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ORIGINAL ARTICLE

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How did Brexit impact EU trade? Evidence from real data

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Abstract

At the time it voted to exit in 2016, the UK was a leading economy within the EU. It contributed about 16 percent of the EU GDP, while the other EU countries accounted for almost half of UK's total trade. This study attempts to answer two research questions: First, how Brexit affected the EU–UK trade and second, how it affected the trade between remaining 27 EU members. To answer these questions, quarterly data are exploited for the period from 2005Q1 to 2022Q3 covering a total of 53 trading partners including the EU members. A gravity model that controls for unobserved bilateral heterogeneity and multilateral resistance is estimated by PPML. Three phases of Brexit (the referendum, transition, and post transition [under the TCA]) are analysed. The results indicate that the Brexit referendum phase depressed UK–EU trade by around 10.5%, and transition phase by around 15%. In both cases, particularly for the transition phase, the effect is greater on the UK imports from EU than the UK exports to EU. We do not find a significant effect due to the post transition (TCA) phase. Estimates show some mild but positive effect on intra-EU trade of about 1.5% and 4.6% due to Brexit referendum and post Brexit respectively, but no significant effect from the transition phase. This suggests that some EU trade with the UK was redirected to other EU members. Hence UK should aggressively seek out new trade agreements with other countries and trade blocs as

well as refine the workings of the trade and cooperation agreement signed with the EU to minimise the loss.

KEYWORDS
Brexit, EU, gravity model, panel data, trade and cooperation agreement

1 | INTRODUCTION

The ideal of a European Union (EU) arose from the devastation wrought by World War II. Six countries that founded the European Coal and Steel Community (Belgium, France, Germany, Italy, Luxembourg, Netherlands) capitalised on the success of the initiative to sign the Rome Treaty that created the European Economic Community (EEC) in 1957 (European Commission, 2022). From these humble beginnings, European Cooperation gradually but steadily deepened and expanded. A Free Trade Area (FTA) was forged in 1960, a Customs Union in 1968 and a Common Market in 1993. The UK's entry in 1973, along with Denmark and Ireland, marked a membership expansion that continued for more than four decades. Membership stood at 12 countries when the treaty on European Union (Maastricht treaty) was signed in 1992 and reached 28 with the entry of Croatia in 2013 (European Commission, 2022). Membership was at 28 countries when the UK voted in a referendum on 23rd June 2016 to leave the EU.

The UK vote set into motion a challenging exit process (Brexit), making the UK the first independent country to leave the union. Walker (2021) describes the Brexit timeline in detail. After the vote, the key milestones in the exit process include the triggering of Article 50 on 29th March 2017, and the signing of the withdrawal agreement on 30th January 2020. The UK started a transition period on 1st of February 2020. EU law still applied to the UK till the end of the transition period on 31st December 2020 when the UK finally left the union. On 30 December 2020, the EU and the UK signed a Trade and Cooperation Agreement (TCA) that was provisionally applied from 1 January 2021 and formally entered into force on 1 May 2021. While the TCA provides for a free trade agreement that removes all tariffs and quotas on UK–EU trade, it is a downgrade from the customs union and single market it enjoyed before. The TCA keeps the UK outside the single market. Unlike when it was within the single market, free movement of people has ceased, and a customs and regulatory border has been introduced between the UK and the EU. This has resulted in non-tariff barriers such as customs checks, sanitary and phytosanitary restrictions on trade in animal and plant products, among others.

While not a total surprise, the 'leave vote' represents a substantial economic and political shock to the EU and probably ranks as one of the most consequential votes of the 21st century. It initiated a major shift in the political and trade relationship between the UK and the EU. Part of the initial challenge was related to process uncertainty. Untangling more than fourty years of economic and political integration was bound to be a legal challenge, compounded by an untested exit procedure and the lack of detail and clarity of Article 50. Greenland exited the union in 1982, but its experience could not provide a realistic lesson for Brexit given its economic size and dependence on a single industry – Fisheries. The UK was the second largest EU economy when it voted to leave in 2016 contributing about 16% to EU GDP (in current prices; Eurostat, 2017). Politically, Brexit raises legitimate questions about the future stability of the EU. Thanks to Brexit, the process of exiting the EU is now much better understood than before. A major member country (UK) has navigated the exit process and managed to strike a decent post exit trade and cooperation agreement, like Greenland earlier. This new reality will influence how unhappy members view the exit option in the future. On the other hand, it might encourage interested
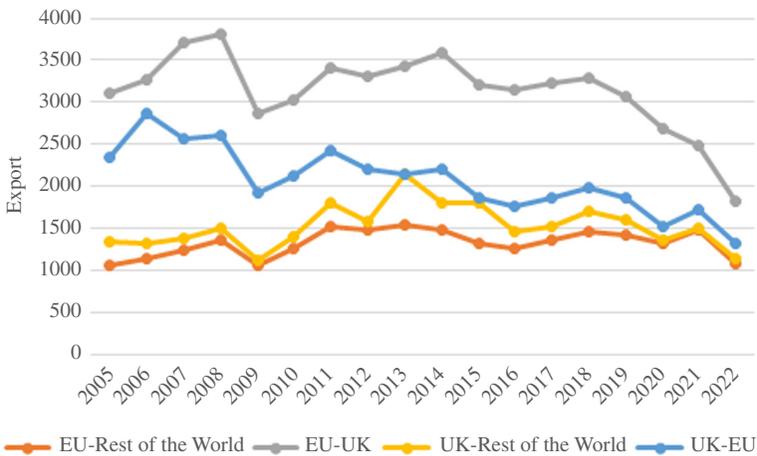
FIGURE 1   EU and UK exports trends from 2015Q1 to 2022Q3. *Note*: Goods Exports is in billions of US dollars except from EU to Rest of World which is in 10 billions of US dollars.
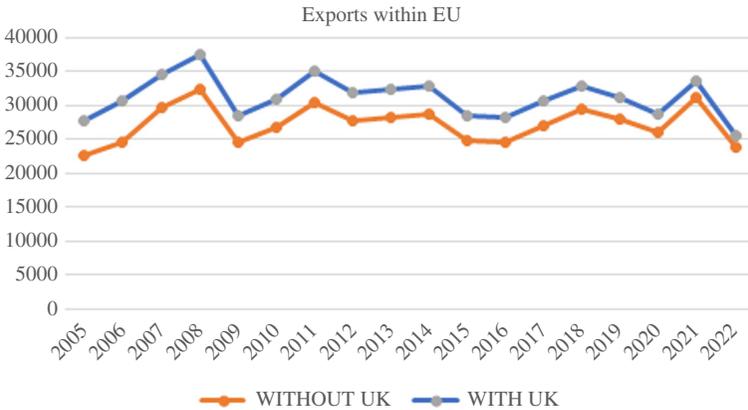

FIGURE 2   Intra-trade for EU member countries between 2015Q1 and 2022Q3 (with and without the UK).

but undecided members to join given that the "exit" option is clearer if membership does not work out. Brexit will very likely also inform how the remaining member countries negotiate future agreements. From a trade perspective, the enormity of the UK decision to leave is reflected in trade volumes. The EU is the UK's largest trading partner. In 2020 it accounted for 46% of UK's total trade (Ward, 2021). Figure 1 shows the recent trends in UK–EU trade from 2015Q1 to 2023Q3.

The trends in Figure 1 suggest some substantial decline in the EU exports to UK and UK exports to EU during the pre-COVID-19 period from 2018Q1 to 2019Q4 compared to exports to the rest of the world which to drop by less. All show reduction in trade during the COVID-19 period. After the COVID-19 lockdowns, EU and UK exports to the rest of the world as well as UK to EU pick up. But EU exports to UK continue to decline. EU exports to UK and to the rest of the world, as well UK exports to EU and rest of the world all show declines from 2021Q1. Figure 2 shows the trade between EU member countries (all 28, and when UK is excluded). In both cases there is some decline in trade from 2018Q, but it is hard to discern clearly from the visual if the trade between remaining 27 fairs better. We clearly see the COVID-19 effects from 2020Q1 in both trends, then some recovery before further decline in 2021.

As expected, Brexit proceeded with a considerable amount of uncertainty. The UK requested and was granted several extensions beyond the two-year window prescribed by Article 50. The UK

left the EU on 1st February 2020 (some 11 months behind schedule) to start a transition period. Crowley et al. (2018) study the effect of the policy uncertainty attributed to Brexit. They estimate that entry of exporters was approximately 5 percent lower while exit of exporters was about 6.1 percent higher compared to a scenario of no policy uncertainty. Douch and Edwards (2022) confirm that Brexit policy uncertainty had strong economic effects that started months before the referendum like Graziano et al. (2021) and Douch and Edwards (2021). This lends support to studies such as Osnago et al. (2015) showing that policy uncertainty acts as a barrier to trade equivalent to a tariff of between 1.7% and 8.7%. Other studies (Ahmad et al., 2020; Douch & Edwards, 2021) similarly identify negative effects of policy uncertainty due to Brexit on services.

A significant literature (Dhingra et al., 2017; Hantzsche et al., 2019; Oberhofer & Pfaffermayr, 2021; Stack & Bliss, 2020) that simulated Brexit scenarios (like hard Brexit/hard Brexit plus, global Britain/ Soft Brexit) found negative effect on UK trade with EU. Most of these studies have used simulations for lack of complete data over the Brexit period as well as uncertainty over the type of post Brexit trade arrangement that would be struck between the UK and EU. Latorre et al. (2020) review some of the earlier literature on Brexit and there is a consensus in the literature that Brexit is damaging for both the UK and EU – though more damaging to the UK (Felbermayr et al., 2018; Stack & Bliss, 2020).

With the conclusion of the Brexit process, a new and still small strand of literature attempting to revise the effect of Brexit is emerging. Du et al. (2022) estimate the effect of the TCA using a synthetic difference-in-difference (SDID) on data up to 2022Q1. They find a negative impact of the TCA that has largely disappeared by the beginning of 2022. Freeman et al. (2022) also applying a difference-in-difference approach, surprisingly, find no evidence of uncertainty and anticipation effects of Brexit in the UK–EU trade. This is estimated for the period after the UK voted for Brexit in 2016 and before the change in policy was implemented under the new Trade and Cooperation Agreement (TCA) in 2021. They do find a large negative effect due to the departure from the EU's single market and customs union to the new TCA trade relationship of about 25% fall in relative UK imports from the EU. However, by changing trade data source and comparison group, Kren and Lawless (2022) findings contradict some of the findings in Freeman et al. (2022). Their results suggest that Brexit decreased trade from the UK to the EU by 16% and trade from the EU to the UK by 20%. Both Freeman et al. (2022) and Kren and Lawless (2022) use product level trade flow, but Kren and Lawless (2022) have applied Poisson pseudo-maximum likelihood (PPML).

Building on this strand of literature, our interest in the present study is to estimate the actual impact of the Brexit process. The objective of the study is to assess the effect of Brexit process on EU trade. Specifically, two main research questions are tackled in the study:

- How did Brexit affect trade between EU and UK?
- How did Brexit affect intra-EU trade for the remaining 27 members?

Our study differs from previous literature in several ways. While it complements earlier studies that have simulated data and scenarios, unlike these studies we use actual data that is now available for the exit period up to 2022Q3, which includes the period when the UK–EU trade falls under the new TCA. We also assess the effect of Brexit on both the trade relations between the UK and EU, as well as its effects on the remaining 27 EU members. While most earlier studies use a subset of EU countries, this study uses the full set of (28) EU countries. Compared to the recent work by Kren and Lawless (2022) and Freeman et al. (2022) that merge the referendum and transition period, this study breaks Brexit analysis into three periods – the initiation of Brexit from referendum to the end of 2019, transition period, and the TCA from January 2021. In addition and more significantly, our study analyses the Brexit effect on the remaining 27 members of the EU, something which these two studies have not.

Our hypothesis is that Brexit has negatively affected trade between UK and EU. This is due to the uncertainty generated by the Brexit process as well as expectation of increased trade restriction during post Brexit. It is also plausible a proportion of the reduced trade (particularly imports) from the UK by the 27 EU member is diverted to the remaining EU members. EU member countries are more convenient substitutes for EU firms looking for alternatives to UK market than countries outside the union. Thus, we expect Brexit to increase intra-EU trade for the 27 EU members. The results seem to support this view. Generally, our findings indicate that Brexit negatively affected UK–EU trade and boosted (mildly) intra-EU trade for the remaining members.

Overall, a large volume of research work has been devoted to understanding the impact of Brexit using various methodological approaches. A sizeable literature (Dhingra et al., 2017; Felbermayr et al., 2022; Oberhofer & Pfaffermayr, 2021; Valverde & Latorre, 2020; Van Reenen, 2016) simulate a range of Brexit outcomes using general equilibrium approach. Du et al. (2022) and Freeman et al. (2022) apply a difference-in-difference approach. Another popular approach is the gravity model (Jackson & Shepotylo, 2018, 2021; Mulabdic et al., 2017; Stack & Bliss, 2020). Following several previous studies (Campos & Timini, 2019; Karlsson et al., 2018; Kren & Lawless, 2022; Stack & Bliss, 2020) we adopt the gravity model. We estimate the regressions by PPML like in Kren and Lawless (2022). Our study contributes to the Brexit debate by providing a more detailed analysis of the stages of Brexit, as well as providing an analysis on its effect on trade between the remaining 27 members of the EU. The later, particularly, has not been well researched in the literature.

The rest of this study is structured as follows. Section 2 presents the data; Section 3 explains the methodology; Section 4 presents empirical results and discussion; and Section 5 concludes and presents policy recommendations.

2 | DATA

Bilateral exports data are obtained from the International Monetary Fund's (IMFs) Direction of Trade Statistics (DOTs, January, 2023) in US dollars. Nominal export value is converted to real exports using US GDP deflator obtained from the IMFs International Financial Statistics with 2005 as the base period. We have quarterly data from 2005Q1 to 2022Q3 covering 53 trading partners including European Union members. The choice of start point is to benefit from several years of data to control for pre-Brexit referendum trade patterns. While trading data are published monthly, quarterly frequency is preferred to prevent measurement noise and lumpiness in monthly trade flows. Appendix 1 lists the countries considered in this study. The countries are selected to cover the most active trading partners of EU and the UK, with consistent trade data.

With 53 countries and 71 quarters, there are 195,676 bilateral trade data points. There are 3180 zero values in the dataset constituting 1.625% of the bilateral trade data only. EU economic integration agreements (EIA) and free trade agreements (FTA) between EU and other countries are sourced from the European Commission (2018) and the World Trade Organisation (2018).

3 | METHODOLOGY

The primary interest of this study is to identify the effect of the Brexit on the EU–UK trade as well as intra-EU trade. We apply a gravity model to find answers to the two research questions specified earlier in the introduction section exploiting Poisson Pseudo-Maximum Likelihood (PPML) estimation. Four gravity specifications have been implemented for both techniques as discussed below.

Developments in the theoretical gravity model have stressed the role of multilateral (price) resistance terms and suggest the framework in Equation (1) below (Anderson & van Wincoop, 2003; Baier & Bergstrand, 2007).

$$
\begin{aligned}
X_{ijt} &= \beta_0 + \beta_1[\ln Y_{it}] + \beta_2\left[\ln Y_{jt}\right] + \beta_3\left[\ln DIST_{ij}\right] + \beta_4\left[ADJ_{ij}\right] + \beta_5\left[LANG_{ij}\right] \\
&\quad + \beta_6\left[CORE_{ij}\right] + \beta_7 EU_{ijt} - \ln P_{it}^{1-\sigma} - \ln P_{jt}^{1-\sigma} + \varepsilon_{ijt}
\end{aligned}
\tag{1}
$$

where X_{ijt} stands for real export between exporter country (i) and importer country (j) in time t. Y_{it} and Y_{jt} are the GDPs of the exporter and importer countries, respectively, and represents the economic size of the trade partners. Other variables that would influence trade between two countries need to be factored in. $DIST_{ij}$ is the distance between capital cities of partner countries i and j. ADJ_{ij} is a dummy adjacency variable indicating if countries share a common border or not (if adjacent = 1, 0 otherwise). $LANG_{ij}$ is a dummy variable equal to 1 if countries share a common official language and $CORE_{ij}$ is also a dummy variable equal to 1 if countries have had a colonial relationship after 1945. $P_{it}^{(1-\sigma)}$ and $P_{jt}^{(1-\sigma)}$ are the multilateral resistance terms. One popular way to account for the multilateral resistance terms is to use country-specific dummies.

We have considered both exporter-time and importer-time effects and time-invariant country-pair fixed effects as below since this specification, theoretically, is the most appropriate model.

$$
\ln X_{ijt} = \beta_0 + \alpha_{ij} + \alpha_{it} + \alpha_{jt} + \beta_3 EU_{ijt} + \varepsilon_{ijt}
\tag{2}
$$

In this model, the time-varying fixed effects (exporter-time [it] and importer-time [jt]) account for the multilateral resistance while the time-invariant country-pair fixed effects (ij) control for potential endogeneity bias. This model controls for nearly every variable included in gravity equation and unobserved factors. All other potential drivers of trade flow variation are subsumed in the fixed effects. These fixed effects should absorb other confounding influences on the overall movement of trade, including those related to the COVID-19 pandemic, and allow the isolation of the specific impact of Brexit on trade with the UK.

A number of trade-related dummies are introduced. To capture the effect of the referendum period (first phase of Brexit) on UK–EU trade, which is the first research question, we create a dummy variable called $Brexit_1$ that takes the value of 1 if countries i and j are UK–EU member country or EU–UK and zero otherwise from 2016Q3 to 2022Q3. We then extract the effect of other phases of Brexit by introducing the relevant dummies. To capture the effect of the transition period, we create a dummy variable called $Brexit_{1-Transition}$ that takes the value of 1 if countries are UK–EU member country or EU–UK and zero otherwise from 2020Q1 to 2022Q3. Finally to capture the effect of TCA, we create a dummy variable called $Brexit_{1-Post}$ variable that takes the value of 1 if countries are UK–EU member country or EU–UK and zero otherwise between 2021Q1 and 2022Q3. We have also split these variables into the export and import components to identity the effect of the Brexit on the export/import of the UK to/from EU.

The next set of estimations test for the effect of Brexit on remaining EU members, which is the interest in the second research question. Like in the previous case we estimate the effect of the three phases of Brexit. We create a $Brexit_2$ dummy variable that is equal to 1 if countries i and j belong to the EU from 2016Q3 until 2022Q3. We also create a dummy variable called $Brexit_{2-Transition}$ that takes the value of 1 if countries i and j belong to EU from 2020Q1 to 2022Q3 to see the effect of the transition period on trade between remaining EU member countries. Lastly, we create a dummy variable called $Brexit_{2-Post}$ that takes the value of 1 if countries i and j belong to EU from 2021Q1 to 2022Q3 to see the effect of the TCA in intra- EU trade. These help to identify, separately, any effects

of the three phases of Brexit on the remaining 27 EU member countries. In this set up, the UK is treated as non-EU member from 2016Q3.

As in some previous studies (Campos & Timini, 2019; Stack & Bliss, 2020), we include other dummy variables to capture the effect of other economic integration agreements. Specifically, to capture the effects of EU membership, a dummy variable EU is created such that EU = 1 if exporting country (*i*) and importing country (*j*) are both EU members. A significant β_{EU} coefficient would imply that European Union has had positive effect on intra-EU trade. Furthermore, dummy variables for EURO and $EU_{FTA/EIA}$ are included to control for the effects of the Euro currency integration and trade agreements between the EU and other trade blocs/countries, respectively.

The regressions are estimated using the Poisson Pseudo-Maximum Likelihood (PPML) estimator developed by Gourieroux et al. (1984a) and popularised by Santos Silva and Tenreyro (2006, 2011). This estimation method is preferred by Blackburn (2007), Fally (2015), Santos Silva and Tenreyro (2022) and Kren and Lawless (2022) among others to overcome the potential bias related to heterogeneity arising from log-linearizing (Mayer et al., 2019) as well to handle the problem of zeros. In PPML regression, only a correct specification of the conditional mean of the dependent variable is required for consistency of the regression estimator (Gourieroux et al., 1984b), and hence can be applied to dependent variables with nonnegative values without the need to explicitly specify a distribution for the dependent variable (Correia et al., 2020). Weidner and Zylkin (2021) have shown that PPML is consistent even for the three-way gravity model (suggested for example in Baier and Bergstrand (2007) and other studies) that contains origin-time, destination-time, and country-pair fixed effects. We replicate all models by using Fast Poisson Estimation Model with multiple high-dimensional fixed effects suggested in Correia et al. (2020) by using STATA ppmlhdfe function. The coefficient estimated from this specification can be converted into a form that can be interpreted as a percentage change using the transformation $\exp(\beta) - 1$.

4 | EMPIRICAL RESULTS AND DISCUSSION

To answer the two research questions, we estimate two main sets of models based on the different versions of the Brexit variable discussed in Section 3 above. The first table of results (Table 1) relate to the first research question addressing the effect of Brexit on UK–EU trade. The next table of results (Tables 2) relates to the second research question on the effect of Brexit on the remaining 27 EU member countries. In each table, our core results based on the PPML model for Equation (2) are provided. This accounts for both country-pair fixed effects and exporter-time and importer-time effects. The EU integration effect captured by the EU dummy is positive and significant in all cases. The estimated effect on intra-EU trade is about 48% [given by $100^*\left(e^{\beta_{EU}} - 1\right)$]. The Euro effect is positive and significant, with estimated average impact on trade of about 9.5%. This lies within the current estimates of the effect of the introduction of the Euro. For example, a recent European Central Bank (ECB) occasional paper (Gunnella et al., 2021) using a similar approach as used in the present paper (PPML, which includes time-varying exporters and importer fixed effects, as well as time-invariant pair fixed effects) estimate an effect of 5.3% for early wave adopters to 10.6% for second wave adopters. This is based on a large data set of 190 countries between 1990 and 1915.

We introduce the Brexit-related dummy variables (defined in the methodology section) successively to enable easy identification of the effects of each of the key stages of the Brexit process as shown in sub-models 1^A to 1^F in Table 1. For example in column 1^A, the Brexit dummy ($Brexit_1$) is introduced, while in column 1^B, this is split into two effects: effect on exports of UK to EU ($Brexit_{1-Export}$), and effects on imports of UK from EU ($Brexit_{1-Import}$). Subsequently in 1^C and 1^D,

TABLE 1 Both EU variable is equal to 1 if countries i and j belong to the European Union at time t and 0 otherwise.

	The effect of the Brexit on EU–UK trade							
	(1^A)	(1^B)	(1^C)	(1^D)	(1^E)	(1^F)	(1^G)	(1^H)
Both EU	0.389***	0.388***	0.393***	0.393***	0.394***	0.393***	0.394***	0.393***
	(0.035)	(0.035)	(0.035)	(0.035)	(0.035)	(0.035)	(0.035)	(0.035)
$Brexit_1$	−0.180***		−0.111***		−0.111***			
	(0.015)		(0.017)		(0.017)			
$Brexit_{1-Export}$		−0.134***		−0.104***		−0.104***		
		(0.024)		(0.027)		(0.027)		
$Brexit_{1-Import}$		−0.212***		−0.118***		−0.118***		
		(0.020)		(0.022)		(0.022)		
$Brexit_{1-Transition}$			−0.165***		−0.162***			
			(0.026)		(0.038)			
$Brexit_{1-Transition-Export}$				−0.073*		−0.044		
				(0.038)		(0.046)		
$Brexit_{1-Transition-Import}$				−0.226***		−0.235***		
				(0.035)		(0.053)		
$Brexit_{1-Post}$					−0.004		−0.278***	
					(0.045)		(0.029)	
$Brexit_{1-Post-Export}$						−0.044		−0.192***
						(0.059)		(0.046)
$Brexit_{1-Post-Import}$						0.014		−0.339***
						(0.061)		(0.038)
$Brexit_{1,includingTransition}$							−0.144***	
							(0.016)	
$Brexit_{1-Export,includingTransition}$								−0.112***
								(0.025)

TABLE 1 (Continued)

	The effect of the Brexit on EU–UK trade							
	(1^A)	(1^B)	(1^C)	(1^D)	(1^E)	(1^F)	(1^G)	(1^H)
$Brexit_{1-Import,includingTransition}$								−0.168***
								(0.021)
Both EURO	0.090***	0.090***	0.091***	0.091***	0.091***	0.091***	0.091***	0.091***
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
FTA/EIA Agreements	0.033***	0.033***	0.042***	0.041***	0.042***	0.042***	0.043***	0.043***
	(0.011)	(0.011)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
Constant	4.105***	4.105***	4.103***	4.103***	4.103***	4.103***	4.102***	4.103***
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Observations	192,130	192,130	192,130	192,130	192,130	192,130	192,130	192,130

Note: $Brexit_1$ variable is only equal to 1 between UK and EU trading partners from 2016Q3 to 2022Q3 and 0 otherwise. $Brexit_{1-Export}$ variable is only equal to 1 if UK is the exporter and EU members are importer from 2016Q3 to 2022Q3 and 0 otherwise. $Brexit_{1-Import}$ variable is only equal to 1 if UK is the importer and EU members are exporter from 2016Q3 to 2022Q3 and 0 otherwise. $Brexit_{Transition}$ variable is equal to 1 between UK and EU trading partners from 2020Q1 to 2022Q3 and 0 otherwise. $Brexit_{1-Transition-Export}$ variable is equal to 1 if UK is the exporter and EU members are importer from 2020Q1 to 2022Q3 and 0 otherwise. $Brexit_{1-Transition-Import}$ variable is equal to 1 if UK is the importer and EU members are exporter from 2020Q1 to 2022Q3 and 0 otherwise. $Brexit_{1-Post}$ variable is equal to 1 between UK and EU trading partners from 2021Q1 to 2022Q3 and 0 otherwise. $Brexit_{1-Post-Export}$ variable is equal to 1 if UK is the exporter and EU members are importer from 2021Q1 to 2022Q3 and 0 otherwise. $Brexit_{1-Post-Import}$ variable is equal to 1 if UK is the importer and EU members are exporter from 2021Q1 to 2022Q3 and 0 otherwise. $Brexit_{1includingTransition}$ variable is only equal to 1 between UK and EU trading partner from 2016Q3 to 2020Q4 and 0 otherwise. $Brexit_{1-ExportincludingTransition}$ variable is only equal to 1 if UK is the exporter and EU members are importer from 2016Q3 to 2020Q4 and 0 otherwise. $Brexit_{1-ImportincludingTransition}$ variable is only equal to 1 if UK is the importer and EU members are exporter from 2016Q3 to 2020Q4 and 0 otherwise. Both EURO variable is equal to 1 if countries i and j use EURO currency at time t and 0 otherwise. UK is considered as an EU member until 2022Q3. FTA-EIA Agreements is equal to 1 if countries have a trade agreement with EU member countries at time t and 0 otherwise. Standard errors are clustered over country pairs, importer–quarter and exporter–quarter. *, **, ***Significant at the 10%, 5% and 1% levels, respectively.

TABLE 2 Both EU variable is equal to 1 if countries i and j belong to the European Union at time t and zero otherwise.

	The effect of the Brexit on intra-EU trade			
	(2^A)	(2^B)	(2^C)	(2^D)
Both EU	0.387***	0.389***	0.389***	0.389***
	(0.035)	(0.035)	(0.035)	(0.035)
$Brexit_2$	0.043***	0.015*	0.015*	
	(0.008)	(0.009)	(0.009)	
$Brexit_{2-Transition}$		0.063***	0.033	
		(0.014)	(0.021)	
$Brexit_{2-Post}$			0.045*	0.093***
			(0.025)	(0.015)
$Brexit_{2,includingTransition}$				0.022**
				(0.009)
Both EURO	0.089***	0.090***	0.090***	0.090***
	(0.013)	(0.013)	(0.013)	(0.013)
FTA-EIA Agreements	0.042***	0.047***	0.048***	0.047***
	(0.011)	(0.011)	(0.011)	(0.011)
Constant	4.098***	4.097***	4.097***	4.097***
	(0.011)	(0.011)	(0.011)	(0.011)
Observations	192,130	192,130	192,130	192,130

Note: $Brexit_2$ dummy is equal to 1 if exporter and importer are EU members between 2016Q3 and 2022Q3 and 0 otherwise. $Brexit_{2-Transition}$ variable is equal to 1 if both exporter and importer are EU members between 2020Q1 and 2022Q3 and 0 otherwise. $Brexit_{2-Post}$ variable is equal to 1 for both importer and exporter are EU members between 2021Q1 and 2022Q3 and 0 otherwise. UK is considered not a member of the EU from 2016Q3 to 2022Q3. Both EURO variable is equal to 1 if exporter and importer countries use EURO currency at time t and zero otherwise. FTA-EIA Agreements is equal to 1 if any country has a trade agreement with EU member countries at time t and 0 otherwise. Standard errors are clustered over country pairs, importer–quarter and exporter–quarter. *, **, ***Significant at the 10%, 5% and 1% levels, respectively.

a dummy variable ($Brexit_{1-Transition}$) is introduced to extract the effect of the events of the transition period. Finally, in columns 1^E and 1^F, a post-Brexit variable ($Brexit_{1-Post}$) is included to account for the introduction of the trade and cooperation agreement (TCA).

The $Brexit_1$ variable is consistently negative and significant in all models estimated, converging to an estimated average effect of about 10.5 percent $\left(\left(e^{-0.111} - 1\right) * 100\right)$. Having accounted for the events of transition and post transition (TCA), the estimated effect of the Brexit referendum and ensuing lengthy withdrawal negotiations in search of a withdrawal agreement, is about 10.5% reduction in UK–EU trade. See column 1^E. Since the UK–UE trade rules had not been changed at this point, the effect captured here is mainly from uncertainty and anticipated change in trade rules. This estimate seems reasonable considering previous findings. Stack and Bliss (2020) predicted that Brexit would negatively influence UK trade with all countries under hard Brexit of between 6% and 13%. The estimates of Douch and Edwards (2022) suggest that UK exports to EU declined by approximately 25% by 2018, while Oberhofer and Pfaffermayr (2021) estimate a decline in UK exports to EU of between 7.2% and 45% 6 years after Brexit took place. Our results differ from the recent study by Freeman et al. (2022) who conclude that Brexit (from referendum to before the TCA) did not shift UK trade away from the EU. Our results are more in line with Kren and Lawless (2022). The study by

Kren and Lawless (2022) estimation splits the referendum effects into two components –the effect on trade flows from UK to EU and from EU to UK. The estimates from their favoured model indicate a reduction of about 7.9% in UK to EU trade, and 15.7% reduction in trade from EU to UK. Our average estimate of 10.5% fall between these two. Furthermore, when we decompose the effect in a similar way to capture the effect on trade from UK to EU and from EU to UK, we obtain 9.8% and 11.1%, suggesting that the referendum period reduced UK exports to EU by about 9.8% and EU exports to UK by about 11.1% (see Column 1^F). This indicates there is slightly larger effect on the imports from EU into UK than exports from UK to EU. However this effect is small.

There is an important difference though. Kren and Lawless (2022) merge the effect of the transition period (2020Q1–2020Q4) with the referendum period. In this paper the effect of the transition period is computed separately using the Brexit transition variable ($Brexit_{1-Transition}$). The estimated average effect is 15%. This indicates that the transition period led to a further decline in the UK–EU trade by 15%. During this period, the withdrawal agreement is ratified, and though the EU rules still apply, intense negotiations on a future UK–EU trade agreement took place. This effect signifies an adjustment to the official withdrawal, as well as the anticipated shape of the future UK–EU trade. Further decomposition of this effect to capture the impact on trade from UK to EU and from EU to UK produces interesting results. The transition effect on UK exports to EU though negative is not significant. The effect on UK imports from EU is negative, significant and substantial in magnitude at 20.9%. There is a distinct asymmetry. Du et al. (2022) suggest this asymmetry could partly be due to diversion of exports to UK by EU exporters unwilling to suffer regulatory requirements for a small market. We believe this substitution is what influences the growth in intra-EU trade among the remaining members.

Lastly, the coefficient(s) on ($Brexit_{1-Post}$) dummy variable (including the export and import decomposition) to extricate the effect of the TCA are not significant. This suggests the new TCA has not had any significant effect beyond the transition effect. Kren and Lawless (2022) estimate the TCA effects on UK imports from EU at 19.6% – which is close to our estimate of transition effect since they do not separate the transition effect. Their estimate of the TCA effect picks up the effect due to transition. In fact when we merge the referendum and transition (as in columns 1^G and 1^H) as a robustness check, our estimate of the TCA effect is a decrease by 24.3%.

While we provide an estimate of this effect, adjustment to changes introduced in the TCA is unlikely to be complete. The implementation is too recent, and data are still too limited. In addition, full customs checks on imports from the EU were initially postponed by the UK and only phased in in 2022 (UK Parliament, 2022). We have used data (that are available) from 2021Q1 to 2022Q3 (7 quarters) for the TCA period. Kren and Lawless (2022) and Freeman et al. (2022) data are even shorter, ending in 2021Q4. We fully expect more refinement of the effect of TCA as more data become available.

Tables 2 address the second research question – the effect of Brexit on intra-EU trade for the remaining EU member countries. Like in Table 1, the estimated effect on intra-EU trade is about 48%. The Euro effect is positive and significant, with estimated average impact on trade of about 9.5%. Again we have included three Brexit-related dummy variables (defined in the methodology section). These are the Brexit dummy ($Brexit_2$), Brexit transition dummy ($Brexit_{2-Transition}$), and a post-Brexit variable ($Brexit_{2-Post}$).

The coefficient on $Brexit_2$ is positive, but modest at 1.5% and significant at 10% significance level. Having accounted for the transition period events, and post transition (TCA), the estimated effect of the Brexit referendum and withdrawal negotiations on intra-EU trade among the remaining 27 EU is an increase of about 1.5%. The coefficient on $Brexit_{2-Transition}$ is not significant, indicating transition period has not had a significant effect on intra-EU trade for the remaining 27 members.

The coefficient on $Brexit_{2-post}$ (TCA effect) is positive and significant. In terms of magnitude, it is larger at 4.6%, indicating the TCA has increased intra-EU trade by around 4.6%. This is an indicator that firms faced with regulatory costs to export to the UK and they have started looking for substitute markets within the EU's single market.[1] When we merge the referendum and transition effect (see Column 2^D), the estimated effect of the TCA is about 9.8% increase, while the referendum effect is about 2.2%. This indicates that TCA has increased intra-EU trade.

5 | CONCLUSION

The European integration proceeded steadily for decades in political, economic, and monetary fronts. It is a significant economic union that has created the third largest economy in the world after the USA and China. It has taken substantial political will to move it to the current level of integration. Studies point out that the euro area only partially fulfilled the requirements for an optimal currency area (Feldstein, 1997; Santos Silva & Tenreyro, 2010). But even with the economic misgivings, the European Monetary Union (EMU) project pressed on, painting a picture of a politically resolute Europe. However, Britain opted out of the EMU. This hesitancy to join the EMU, in retrospect, was a sign of things to come. While a referendum was never held on the EMU question in the UK, some opinion polls such as the MORI polls (Potton & Mellows-Facer, 2003) suggest the "No vote" led the intention polling. Political will seemed lacking too as the Labor government insisted on a "clear and an unambiguous" economic benefit for UK membership of EMU before joining (Potton & Mellows-Facer, 2003). Thus, the Brexit vote was not totally unexpected or unforeseen. Still the vote was a shock to the EU bloc given the importance of the UK in the union.

In this study, we assess the effects of Brexit on UK–EU trade and on the intra- EU trade among the remaining 27 EU members. This is a relevant research question given the significance of the UK in the EU trade. Several simulation studies predicted losses for several Brexit scenarios. In this study, we compile quarterly data (2005Q1–2022Q3) for 53 trading partners including European Union members from a variety of sources such as the IMFs DOTS and IFS, European Commission, and the World Trade Organisation. For analysis, we use PPML techniques to estimate a gravity model. Three stages of the Brexit are analysed. These are the Brexit referendum period which runs from 2016Q3 to 2019Q4, the transition period which runs from 2020Q1 to 2020Q4 and the post Brexit period coinciding with the TCA from 2021Q1 to the end of the data.

Several important findings emerge from the study. The EU has produced a positive intra-EU trade effect of about 48 percent. This seems to be within the ballpark figures in previous estimates. Baier et al. (2014) provide estimates of deep integration of more than 50 percent, while Eicher and Henn (2011) estimate the effect of the EU accession at 37%. We also find a smaller but significant effect of around 9% on trade due to EMU. Our central findings relate to the effect of Brexit. We find that Brexit has significantly impacted UK–EU trade negatively. The Brexit referendum phase reduced UK–EU trade by about 10.5% on average, while the UK–EU trade reduced by a further 15% decrease due to the transition phase. We do not find any extra impact from the TCA though the coefficient is negative. These estimates are in line with estimates in Kren and Lawless (2022), though in their study they have analysed only two phases of Brexit. When we redefine Brexit into two categories (combined referendum/transition period, and post Brexit), the referendum/transition period reduces UK–EU trade by 13%, and TCA by a further 24%. We take this to imply that a significant portion of the effects of the TCA took place as it was negotiated during 2020 as businesses adjusted in readiness

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[1]As a robustness check, the same analysis is carried out considering UK as non-EU member starting from 2005Q1. The findings are very similar.

for its implementation. At this point of Brexit it was understood by businesses that the UK was out of the EU pending the implementation of the trade agreement under negotiation. In both definitions of Brexit phases, the effect is asymmetric with more effect on the trade from EU to UK than from UK to EU. Brexit has boosted trade between the remaining 27 EU members. The estimates suggest the Brexit referendum phase increased intra-EU trade by about 1.5% while the TCA provided a further boost of about 4.5%. This suggests some of the UK–EU trade has diverted to other EU countries as remaining EU country firms adjust to the non-tariff border wall that the TCA introduced.

Our findings reveal that the UK should aggressively pursue and negotiate trade agreements with other countries and trade blocs to compensate for some of the lost trade with EU. Since the TCA remains basically a Free Trade Agreement, it will not offer the same trade advantages as the single market the UK decided to leave. UK–EU trade must inevitably face some customs procedures, in particular the rules of origin, quality standards requiring testing and certification, and changes to transportation rights and movement of personnel. The UK is in the process of negotiating trade agreements with Mexico, Canada, Israel, India and GCC countries. UK is aiming to join the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP) that is an agreement between Australia, Brunei, Canada, Chile, Japan, Malaysia, Mexico, New Zealand, Peru, Singapore and Vietnam. If these trade agreements enter into force quickly, the gain from these agreements will alleviate the loss resulting from Brexit. In particular, the pursuit of a trade deal with India might turn out the most beneficial over the medium and longer term. It is a huge emerging market that does not pose much political controversy given its relative neutral stand (compared say to a deal with China), and would capitalise on the two countries' long historical links. Some studies suggest new agreements might not erase all the losses due to Brexit. For example, in their study assessing the expected welfare gains for the UK from signing new trade pacts with other partners, Mayer et al. (2019) found them to be positive but of a magnitude less than welfare losses from Brexit, signifying the importance of minimising UK–EU trade losses. To achieve this, the UK will need to continue engaging with the EU to streamline the functioning of the new TCA. This is especially true on the question of the Northern Ireland land border with the EU. Both sides need to be open to innovative ways to manage the EU–UK border while minimising the possibility of animosity rearing up in the region. It is worth noting that our investigation relates only to trade in goods due to data limitations. Effects on the service sector has not been factored in.

DATA AVAILABILITY STATEMENT
The data that support the findings of this study are available from the corresponding author upon request.

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APPENDIX 1: LIST OF COUNTRIES CONSIDERED IN THIS STUDY

Albania	China	Hong Kong	Malta[a]	Slovenia[a]
Argentina	Colombia	Hungary	Mexico	South Korea
Australia	Croatia[a]	Iceland	Netherlands[a]	Spain[a]
Austria[a]	Cyprus[a]	India	New Zealand	Sweden[a]
Belarus	Czech Republic[a]	Indonesia	Philippines	Switzerland
Belgium[a]	Denmark[a]	Ireland[a]	Poland[a]	Thailand
Bosnia and Herzegovina	Estonia[a]	Israel	Portugal[a]	Turkey

(Continues)

Brazil	Finland[a]	Italy[a]	Romania[a]	United Kingdom
Bulgaria[a]	France[a]	Japan	Russian Federation	United States
Canada	Germany[a]	Latvia[a]	Saudi Arabia	
Chile	Greece[a]	Lithuania[a]	Slovakia[a]	

[a]European Union Member. Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia joined EU in 2004, Bulgaria and Romania in 2007 and Croatia in 2013. United Kingdom left the union in January 2020.