefit less from a reduction in transaction costs resulting from exchange rate volatility[12]. We find this effect to be negative as predicted, but statistically insignificant for the total trade in Slovakia, so exporters with low and high import intensity did not benefit differently from the introduction of the euro. One explanation for this finding is that the exports of our sample countries are more labour intensive than those from their euro area trade partners, and there is an important pass-through of exchange rate volatility from labour costs to trade prices.

[12] Unfortunately, we cannot test whether the effects of the euro were different for firms trading intensively in euros before the changeover, as we do not have the invoice data at our disposal for both of the sample countries. The invoicing is available in the Estonian customs data and the results show that firms trading intensively in euros had lower effects from the euro, but the effect is statistically insignificant like the overall effect of the euro on exports in Estonia.

Table 8. The euro effect over other firm characteristics, Slovakia 2006-2011, manufacturing firms, within group estimation

	Export decision in each destination	Export decision in each destination×product	Number of products per destination, N_{ijt}	Average export value per product in destination, $\bar{x}_{ijt}$	Total exports per destination, X_{ijt}
$Post_t \times EA_{ij}$	0.017***	0.019***	0.017	0.110***	0.125***
	(0.007)	(0.002)	(0.014)	(0.030)	(0.032)
$Post_t \times EA_{ij} \times Young_i$	-0.018	0.001	0.124**	0.013	0.126
	(0.023)	(0.012)	(0.053)	(0.105)	(0.113)
$Post_t \times EA_{ij}$	0.006	0.008***	0.006	0.113***	0.118***
	(0.008)	(0.003)	(0.017)	(0.036)	(0.038)
$Post_t \times EA_{ij} \times FDI_i$	0.024***	0.018***	0.028	-0.006	0.020
	(0.009)	(0.003)	(0.019)	(0.041)	(0.043)
$Post_t \times EA_{ij}$	0.020**	0.020***	0.044***	0.141***	0.178***
	(0.009)	(0.003)	(0.019)	(0.043)	(0.045)
$Post_t \times EA_{ij} \times Debt_i$	-0.005	-0.008	-0.081*	-0.120	-0.186*
	(0.021)	(0.008)	(0.044)	(0.101)	(0.106)
$Post_t \times EA_{ij}$	0.016**	0.020***	0.026*	0.106***	0.130***
	(0.007)	(0.002)	(0.014)	(0.031)	(0.033)
$Post_t \times EA_{ij} \times Import\ intensity_i$	-0.0001	-0.005***	-0.012	0.004	-0.005
	(0.0037)	(0.001)	(0.010)	(0.019)	(0.020)

Note: The table presents only the coefficients of the treatment variable and its interaction with firm characteristics. The rest of the control variables, not presented, are the same as in the baseline estimations or in equation (1). Three separate regressions are estimated for each trade margin, but only the coefficient of the treatment effect and its interaction effect are presented from each regression. Significance levels *10%, **5%, ***1%. Clustered standard errors in parenthesis.
Source: Authors' calculations from the Commercial Register and Customs data.

Table 9. The euro effect over other firm characteristics, Estonia 2008-2013, manufacturing firms, within group estimation

	Export decision in each destination	Export decision in each destination×product	Number of products per destination, N_{ijt}	Average export value per product in destination, $\bar{x}_{ijt}$	Total exports per destination, X_{ijt}
$Post_t \times EA_{ij}$	0.046**	0.012	-0.004	-0.006	-0.012
	(0.020)	(0.009)	(0.034)	(0.066)	(0.067)
$Post_t \times EA_{ij} \times Young_i$	-0.050	0.036	0.227*	-0.033	0.194
	(0.074)	(0.028)	(0.123)	(0.250)	(0.266)
$Post_t \times EA_{ij}$	0.059***	0.012	-0.037	0.018	-0.021
	(0.023)	(0.012)	(0.039)	(0.073)	(0.074)
$Post_t \times EA_{ij} \times FDI_i$	-0.040	-0.001	0.095**	-0.055	0.037
	(0.028)	(0.013)	(0.048)	(0.087)	(0.081)
$Post_t \times EA_{ij}$	0.030	0.006	0.018	-0.028	-0.010
	(0.022)	(0.010)	(0.039)	(0.072)	(0.071)
$Post_t \times EA_{ij} \times Debt_i$	0.133**	0.067*	-0.110	0.204	0.089
	(0.067)	(0.036)	(0.127)	(0.241)	(0.221)
$Post_t \times EA_{ij}$	0.043**	0.017*	0.008	0.011	0.016
	(0.020)	(0.010)	(0.034)	(0.067	(0.067)
$Post_t \times EA_{ij} \times Import\ intensity_i$	-0.0004	-0.002	-0.001	-0.002*	-0.003***
	(0.0008)	(0.002)	(0.001)	(0.001)	(0.001)

Note: The table presents only the coefficients of the treatment variable and its interaction with firm characteristics. The rest of the control variables, not presented, are the same as in the baseline estimations or in equation (1). Three separate regressions are estimated for each trade margin, but only the coefficient of the treatment effect and its interaction effect are presented from each regression. Significance levels *10%, **5%, ***1%. Clustered standard errors in parenthesis.
Source: Authors' calculations from the Commercial Register and Customs data.

5.3. Effects over the distribution of exports

This subsection, like the previous one, tests the heterogeneity of gains from trade from the introduction of the euro. Here we test whether the gains from trade from the reduction of transaction costs differ across the outcome variable, which is exports. As the effects on the distribution of the outcome variable are estimated, the data with positive trade flows are used and the binary variables like the decision to export are not analysed. Exports are usually concentrated at large and more productive firms (see e.g. Wagner (2007) and Berthou et al. (2015)), so it is expected that we would observe a similar pattern of effects to those for TFP and firm size. The previous subsection indicated that more productive firms gained the most

from the introduction of the euro in Slovakia, while the effects were quite equally distributed across firm size.

The unconditional quantile regression by Firpo et al. (2009) is applied and the xtrifreg command by Borgen (2016) is used to implement the panel estimations with fixed effects in Stata. This method allows us to estimate how the explanatory variables affect the unconditional distribution of the outcome variable by using the recentred influence function technique. The advantage of this method is that unlike the conventional quantile regression, where the results are interpreted in terms of the conditional distribution of the outcome variable, this approach allows much more intuitive interpretation of the results in terms of the unconditional distribution of the outcome variable. The unit of analysis is firm-level exports to a destination country like in the previous sections. The same specification as in equation (1) has been used and the estimations have been run for nine percentiles to distribute the firm-destinations export flows into ten equal groups from the 10th percentile to the 90th.

Figures 3 and 4 present the results. Only the effects of the treatment dummy on the export margin are presented, and the rest of the coefficients are not shown. The results confirm the finding that the euro had strong effects on trade in Slovakia, but no effect in Estonia. Most importantly, the distribution of effects for Slovakia is cardinally different along the extensive margin and the intensive margin. On the extensive margin it is shown that those firms that already exported a large number of products to a market started to export new products following the introduction of the euro. The newly traded goods hypothesis seems to be an important channel for benefits for firms that already export a lot of products or for destinations which are already served by many products. It may be noted that the recentered influence function of the percentile cannot be defined for the part of the distribution where there is no variation in the dependent variable, so the graph only starts from the 40th percentile for the product margin where only one product was exported.

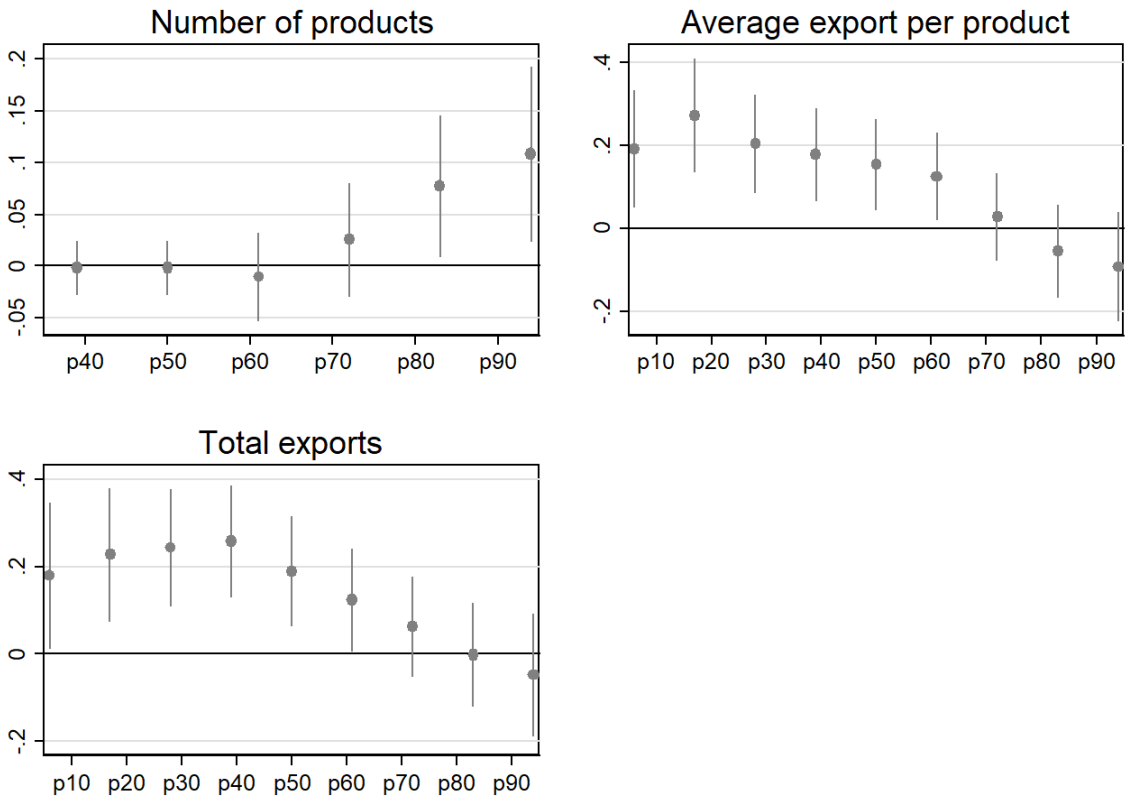

Figure 3. The distribution of the euro effect on exports, Slovakia 2006-2011, manufacturing firms

Notes: Each coefficient on the figure represents one regression for the particular percentile, e.g. p10 shows the effect of the euro on exports at 10th percentile of firm-destination export flows. The confidence intervals reflect statistical significance at 10%.

Source: Authors' calculations from the Commercial Register and Customs data

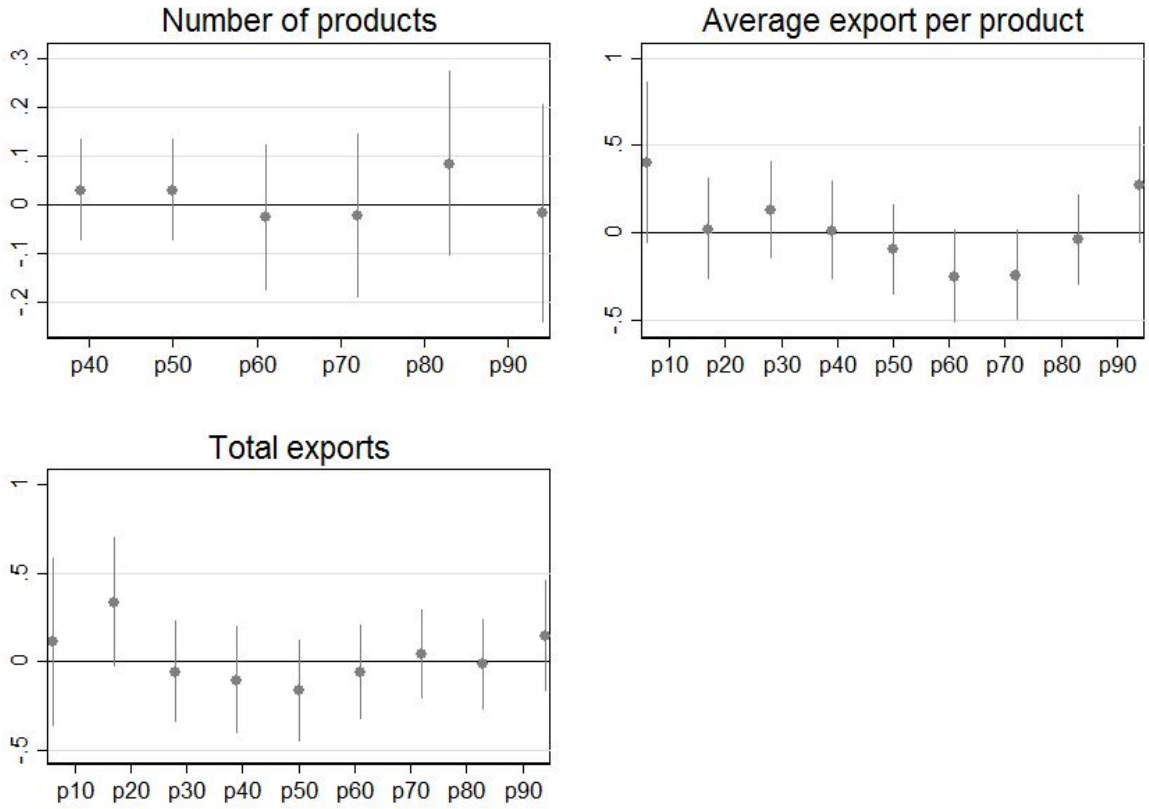

Figure 4. The distribution of the euro effect on exports, Estonia 2008-2013, manufacturing firms

Notes: Each coefficient on the figure represents one regression for the particular percentile, e.g. p10 shows the effect of the euro on exports at the 10th percentile of firm-destination export flows. The confidence intervals reflect statistical significance at 10%.

Source: Authors' calculations from the Commercial Register and Customs data

In contrast to the case of the extensive margin, it was rather smaller exporters or markets where small amounts were exported that gained most from the euro along the intensive margin. The effects are statistically significant up to the 60th percentile for Slovakia and are as large as 30% for the smallest firm-destination combinations. In the overall effect on trade, the intensive margin dominates over the extensive margin, so total exports also increased for smaller exporters or in destination markets where exports were small. The overall effect on exports is large and statistically significant up to the 60th percentile of firm-destination trade flows in Slovakia. These results are surprising given that the most productive firms experienced the largest gains. The difference between the findings for exports and the productivity distribution can be explained by the wide distribution of gains along firm productivity and by the imperfect correlation between productivity and exports.

The important takeaway message from this section is that a reduction in transaction costs can affect the distribution of trade margins in different ways, so that exports become more concentrated along the extensive margin, while the distribution of trade becomes more equal along the intensive margin. As we observe that the reduction of transaction costs takes effect mainly through the intensive margin, our results suggest that smaller transaction costs contribute to more equal distribution of export flows.

5.4. Effects over industry and product groups

The findings from the introduction of the euro suggest that the gains from trade from it differed for various industries. Baldwin and Taglioni (2004) note that the exports of industries that are characterised by imperfect competition and increasing returns to scale increased more following the introduction of the euro than did the exports of industries working with natural resources or producing raw materials. Baldwin et al. (2008) summarise the macro-level sectoral findings by stating that the gains from trade from adopting the euro have been concentrated in a few industries and most industries did not experience any increase in trade from the introduction of euro. They suggest that transaction costs cannot be the main mechanism behind the euro effects, because transaction costs would induce much wider gains. There is also evidence that the euro has enhanced vertical specialisation and especially increased the trade in intermediate and final goods (Flam and Nordström (2007) and Martinez-Zarzoso and Johannsen (2016)).

The micro-level studies do not provide much information on the sectoral distribution of the euro effects. De Nardis et al. (2008) find from Italian micro data that it was indeed the scale-intensive industries dominated by traditional goods or suppliers that experienced a boost to exports from the introduction of the euro. They use Pavitt's (1984) taxonomy to divide sectors into four groups and find that there was no effect in science-based industries and industries of specialised suppliers that produce specialised technology or inputs for other firms. We contribute to this discussion by testing whether there are different euro effects for firms from different NACE 2-digit industries. Table 10 presents the results.

We observe that the euro effects on total exports are large and positive in the majority of industries for Slovakia, but are always statistically insignificant for Estonia. In four out of 21 industries in Slovakia, exports increased statistically significantly due to the adoption of the euro. It is difficult to say whether this reflects concentrated or not concentrated effects; unlike in aggregate studies the statistical significance of the effects is not easily comparable across industries because of the differences in the number of observations. The effects are statistically significant in wood products, printing and media, fabricated metal products and machinery. Except in the case of machinery, the significant effect on total exports does not usually imply a statistically significant effect for new destinations or products, and the intensive margin dominates the effects (the results on the product margin are not reported and are available from the authors upon request). All these industries are in the group for which Baldwin and Taglioni (2004) find medium sized effects. However, our findings support the results of Baldwin and Taglioni (2004) and De Nardis et al. (2008) along the lines of Pavitt's taxonomy, as the three out of our four industries with a statistically significant effect are in the group of scale-intensive sectors dominated by traditional suppliers.

The estimations for the four categories of Pavitt's taxonomy confirm this finding, and the effect on total trade is statistically significant only for scale-intensive sectors and those dominated by traditional suppliers (these results are available from the authors upon request). Along the new destinations, the probability of exporting has increased only for specialised suppliers in Slovakia and for scale-intensive industries in Estonia. In sum, our results support the idea that scale-intensive and traditional sectors producing highly differentiated goods benefited the most from the introduction of the euro, while our results do not undermine the transaction costs channel argument, as the majority of industries experienced increased exports after the introduction of the euro in Slovakia.

Table 10. The euro effect on exports across 2-digit NACE industries, Slovakia and Estonia, manufacturing firms

NACE Rev 2 industries		Slovakia		Estonia	
No	Name	Export decision in each destination	Total exports per destination	Export decision in each destination	Total exports per destination
10	Food products	0.021	-0.047	0.074	-0.098
11	Beverages	0.030	0.489	0.107	
13	Textiles	-0.016	0.201	0.127	-0.049
14	Wearing apparel	0.055*	0.131	0.030	0.025
15	Leather	0.036	-0.237	0.048	0.147
16	Wood products	0.014	0.390**	0.017	-0.053
17	Paper	-0.001	0.168	0.226*	-0.341
18	Printing and media	0.115**	0.396**	0.081	0.351
20	Chemicals	0.193**	-0.310	-0.200	
22	Rubber and plastic	-0.015	0.043	0.160**	-0.029
23	Non-metallic products	0.054*	0.115	0.018	0.592
24	Basic metals	-0.036	-0.108		
25	Fabricated metal	0.020	0.331***	-0.021	0.242
26	Computers	0.001	0.197	0.050	0.319
27	Electrical equipment	0.060**	-0.067	-0.101	-0.306
28	Machinery	0.035*	0.200**	0.080	0.082
29	Motor vehicles	-0.042*	0.159	-0.042	-0.381
30	Other transport	-0.049	0.553		
31	Furniture	-0.033	0.236	0.108	0.056
32	Other manufacturing	-0.022	0.060	-0.202	0.150
33	Repair of machinery	-0.022	-0.447	0.234	

Notes: Each coefficient in the table represents one regression for the particular sector and trade margin. Estimates for some industries are missing for Estonia due to the small sample size.
Source: Authors' calculations from the Commercial Register and Customs data.

Another way of dividing manufacturing firms would be to assign groups based on type of product exported rather than sector of activity. We use the standard end use product group categories of HS 6-digit goods used by the World Bank, which divides products into raw materials, intermediate goods, consumer goods and capital goods (see https://wits.worldbank.org/referencedata.html for the reference). This exercise serves as a robustness test for our findings on different sectoral taxonomies with a focus on vertical specialisation, and it also serves as a robustness test for the baseline estimates. The changeover to the euro in Slovakia coincided with the Great Recession in 2009, which makes it harder to identify the euro effect. We control for various economic factors in destination countries such as GDP, REER and import prices, but it remains possible that there were other factors that affected developments in the euro area countries in a different way to how they

affected other EU countries. We use the finding that the unprecedented drop in trade recorded in 2009 did not manifest itself equally across all product groups. Levchenko et al. (2010) argue that trade in intermediate goods was hit harder. So if we observe different effects for intermediate goods, it should raise doubts that the effect of Great Recession is not well controlled for.

Figures 5 and 6 show the results. The euro effect on total firm exports other than for raw materials is quite equally distributed across intermediate, consumer and capital goods in Slovakia. For Estonia, the effects on total exports are statistically insignificant for all the product groups. The effects on the probability of exporting to a new destination market were manifested mostly through capital goods in Slovakia and consumer goods in Estonia. These estimates confirm our previous findings that quite a broad range of industries benefited from the introduction of the euro, and they support the macro-level findings that the trade in intermediate and consumer goods increased the most and the trade in raw materials did not increase following the introduction of the euro. This implies that the euro further increased the vertical specialisation of trade in Slovakia. Both of our sample countries have among the highest degrees of vertical integration in the OECD (OECD (2009)).

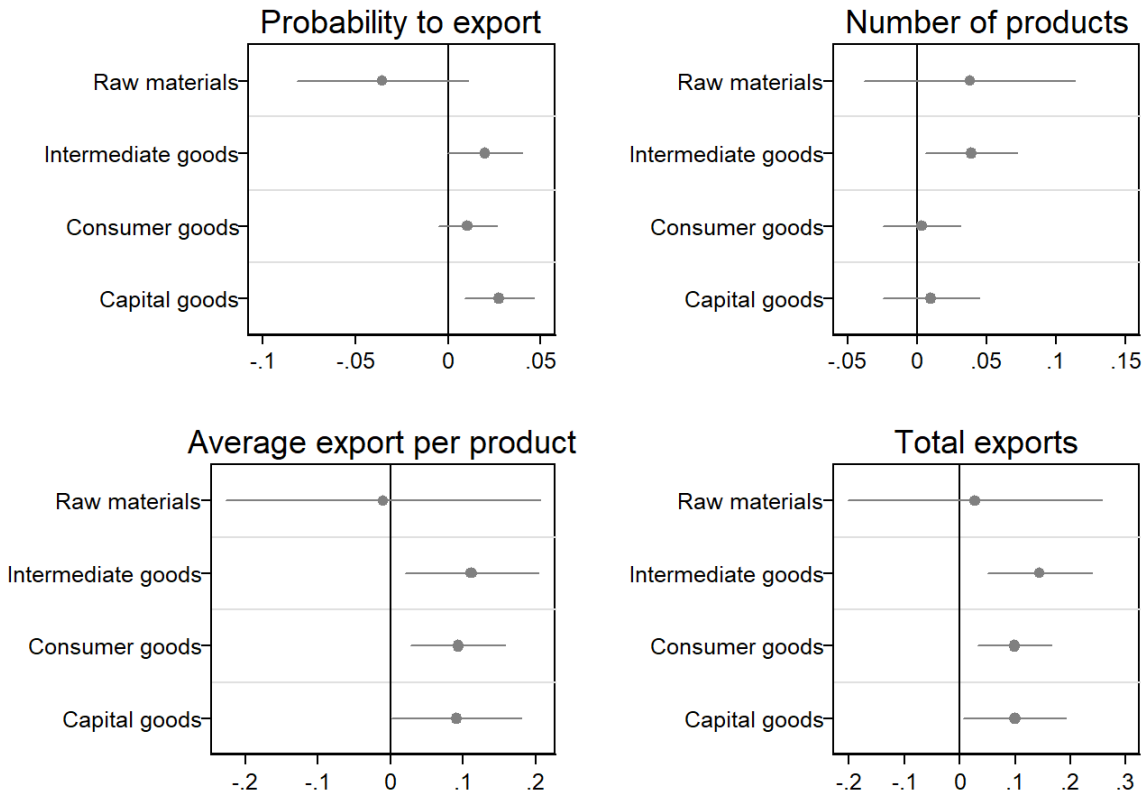

Figure 5. The effect of the euro on different goods, Slovakia 2006-2011, manufacturing firms
Notes: Each coefficient in the table represents one regression for the particular sector and trade margin. The confidence intervals reflect statistical significance at 10%.
Source: Authors' calculations from the Commercial Register and Customs data.

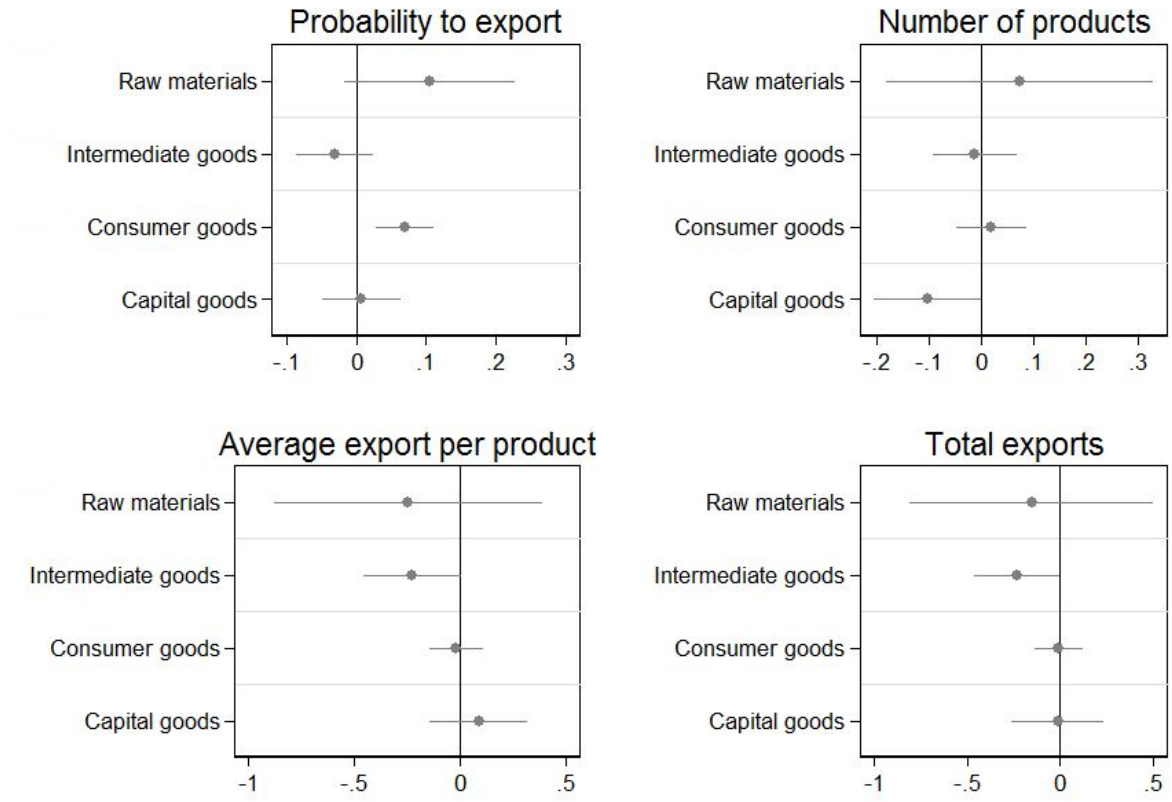

Figure 6. The effect of euro on different goods, Estonia 2008-2013, manufacturing firms
Notes: Each coefficient in the table represents one regression for the particular sector and trade margin. The confidence intervals reflect statistical significance at 10%.
Source: Authors' calculations from the Commercial Register and Customs data.

5.5. Robustness tests

We run a number of robustness tests to validate the results. First, we perform the placebo tests over time and the cross section. Second, we test for the role of the estimation method and control for the Nickell bias in our dynamic specification by GMM estimation.

The placebo year effects are expected to be statistically insignificant before the euro was adopted and they should become statistically significant after the adoption of the euro in order to support the causal interpretation of the results. The yearly effects also allow testing for the common trend assumption before the changeover, because if the yearly effects before the changeover are statistically insignificant, it shows that the conditional trends in the dependent variable are similar for the treatment and control group. These yearly effects also show the timing of the effect.

Figures 7 and 8 present the results. The results for Slovakia show that there were no differences between exporting to euro area and non-euro area countries before the changeover, while there were more exports to euro area countries after the changeover. The strongest effect along both the intensive and extensive margins appears one year after the adoption of the euro. The results for the longer timespan over five years show that the effects for all the trade margins remained in the same magnitude for five years after the euro changeover. The effect is persistent for all the statistically significant cases, so it is not an on-

off effect from the temporary experimentation, but persists over the treatment period of three or five years. The results for the longer timespan of five years before and after the euro adoption are available from authors upon request.

The results for Estonia are clearly statistically insignificant for the volume of trade, while similarly for Slovakia, the probability of exporting to new destinations increases immediately after the euro is introduced.

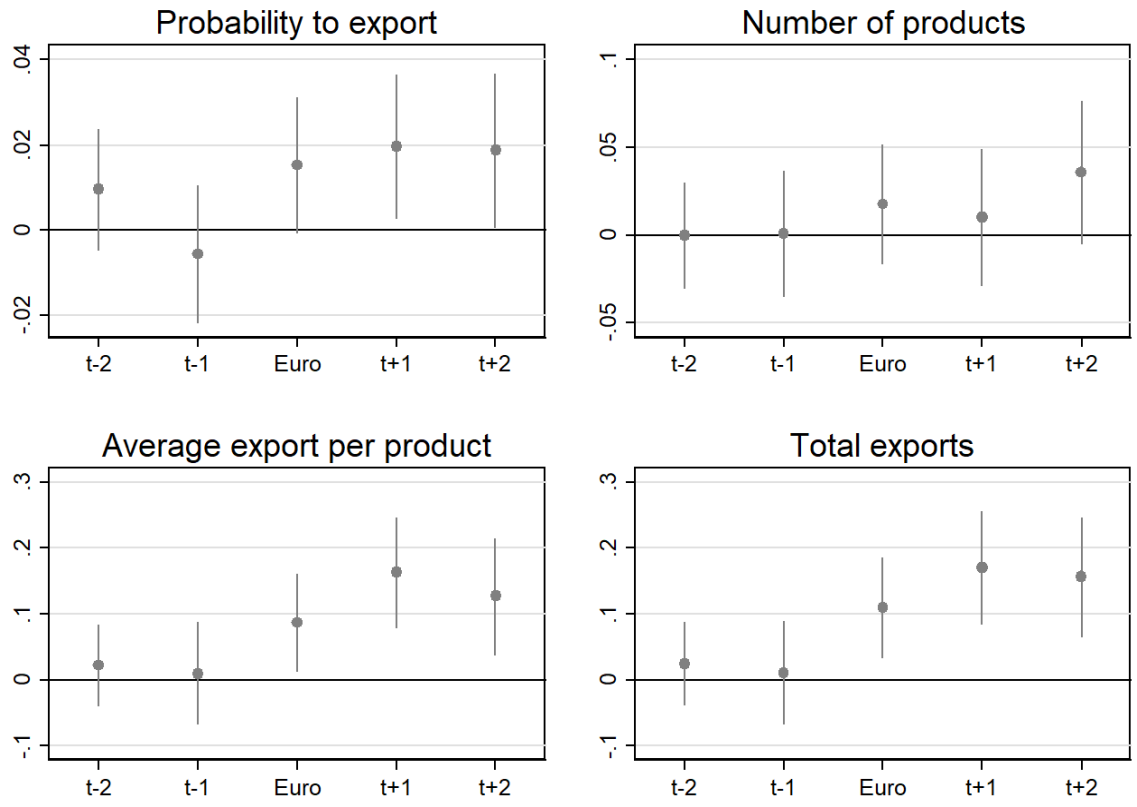

Figure 7. Timing of the effect of the adoption of the euro, Slovakia, 2006-2011, manufacturing firms

Note: Each figure represents the results from one regression, where instead of one treatment dummy in equation (1) five treatment dummies have been used: year two years before the accession time EA_{ij}; year one year before the accession time EA_{ij} and so on. The year three years before the accession has been used as a reference period and this dummy is omitted from the regressions. The confidence intervals reflect statistical significance at 10%.

Source: Authors' calculations from the Commercial Register and Customs data

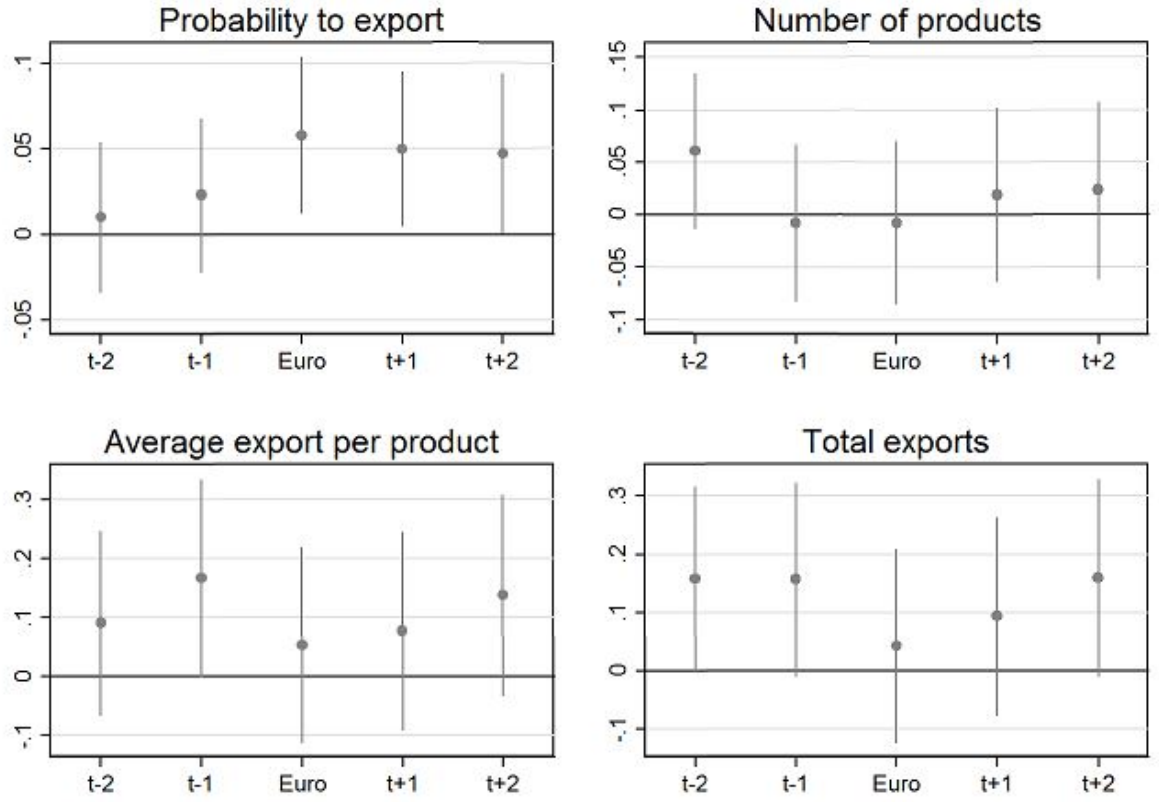

Figure 8. Timing of the effect of the adoption of the euro, Estonia, 2008-2013, manufacturing firms

Note: Each figure represents the results from one regression, where instead of one treatment dummy in equation (1) five treatment dummies have been used: year two years before the accession time EA_{ij}; year one year before the accession time EA_{ij} and so on. The year three years before the accession has been used as a reference period and this dummy is omitted from the regressions. The confidence intervals reflect statistical significance at 10%.
Source: Authors' calculations from the Commercial Register and Customs data

The placebo treatment over the cross section is defined so that the sample is limited to non-euro area export destinations and the treatment and control groups have been assigned randomly. The effect of this placebo treatment is expected to be statistically insignificant. Table 11 presents the results, and the placebo treatment over the cross section shows no statistically significant treatment effects. This raises confidence that our specification is able to control for destination country-specific shocks to trade that occurred during the changeover but were not related to the changeover. This demonstrates that the euro effect is not just a residual trend in the data, but that it disappears when the treatment group is assigned in an alternative, or wrong, way.

The robustness of the estimation method has been tested by estimating the specification in equation (1) with OLS and system GMM, as system GMM addresses the Nickell bias in our baseline fixed effects estimates. Table 11 reports that the persistence of trade margins is underestimated by our default fixed effects estimator, as expected, but the statistical significance and the size of the long-run effect at 18% (exp(0.109/(1-0.325))-1) for Slovakia are unchanged.

Table 11. The euro effect on total firm-level exports for each destination, manufacturing, robustness tests

	Slovakia			Estonia		
	Placebo treatment, non-euro area countries only [a)]	Alternative estimation method, system GMM	Alternative estimation method, OLS	Placebo treatment, non-euro area countries only	Alternative estimation method, system GMM	Alternative estimation method, OLS
Lagged dependent	0.225***	0.325***	0.859***	0.136***	0.288***	0.868***
	(0.016)	(0.017)	(0.003)	(0.031)	(0.043)	(0.007)
$Post_t \times treatment_{ij}$	0.065	0.109***	0.016	0.020	-0.048	0.053
	(0.053)	(0.036)	(0.019)	(0.095)	(0.042)	(0.040)
$Log(TFP_{ijt-1})$	0.041	-0.086***	0.124***	0.054	-0.062	0.058**
	(0.036)	(0.024)	(0.011)	(0.058)	(0.049)	(0.027)
$Log(GDP_{jt})$	0.666***	0.479**	0.061***	0.703	1.683***	0.033***
	(0.256)	(0.216)	(0.006)	(0.472)	(0.392)	(0.011)
$Log(MP_{jt})$	-0.122	0.131	0.341	-0.289	-0.733	-0.738
	(0.364)	(0.300)	(0.217)	(0.843)	(0.755)	(0.454)
$Log(REER_{jt})$	-0.329	-0.170	-0.359*	-0.867	-0.513	-0.021
	(0.346)	(0.305)	(0.197)	(1.017)	(0.749)	(0.589)
Year×sector FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm×destination FE	Yes	No	No	Yes	No	No
Observations	15550	32991	32991	2966	5979	5979
No of objects	4,922	10,523		1140	2262	
Within R^2	0.124		0.761	0.183		0.772
Sargan test		5.526			1.651	
No of instruments		123			119	

Notes: [a)] The treatment group consists of Denmark, Hungary, Lithuania, Sweden and Romania; and control group of Bulgaria, Czechia, Latvia, Poland and UK. Significance levels *10%, **5%, ***1%. Clustered standard errors in parenthesis.

Source: Authors' calculations from the Commercial Register and Customs data.

6. Conclusion

This paper studies the effect of adopting the euro on firm-level exports using data from two recent euro changeovers in Slovakia and Estonia. This paper is the first to test the firm-level trade effects of the euro in countries that were not initial members of euro area. The contribution of the paper is twofold. First, the paper provides evidence of the effect of the euro on exports by studying two cases of changeovers where the trade costs of a new member

were reduced, while the competition in the euro area was unaffected. In addition, the two countries had different exchange rate regimes prior to the changeover. By doing this we can point to the exact channel in action much better than previous studies can. Second, the paper provides new evidence for the scarce and inconclusive findings about the heterogeneous effect of the euro on exports.

The difference in differences methodology is applied where trade flows of firms to the euro area countries before and after accession to the euro are compared with the trade flows to other EU countries. How the euro affects various trade flows is studied: new export destinations, newly exported goods, and the intensive margin seen in increased trade within existing trade flows. The heterogeneity of effects is tested along firm productivity, firm size, exports, sector of activity, product type, and other firm characteristics.

The few available results on the euro trade effect using detailed firm-level data show a positive effect originating mostly either from the extensive or the intensive part of export growth. Our findings for new euro area countries using micro data show a relatively large positive trade effect from the adoption of the euro in Slovakia that has manifested itself mainly through the intensive margin, and almost no effect in Estonia. We find that joining the euro area increased Slovakian exports to the euro area by 14%. In contrast to the previous studies we have the advantage of studying countries that adopted the euro separately, so we can abstract away from the effect of increased competition and consider only the channels of foreign exchange transaction costs or transaction costs related to exchange rate volatility. Taking into account the differences in the pre-euro exchange rate regimes in the countries analysed, where Slovakia had a floating exchange rate with the euro and Estonia a fixed rate, our results indicate that the major part of the euro trade effect can be assigned to savings from the reduction in exchange rate volatility. This result, however, does not imply that countries with a fixed exchange rate to the single currency are not subject to gains in exports from joining the single currency. The gains from the transaction costs channel can arise much earlier in a case where the exchange rate is fixed. In addition, the costs from giving up country-specific monetary policy are also lower for countries with a fixed exchange rate to the single currency.

The analysis of the heterogeneity of effects shows that the positive overall effect on the value of exports was the strongest for the most productive firms, but in contrast to previous studies we find gains to be more equally distributed across firm size. The euro changeover does not have any stable interaction effect with other firm characteristics such as firm age, foreign ownership, debt burden or import intensity. The results of the unconditional quantile analysis show that it was smaller exporters that increased their exports as a result of the changeover to the euro and they benefited mostly from the intensive margin. These results suggest that small and already very open economies can experience a wider distribution of gains and a wider distribution of exports from the reduction in trade costs. Our results indicate that scale-intensive and traditional sectors producing highly differentiated goods benefited the most from the introduction of the euro. Various robustness tests, including estimation of the placebo treatment effect or longer time spans or using system GMM estimation, confirm our baseline results.

Our results are encouraging for small open economies with floating exchange rates that are planning to join the euro area or any other currency union. If the reduction in trade costs is substantial, it can lead to a substantial increase in trade. The differences in the scale and the heterogeneity of the trade effect are an interesting space for further research. They may, among other factors, be driven by the differences in the economic positions of the new member states in global value chains and the strong dependence of the new member states on foreign direct investment from the original euro area countries.

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Appendix 1. Comparison of the new euro area countries

Table A1 Main macroeconomic indicators of the new euro area countries

	CEE		Baltics			Mediterranean	
	Slovenia	Slovakia	Estonia	Latvia	Lithuania	Cyprus	Malta
Gross domestic product in billions of EUR	37.3	75.9	19.8	23.6	36.6	17.6	8.4
Gross domestic product per capita in PPS (% EU 28)	82.6	77.2	75.7	63.4	75.0	81.2	89.9
Import openness (% GDP)	58.6	79.1	61.2	52,5	67.5	32.0	44.6
Export openness (% GDP)	61.5	82.5	56.1	43.2	64.9	16.0	32.3

Note: Import openness is calculated as a ratio between imports of goods and gross domestic product. Export openness is calculated as a ratio between exports of goods and gross domestic product. All values in 2014.

Source: Eurostat.

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