The uncertainty of Brexit and COVID-19 as factors determining EU exports

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Abstract

The repeated risk of the so-called hard Brexit created great uncertainty about the future of mutual EU-UK trade relations. In 2020, the uncertainty was exacerbated by the COVID-19 global pandemic. These critical situations affected the EU's external trade and, in particular, the EU export capacity. Therefore, in addition to the standard factors, such as GDP, labour productivity or the presence of the FTA determining EU exports, this paper examines those factors that were relevant for EU export between 2016 and 2020, i.e. the uncertainty stemming from Brexit and the global COVID-19 pandemic. Fixed and time effects panel data analysis combined with the difference in difference method and a Poisson pseudo-maximum likelihood estimator were used. The negative impact of Brexit uncertainty on EU exports has not been proven. The COVID-19 pandemic, which caused a deep downturn in international trade in 2020, had a negative impact on EU exports. However, EU exports to all partners decreased significantly regardless of the COVID-19 prevalence. This study updates the literature on the nexus between uncertainty and trade by examining the recent critical factors affecting EU export developments.

Keywords: European Union, Brexit, COVID-19 pandemic, export, PPML

Introduction

The motivation of this study was, from the perspective of the history of European integration, an unprecedented fact - the decision of British citizens to leave the EU after 43 years of membership in 2016. The referendum was a call to regain sovereignty and control over their own economy. The Brexit vote raised numerous concerns about its negative effects, both for the UK and the EU, and even of other member states leaving the EU by pointing to the possible disintegration of the EU. The exact terms of the post-Brexit EU-UK relationship were the subject of difficult and lengthy negotiations. There was a repeated risk of failure to conclude a mutual agreement and the emergence of the so-called hard Brexit, which created high uncertainty about the future of mutual trade relations. This development provided us

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with the opportunity to study and understand the effect of uncertainty resulting from extraordinary events on trade.

Brexit occurred in January 2020 and the EU and UK representatives negotiated an agreement to regulate relations during the next challenging 11 month transition period until the end of 2020. The United Kingdom was still part of the EU internal market and applied EU legislation during the transitional period. The COVID-19 pandemic, which paralyzed not only European, but also global markets, exacerbated several years of uncertainty stemming from Brexit in 2020. Economies began to isolate and close markets in order to prevent the spread of the COVID-19 pandemic, which disrupted the existing supply chains and suspended investment. As a part of a package of agreements negotiated between the EU and the United Kingdom, the Trade Cooperation Agreement (TCA) was provisionally applied from January 2021, while its full implementation was postponed until 2022.

The uncertainty arising from lengthy negotiations on the organization of trade relations between the United Kingdom and the EU exacerbated by the COVID-19 global pandemic leads us to explore how these unprecedented facts affected the EU external trade, in general, and the EU export capacity, in particular. Therefore, in addition to standard factors determining EU exports, such as GDP, labour productivity or the presence of the FTA with the EU, the factors that were relevant between 2016 and 2020 were examined, i.e. the uncertainty stemming from the Brexit and the global COVID-19 pandemic. The research period was extended to 2012-2020 for comparison purposes.

By including both the risk of hard Brexit and the COVID-19 global pandemic as additional variables, this study contributes to the literature examining the EU export resilience during crises and the resulting uncertainty. While in earlier works, the estimates of Brexit uncertainty effects were based on data only for the initial months of uncertainty, this study covers the entire period of uncertainty. This study verifies the literature suggesting that trade uncertainty negatively influences exports. Similarly, the study verifies predictions of earlier studies on the negative short-term effects of the COVID-19 pandemic on EU exports. The novelty of our study is in the ex-post assessment of effects of uncertainty resulting from the Brexit vote during its entire period, indicating that the immediate negative effects were outweighed by EU export growth in the medium term.

First, the paper provides an overview of the literature covering Brexit and its impact on the trade between the EU and the United Kingdom. It does focus, in particular, on the literature dealing with the growing uncertainty arising from the EU-UK withdrawal as much as on the spread of the COVID-19 pandemics. The second section explains the research methods and methodology used in the paper. The Results and Discussion section first monitors the development of the value of EU exports and imports to / from the UK. Year-on-year changes in EU exports / imports to / from the UK are also compared with year-on-year changes in EU exports / imports to / from the world. The result of the comparison indicating the negative

impact of Brexit uncertainty on the EU exports to the UK is verified using a gravity model, while 3 model specifications were compiled. The results of our research are compared with the results of other authors. Finally, the conclusions, limitations, as well as the theoretical and practical implications of the research are presented.

1. Literature review

In the first two decades of the 21st century, the EU faced several crises including sovereign debt crises in the euro area, mass refugee migration, Russian military intervention in Ukraine, Brexit or the COVID-19 pandemic. These crises tested the existing integration model and re-increased the interest of authors in exploring European integration mainly between 2016 and 2020 (e.g. Bulmer & Joseph, 2016; Börzel & Risse, 2018; De Vries, 2018; Hooghe & Marks, 2019; Hodson & Puetter, 2019). As far as the Brexit issue is concerned, a significant number of authors initially focused on the circumstances and reasons which led to the Brexit referendum vote (e.g. Glencross, 2016; Clarke et al., 2017; Duff, 2021). Several empirical studies further examined the effects of Brexit on the United Kingdom, trying to uncover the effects on various spheres of the British economy (e.g. Van Reenen, 2016; Wenz et al., 2020; White, 2021; Baldini & Chelotti, 2022; Dhingra & Sampson, 2022). The studies on the impact of Brexit on the EU were less represented in the existing literature, initially focusing on comparing the expected effects under different Brexit scenarios (e.g. Thissen et al., 2020; Dhingra et al., 2017) and, later on, evaluating the immediate effects resulting from the Brexit vote (Douch & Edwards, 2021).

Several authors have pointed to the fact that the UK decision to withdraw from the EU led to a significant increase in uncertainty about the economic future of the United Kingdom, its EU partners and the future direction of the Union (Taggart & Szczerbiak, 2018; Silveira et al., 2020; Celebi, 2021; Faccini & Palombo, 2021). According to some authors, the UK decision to withdraw from the EU even caused "persistent uncertainty" (Bloom et al., 2018). The impact of trade policy uncertainty on trade was researched e.g. by Handley (2014), Handley and Limao (2015), Graziano et al. (2021) or Douch and Edwards (2021). According to Handley (2014), the impact of trade policy uncertainty on trade is negative as it delays the entry of exporters into new markets. Similarly, Handley and Limao (2015) found that exports of firms are lower under trade policy uncertainty. Graziano et al. (2021) modelled the impacts of uncertainty shocks on trade flows in the context of Brexit. They used monthly trade data from August 2015 to June 2017. It was found that increases in the probability of a "hard" Brexit reduced bilateral export values between the UK and the EU. Douch and Edwards (2021) examined the effects of uncertainty associated with the Brexit vote on trade flows between the UK and several EU and non-EU countries up until March 2018. They found the strongest negative effects on British exports to the EU, while UK imports showed a smaller decline.

The impact of the uncertainty caused by geopolitical disruptions on the manufacturing supply chain location decisions of managers in multinational firms was researched by H. Moradlou et al. (2021). These decisions also affect trade relations between the concerned countries. The findings of the study indicate that the Brexit, as a major geopolitical disruption, created heightened uncertainty for managers. To mitigate the uncertainty, they decided to relocate facilities from the UK to the EU before any deal was negotiated between the UK and the EU. The finding implies reduced EU - UK trade. The authors concluded that the decision on production relocation was not primarily driven by cost reduction, resource availability, or government incentives. Instead, the decision was influenced by the perceptions of heightened uncertainty.

The withdrawal of the UK from the European Union has also increased the uncertainty about the economic and political position of the EU, more particularly, it has raised concerns that there may be an imbalance in decision-making within the EU, as a result of which the EU begins to pursue a more protectionist policy (IFO Institute, 2021). EU members were forced to seek compromises in decision-making processes in the past. The four powers, in particular, played a key role: Italy and France, which tended to pursue protectionist policies, and the United Kingdom and Germany, which emphasized free market and subsidiarity-based policies. The role of the UK as a protagonist of free trade within the EU has been underlined in the rich and extensive scholarship (Warlouzet, 2018). The validity of these concerns was confirmed by the results of a survey (Vaitilingam, 2021), which was carried out between European and American economists to find out the views on the long-term impact of Brexit on the UK and EU economies. 23% of experts strongly agreed with the statement that the EU economy is to face a few percentage points decrease by 2030 if the United Kingdom withdrew from the EU. Among other things, as the reason for agreeing to this claim, experts stated that, without the United Kingdom, the EU is to be more protectionist.

Numerous studies researched the likely scenarios and economic effects of Brexit before the COVID-19 pandemic. With the advent of the COVID-19 pandemic, the question whether the individual economic consequences were the result of trade disruptions due to Brexit or whether it was a short-term effect caused by restrictive measures to prevent the spread of the COVID-19 pandemic was raised. While for the COVID-19 pandemic, the negative effects were predicted only in the short term (Pichler & Farmer, 2022; Rakha et al., 2021), for Brexit, they were also expected in the long term (Bergin et al., 2017). Tong (2021) explains that companies perceived COVID-19 as a temporary shock, while Brexit was perceived as a permanent shock that increased the cost of trade between the UK and the EU. Companies respond to economic shocks differently, depending on whether the shocks are perceived as temporary or permanent. Adapting production processes is more likely in the case of permanent shocks as the production of firms responds to shocks with a delay (Copeland & Hall, 2011). According to De Lyon and Dhingra

(2020), it is necessary to distinguish between key sectors in the EU-UK trade that are exposed to the long-term impact of Brexit and to the uncertainty associated with it; and other sectors affected only temporarily by pandemic-related restrictions. According to them, the negative impact of Brexit was expected especially in transport, electrical equipment and textiles, where trade volumes did not decrease significantly during the pandemic in the first half of 2020. On the contrary, sectors such as the metal and food industries were most affected by the pandemic.

In general, distinguishing the economic impacts of Brexit from the COVID-19 pandemic is challenging. D. Bodnar (2021) researched how Brexit and the COVID-19 pandemic affected the UK trade, comparing the value of the UK-EU trade in 2021 with that of 2018, thus with the period before the pandemic, as well as the highest uncertainty associated with Brexit. The results showed a more significant decline in the UK trade with the EU (-18.9%) than with non-EU countries (-9.1%), which, according to the author, suggests that the Brexit uncertainty played a significant role in the decline in trade.

2. Methods and methodology

In this study, the basic methodological starting point for the study of the COVID-19 disease and the uncertainty arising from Brexit, as determinants of EU export, is the classical gravity model of exports in combination with the difference in differences method (Fišera, 2022), supplemented by Poisson pseudo-maximum-likelihood (PPML) estimator with fixed and time effects.

The historical and methodical summary of gravity models was compiled by Bubáková (2013). According to this overview, the variables commonly used in gravity models include the gross domestic or national product of the exporting and importing country in nominal terms or per capita. Furthermore, variables such as the population of partner countries, their distance expressing geographical factors affecting trade, trade policy instruments, historical links, or macroeconomic indicators such as inflation rates, investments or risks at the state level are used. Still, it should be remembered that, if we insert fixed effects into the specifications of our equations, it is not possible to estimate time-invariant variables such as the distance. However, the advantage is that fixed effects cover all variables that would be missing from the model.

Other variables can also be encountered in the literature, e.g. Frensch et al. (2013) used not only GDP but also the average wages of the exporting and importing country and their relative differences to the average world wage / differences in labour costs of exporting and importing countries. These authors used a dynamic panel data estimator developed by Arellano-Bond (1991). Egger (2002) worked on other options for choosing an estimator in gravity models, namely, the analysis of panel data with random effects, with fixed effects, but also Hausman-Taylor and Between estimators. For the problem with missing values in gravity models, Grančay

et al. (2015) applied the so-called Heckman correction. Breinlich et al. (2021) states that the gravity equation can be estimated by a linear ordinary least-squares method, but this is strictly due to the fulfilment of statistical assumptions and does not solve the problem of zero values. Therefore, the Poisson Pseudo-Maximum Likelihood (PPML) estimate is commonly used today, especially since the article by Silva and Tenreyro (2006) was published. This work was followed by Fally (2015), who recommends a PPML estimator in combination with fixed effects due to possible bias of estimates. According to Yotov et al. (2016), PPML estimator is suitable to use in case of presence of zero trade flows. In addition, fixed effects solve the problem of not capturing the so-called multilateral resistance terms (König, 2021).

The traditional approach of analysing panel data with fixed and time effects was used in this study because it offers several advantages such as higher degrees of freedom, elimination of the collinearity problem, ability to monitor dynamics over time and uses fixed and time effects to express the impact of unclassified variables (Hsiao, 2014). In addition, PPML with fixed and time effects was used, which solved the problem of zero and low values, as well as heteroskedasticity. In a similar manner to our study, authors Akça (2024) or Zheng and Sun (2023) used PPML as a gravity equation estimator.

The PPML estimator was estimated in the environment of RStudio with glm function (family - quasipoisson; R Core Team, 2022) and with the help of the gravity package 1.0 (Woelwer et al., 2022). Other calculations were carried out in Microsoft Excel and GRETL (Cottrell & Lucchetti, 2021). Fixed effects were added manually among other regressors.

The problem of heteroskedasticity was mitigated using robust standard errors (Lukáčik et al., 2011; Zeileis & Hothorn, 2002; Zeileis, 2004 and 2021; Zeileis et al., 2020). In this case, there should be no problem with unit roots due to the short time series (Frensch et al., 2013). Our model was prone to the presence of collinearity error. It was diagnosed in pool models with time effects by using Variance Inflation Factors (VIF; Adkins et al., 2015). We prepared two main alternative model specifications and one robustness check. In the alternative specification, instead of GDP p. c., we used the labour productivity (as GDP per person employed) of the partner country relative to the productivity of the EU, and the robustness check contained only two time periods: 2019 and 2020, while we mainly focused on the variable expressing the severity of the COVID-19 pandemic in individual states. The general econometric equation of panel data with fixed-effects had the following form (Lukáčiková, 2013):

$$y_{it} = \alpha_i + \beta_1 x_{it1} + \beta_2 x_{it2} + \cdots + \beta_k x_{itk} + u_{it} \qquad (1)$$

The difference in differences (diff-in-diff) method was used in the panel analysis, fixed (αi) and time (λt) effects were also included in the specification of the econometric equation (Fišera, 2022):

$$y_{it} = \alpha_i + \gamma_t + \delta TREAT_i \times POST_t + \epsilon_{it} \qquad (2)$$

Based on these linear equations, our two alternative gravity equations, estimated by the PPML estimator, have the following forms (Silva & Tenreyro, 2006; Breinlich et al., 2021; Grübler & Reiter, 2021):

$$EX_{ijt} = \exp{(l_{GDPpc_{jt}}\beta_1 + l_{Remot_{jt}}\beta_2 + FTA_{CEPII_t}\beta_3 +}$$
$$+COVID_{j\_x\_Year\_2020_t}\beta_4 + BREXIT_{UK_t}\beta_5 + \alpha_j + \gamma_t + \epsilon_{ijt}) \qquad (3)$$

$$EX_{ijt} = \exp{(l_{re_{Lab_{prod_t}}}\beta_1 + l_{Remot_{jt}}\beta_2 + FTA_{CEPII_t}\beta_3 +}$$
$$+COVID_{j\_x\_Year\_2020_t}\beta_4 + BREXIT_{UK_t}\beta_5 + \alpha_j + \gamma_t + \epsilon_{ijt}) \qquad (4)$$

An overview of individual variables can be found in Table 1. The parameters β represent individual estimates of the influence of independent variables on the dependent variable, α_j are partner fixed-effects and γ_t are time effects. The period under review covers the years 2012-2020, i.e. 4 years before the Brexit vote and the period itself influenced by uncertainty about Brexit, that is, from 2016 to the moment until the terms of trade between the EU and the UK in the TCA were agreed. Table 2 contains summary statistics of the variables used, except for the interaction term.

Difference in differences divide the dataset into two categories. In our case, when the treatment group reaches the value of 1, it refers to economies that have been most affected by the COVID-19 pandemic. Other economies belong to the control group. The condition of parallel trends must be met before using diff-in-diff (WBG, 2024). We confirmed this with a placebo treatment group, in which the affected states were assigned the value of 0 and the control group was assigned the value of 1 by using random selection in Microsoft Excel. This is how the placebo treatment group was formed. We anticipate insignificant estimates of the placebo treatment group parameter.

Table 1. Description of variables and assumed relationship of independent variables to dependent variable

y_{ijt} / $x_{it(jt)}$	Description
EX_{ijt}	Dependent variable: goods exports of all EU member states (i) to the third partner country, including the UK (j), in million USD from 2012 to 2020 (UNCTADstat, 2022a-b; WBG, 2022c). Missing values were replaced by zero (database accessed on February 10, 2022).
$GDPpc_{jt}$	Independent variable: gross domestic product per capita in current USD (j) (WBG, 2022a). With the growth of GDP p. c. of a partner, an increase in EU exports is expected but, based on the literature, a decrease in exports can also be observed (Bubáková, 2013).

re_Lab_prod$_{ji/it}$	Independent variable: the labour productivity (expressed as GDP per person employed, constant 2017 PPP $) of the partner country (j) relative to the aggregate value of EU labour productivity (WBG, 2022b). The increase is expected to increase EU exports.
FTA_CEPII$_t$	Independent variable: dummy variable of preferential trade agreements (CEPII, 2022). If a preferential agreement between the EU and a partner country is applied, this independent variable has the value of 1 from the year the agreement enters into force. Otherwise, it is 0. EU export is expected to be higher to partner countries with which a preferential trade agreement is applied.
COVID$_j$_x_Year_2020$_t$	Independent variable: the dummy variable of the interaction term expressing the severity of the impact of the COVID-19 pandemic based on the number of deaths per 100,000 population (WHO, 2021). For countries with a number of cases higher than the average value (= 45.45 deaths per 100,000 inhabitants from the sample of all WHO-reporter territories), the variable becomes 1 in 2020, and for other countries 0. Out of a total of 190 countries in 2020, variable value 1 was reached in 44 partner countries (j). The interaction term with a negative sign is expected, which means that EU exports to countries with a COVID-19 prevalence higher than the average have declined more significantly compared to other countries (database accessed on February 20, 2021).
Brexit_UK$_t$	Independent variable: a dummy variable expressing uncertainty from Brexit. The indicator has a value of 1 in relation to the United Kingdom for the years 2016 to 2020. Otherwise, it acquires the value 0. A negative sign is expected, so uncertainty about Brexit is accompanied by a decline in EU exports to the UK.
Remot$_{jt}$	Independent variable: remoteness calculated as the product of the geographical distance according to the CEPII (Mayer & Zignago, 2012) and the share of the GDP of partner country (j) in world GDP in a given year (t) (LU Department of Econometrics, 2021; Head, 2003). As the Gravity 1.0 statistical package requires the use of remoteness, methodologically, using fixed effects, this remoteness expresses changes in the partner country share of world GDP. With the increase in remoteness, EU export is expected to grow due to the growing share of the GDP of the partner country.

Legend: Under the EU label, data for 27 countries is presented: Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Greece, the Netherlands, Croatia, Ireland, Lithuania, Latvia, Luxembourg, Malta, Hungary, Germany, Poland, Portugal, Austria, Romania, Slovak Republic, Slovenia, Spain, Sweden, Italy.
Source: authors' representation

Table 2. Summary Statistics

Variable	Mean	Min.	Max.	Std. Dev. (pool)	Skew.	Missing obs.	Obs.
EX_{ijt}	11,479,000.00	0	432,130,000.00	41,983,000.00	6.67	0	1,710
$Remot_j$	33.35	0.001	1,448.20	152.77	7.52	227	1,483
$GDPpc_{jt}$	13,332.00	270.69 (Burundi)	183,240.00 (Monaco)	22,055.00	3.32	145	1,565
FTA_CEPII_t	0.38	0.00	1.00	0.48	0.51	108	1,602
$Brexit\_UK_t$	0.00	0.00	1.00	0.05	18.41	0	1,710
$COVIDj\_x\_Year\_2020_t$	0.03	0	1	0.16	5.99	0	1,710
$re\_Lab\_prod_t$	0.40	0.02	2.81	0.39	1.81	381	1,329

Source: authors' representation

The used dummy binary variables cannot be logarithmised and, therefore, their coefficients are transformed according to the following relation (Silva & Tenreyro, 2006):

$$(e^{b_i} - 1) \times 100 = \% \tag{5}$$

3. Results and discussion

In the past, trade relations between EU countries and the United Kingdom were intensive thanks to their membership in the integration group (Krivosudská, 2022). Graph 1 shows the development of trade in goods between the EU and the United Kingdom in 2012-2020.

EU exports to the United Kingdom had a growing trend until 2019. On the contrary, imports of goods from the United Kingdom into the EU were prone to volatility with a declining trend. With the advent of the COVID-19 pandemic and related restrictions in 2020, the EU total trade with the United Kingdom fell by 67.3 billion EUR year on year while exports and imports of EU goods decreased to the same extent (by 13%). At the same time, the import of goods reached the lowest value in the whole monitored period.

Figure 1. The development of EU and UK trade in 2012 - 2020 (in billions of EUR)
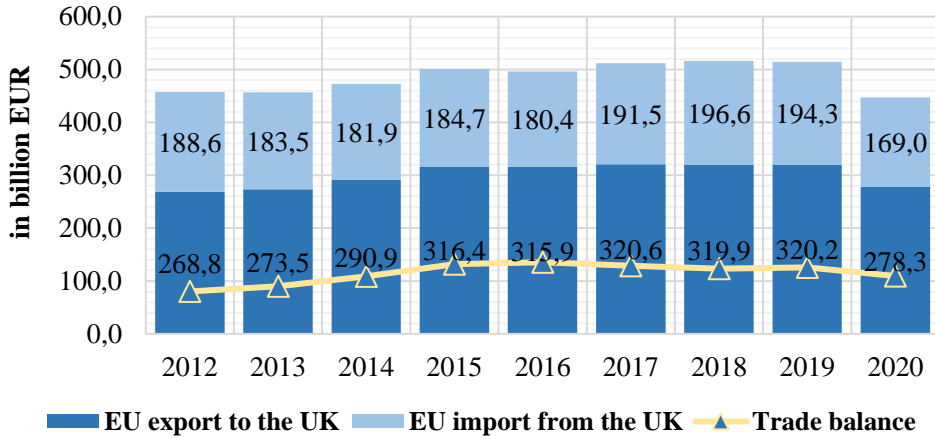
Source: authors' representation based on Eurostat data, 2022

Figure 2. Year-on-year change in EU goods trade in the context of Brexit in 2012-2020 (%)
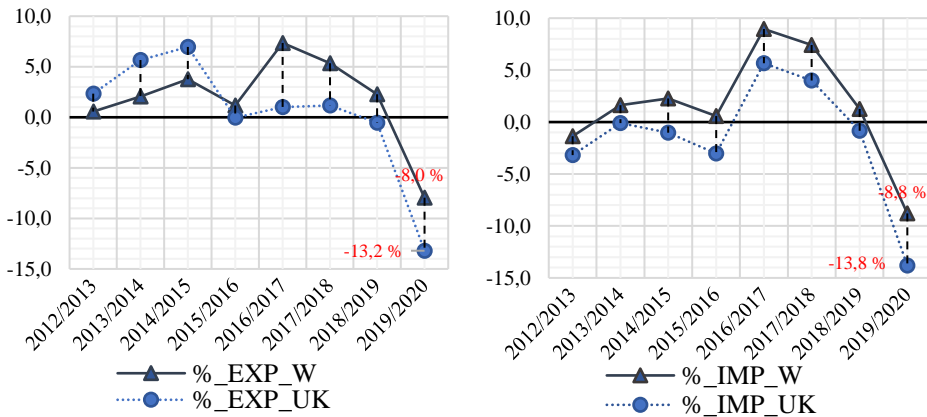
Legend: % _EXP_W represents the year-on-year change in EU exports to the world in %, % _EXP_UK is the year-on-year change in EU exports to the UK in %, % _IMP_W is the year-on-year change in EU imports from the world in %, % _IMP_UK is the year-on-year change in EU goods imports from the United Kingdom in %.
Source: authors' representation based on ITC data and Eurostat, 2022

Due to the fact that trade between the EU and the United Kingdom was affected in 2020 not only by Brexit but also by restrictive measures against the spread of the pandemic, it is necessary to distinguish the impact of Brexit on trade from

pandemic, as it distorts the data. Graph 2 shows the year-on-year changes in EU exports / imports to / from the United Kingdom and EU exports / imports to / from the world which distinguishes between changes in the overall trade in the EU and changes in relation to the United Kingdom. From the data presented in Figure 2, it follows that, since the referendum, the EU started exporting goods more to the world than to the United Kingdom. Under the influence of the pandemic, the EU exports to the UK and the world fell sharply in 2020. However, the decrease in exports to the United Kingdom (-13.2%) was greater than the decrease in EU exports to the world (-8.0%). The comparison of the year-on-year changes in EU exports to the UK and the world can therefore indicate a negative impact of Brexit on EU exports to the UK. With respect to the EU imports from the UK, a larger year-on-year increase can be observed throughout the observed period, resp. a smaller year-on-year decline in EU imports from the world than in the UK. Thus, in connection with the Brexit vote, no significant changes are observed in imports. The most significant difference between the year-on-year decrease in EU imports from the United Kingdom (-13.8%) and the year-on-year decrease in imports from the rest of the world (-8.8%) was recorded in the whole monitored period in 2020. It can, therefore, be concluded that the most significant change took place on the EU export side since 2016, when Brexit was voted on. This comparison suggests that uncertainty about Brexit had a negative impact on the EU exports to the UK. To verify this impact, 3 models were compiled (Table 3). In Model 1, independent variables expressing the GDP p.c. of partner countries, remoteness, 2 dummy variables, as well as an interaction term expressing the impact of COVID-19 were used.

Table 3. PPML gravity model estimated with partner fixed-effects

	(1)	(2)	(3)
Dependent variable: EX_{ijt}	PPML (FE)	PPML (FE)	PPML (FE)
Const	13.47***	14.95***	16.13***
l_GDPpc_{jt}	0.17**		
$l\_re\_Lab\_prod_t$		0.19	0.16
l_Remot_{jt}	0.61***	0.66***	0.56***
FTA_CEPII_t	0.70***	0.94***	
$COVID_j\_x\_Year\_2020_t$	0.98***	1.16***	2.07***
$Brexit\_UK_t$	0.34*	0.43**	
dt_2013	0.03	0.03	
dt_2014	0.04	0.04	
dt_2015	-0.10*	-0.10	
dt_2016	-0.17***	-0.18***	
dt_2017	-0.09	-0.10	
dt_2018	-0.02	-0.04	
dt_2019	-0.07	-0.09	
dt_2020	0.20	-0.50*	-0.76**
Placebo_ $COVID_j\_x\_Year\_2020_t$	insignificant; negative sign	partially significant (*); negative sign	insignificant; negative sign

	(1)	**(2)**	**(3)**
N	1,401	1,238	286
Time-Period	2012-2020	2012-2020	2019-2020
Robust st. error	Yes	Yes	Yes
Partner FEj	Yes	Yes	Yes
Pseudo R2	0.983	0.979	0.934
max. VIF (pool OLS)	1.301	1.388	1.291

Legend: Standard errors in parentheses; * significant at the 10 percent level; ** significant at the 5 percent level; *** significant at the 1 percent level

Pseudo R2 refers to the Pearson correlation coefficient between the actual and fitted values of independent variables.

Source: authors' calculations

Based on the results of Model 1, the null hypothesis of a statistical insignificance of the estimate of the variable GDP p.c. partner country (j) can be rejected with a 90% probability. With the growth of GDP p. c. partner country by 1%, EU exports are expected to increase by 0.17% in the monitored period. Since the distance between countries does not change over time, remoteness represents the change in the share of the partner country's GDP in the global GDP in a panel analysis with fixed effects. With a one-percent increase in the partner's share of GDP in global GDP, we expect an increase in EU exports by 0.61%. The interaction term expressing the effect of COVID-19 is estimated significantly, but with an unexpected sign. So, there is no evidence that countries experiencing a higher number of deaths per COVID-19 than the average would also see a statistically significant decrease in EU imports. As with the interaction term, the null hypothesis of the insignificance of the estimate was rejected in the variable expressing the effect of Brexit. However, the polarity was unexpected.

Model 2, in which the variable expressing GDP p.c. was replaced by the labour productivity of the partner country relative to the aggregate value of EU labour productivity, was compiled. Based on the results of model 2, the null hypothesis of the insignificance of the labour productivity variable estimate cannot be rejected, and we cannot interpret this variable. The variable expressing the impact of Brexit on the EU exports for the years 2016 to 2020 is estimated statistically significant, but with an unexpected positive sign. Thus, compared to the findings of previous studies (Graziano et al., 2021 or Douch & Edwards, 2021) concerning the immediate negative reaction of trade to the Brexit vote, our results taking into account the entire period of Brexit uncertainty are different. This points to the fact that the time perspective is an important factor influencing the response of trade to an event as extraordinary as the withdrawal of the UK from the EU. We explain the growth in EU exports in 2017 and 2018 by several factors. First, rising commodity prices contributed to the growth in the value of exports. Secondly, there were also factors that influenced the growth of EU export volumes, in particular the robust growth of global output in most countries of the world, which supported the growth of

investment (UNCTAD, 2019). In relation to the UK, EU exports continued to grow due to concerns about unregulated Brexit. Hard Brexit could cause significant complications in some commodities when imported from the EU into the UK, which British companies wanted to avoid. Therefore, imports, which they planned to achieve only in the longer term, were prematurely achieved. The accumulation of stocks in the UK due to concerns about the hard Brexit in 2019 was confirmed by Kittová and Krivosudská (2020), or the Premium Credit survey (2019). The Office for National Statistics (2021) confirmed the accumulation of stocks at the end of 2020 however; in addition to Brexit, the ongoing COVID-19 pandemic could be the reason for the frontloading of British companies. Similarly, a CIPS survey (2021) showed that about 20% of 185 British and European companies were frontloaded by the end of 2020 due to the fear of delay at the borders and the uncertainty associated with it.

Models 1 and 2 did not confirm the expected statistical decline of EU exports due to the uncertainty caused by Brexit and the high number of deaths per COVID-19 in partner countries. Model 3 was compiled as part of the confrontation of our results based on models 1 and 2. In the case of model 3, we created a basic difference-in-differences model with only two time periods of 2019 to 2020. This specification can be considered as a robustness check.

In model 3, as in model 2, the labour productivity of the partner country relative to the aggregate value of the EU labour productivity was used, instead of the variable expressing GDP p.c. The results of model 3 show that the growing remoteness of the partner country has a positive impact on EU exports due to the use of fixed-effects estimates. The estimation was statistically significant with a 99 % probability. In this case, the null hypothesis of the insignificance of the estimate with a 99% probability for the interaction term expressing the impact of the COVID-19 pandemic was rejected, but again, with an unexpected positive sign (2.06). In the countries that belong to the group more affected by the COVID-19 pandemic than the average, EU exports can be expected to increase compared to countries with an average death rate. In terms of time effects, 2020 was estimated with a negative sign (-0.76) in comparison with 2019, with a 95% probability. In 2020, there was a modelled general decrease in exports compared to 2019 by approximately 46.77 %.

$$(e^{-0.76} - 1) \times 100 = -46.77\% \qquad (4)$$

Based on these results of Model 3, it is concluded that there was a statistically significant decrease in EU exports to all partner countries in 2020 regardless of the extent to which they were affected by the pandemic. Our findings on the impact of the COVID-19 pandemic on EU exports can be compared with the results of a study by Hayakawa and Mukunoki (2021), in which the authors examined the impact of COVID-19 on exports from 34 countries (of which 11 countries were from the EU) in 2020. According to their findings, this impact was significantly negative,

especially until July 2020, regardless of the measure of the severity of COVID-19 used (whether it was the number of COVID-19 cases and deaths, people's mobility with regard to workplaces or share of days when workplace-closing orders were in effect). The decrease in exports in labour-intensive industries such as textiles, footwear or leather was the most significant, which is explained by the authors through the fact that it is difficult to use remote work in these sectors. Being present in person is also important for the production of transport equipment, whose exports also fell sharply.

Conclusions

The motivation of this study was the unprecedented decision of the EU member state to leave this integration group. Due to the fact that it is not yet possible to verify the long-term effects of the UK withdrawal from the EU, we focused on the ex-post analysis of the effects of the uncertainty that accompanied the long and demanding process of agreeing the terms of trade relations between the EU and the UK. In 2020, the EU had to face not only Brexit, but also the advent of the global COVID-19 pandemic, which caused the deepest downturn in international trade in history. The object of our interest was to examine not only the uncertainty arising from Brexit but also the COVID-19 pandemic together with other factors that affect EU exports.

It was found that, with the growth of partner countries' GDP p.c., EU exports to these countries were increasing. In fixed effects models, remoteness is interpreted as a change in the partner's share of GDP in global GDP because distance does not change over time. Our results indicate that EU exports were attracted by countries with a growing share of their GDP in global GDP. The positive impact of the preferential agreement application between the EU and the partner country has been proven. We treat this variable as a control variable in our approach. In 2020, there was a statistically significant decrease in EU exports to all partner countries regardless of their COVID-19 prevalence measured by the number of deaths per 100,000 population. It was not proved whether the anticipation and uncertainty of Brexit had a negative impact on EU exports during the 2016-2020 period or not, which is explained by the overall favourable development of global output, especially in the years 2017-2018, as well as by the efforts of companies to pre-supply in the period of impending hard Brexit.

Furthermore, it must be acknowledged that EU exports were also affected by other factors that were not incorporated into our models. The aggregation of data for the 27 EU countries can also be seen as a limitation, which does not allow a more detailed look at the specifics of individual member states.

Our study contributes to the literature on the nexus between trade uncertainty and exports. While earlier works have concluded that the relationship is negative, we have not confirmed the decline of EU exports due to the uncertainty caused by

Brexit. The differences between our results, which are based on the entire period of uncertainty and those of earlier studies showing negative immediate effect of the Brexit vote on trade may imply that the effects vary with time, i.e. they differ depending on whether they are immediate, medium-term, or long-term. It follows that future research, focused on EU exports following the end of the pandemic, as well as ex-post long-term impact assessments of Brexit, that is after several years needed to adapt the supplier-customer relationship to the new conditions is needed.

Understanding the time-varying effects of uncertainty on exports can help to streamline and improve decision-making processes at the level of European companies, as well as national or European policymakers.

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