The Announcement Effect of Brexit on UK's Trade Flows with the EU

Econ 613 Group Project

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Contents

Abstract

In the EU referendum of 23 June 2016, UK voted to leave the European Union created an exogenous shock for the global economies. The event had been seen as a sign of end of globalization era. The Brexit is likely to reduce the free movement of goods, services, labor and capital between UK and the EU. Due to the uncertainly of the trade terms, the event is predicted to decrease the economic growth and productivity of UK, and largely depends on the trade agreements negotiated by the UK leaders.

This study selects the monthly trade data of the UK with 27 EU countries and 160 non-EU countries from January 2012 to June 2017 to analyze the announcement effects of three key Brexit events, which are David Cameron Brexit speech (23rd Jan 2013), Passing of referendum law (27th May 2015), and Brexit vote (23rd June 2016) on the trade flows of the UK with EU and non-EU countries through Difference-in-Difference method. The study found that there was a significant reduction in UK's net exports to EU countries or regions after Brexit events, but no significant change in UK's net exports to non-EU countries. Among these three events, the announcement effect on the trade flow between the UK and EU and non-EU countries is stronger in the earlier event than in the later one.

1 Introduction

In 1957, the 'inner six' European countries signed a treaty to form European Economic Community (EEC). The 'inner six' are referred to as France, West Germany, Belgium, Italy, Luxembourg and the Netherlands. Later in 1967, the economic community is renamed as European Community (EC). Earlier in 1963 and 1967, United Kingdom applied to join the European Economic Community (EEC), but it was denied then by the Charles de Gaulle, the ruling president of France. However, in 1969 United Kingdom re-attempted to join the EEC, and later in 1972, United Kingdom successfully signed the treaty and joined the EEC. In 1975, 67 percent of the UK administrative counties voted in favor to stay in European Community (EC).

In 1989, Britain had a higher poverty rate as compared to other European countries. However, the eligible farm subsidies share of United Kingdom was very low due to its relative lack of farms. The United Kingdom contribution had to be lower as compared to other EC nations. In 1984, Margaret Thatcher, then prime minister negotiated a rebate on the budget and succeeded in a reduction of 66% from the erstwhile budget contribution.

IThe Maastricht Treaty in 1992 laid down the foundation of European Union between the twelve member countries of Europe. The European Union agreement signed between the member countries became effective from 1st January 1993. The European Union is the economic and political bloc of 27 member countries (erstwhile 28 countries including United Kingdom) located primarily in the Europe. The basic pillar of the European Union is the European Communities (EC), Common Foreign and Security Policy (CFSP) and a single European Citizenship across the European Union. The European Union was formed as an Economic Union, but later emerged as a union of policy, laws, security, and health.

The prime objective of European Union is to provide a free movement of goods, services, people and capital across the whole European Union region. EU eliminates the trade barriers, trade duties, quotas and tariff to a free flow of export and import across the region. The European Union's aim is prospering the region by improving the relations between the nations and mutual cooperation.

The British prime minister David Cameron on 23rd January 2013 delivered a controversial speech to EU referendum. On 27 May 2015, the referendum

law was passed. On 23 June 2016, United Kingdom voted the choice to leave or remain with the European Union. On the result day 24 June 2016, United Kingdom decided to leave the European Union by 52 percent against 48 percent to remain. On 31 January 2020, European Union officially exited herself from the European Union, and entered in an eleven-month transition period.

On 23 June 2016, UK voted to separate with the European Union in a referendum. The result of EU referendum on 24 June 2016 was a shocking news for the world. The event created an exogenous shock in the global economic situation which could affect the business and the firms around the world. The event was strategically important for the firms and business as the sales, cost and exports are affected for companies based out of United Kingdom. Although the UK had not completely left the EU after the prescribed two-year Brexit period, the Brexit event during this period UK had had an extremely significant announcement effect on UK and EU countries or non-EU countries (Vroom and de Wit, 2018) . This study examines whether Brexit events have negative announcement effect on the UK's trade flows with EU countries. Against the backdrop of close trade relations between UK and EU, a weak global economy and rising trade protectionism, it is crucial to study the direction of the announcement effect of Brexit on UK's trade flow in depth, so as to deal with the multidimensional impact of Brexit in a timely and effective manner.

At present, researches mostly focus on the impact of Brexit event, and the relevant achievements are mainly focused on the two aspects: the in-depth causes of Brexit event from a historical and realistic perspective and the impact on UK's economy, diplomacy and security. Although there is insufficiency of the study of the impact of Brexit on the trade, it mainly focuses on descriptive statistics and basic qualitative analysis. For example, Hestermeyer and Ortino (2016) believed that Brexit would cause international trade risks and economic uncertainties, which will force enterprises to adjust their trade strategies. Swinbank (2018) believed that the fall in the exchange rate of British pound due to Brexit would help to narrow the long-term surplus of trade in goods and deficit of trade in services between China and Britain. Blake (2020)believe that Brexit is an important opportunity for the launch of China-UK FTA negotiations. And most of the literature is limited to using the 2016 referendum as a shock.

Another two important events, David Cameron Brexit speech (23rd Jan 2013) and Passing of referendum law are also included in this study to provide evidence for the growing research on the impact of Brexit on UK's trade flows with other countries. Results shows that the impact of the three Brexit events on the UK's net exports to EU countries is not consistent from significantly positive, significantly negative, to not significant. For **David Cameron Brexit speech**, it significantly increases UK's net export to EU countries; For **Passing of referendum law**, it significantly reduces UK's net export to EU countries; And for **Brexit vote**, it has no significant effect on UK's net export to EU countries.

2 Literature Review

2.1 The impact of Brexit on the UK's foreign trade and economy

Brexit means UK loses its EU identity. EU identity is of great significance for improving the openness of UK and promoting trade and investment, which provided access to the European market and connects UK to global markets (Araujo, 2019). This is important for a dynamic economy with a strong presence in services and advanced manufacturing, as well as the complex global supply chains that many industries depend on. With services now accounting for nearly 80 % of its GDP, UK is powered by services, both within the country and trade in services (Hix, 2018). Because of its membership of the EU, UK benefits from lower trade barriers and transaction costs, making it easier to trade with the EU and world markets (Lyons et al., 2017). The elimination of tariffs and quotas and the creation of a customs union aimed at reducing the cost of goods and services across borders are benefits of EU membership. In particular, non-tariff barriers. Estimates show that the total cost of non-tariff barriers to trade manufacturing is 2 to 3 times that of tariffs (Diker Vanberg and Maunick, 2018). Efforts to reduce non-tariff barriers within the EU region have done better than most trade agreements. The Treasury calculates that trade already accounted for 65% of UK national income in 2015, compared with 23% in 1965, before the country joined the EU. Industries linked to exports to the rest of EU created 3.3m jobs (Thissen et al., 2020).

EU is the biggest trading partner of UK. Between 2006 and 2016, 55% of UK's exports went to the rest of EU; And 54 % of UK's imports came from EU. In terms of volume, the total value of UK exports in 2016 was 418.9 billion US dollars, and its total value of imports was 634.2 billion US dollars, exceeding one trillion US dollars (Lyons et al., 2017). Its economic characteristic shows the remarkable extroversion characteristic.

Table 1: UK's trade flow with its major trading partners in 2016

UK's exports to its major trading partners				UK's imports from major trading partners			
Country and Region	Volume	Compared to last year %	Accounted for %	Country and Region	Volume	Compared to last year %	Accounted for %
Total volume	634236	0.4	100.0%	Total volume	418946	-10.6	100.0%
Germany	89092	-6.1	14.0%	The United States	63012	-9.4	15.0%
The United States	58483	0.5	9.2%	Germany	44348	-5.3	10.6%
China	55264	-12.7	8.7%	French	26739	-2.5	6.4%
Netherlands	47434	-0.7	7.5%	Netherlands	25906	-2.6	6.2%
French	36587	-6.0	5.8%	Irish	23.19	-9.8	0.0%
Belgium	32102	1.7	5.1%	Swiss	19905	-41.7	4.8%
Swiss	26303	156.9	4.1%	China	18541	-33.1	4.4%
Italy	24552	-2.6	3.9%	Belgium	15965	-10.4	3.8%
Spain	22209	2.7	3.5%	Italy	13308	2.9	3.2%
Irish	18.358	-4.9	0.0%	Spain	13160	-3.3	3.1%
Norwegian	17394	-7.4	2.7%	Hong Kong	9487	-6.8	2.3%
Canada	13565	26.0	2.1%	The United Arab Emirates	9250	-11.8	2.2%
Japan	12544	22.4	2.0%	Saudi Arabia	6715	-19.3	1.6%
Poland	12534	0.3	2.0%	Japan	6620	0.1	1.6%
Turkey	12283	10.5	1.9%	Canada	6309	7.0	1.5%

Source: IMF (2006-2016)

From the table 1 above another trend can be seen. The total export of UK to Germany, France, Spain and Belgium fell by 5.3%, 2.5%, 3.3% and 10.4% respectively in 2016 compared with last year's period. UK 's imports from Germany and France also fell by 6.1% and 6.0 % respectively, while imports from Spain and Belgium rose by only 2.7 % and 1.7 % respectively. Trade between the UK and the major EU countries has contracted slightly in 2016.

Brexit means that UK lost its benefits to trade with the European market, and took the loss caused by higher trade barriers and tariffs. UK's trade of goods and services would bear a significant increase in costs, and the total transaction volume will decrease. Also, the domestic industries that related to exports will contract consequently. As a result, national income and employment can be influenced. From the latest research of the London School of Economics, although some studies painted a more complicated picture, Brexit would cause the UK's GDP to fall by between 1.3% and 2.6%. It was estimated that if UK to take off after the implementation of protectionism, then the cost would be likely to reach 2.2% of the gross national product (GNP) (2030) (Hantzsche et al., 2019). More importantly, trade in services takes a considerable proportion of UK's trade because the

UK had developed financial sector, legal, consulting and financial services (Wright and Dhaun, 2018). After Brexit, the domestic service production factors could not flow freely within the EU anymore, causing the decrease of industrial productivity. As a result, there was bound to be an exodus of services, undermining London's position as the world's financial center. If the UK chooses other trade arrangements after Brexit, the above trade barriers and obstacles could be reduced, and the loss caused by Brexit can be reduced accordingly. Brexit could also lead to a derogation of the UK's status as a host of foreign direct investment. Because labor, capital and technology could no longer flow freely as before, investors' preference for UK would fall. In turn, the advantages that Brexit may bring to the UK include getting rid of the high EU membership fee, the issue of refugees and immigrants, the strict EU rules and regulations, and the transfer of national sovereignty (Anderson and Wittwer, 2018). It can stimulate the vitality of the UK economy to a certain extent.

2.2 The impact of Brexit on the EU's foreign trade and economic cooperation

The EU countries form a huge market which is a substantial base of their economic development, and the solid European economic foundation is another reason to make the EU to become a powerful economy in the world. According to the exchange rate between Euro and US dollar on December 30, 2016, the total GDP of the EU was about 15.57 trillion US dollars, while that of the UK was about 2.63 trillion US dollars, accounting for about 16.89% of the EU in 2016 (Prescott et al., 2020). While China's total GDP in 2016 reached 11.28 trillion US dollars. After the UK's GDP is removed, the EU's comparative advantage with China's total GDP decreases sharply. If measured in terms of purchasing power, China has already become the most purchasing power economy followed by the US, but the EU will retrograde to the third purchasing power economy. In this case, the material EU market will lose the scale effect, and will not be able to play a favorable leading role in the global economic development (Langan, 2016).

This has a more obvious impact on some less developed countries in Europe. CEE countries will gradually lose the advantage of the world's largest market on which they rely for economic development, and the driving force of the European Union for their economic growth will gradually decline. After Brexit, the open labor market policy of "internal free employment" followed by EU countries will definitely change. After the change of policy,

the restrictions on immigrants from Central and Eastern European countries entering the British labor market will gradually increase, and the so-called Polish plumber, Lithuanian firefighter, etc., may gradually disappear (Brakman et al., 2018). If the policy changes, more than 1m workers from other EU countries will have only the choice of returning home or moving elsewhere. It has a great impact on the employment market of these countries, leading to the rise of the unemployment rate in these countries (Nuthall, 2016). After Brexit, the EU structural funds and aggregation now on anything "gap" in promoting the balanced role must be suffered, the two funds mainly come from European Banks and the European Union, from 2014 to 2016, the UK has contributed around 15% of the entire EU budget, these two funds after Brexit the source of funds must be suffered. As a result, EU funding to central and eastern Europe has declined. In addition, the ability of Europe to deal with the debt crisis of Greece, Italy and other countries will also be reduced. Once the debt crisis spreads to other countries, it may have a devastating impact on the economy of EU countries (Wright and Dhaun, 2018).

As for trade, transatlantic trade and investment partnership agreement (TTIP) is one of the most important agreement in the 21st century world economic development of the economic cooperation organization. EU and US to reach a consensus on TTIP agreement will form the world's largest free trade area, covering about 40% of economic output and 50% of global trade activity, is for the United States, the European Union has great attraction power (Nuthall 2016). The differences between the United States and the European Union on TTIP are very big, mainly reflected in the right to speak and the dominant power of TTIP, and also in specific industrial policies. As the most important political ally of the United States, the United Kingdom has been sparing no effort to promote the TTIP negotiation between the United States and the EU before Brexit. With the support of the political ally of the United Kingdom, the probability of the realization of the TTIP agreement is undoubtedly much greater (Raudsepp, 2019). The biggest differences between the European Union and the United States on the economic dominance, is the main character in TTIP is the United States. In the economic cooperation organization, while the participating in the organization for economic development in other countries can also play a good role in promoting, the implementation of TTIP can strengthen the U.S. dominance in the world economy, the international political rules, and economic initiatives. In contrast, the main task of the European Union in the recent period of time is to solve the problem of internal economic development, the two in

pursuit of a great difference.

3 Research methods and data processing

3.1 Theoretical model

The gravity model of trade is developed from the gravity model in physics, which was first proposed by Tinbergen. Gravity models can be derived from Krugman's monopoly competition model, traditional H-0 model, Ricardo model and Melitz model, with a solid theoretical basis (Anderson, 2011). Therefore, it has been widely used in the analysis of the influencing factors and development potential of trade volume between countries. The basic gravity model assumes that the volume of trade between two countries is proportional to the national demands and inversely proportional to the distance between them. The national demand of the two countries can be measured by their GDP. Its basic form is:

$$X_{ij} = GS_iM_j\Phi_{ij}$$

X_{ij}: the export volume from country i to country j.
M_j: All the specific factors of the importing country, representing the total demand of the importing country.
S_i: All the specific factors of the exporting country, representing the aggregate supply desire of the exporting country.
G: Variables independent of country i and country j, such as the degree of world liberalization.
Φ_{ij}: Represents the difficulty of exporting country i to country j.

Therefore, in order to test whether the impact of Brexit on the trade volume between the UK and the EU is significant, this study uses the gravity model as a basic analytical tool. After considering the key factors affecting the volume of bilateral trade, this study included the abrupt event factor of the Brexit announcement and introduced the Difference-in-Difference (short for DID) model to evaluate the announcement effect of the Brexit on the trade between the UK and the EU more objectively.

Meanwhile, in order to simplify the study, the following specification are made for the model:
(1) The initial model will rely on the assumption that the announced shocks affect only net exports to EU and EFTA countries – non-EU trade with the UK is unaffected and continues to follow a trend similar to that observed before the announcement.

(2) The study understands that the assumption in the above model may not be credible. There may be general equilibrium effects as the Brexit announcements may trigger spillover effects affecting UK trade with non-EU countries. Potential reduced UK exports to the EU following the announcement may consequently induce increased export volume to non-EU countries(Crowley et al., 2018). Assuming the gravity model holds, the induced effect of increased exports should be larger for non-EU countries that are geographically close to the EU compared to non-EU countries far from the EU region given the predictions of the gravity model (Anderson 2011). Therefore, the evaluation model of the effect of the Brexit announcement in this study is as follows:

$$Export_{it} = \beta_0 + \beta_1 treatment_t + \beta_2 post_t + \beta_3 treatment_t * post_t + \sum X_{it} + X\varepsilon_{it}$$

$Export_{it}$: the export volume of UK to country i in the period of t;
$treatment_t$: the dummy variable that distinguishes the experimental group from the control group. For EU and EFTA countries, it is 1, and for other countries, it is 0;
$post_t$: the dummy variable that distinguishes between before and after the Brexit announcement shocks. It is 0 before and 1 after the Brexit announcement shocks.
$treatment_t * post_t$: multiplicative interaction term.
Therefore, β_1 measures the difference between the exports of UK to EU and EFTA countries and exports of UK to other countries before the Brexit announcement shocks; β_2 measures the difference of UK's export to other countries before and after the Brexit announcement shocks; β_3 measures the difference between the UK's exports to EU and EFTA countries after the Brexit announcement shocks and other UK's exports in other conditions. $\sum X_{it}$ represents other controlling variables that affect UK's export. The model will control for distance, reflecting the fact that it is a gravity model; population; and GDP. This study takes logarithms of population to eliminate heteroskedasticity. To conclude, the final model is as follows:

$$\text{Export}_{it} = \beta_0 + \beta_1 treatment_t + \beta_2 post_t + \beta_3 treatment_t * post_t + \beta_4 GDP_{it} + \beta_5 UKGDP_t + \beta_6 ln(Population)_{it} + \beta_7 Distance_{it} + \varepsilon_{it}$$

3.2 Sample, data source and variable description

The empirical analysis is conducted using UK world trade panel data from January 2012 to June 2017. Since this study plans to measure the effect of the three Brexit announcement shocks, which are 23rd Jan 2013 David Cameron Brexit speech, 27th May 2015 passing of referendum law, and 23rd June 2016 Brexit vote, on the UK's trade flows with the EU. Crowley et al. (2018) used six months data before and six months after the Brexit vote in the UK. Therefore, it can be inferred that significant effects within the six months window of each announcement will be seen. To measure the UK trade flow with other 208 countries or regions, this study collected monthly value of the net export in US dollars from IMF (2019a). Since it is measured in US Dollars, the study will not control for exchange rates. For explanatory variables, the quarterly GDP data from IMF (2019b) were collected. The yearly population data for EU countries are collected from OCED (2019), and the yearly population data for non-EU countries is taken from the Bank (2019). Data regarding distances between two countries is obtained from Calculator (2020), and this study using the distance between the capital cities of the countries and London. Variables and descriptive statistics are shown in Table 2.

Table 2: Variable and description

Variable	Description
Export	UK's net exports to foreign countries
Treatment	Whether the foreign country is EU and EFTA country (Yes=1, No=0)
post	Before or after the Brexit announcement shocks (After =1, Before =0)
*treatment * post*	Multiplicative interaction term
GDP	GDP of foreign country
UKGDP	GDP of UK
Population	Population of foreign country
Distance	Distances between capital cities of UK and foreign country

4 Results and findings

4.1 Regression Results

As described in the third part, the regression of three events is performed on the above model. The descriptive and regression results are shown in Table 3. In this study, firstly, only *treatment*,*post*,and *treatment* * *post* are included in the regression, and the results are shown in Model 1; Then, the control variables are included in the regression, and the results were shown in Model 2; As discussed above, this study also groups regression according to distance, and the results are shown in Model 3 and Model 4.

Table 3: Descriptive statistical results six months window

Period	Variable	Observation	Mean	Std. Dev.	Min	Max
2012/7	*Export*	2425	-71.23	580.74	-7363.25	11054.93
-2013/7	*GDP*	2425	10.58	3.57	1.11	20.62
	UKGDP	2425	12.08	0.02	12.06	12.11
	Population	2425	34700000	1.4E+08	0.32	1.36E+09
	Distance	2425	4057.25	2373.67	226.5	11683
2014/11	*Export*	2464	-73.25	464.98	-4663.98	4230.23
-2015/11	*GDP*	2464	10.64	3.66	1.24	20.78
	UKGDP	2464	12.29	0.04	12.21	12.33
	Population	2464	35100000	1.42E+08	0.33	1.37E+09
	Distance	2464	4066.36	2359.1	226.5	11683
2015/12	*Export*	2045	-118.21	529.36	-4245.66	5639.09
-2016/12	*GDP*	2045	10.59	3.83	1.37	20.9
	UKGDP	2045	12.22	0.04	12.18	12.27
	Population	2045	39400000	1.57E+08	0.33	1.38E+09
	Distance	2045	4071.78	2525.32	226.5	11683

Table 4: Regression results on David Cameron Brexit speech (23rd Jan 2013)

	Model 1	Model 2	Model 3	Model 4
Dependent Variable	*Export*	Export	Export distance>6214	Export distance≤ 6214
treatment	227.373***	227.992***	-	222.562***
**post*	(43.057)	(285.901)		(290.44)
treatment	-352.135***	38982.133*	-	39089.108*
	(88.957)	(20849.34)		(23142.197)
post	32.528*	-153.459	565.295**	-151.372

	(17.278)	(120.745)	(236.608)	(138.675)
GDP		-23.549	-10.949	-32.068
		(25.339)	(53.625)	(29.433)
UKGDP		-3873.936**	14109.228**	-3887.68*
		(1962.718)	(5954.277)	(2177.934)
Population		345.978	1543.426	43.768
		(3896.734)	(1666.494)	(4386.021)
Distance		8.281***	-29.451**	8.751***
		(2.953)	(12.526)	(3.246)
Constant	-46.476	-	-	-
	(35.646)			
Number of observations	2425	2425	390	2035
R-squared	0.033	0.590	0.680	0.588

**** p<.01, ** p<.05, * p<.1*

For the David Cameron Brexit speech on $23^{rd} Jan, 2013$, the coefficient of $treatment * post$ is significantly positive at 90% level, indicating that David Cameron's Brexit speech significantly increases UK's net export to EU countries. This isn't consistent with previous discussions in this study and the results of the four models are consistent; the coefficient of *treatment* is significantly negative, indicating that before David Cameron's Brexit speech, there is a significant difference in UK's net exports to EU countries and non-EU countries; and the coefficient of *post* is significantly negative, indicating that before and after David Cameron's Brexit speech, there is a significant difference in UK's net exports to non-EU countries. However, as the R-squared in Mode1 is 0.033, showing that this model is unreasonable and more variable should be taken into consideration. Therefore, in model 2, we involved the GDP of other countries and areas, the GDP of UK, the ln(population) of the foreign country and the distance between UK and outside UK. Although the coefficient of interaction term still remain significant, the coefficient of post is not significant, suggesting that the export to the members in EU or EFTA did be positively affected by the speech in 2013. This study then separate the outside UK countries or regions by distance of 6214 km, within which 85% countries located in, and do a separate regression. The effect of announcement still remain the same, while the coefficient of UKGDP and distance turns into positive.

Table 5: Regression results on Passing of referendum law (27th May 2015)

	Model 1	Model 2	Model 3	Model 4
Dependent Variable	*Export*	Export	Export distance>6214	Export distance<=6214
*treatment*post*	-45.004***	-46.036**	-	-46.506**
	(15.944)	(32.394)		(32.493)
treatment	-309.33***	-5731.141	-	-6272.638
	(85.84)	(4714.471)		(5264.997)
post	-1.758	125.492***	-0.711	149.066***
	(6.343)	(45.085)	(37.989)	(52.681)
GDP		-12.912	-19.014	-14.551
		(36.01)	(47.915)	(37.857)
UKGDP		-1229.532***	-263.717	-1408.448***
		(439.603)	(275.5)	(516.606)
Population		-832.682	-309.167	-917.178
		(711)	(773.133)	(795.542)
Distance		-0.018	1.718	-0.015
		(0.08)	(8.546)	(0.084)
Constant	-20.136	21519.82***	-	24338.612***
	(34.111)	(7728.507)		(8801.808)
Number of observations	2464	2464	390	2074
R-squared	0.068	0.017	0.909	0.912

**** p<.01, ** p<.05, * p<.1*

For the announcement of passing the referendum law on May 27th, 2015, the results is shown in the table above. The coefficient of $treatment * post$ is significantly negative, as well as the sum of these three terms, indicating that Passing of referendum law significantly reduces UK's net export to EU countries. This is consistent with previous discussions in this study and the results of the four models are consistent; the coefficient of *treatment* is significantly negative, indicating that before Passing of referendum law, there is a significant difference in UK's net exports to EU countries and non-EU countries.

Table 6: Regression results on the Brexit vote (23rd June 2016)

	Model 1	Model 2	Model 3	Model 4
Dependent Variable	*Export*	Export	Export distance>6214	Export distance≤ 6214
treatment post*	10.724	12.574	-	15.675
	(32.242)	(32.287)		(36.298)
treatment	-351.076***	21901.679	-	25330.477
	(89.1)	(30621.89)		(35863.231)
post	-13.923	124.264	23.835	146.977
	(14.092)	(118.79)	(81.777)	(143.071)
GDP		13.423	206.175	13.728
		(99.57)	(161.462)	(111.808)
UKGDP		2700.451*	554.534	3174.407
		(1603.038)	(1072.469)	(1936.789)
Population		3387.551	-1334.961	3914.57
		(4687.464)	(3760.982)	(5489.76)
Distance		-0.029	0.003	-0.032
		(0.166)	(2.366)	(0.182)
Constant	-44.019	-58404.248	-	-68130.513
	(38.744)	(40030.928)		(47405.03)
Number of observations	2045	2045	365	1680
R-squared	0.065	0.737	0.741	0.735

**** p<.01, ** p<.05, * p<.1*

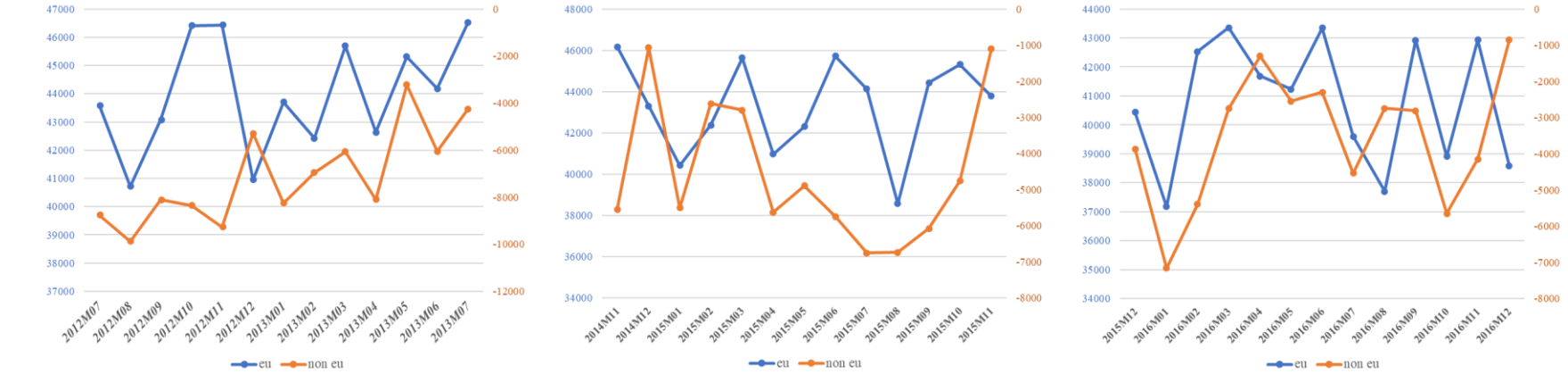
As for the results of the Brexit vote on 23rd June, 2016, in these four model, it turns out to be none of them are significant. In other words, the Brexit vote on 23rd June, 2016 did not have significantly effects over the net exports.

4.2 Parallel trend test

The analysis of DID is based on the assumption that the treatment group and the control group had a common trend before the event. If the differences between the treatment group and the control group are fixed before the experiment occurred, that is, they showed the same trend before the experiment occurred, then the control group can be considered to be the appropriate control group. (Qi et al., 2021) This test is performed with data

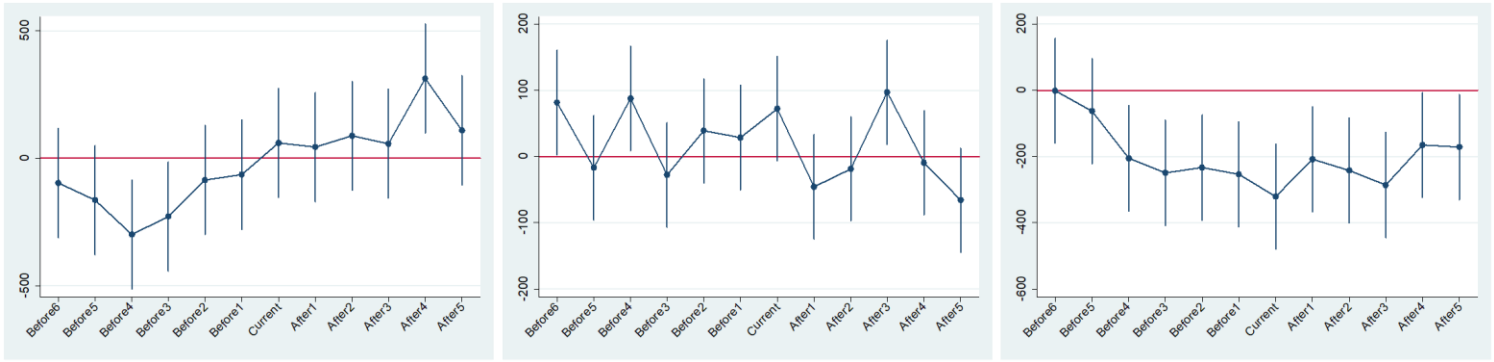
from a six-month window of three events. To compare the data, the study first calculated the total net exports of the UK to European countries and the total net exports to non-EU countries respectively (Figure 1), and then carried out a parallel trend test (Figure 2).

It can be found from Figure 1 that in the three events, the overall trend of UK's net exports to EU countries and non-EU countries was relatively consistent before the occurrence of the event. After the occurrence of the event, the overall trend seemed to have a relatively large change. Parallel trend tests continue were conducted followed. The results showed that in event 1, the coefficient did fluctuate below 0 before the event, but was significantly positive after the event. This suggests that the experimental group and the control group can indeed be compared, and that the announcement effect may occur one month after the occurrence. In event 2, the coefficient did fluctuate above 0 before the event, while it fluctuated around 0 after the event, and the amplitude became significantly positive. In event 3, the coefficient does fluctuate below 0 in all events, but after the event, it approaches 0. This shows that the experimental group and the control group can indeed be compared.



Before and after David Cameron Brexit speech | Passing of referendum law | Before and after Brexit vote

Figure 1 UK's total net exports to EU countries vs non-EU countries (six months window)



Before and after David Cameron Brexit speech | Passing of referendum law | Before and after Brexit vote

Figure 2 Parallel trend test (six months window)

4.3 Robustness test: Analysis results of the 1-year window

As described in the third part, regression of three events was performed on the above model of the 1-year window. The descriptive and regression results are shown in Table 7. And the regression results are showed in table 8. The parallel trend tests showed in Figure 3 and Figure 4.

Table 7: Descriptive statistical results (1 year window)

Period	Variable	Observation	Mean	Std. Dev.	Min	Max
2012/1	*Export*	4632	-75.2	536.79	-7363.25	11054.93
4**2014/1*	*GDP*	4632	10.58	3.57	1.11	20.64
	UKGDP	4632	12.08	0.03	12.05	12.14
	Population	4632	34800000	141000000	0.32	1.36E+09
	Distance	4632	4058.07	2379.43	226.5	11683
2014/5	*Export*	3943	-100.6	506.49	-4759.22	5639.09
4**2016/5*	*GDP*	3943	10.54	3.79	1.24	20.9
	UKGDP	3943	12.25	0.06	12.15	12.33
	Population	3943	38900000	155000000	0.33	1.38E+09
	Distance	3943	4071.4	2525.37	226.5	11683
2015/6	*Export*	3935	-109.76	505.35	-4663.98	5639.09
-2017/6	*GDP*	3935	10.58	3.83	1.37	20.93
	UKGDP	3935	12.24	0.05	12.18	12.33
	Population	3935	39400000	157000000	0.33	1.39E+09
	Distance	3935	4072.82	2524.89	226.5	11683

The regression results show that:

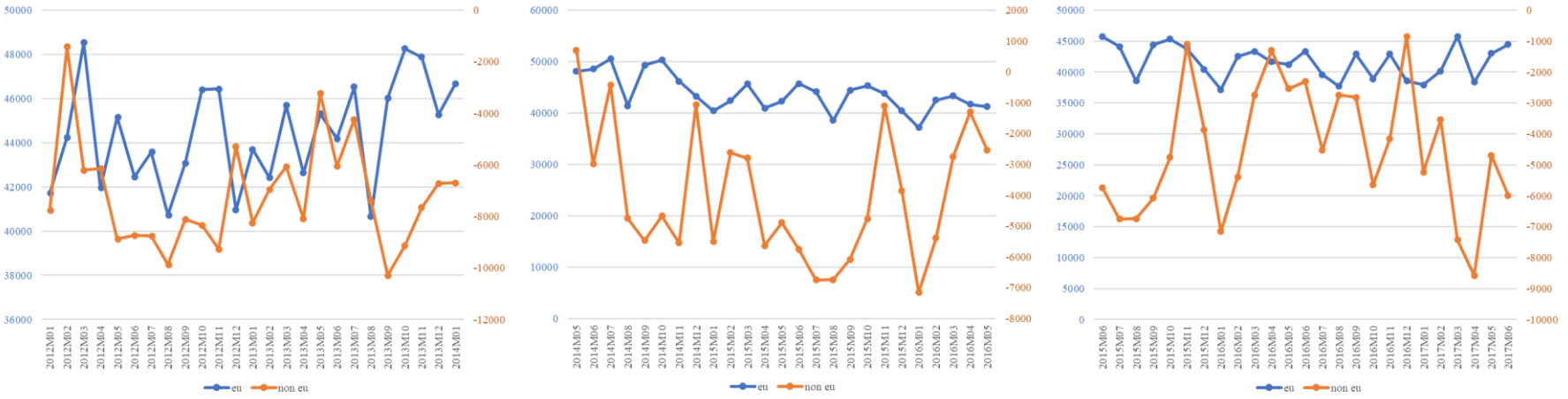
1. David Cameron Brexit speech In Model 1, the coefficient of $treatment * post$ is significantly positive, indicating that David Cameron's Brexit speech significantly increases UK's net export to EU countries. This isn't consistent with previous discussions in this study and the results of the three models (Model 1, 2, and 4) are consistent.

2. Passing of referendum law In Model 1, the coefficient of $treatment * post$ is significantly negative, indicating that Passing of referendum law significantly reduces UK's net export to EU countries. This is consistent with previous discussions in this study and the results of the three models (Model 1, 2, and 4) are consistent.

3. Brexit vote For the result of the final Brexit vote on June 23rd, 2016. In Model 1, the coefficient of $treatment * post$ is not significant, indicating that Brexit vote has no effect on UK's net export to EU countries. Therefore, the impact of the three Brexit events on the UK's net exports to EU countries is not consistent from significantly positive, significantly negative, to not significant, which is consistent with the results of the six months window.

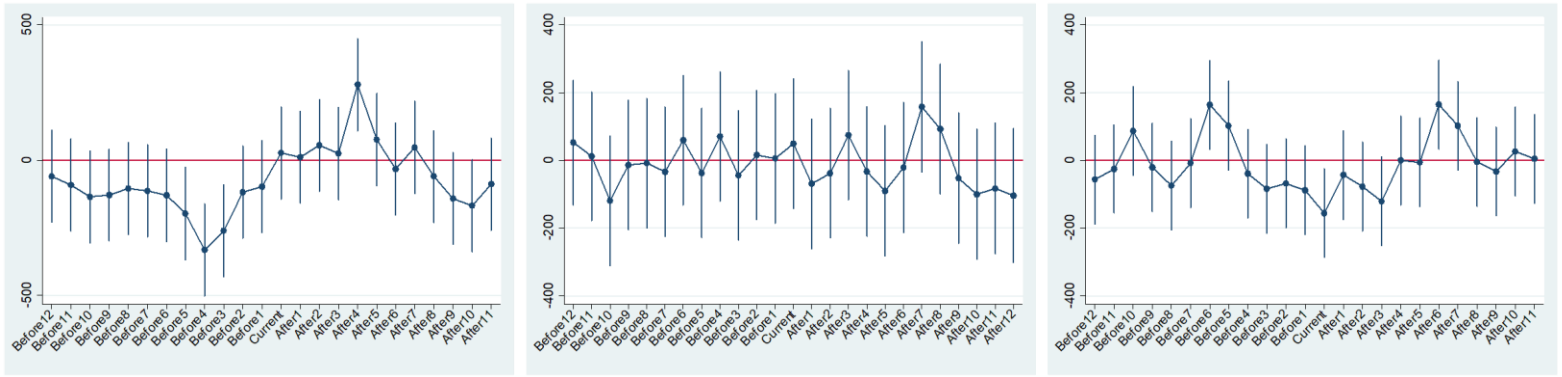
Table 8 Regression results (1 year window)

Period	2012/1-2014/1				2014/5-2016/5				2015/6-2017/6			
Dependent Variable	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
	Export	Export	Net exports （distance>6214）	Net exports （distance<=6214）	Net exports	Net exports	Net exports （distance>6214）	Net exports （distance<=6214）	Net exports	Net exports	Net exports （distance>6214）	Net exports （distance<=6214）
treatment * *post*	134.01*** (24.483)	140.465*** (26.319)	-	136.072*** (29.787)	-22.487** (16.532)	-21.245** (17.167)	-	-24.412** (19.439)	21.77 (19.127)	26.87 (19.799)	-	29.635 (22.371)
treatment	-327.858*** (87.369)	7914.338 (9378.549)	-	7195.351 (10872.094)	-314.427*** (91.884)	20058.617 (18418.541)	-	18979.898 (20338.208)	-347.948*** (88.005)	6662.591 (7373.529)	-	7601.266 (8624.766)
post	23.328** (9.864)	59.909 (71.458)	-1789.725 (1996.321)	56.276 (82.954)	1.318 (7.175)	3.102 (87.377)	1107.18 (1507.339)	5.3 (95.956)	-10.702 (8.369)	167.227 (279.905)	-149.352 (198.696)	235.413 (338.348)
GDP		-24.828 (47.222)	5.461 (42.704)	-31.462 (53.55)		-22.207 (34.291)	-19.502 (42.29)	-24.189 (39.057)		10.433 (40.277)	137.514* (74.881)	9.372 (44.967)
UKGDP		-751.089 (887.943)	19818.55 (22168.866)	-677.39 (1030.65)		-263.901 (810.385)	-10212.151 (13725.89)	-291.159 (893.817)		1832.214 (2655.761)	-1287.362 (1883.209)	2522.755 (3210.691)
Population		1235.968 (1426.468)	864.113 (957.223)	1124.179 (1652.149)		156.479 (928.198)	-177.436 (851.232)	185.634 (1084.8)		1051.74 (1132.714)	26.553 (976.06)	1197.223 (1325.152)
Distance		0.02 (0.201)	-20.942 (22.865)	0.025 (0.248)		4.315 (3.975)	20.179 (26.758)	4.032 (4.369)		-0.018 (0.087)	-4.412 (32.183)	-0.019 (0.095)
Constant	-43.295 (35.001)	-	-	-	-38.856 (39.92)	-	-	-	-38.439 (38.23)	-	-	-
Number of observations	4632	4632	750	3882	3943	3943	720	3223	3935	3935	707	3228
R-squared	0.036	0.689	0.629	0.689	0.063	0.849	0.784	0.85	0.068	0.795	0.776	0.795



Before and after David Cameron Brexit speech | Passing of referendum law | Before and after Brexit vote

Figure 3 UK's total net exports to EU countries vs non-EU countries (1 year window)



Before and after David Cameron Brexit speech | Passing of referendum law | Before and after Brexit vote

Figure 4 Parallel trend test (1 year window)

As for the parallel trend test:
As can be seen from the Figure 3, in these three events, the overall trend of UK's net exports to EU and non-EU countries was relatively consistent before the events occurred. The overall trend seems to have changed considerably since the events. The parallel trend test was then continued. The results show that in event 1, the coefficient did fluctuate below 0 before the event, but was significantly positive after the event, and then returned to negative in the eighth month. This indicates that the experimental group and the control group can indeed be compared, and the announcement effect may appear one month after the occurrence of the event, and recover to the pre-event in the eighth month. In event 2, the pre-event coefficient does fluctuate above 0, while the post-event coefficient fluctuates around 0, and the amplitude becomes larger. In event 3, the pre-event coefficient does fluctuate above 0, while the post-event coefficient fluctuates around 0, and the amplitude becomes smaller.

5 Conclusion

Therefore, the impact of the three Brexit events on the UK's net exports to EU countries is not consistent from significantly positive, significantly negative, to not significant. For David Cameron Brexit speech, it significantly increases UK's net export to EU countries; For Passing of referendum law, it significantly reduces UK's net export to EU countries; And for Brexit vote, it has no effect on UK's net export to EU countries. The results are consistent in both six months and 1-year window.

It can be inferred that the earliest event (David Cameron Brexit speech) did not have a strong announcing effect on the outside world, but when the second event occurred (Passing of referendum law), public had become more confident that Brexit would happen and had adjusted their expectations and trade practices. Therefore, the negative impact of drastic trade flows appeared. The third event (Brexit vote) was after the second event, and the two window periods were relatively close. Therefore, the impact had been absorbed by the second event, so it was not obvious in the third event.

References

Anderson, J. E. (2011). The gravity model. *Annual Review of Economics*, 3(1):133–160.

Anderson, K. and Wittwer, G. (2018). Cumulative effects of brexit and other uk and eu-27 bilateral free-trade agreements on the world's wine markets. *The World Economy*, 41(11):2887.

Araujo, B. A. M. (2019). Uk post-brexit trade agreements and devolution. *Legal Studies*, 39(4):572.

Bank, W. (2019). Population data for non-eu countries.

Blake, D. (2020). How bright are the prospects for uk trade and prosperity post-brexit? *Journal of Self-Governance Management Economics*, 8(1).

Brakman, S., Garretsen, H., and Kohl, T. (2018). Consequences of brexit and options for a 'global britain'. *Papers in regional science*, 97(1):69.

Calculator, D. (2020). Distance calculator.

Crowley, M. A., Exton, O., and Han, L. (2018). Renegotiation of Trade Agreements and Firm Exporting Decisions: Evidence from the Impact of Brexit on UK Exports. Cambridge Working Papers in Economics 1839, Faculty of Economics, University of Cambridge.

Diker Vanberg, A. and Maunick, M. (2018). Data protection in the uk post-brexit: the only certainty is uncertainty. *International Review of Law, Computers & Technology*, 32(1):201.

Hantzsche, A., Kara, A., and Young, G. (2019). The economic effects of the uk government's proposed brexit deal. *The World Economy*, 42(1):5–20.

Hestermeyer, H. and Ortino, F. (2016). Towards a uk trade policy post-brexit: The beginning of a complex journey. *King's Law Journal*, 27(3):452–462.

Hix, S. (2018). Brexit: where is the eu–uk relationship heading? *Journal of Common Market Studies*.

IMF (2019a). Exports and imports by area and countries.

IMF (2019b). Gdp-imf data.

Langan, M. (2016). Brexit and trade ties between europe and commonwealth states in sub-saharan africa: Opportunities for pro-poor growth or a further entrenchment of north–south inequalities? *The Round Table*, 105(5):486.

Lyons, B., Reader, D., and Stephan, A. (2017). Uk competition policy post-brexit: taking back control while resisting siren calls. *Journal of Antitrust Enforcement*, 5(3):347–374.

Nuthall, K. (2016). Brexit sparks uncertainty over food rules and trade for uk - comment.

OCED (2019). Population data for eu countries.

Prescott, C., Pilato, M., and Bellia, C. (2020). Geographical indications in the uk after brexit: An uncertain future? *Food Policy*, 90:101808.

Qi, S., Cheng, S., and Cui, J. (2021). Environmental and economic effects of china's carbon market pilots: Empirical evidence based on a did model. *Journal of Cleaner Production*, 279:123720.

Raudsepp, J. (2019). Perspectives of the transatlantic free trade agreement between the eu and the us after brexit. *Review of Business and Economics Studies*, 7(4):65.

Swinbank, A. (2018). Brexit, ireland and the world trade organization: possible policy options for a future uk–australia agri-food trade agreement. *Australian Journal of International Affairs*, 72(4):371–383.

Thissen, M., van Oort, F., McCann, P., Ortega-Argilés, R., and Husby, T. (2020). The implications of brexit for uk and eu regional competitiveness. *Economic Geography*, pages 1–25.

Vroom, M. and de Wit, W. (2018). Brexit: the road ahead for eu-uk trade. *EC Tax Review*, 27(4).

Wright, L. and Dhaun, N. (2018). State aid in the uk post-brexit. *CLPD*, 4:60.