European integration and Central and Eastern Europe's value-added exports. What does it say about Brexit? *

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Abstract

We revisit the topic of trade effects of European integration. We employ a structural gravity model to flows of domestic value added embedded in international trade for the period of 1995 to 2014. Our model takes into account the current state of the art in estimation of gravity models: PPML estimation and multi-dimensional fixed effects. We base our estimations on both the WIOD and TiVA datasets for maximum robustness and provide aggregate and sectoral estimates. Our results show stable and robust estimates of EU integration on value added trade. The advantage of our approach is the direct calculation of the trade impact on the GDP level. Based on these estimates we also provide insights into the effects of Brexit.

Keywords: European integration, gravity, value-added trade
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1 Introduction

The topic of European integration had its peaks of popularity in the economic literature on several occasions. One of them, was the completing of the internal market through the Single Market Program of 1992 announced in the 1985 Commission of European Communities' White Paper[1] and implemented in the Single European Act of 1992[2]. This large structural change de facto introducing a single market guaranteeing free movement of goods, capital, services and people spurred a first wave of *ex ante* studies. These start with the so-called Chechini report (EC (1988)) providing a comprehensive sectoral and macroeconomic study of the impact of the removal of remaining trade barriers as well as Smith and Venables (1988), Allen et al. (1998), Baldwin (1989) and Harrison et al. (1996). These early works emphasize the effects of increased competition on better allocation of resources and in turn, welfare as well as the removal of non-tariff barriers together with EU standardization policy (harmonization of product regulations) and were mainly based on simulation models (either partial or general equilibrium) that were gaining popularity at that time.

The second wave of *ex ante* studies started with the prospective EU enlargement of 2004 and 2007. The process started in early 1990s when The Central and Eastern European (CEE) countries signed a series of EU Association Agreements and committed to comprehensive reforms increasing transparency and competition, improving market and democratic institutions, as well as adjusting domestic laws towards the European standards. This also involved gradual trade liberalization: the CEE have formed several free trading agreements between themselves: e.g., CEFTA (in 1992, originally between Czech Republic, Slovakia, Poland, and Hungary, later extended to mode countries, BAFTA (between Baltic countries), and other bilateral agreements[3]. However, the EU Association Agreements also triggered bilateral trade liberalization with the EU; by 2000 most tariffs (except for sensitive agricultural products) were already gone in bilateral trade between EU and the first wave of prospective members. Large part of the effects of tariff liberalization and the reforms have in fact materialized before the actual EU accession, with the accession itself being similar in scope to the introduction of the 1992 program: i.e., removal of remaining non-tariff barriers and unrestricted access to the single market (further strengthened in services by the Services Directive and through delayed unrestricted movement of labour force). Early macroeconomic evaluations of the welfare effects of accession used similar methodology to those employed for the original 1992 program. The notable works include, among others: Baldwin et al. (1997), Kohler (2004) and Maliszewska (2004) showing significant macroeconomic impact of EU accession.

Over two decades after after the 2004 EU enlargement the topic has emerged together with centrifugal forces within the EU and the increased popularity of economic nationalism across Europe culminating in the 2021 Brexit Agreement and the actual departure of the United Kingdom from the EU. The appearance of new trade data sets spanning several decades have enabled scholars to look at long-term ef-

[1] Completing the Internal Market, COM (1985) 310 final, 14 June 1985, https://op.europa.eu/pl/publication-detail/-/publication/4ff490f3-dbb6-4331-a2ea-a3ca59f974a8/language-en

[2] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:11986U/TXT

[3] see Cieślik and Hagemejer (2011) for an ex-post study of trade effects of those agreements.

fects of EU integration. There have also been critical developments to the empirical methodologies. This include the developments in the gravity model framework, in particular the theory-consistent methods of estimation (for an overview see Yotov et al., 2016) allowing for unbiased estimates of effects of trade agreements. A notable application of this methodology are the ex-post estimates of the costs of non-Europe (Mayer et al. 2019) showing large but differentiated welfare gains of EU integration. Another important contribution is the development of the synthetic counterfactual method that relies on building a hypothetical reference scenario (Abadie et al., 2010) and its application to the EU membership by Campos et al. (2019) showing significant divergence between the integration and non-integration scenarios of the pre-2004 members of the EU while Hagemejer et al. (2021) show similar effects also for 2004 and 2007 enlargements. Last but not least, there have been several attempts to quantify the effects of Brexit. They include both computable models of different flavours (see, e.g., Dhingra et al., 2017), macro models (see, e.g., Berthou et al., 2019; Erken et al., 2018) and structural gravity estimates (see, e.g., Felbermayr et al., 2018; Oberhofer and Pfaffermayr, 2021). This literature is quite ample and the examples given here are only a fraction of the overall available literature.

In this paper we revisit the effects of European integration, in particular the effects of the 2004, 2007 and 2013 EU enlargements. We employ a structural gravity framework. However, unlike the bulk of existing literature, we make use of the methodological developments on the topic of global value chains (in particular the measures developed by Johnson and Noguera 2012) and base our estimates on the value added flows. This is enabled by the availability of data from new data sources i.e., the WIOD database that span the period of 1995-2014, covering datapoints before and after accession. Our gravity estimates include all features required for consistent estimation.

This approach has important advantages as opposed to standard estimations based on gross trade. First, trade in value added is consistent with national accounts and therefore these estimates are easily converted to contributions to GDP and therefore provide a direct estimate of the macro effects of trade liberalization without the need to impose a theoretical framework to compute these effects (such as a general equilibrium model). Second, it covers both trade in goods and services in a consistent fashion, taking into account not only direct trade but also exported value added of service sectors *embedded* into manufacturing exports. Third, as the EU countries are interlinked in production chains, export-oriented output is very import-oriented and the bulk of exports are intermediate goods, which makes the link between gross-trade and GDP cumbersome - value-added trade approach solves this problem.

This paper is structured as follows. Section 2 contains the methodology and data description. Section 3 presents the baseline results of gravity estimation. Section 4 provides more detailed insights into the structure of gains from EU integration. Section 5 provides estimates of the likely effects of Brexit. Section 6 concludes.

2 Methodology and data

To estimate the effect of the EU integration we use the structural gravity model (see Yotov et al., 2016, for a discussion on different options and the theoretical background) in the form proposed by Silva and Tenreyro (2006), i.e., the Poisson pseudo maximum likelihood model. Using PPML solves the common selection problem in gravity estimation, i.e., the zero trade flows between selected pairs of countries. Moreover, thanks to the multiplicative form (instead of the original linearized gravity equation), helps with the treatment of heteroskedascisity in the trade data.

The empirical model takes the following form:

$$VA_{ijt} = \exp\left(\beta_0 + \delta_{ij}\mathcal{EU}_{ijt} + \beta X_{ijt} + u_{it} + u_{jt} + u_{ij}\right) \times \varepsilon_{ijt}, \tag{1}$$

where VA_{ijt} is the value added produced in the i-th country and absorbed in the j-th economy at time t, X_{ijt} is the set of control variables while ε_{ijt} is the error term. Key variable of interest, i.e., $\mathcal{EU}_{ijt}$ is an indicator variable which takes one if two trading economies belong to the European Union at time t. Importantly, the $\mathcal{EU}_{ijt}$ is time-varying as the sample will cover the period in which new countries joined the European Union.

It is important to note, that our specification is purely focused on within variation, as we include the pair-specific fixed effects u_{ij} that help to solve several problems related to endogeneity (see, e.g., Baier and Bergstrand, 2007). They are perfectly collinear with all the time-invariant bilateral variables, including the standard gravity ones (e.g., distance, colonial ties, contiguity). Moreover, we also include time varying fixed effects u_{it} and u_{jt} that are used to account for unobserved inward and outward multilateral resistance terms (Anderson and van Wincoop, 2003). These fixed effects also capture the exporter output and the importer demand and any unobserved factors both at the exporter and exporter side. Such approach to gravity estimation provides high level of robustness but only allows for time-varying bilateral control variables and hence, it is not possible to obtain estimates for the pre-2004 EU membership status effects as it does not change within the sample size. It is also important to note that the changes to economic activity that result from EU integration and the reforms undertaken by the prospective member states are already captured by the time-varying fixed effects and therefore the EU dummy is purely the effect on trade that is resulting from increased trade in the EU.

Importantly, the estimates of δ_{ij} could be biased and measure more general effect of trade liberalization. Therefore, the typical control variables will be included in the underlying regression, i.e., participation in WTO (denoted as wto_{ijt}) and relative trade agreements rta_{ijt}.

A key difference in our empirical strategy from existing literature is the outcome variable. Instead of explaining the gross exports we use the value added. Specifically, we use the the measure of value added that is generated domestically in the country of origin and ultimately absorbed in the destination country. This includes the value added in sectors that export directly to the destination countries, the value added which is produced in domestic non-exporting sectors (e.g., some service sectors) and sold to manufacturing sectors and then embedded in such sectors exports, as well as value added that is first embedded in intermediate goods sold to a third country in

the form of intermediate goods and then ultimately consumed in the form of final goods in the destination country. Therefore, the effects of economic integration we observe capture the effects of trade that happens within the European Union when the final consumer (in the form of private, government or investment demand) is in the EU and at least some part of the production process is in the EU. Our $\mathcal{EU}_{ijt}$ dummy does not capture the effects of increased trade in intermediate goods that ends up being exported outside the EU.

Next, in the (1) the effect of economic integration is assumed to be heterogeneous. Although this strategy is quite common in section 4 we will additionally investigate possible heterogeneity in this effect by including interaction variables with both the importer and exporter country. Moreover, we also are interested how these integration effects change with distance between the exporter and importer as well as the size of the former and the latter. We capture those effects by employing appropriate interactions. Moreover, we also take into account that our data comes in sectoral aggregation (NACE 2-digit for some sectors, in some cases aggregates of two or three sectors) and we use these sectoral data to rerun our empirical specification. Through the use of interactions, we distill the effects of economic integration on production sectors.

Our principal database is the World Input Output Database (henceafter WIOD), as described by Timmer et al. (2015). It offers detailed information about industry linkages between 56 sectors in 43 countries over time span ranging from 1995 to 2014 in the form of a multi-country input-output table. We use two editions of WIOD that span different time periods (1995-2009 for the 2013 edition and 2000-2014 for the 2016 edition). Since the sectoral classification differ across the two datasets, we match the conflicting sectors by joining them to higher level aggregates.

3 Baseline results

In this section we provide baseline estimates of the European Integration on the exported value added. To do so, we extend structural gravity model by key indicator variable as well as control variable.

Table 1 presents the baseline results. Columns (1)-(3) contains estimates for the bilateral flows in value added between countries. It is straightforward to observe that integration within European Union moves up exported value added by around 13%. Importantly, this number remains similar even if control variable are included in regression.

In the next step, we consider more detailed data to estimate underlying parameters. The next three columns, (4)-(6), summarize estimation results for data in which the exported value added is additionally assigned to the industry. Using more granular data allows to cross-check whether key estimates are robust to potential heterogeneity between industries. However, the differences between these estimates are negligible. This suggest that our key estimate implying the 13% premium for European integration is quite robust.

Table 1: Baseline estimated effect of European integration on exported value added

	(1)	(2)	(3)	(4)	(5)	(6)
	Exporter × Importer			Exporter × Importer × Industry		
$\mathcal{EU}_{ijt}$	0.130***	0.129***	0.129***	0.125***	0.124***	0.124***
	(0.0361)	(0.0359)	(0.0359)	(0.032)	(0.032)	(0.032)
wto_{ijt}		0.202**	0.201**		0.156*	0.155*
		(0.082)	(0.082)		(0.080)	(0.080)
rta_{ijt}			0.018			0.0147
			(0.022)	(0.017)		
N	34,890	34,890	34,890	1,811,532	1,811,532	1,811,532
R^2	0.997	0.997	0.997	0.994	0.994	0.994

Note: ***, ** and * denote the rejection of null about parameters' insignificance at 1%, 5% and 10% significance level, respectively. The expressions in round brackets stand for robust standard errors

4 Heterogeneity in the effect of European Integration

In the next step we account for a possible heterogeneity in effect of European integration. The baseline results presented in the section 3 base on an assumption that this effect is homogeneous. However, it could be different among countries as well as for industries.

To account for heterogeneity the key variable $\mathcal{EU}_{ijt}$ is interacted with specific dummies. Table 2 presents results in which the effect is different for exporters (columns (1) and (3)) or importers (columns (2) and (4)) wile the specific estimates are plotted on the figure 3.

At the aggregate level, the estimated premium from European Integration is slightly above the baseline results. Furthermore, the formal statistical test allows to reject the null of homogeneity in δ. This is also supported by visual inspection of the estimated effect which in some cases could be negative and varies from $-.2$ to .5.

To document possible regularities in the premium for European integration we extend our structural gravity model by the interaction of the $\mathcal{EU}_{ijt}$ with fundamental gravity variables, i.e., distance (in logs, denoted by $logdist_{ij}$) and size of trading economies measured by the GDP (GDP_{tij}^{IMP} and GDP_{tij}^{EXP} denoting the GDP for exporter and importer, respectively.) With such choice we will be able to investigate how the European integration is able to reshape the trade in value added.

Table 3 summarizes estimates of such extended structural gravity model. In fact, all interactions are statistically significant while the estimates on control variables are very close to the previous results. Interestingly, these results reveals a fact that European integration mitigate effect of the standard trade forces in shaping the export activity. For instance, the estimates on the logged distance is positive which means that a tight cooperation within the EU allows to access more distant and to some extent reduces so-called iceberg effect. Probably, it is related to a higher degree of vertical specialization. Since the production process became highly fragmented then more intermediates are exported in order to satisfy final demand

Table 2: Estimates of heterogeneity in the effect of European integration

	(1)	(2)	(3)	(4)
	Exporter × Importer		Exporter × Importer × Industry	
wto_{ijt}	0.204***	0.185***	0.143***	0.134***
	(0.0104)	(0.0104)	(0.020)	(0.020)
rta_{ijt}	0.020*	0.0156	0.017***	0.013***
	(0.0104)	(0.0104)	(0.004)	(0.004)
average $\mathcal{EU}_{ijt}$	0.167***	0.154***	0.209***	0.197***
	(0.0128)	(0.0129)	(0.005)	(0.005)
$\mathcal{H}_0$: homogeneous δ	[0.000]	[0.000]	[0.000]	[0.000]
N	34,890	34,890	1,811,532	1,811,532
R^2	0.997	0.997	0.994	0.994

Note: ***, ** and * denote the rejection of null about parameters' insignificance at 1%, 5% and 10% significance level, respectively. The expressions in round brackets stand for robust standard errors

on more geographical distant market.

Table 3: Estimates of heterogeneity in the effect of European integration

	(1)	(2)	(3)	(4)
	Exporter × Importer		Exporter × Importer × Industry	
wto_{ijt}	0.1987***	0.309***	0.152*	0.162
	(0.037)	(0.067)	(0.080)	(0.167)
rta_{ijt}	0.021**	0.023**	0.018	0.020
	(0.010)	(0.010)	(0.018)	(0.018)
$\mathcal{EU}_{ijt}$	-1.071***	2.639***	-1.044***	0.204***
	(0.072)	(0.267)	(0.170)	(0.611)
$\mathcal{EU}_{ijt} \times logdist_{ij}$	0.174***	0.202***	0.170***	0.193***
	(0.010)	(0.01)	(0.023)	(0.024)
$\mathcal{EU}_{ijt} \times logGDP_{tij}^{IMP}$		-0.072***		-0.059***
		(0.006)		(0.014)
$\mathcal{EU}_{ijt} \times logGDP_{tij}^{EXP}$		-0.074***		-0.062***
		(0.007)		(0.013)
N	34,890	34,890	1,811,532	1,811,532
R^2	0.997	0.997	0.994	0.994

Note: ***, ** and * denote the rejection of null about parameters' insignificance at 1%, 5% and 10% significance level, respectively. The expressions in round brackets stand for robust standard errors

The same applies the role of economy's size. Negative estimates on the exporter's and importer's GDP translate into the case in which smaller and less advanced economies benefit to a larger extent from European integration. This relationship also confirms the role of regional value chains. Viewed from the theoretical point of view, one might relate this to fixed costs. For firms in smaller and less advanced economies it is easier to specialize only in production of selected intermediates or final goods to improve the market share by minimizing the magnitude of fixed costs relative to aggregate production value.

On the demand side, the negative coefficient can be explained by the fact that operating in each destination is also associated with some non-negligible fixed costs (e.g., adjustment of products to local preferences) which could be disproportional to the size of the market. Therefore, by cooperating within regional value chains this cost may be distributed over the firms in different stages of production which makes sales on smaller market more profitable.

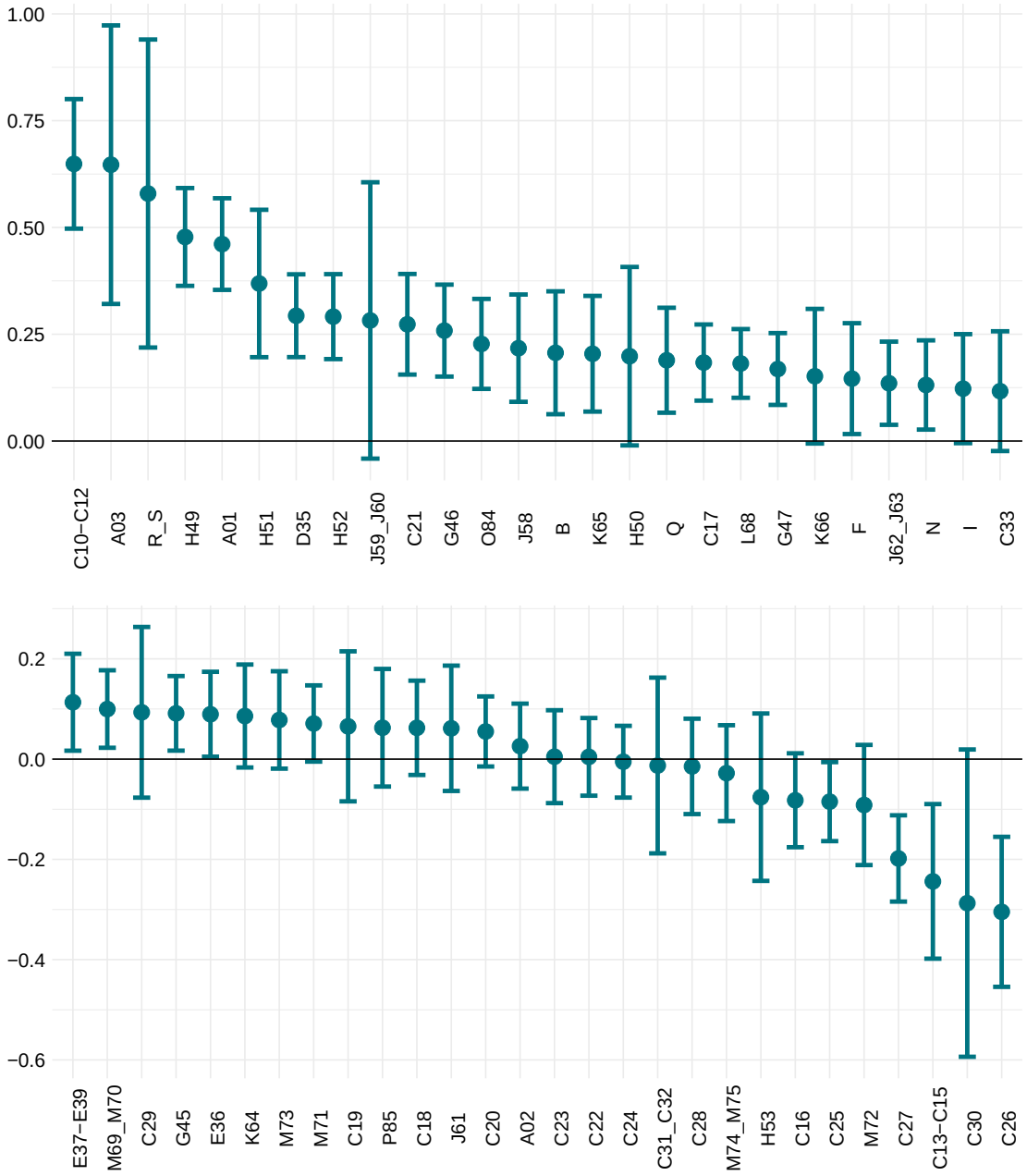
Finally, we also investigate heterogeneity at the industry level. To do so, we re-run panel structural gravity model for each industry separately. This choice stems form fact that both effect from European integration and more general trade liberalization, which is captured by control variables, could be product- or industry-specific.

Figure 1 portrays industry-specific effects of European integration. Although the documented heterogeneity is quite substantial because the estimates range from $-.3$ to .6 several conclusions can be drawn. Firstly, the overall effect is positive for the most industries. Secondly, the largest gains are observed for agriculture sector and industries that use unprocessed food (manufacturing of food, beverages and tobacco products, C10-C12). So large effect for that industries can be explained by a high degree of protectionism within the EU and substantial role of classical trade barriers (i.e. trade costs) that were removed with the EU enlargement. It has to be mentioned that one could also expect to result from the Common Agricultural Policy in the EU but this policy is unilateral in nature and hence, it is captured by the time-varying fixed effects. Thirdly, services exhibits relatively higher gains which suggests and the most outlying difference can be observed for transportation which is related to freedom of movement and residence for citizens within the EU. Fourthly, the negative effect is reported for industries that are most spectacular examples of the activity within the global value chains, i.e., manufacturing of computers (C26), electric equipment (C27) and other transport equipment (C30). The counter intuitive estimates here can be explained by a fact that production within these industries is extremely specialized and fragmented, not only between European economies, but over many countries. Additional key feature of those industries is that they produce investment goods which production requires complementary (to investment goods) but specific technologies that are not common and developed in several countries in which the R&D centers are located. Given that the R&D activity is to a large extent concentrated in several economies this implies that the supply chains producing investment goods could be quite complex and cross the EU border. In comparison, the estimated European integration premium for manufacturing of motor vehicles, trailers and semi-trailers (C29) is significantly positive because this branch offers mostly consumption goods (that are later retailed) rather than investment goods.

5 Estimating an effect of Brexit on GDP

Finally, we assess the *ex ante* effects of Brexit on GDP among exporters. Our empirical strategy has an advantage related to measurement. Namely, the estimated effect of the European integration can be translated directly into gains in value added. Combining this with information about the structure of value added by final destination (i.e., the share of value added exported to the UK in the total GDP of

Figure 1: Estimated industry-specific effect of European Integration



the exporting country) it can be aggregated and interpreted as total macroeconomic effect that is transmitted through complex trade linkages.

We re-run the estimation of structural gravity model with additional variable that is an interaction between the $\mathcal{EU}_{ijt}$ and the dummy indicating that the value added is absorbed in the United Kingdom (IMP_{ijt}^{GBR}). A motivation for such re-setting is related to efficiency of estimation. Although our previous inspection on heterogeneity has illustrated that the estimated effect of European integration could vary a lot we should keep in mind that we are interested in the specific effect on CEE trade with the UK. The expected size of the coefficient is not clear as the different features of that country operate in opposite direction since it is on of larger importers in the EU but geographically a rather distant market (within the EU countries group), in particular to the CEE.

Table 4 presents the extended estimates. In fact, the effect of EU integration on exports of value added that are ultimately absorbed in the UK final demand is more than two times higher than average. This premium is present irrespective of the choice of the dataset (aggregate versus sectoral data). Importantly, estimates on control variables remain very close to the previous cases.

Table 4: Estimated effect of the Brexit on exported value added

	(1)	(2)
$\mathcal{EU}_{ijt}$	0.120***	0.116***
	(0.036)	(0.036)
wto_{ijt}	0.201**	0.156*
	(0.081)	(0.080)
rta_{ijt}	0.018	0.015
	(0.022)	(0.017)
$\mathcal{EU}_{ijt} \times IMP_{ijt}^{GBR}$	0.182***	0.164***
	(0.069)	(0.059)
N	34,890	1,811,532
R^2	0.997	0.994

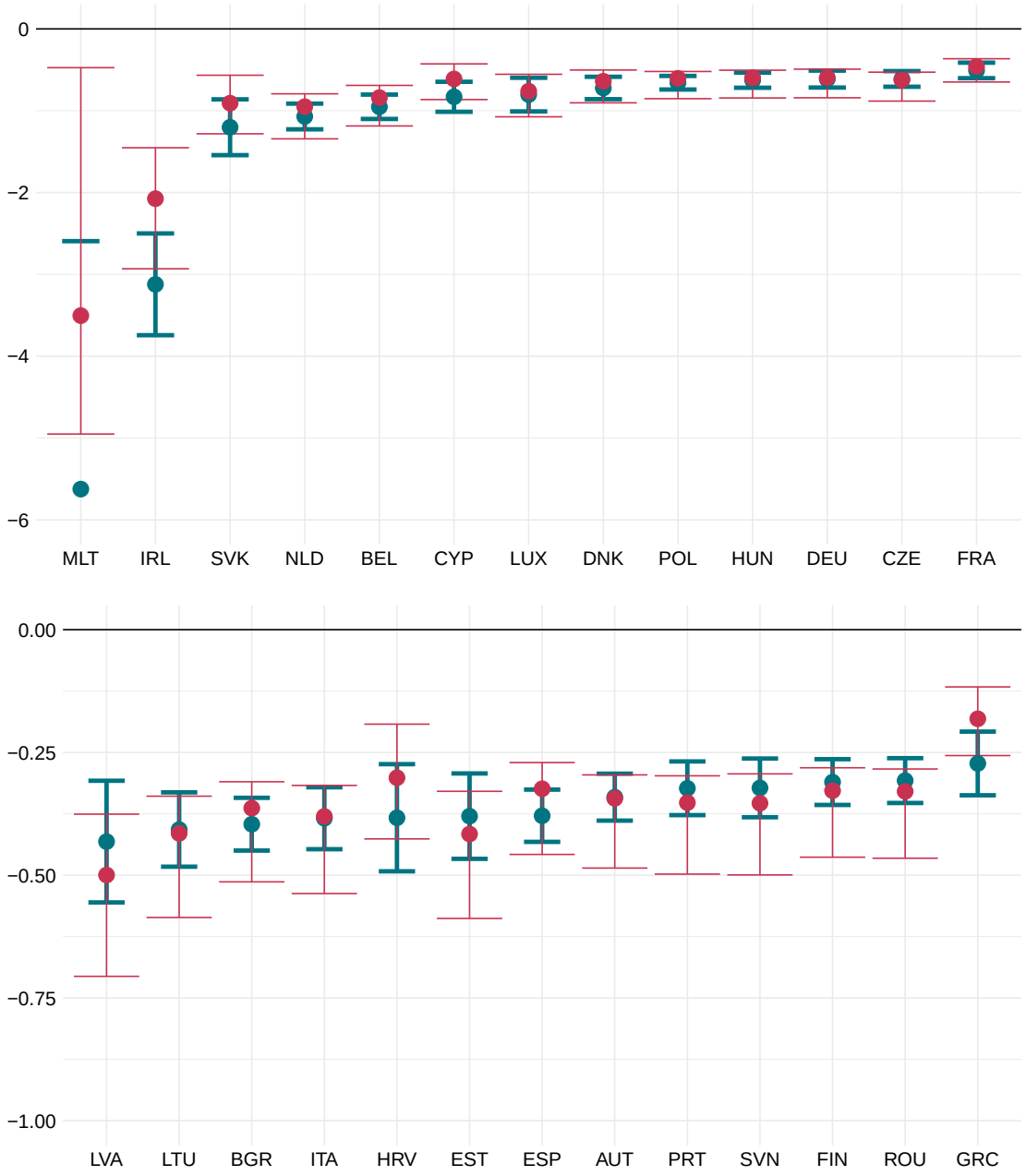
Note: ***, ** and * denote the rejection of null about parameters' insignificance at 1%, 5% and 10% significance level, respectively. The expressions in round brackets stand for robust standard errors

Macroeconomic implications are illustrated on figure 2. To check robustness we sketch calculations based on estimated effect from (i) bilateral dataset (estimates in column (1) in table 4) and, (ii) industry-specific estimation of structural gravity model.[4] Clearly, the effect is the highest for economies for which the UK is the key final destination. Malta and Ireland can expect a drop by more than 3% of GDP. For the rest of exporters potential losses in the GDP does not exceed 1% of GDP but still is statistically significant. Importantly, the results are not biased by structure of exports which is confirmed by similarity between estimates basing

[4]The results are available upon request. The remaining estimates, i.e, in column (2) in table 4, provide the same picture.

on bilateral dataset and industry-specific estimates accounting for heterogeneous industry effect.

Figure 2: Estimated effect of the Brexit (in % of GDP)



6 Conclusions

In this paper, we revisit the the topic of trade effects of European integration. Unlike most of the existing literature, we focus on trade in value added. This makes a sizeable difference in terms of interpretation of the result; while the boost in gross trade after EU enlargement has been sizeable, some of it has been due to the process

of increased production fragmentation—increasing share of foreign value added in exports and therefore a lower per output unit domestic value added with higher gross trade volume.

While our results show a sizeable boost in the exports of value added on average, there is a great deal of heterogeneity of the effect. This heterogeneity is present in both the country and the sector dimension. Surprisingly, in several important export-oriented manufacturing sectors, the exports of value added did not experience a significant increase or even fell. A large increase of exports of value added have been noted in the services sectors, where direct exports grew or exports embedded in the exports of manufactures. Large increase in exported value added was also experienced in agri-food trade.

Our results allow for a some speculations about the effect of Brexit, which to a large extent is a reversal of the integration process. While the UK will still have a free trade area with the EU, it was in fact a similar arrangement with the CEE countries before the EU enlargements. Based on these estimates, we compute the likely trade effect of Brexit, stemming from the re-introduction of non-tariff barriers to trade. This effect is estimated to be less than 1% of GDP for most of the EU members (except Malta and Ireland, where it is significantly larger). It has to be noted, that this is a static effect, i.e., it does not take into account long-term effects of capital (dis)accumulation. These effects are similar in magnitude to those found in the literature, in particular the short-term estimates of Brexit.

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Appendix

Figure 3: Heterogeneous export- and import-specific estimated effects of European integration