The negative impact of disintegration on trade: the case of Brexit*

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Abstract

Using firm-level export and import transactions and by applying an event-study methodology, we quantify the impact of the UK's withdrawal from the EU's single market and customs union on Spain-UK trade flows. We find that Spanish exports and imports to the UK decreased by 23% and 27%, respectively, relative to the period before the Brexit referendum. Spanish exporters and importers entry into the UK declined and the probability of ending a trade relationship with the UK increased. Products affected by sanitary and phytosanitary measures, and more stringent rules of origin experienced a stronger decline in trade flows. Large firms faced a more severe decrease in exports than small ones after disintegration.

JEL: F10, F14

Keywords: Brexit, trade costs, trade policy uncertainty, Spanish firms, rules of origin, European Union.

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1 Introduction

Brexit is the most significant trade disintegration event that has occurred in recent times. On January 1st, 2021, the United Kingdom (UK) withdrew from the European Union (EU)'s single market and customs union and a new trade agreement between the UK and the EU came into effect: the Trade and Cooperation Agreement (TCA).

The TCA introduced no tariffs or quotas in the EU-UK trade if products originated in any of these partners. However, the withdrawal of the UK from the EU's single market and customs union generated new trade costs between these partners. Since customs must clear all transactions between Spain and the UK, there were new costs related to (i) the procedures to record trade transactions in customs; (ii) the certification of rules of origin (RoO); (iii) the compliance with the partner's sanitary and phytosanitary measures; (iv) inspections on animals, plants, and food products; (v) higher transport costs due to the time spent in customs waiting cargo and documents to be checked; and (vi) the payment of the value-added tax (VAT) at customs for imported products.[1]

We use the universe of Spanish firm-level export and import transactions to quantify the impact of the UK's withdrawal from the EU's single market and customs union on Spain-UK trade flows. Our identification strategy is to compare the difference of a firm's exports of a particular product to the UK and another market (first difference) before the Brexit referendum and after the TCA was implemented (second difference). The unexpected result of the referendum indicates that firms could not anticipate the UK's withdrawal from the EU. Furthermore, the rejection by the UK Parliament of two withdrawal agreements proposed by the government, extensions for the date of the official separation of the UK from the EU, and the provisional implementation of the TCA suggest that firms could not anticipate the characteristics of the new EU-UK trade relationship. This enables us to consider Brexit as a quasi-natural experiment and interpret our estimates as causal.

We find that Spanish firm-level exports and imports to the UK decreased relative to the pre-referendum period, and relative to other partners, by 23% and 27%, respectively, after the TCA. Furthermore, Spanish exporters and importers' entry into the UK decreased by 5.7% and 7.4%, respectively and the probability of ceasing an export and import relationship with a UK partner increased by 5.1% and 21.4%, respectively after the TCA. Since our estimations control for variations in real GDP and real bilateral exchange rates, these results indicate that the transition from a deep to a shallow integration between the EU and the UK had a large negative impact on Spain-UK trade flows. We also find that the withdrawal of the UK from the EU's single market and customs union

[1]Before the TCA, since products were imported from other EU countries, the VAT was paid when a firm presented its VAT declarations to its domestic revenue agency. In the new regime, there is an additional cost because firms must advance VAT payments.

had a much larger negative impact on trade flows than the previous two Brexit stages: 1) The period that spans from the Brexit Referendum to the official Brexit, when the UK was still a member of the EU (23 June 2016-31 January 2020); and, 2) The period that spans from the official Brexit to the TCA, where the UK was not member of the EU but it was part of its single market and customs union (1 February 2020-31 December 2020). This result suggests that the uncertainty about the future trade policy between the EU and the UK of the first two Brexit stages had a much smaller negative effect on trade flows than the new trade costs that emerged after the TCA.

The withdrawal of the UK from the EU's single market and customs union should raise trade costs in products more affected by sanitary and phytosanitary measures (SPS) and stringent rules of origin (RoO). In line with expectations, we find that Spanish imports from the UK decreased more after the TCA for SPS-intensive products. However, we do not find any difference in the impact of the TCA on SPS-intensive and the rest of products in Spanish exports. This difference can be explained by the fact that EU authorities demanded certifications and introduced inspections on UK imports since the beginning of the TCA. In contrast, by the end of the second quarter of 2022 (the last quarter covered by our analysis), the UK had not introduced these controls on EU imports yet. We use the information contained in the TCA to build a product-level measure of the stringency of RoO in the EU-UK trade after 2020. As expected, we find that exports and imports decreased more in products that should abide to more stringent RoO after the TCA.

We further explore whether trade disintegration had heterogeneous effects across firms. We discover that the export revenue of large exporters decreased more after the TCA than the one of small exporters. This result suggests that, in the case of Brexit, the trade cost elasticity of large exporters was higher than the one for small exporters. Contrarily, we do not find any difference in the impact of the TCA on import revenue between small and large importers. Regarding the extensive margin, we find that small firms exhibit a larger probability to cease to trade with the UK than large firms after the TCA.

Our paper makes five contributions to the literature. First, we add to the literature on the trade effects of Brexit. Using firm-level data, Fernandes and Winters (2021) found that one year after the Brexit referendum, Portuguese firms decreased their exports to the UK by 5.5% relative to other countries. Douch et al. (2020) showed that British firms increased their exports to non-EU markets relative to EU markets in the 16 months following the Brexit referendum. Crowley et al. (2020) documented that British firms had a lower probability to introduce new products into the EU six months after the Brexit referendum if those products were more likely to experience a tariff hike in a hard-Brexit scenario. We extend these analyses documenting the effect of the UK's withdrawal from the EU's single market and customs union on firms' intensive and extensive margins. As

the above-mentioned studies, we find that the first stage of Brexit, characterized by trade policy uncertainty, had a negative effect on export flows and entry.[2] However, this effect dwarfs compared to the one provoked by the implementation of the TCA. Using product-level data, Freeman et al. (2022) conclude that the TCA had only a temporary negative effect on UK exports to the EU and a permanent negative effect on UK imports from the EU. Using a different benchmark and a hybrid dataset, Kren and Lawless (2022) found the the TCA had negative effects on both UK to EU and EU to UK trade. We explore the impact of TCA on firms, the economic units at which export and import decisions are taken. We show that the TCA had a permanent negative effect on Spanish exports and imports to the UK.

Second, our paper contributes to the debate on the effects of trade policy uncertainty on trade flows. Using Portuguese firm-level data, Handley and Limão (2015) showed that the reduction in trade policy uncertainty due to the integration of Portugal into the European Economic Community (EEC) had a positive effect on firm's entry and exports to the EEC. Furthermore, this positive effect was larger than the one accounted for by the actual reduction in tariffs. Graziano et al. (2020) documented that increases in the probability of Brexit reduced EU-UK exports and net export entry in the months preceding the Brexit referendum. We show that the increase in trade policy uncertainty has a much lower impact on firms' entry, exit, exports, and imports than the one provoked by new trade costs in a trade disintegration process.

Third, our paper is also related to the literature on the costs of non-Europe. Mayer et al. (2019) and Felbermayr et al. (2022) concluded that the disappearance of the EU's single market would be the largest contributor to the fall in trade in a non-EU scenario. Using micro-data, we confirm that UK's disengagement from EU's single market had a large negative effect on firms' extensive and intensive trade margins.

Fourth, we contribute to the novel literature on the response of small and large firms to a common trade shock. Bricongne et al. (2022) found that large French exporters were more sensitive to foreign demand shocks, such as those provoked by the Great Recession and the Covid-19, than small exporters. We find that large exporters are also more sensitive to a trade-cost shock than small ones. However, we do not find any difference between large and small importers in trade-cost sensitivity.

Fifth, our work is also related to the literature that estimates the cost of using RoO in preferential trade agreements. Several papers conclude that the current system of trade restrictions associated with RoO should be simplified (Cadot and De Melo, 2008), and that the widespread and unconditional use of RoO is irrational since trade diversion

[2] Gutiérrez Chacón et al. (2021) showed that the decrease in trade with the UK after the referendum was larger for Spanish firms more exposed to the UK market and facing a larger tariff in a hard-Brexit scenario.

is not usually profitable (Felbermayr et al., 2019). We show that exports and imports between Spain and the UK decreased more after the TCA in products with more stringent RoO. Since Spain and the UK have similar external tariffs and there is, therefore, a low incentive for trade deflection, our result confirms that Ro0 introduce unnecessary trade costs.

The rest of the paper is organized as follows. Section 2 provides a description of the firm-level dataset used in the empirical analyses and presents the equations to estimate the effect of Brexit on Spanish trade flows with the UK. Section 3 presents the baseline results of the regression analyses on the impact of the withdrawal of the UK from the EU on Spanish firm's intensive and extensive margins of trade with the UK. This section comments on some further analyses to assess the robustness of our results. Section 4 explores whether the EU-UK trade disintegration had a heterogeneous impact across products and firms. The last section concludes.

2 Data and specifications

Quarterly data on the universe of Spanish firms' export and import transactions in goods was obtained from the Customs and Excise Department of the Spanish Tax Agency. The dataset contains a firm identifier, export destination or import origin, the product's combined-nomenclature eight-digits (CN 8-digit) classification, the value of the flow, and the traded quantities. Our data begins in the first quarter of 2014 and ends in the second quarter of 2022.[3] To reduce noise in the data, we removed all trade transactions with a value below or equal to 10,000 euros. As explained below, the regression equations control for export destinations and import origins' real GDP and real bilateral exchange rate. These pieces of information come from the Organization for Economic Co-operation and Development (OECD) and the International Monetary Fund's (IMF) International Financial Statistics databases, respectively. Since quarterly real GDP and real bilateral exchange rate data were not available for all countries, the dataset was reduced to 44 export destinations and import origins.[4] They account for 75% and 69% of the value of Spanish exports and imports in 2014 (the first year of our period of analysis), respectively. Our final dataset treats UK as a single country. Since Northern Ireland remained in EU's single market for goods after the TCA came into force, statistics of trade flows with this territory use the Intrastat system while the trade flows with the rest of the UK use the Extrastat system.

The UK accounted for 7% of Spanish exports of goods and occupied the top-4 position

[3] We ensure a consistent concordance across the CN 8-digit products over time following Van Beveren et al. (2012).

[4] The countries included in the sample are listed in Table A.1 in Appendix A.

as destination of Spanish exports in 2015, the year before the Brexit referendum. The UK was the top-6 supplier of Spain, accounting for 5% of its total imports of goods.[5]

Table 1 presents some descriptive statistics about the Spanish firms that traded with the UK in 2015. There were 6,846 exporters to the UK and 6,117 importers from the UK. The median exporter to the UK exported 224 thousand euros to the UK and 178 thousand euros to a non-UK destination. The value of exports to all destinations for the median exporter to the UK was 3,018 thousand euros. The median importer from the UK imported 149 thousand euros from the UK and 248 thousand euros from a non-UK market. The median importer from the UK imported 1,938 thousand euros from all markets. The median exporter to the UK had 14 export destinations and the median importer had 8 supplier countries. The median exporter to the UK sold one product in the UK and in a non-UK market. The total number of products exported by the median exporter to the UK was 3. The median importer from the UK imported one product from the UK and 2 products from a non-UK market. The total number of products imported by the median importer from the UK was 6. The UK accounted for almost 9% of total exports for the median UK exporter, whereas non-UK destinations only represented 2.7% of total exports. For the median importer from the UK, 10% of all its imports came from the UK and 5% from other markets. For almost 20% of firms exporting to the UK, this market represented their top destination. For importers to the UK, this market was the top supplier for 25% of firms.

Table 1: Descriptive statistics on Spanish firms trading with the UK in 2015

	Exporters			Importers		
	UK	Non-UK	Total	UK	Non-UK	Total
Number of traders	6,846			6,117		
Value of flow (thousand euros)	224	178	3,018	149	248	1,938
Number of markets			14			8
Number of products	1	1	3	1	2	6
% in total flow	9	3	100	10	5	100
% of firms for which top market	20			25		

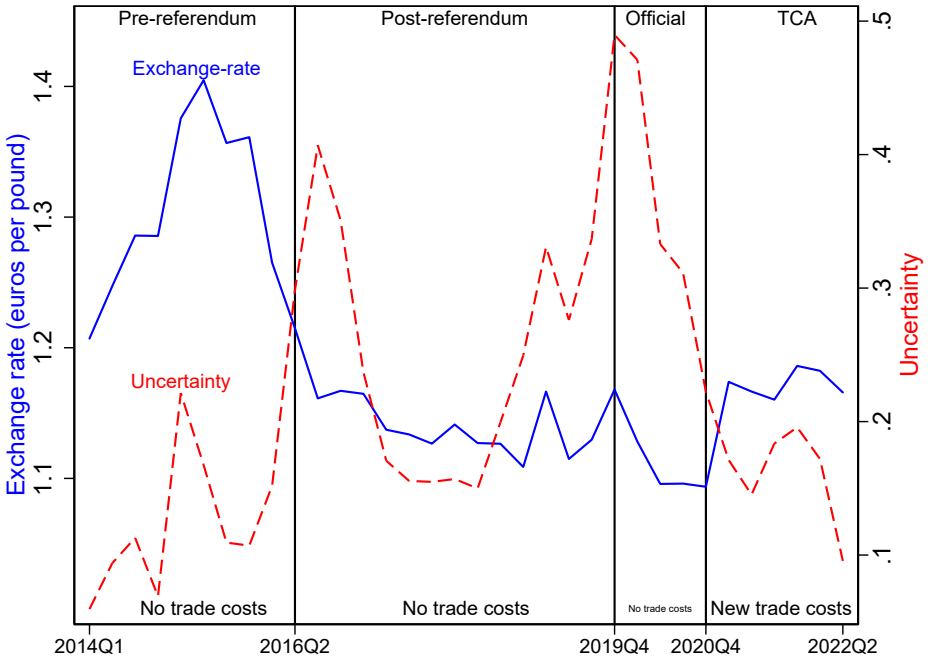
Note: Except for total, values correspond to the median trader. Source: authors' own calculations based on the Spanish Customs' database.

As explained in the introduction, we identify three Brexit stages. The first covers the period between the referendum and the official withdrawal of the UK from the EU (2016Q3-2019Q4). During this stage, the UK was still a member of the EU, so there were no new trade costs in the Spain-UK trade. In this period, two major mechanisms could

[5]Spain's trade flows with Gibraltar are not included in Spain's trade flows with the UK.

have affected trade flows between Spain and the UK, relative to the ones between Spain and other partners: trade policy uncertainty and the depreciation of the pound against the euro. Figure 1 plots the UK's overall uncertainty index calculated by Ahir et al. (2022).[6] It multiplied by three around the Brexit referendum (23 June 2016). Although uncertainty declined during 2017, it rose again and reached a maximum just before UK's official withdrawal from the EU (31 January 2020). As explained by Handley and Limão (2017), uncertainty about the conditions of a future trade relationship between the EU and the UK could have delayed firms' investments to increase their sales or purchases in the partner country, negatively affecting bilateral trade flows.

Figure 1: Uncertainty in the UK, nominal exchange rate, and new trade costs during the three Brexit stages



Source: authors own elaboration using exchange rate data from the International Monetary Fund and uncertainty data from Tab 6 of the dataset from Ahir et al. (2022).

Figure 1 also plots the euro-pound exchange rate. The pound was depreciating against the euro since the second quarter of 2015. The value of the pound relative to the euro experienced an additional 10% depreciation right after the referendum and it continued depreciating until the end of 2018. This depreciation could have negatively affected Spanish exports to the UK and favored Spanish imports from the UK.

[6]The uncertainty index is calculated counting the number of times the term "uncertainty", or variants of this term, appears in the Economist Intelligence Unit country reports. We select the three-quarter weighted moving average, the uncertainty index most preferred by the authors when working with country-level data. See also Hassan et al. (2020) for an alternative measure of Brexit-related uncertainty.

The second stage covers the period between the official Brexit and the new trade agreement (2020Q1-2020Q4). During this period, denoted as Official, the UK was still a member of the EU's single market and customs union. Thus, no new trade costs had arisen yet between the EU and the UK. The level of uncertainty in the UK was reduced by more than half and the exchange rate of the pound against the euro further depreciated.[7]

The third stage covers the implementation of the TCA (2021Q1-2022Q2). This agreement introduced no tariffs or quotas in the EU-UK trade if products originated from any of these partners. However, it introduced new non-tariff measures in the UK-EU trade.[8] During this stage, uncertainty in the UK decreased to pre-referendum levels and the exchange rate appreciated.

To identify the causal effect of the TCA, and the previous two Brexit stages, on Spanish firms' trade with the UK, we estimate the following difference-in-differences regression:

$$\ln x_{fkct} = \beta_1(UK_c \times PostReferendum_t) + \beta_2(UK_c \times Official_t) + \beta_3(UK_c \times TCA_t) + \alpha_1 \ln RER_{ct} + \alpha_2 \ln RGDP_{ct} + \gamma_{fkc} + \gamma_{fkt} + \epsilon_{fkct} \quad (1)$$

where x_{fkct} are exports by firm f of product k to country c at time t. UK_c is an indicator variable that turns one if the destination of exports is the UK. $PostReferendum_t$, $Official_t$, and TCA_t are indicator variables that turn one if t is between the third quarter of 2016 and the fourth quarter of 2019, the first quarter of 2020 and the fourth quarter of 2020, and the first quarter of 2021 or later, respectively. RER_{ct} is the real bilateral exchange rate between Spain and country c at time t.[9] An increase in RER_{ct} means a real depreciation of the euro against the currency of country c. $RGDP_{ct}$ is the real GDP of country c at time t. γ_{fkc} is a firm×product×country fixed effect. It captures the permanent differences in a firm's export of product k across destinations, such as distance, speaking the same language, or the size of markets. γ_{fkt} is a firm×product×time fixed effect that controls for the evolution of the marginal cost of manufacturing product k by firm f and of any time-specific global supply and demand conditions that may affect exports of product k. ϵ_{fkct} is the disturbance term.

Our key parameter is β_3. It captures how the difference in firm f exports of product k between the UK and another destination (first difference) changed between the pre-referendum period and the UK's withdrawal from the EU's single market and customs

[7] Note that Official coincides with the period in which the most stringent confinement measures to arrest the spread of the Covid-19 virus were implemented. As explained below, our difference-in-differences methodology neutralizes the effect of those measures on trade flows.

[8] It is important to note that due to the Northern Ireland Protocol, this UK region remains in the EU's single market for goods.

[9] It is defined as $RER_{ct} = NER_{ct}\frac{CPI_{ct}}{CPI_t}$, where NER_{ct} is the nominal exchange rate of the euro against the currency of country c at time t. It is measured as euros per unit of currency of c. CPI_{ct} and CPI_t are the consumer price index in c and Spain, respectively.

union (second difference). The parameters β_1 and β_2 enable us to compare the effect of the first two Brexit stages, characterized by trade policy uncertainty, with that of the third stage, characterized by the emergence of new trade costs.

We also estimate a specification that includes interaction terms for each quarter included in the sample period (2014Q1-2022Q2):

$$\ln x_{fkct} = \sum_t \beta_t (UK_c \times D_t) + \alpha_1 \ln RER_{ct} + \alpha_2 \ln RGDP_{ct} + \gamma_{fkc} + \gamma_{fkt} + \epsilon_{fkct} \quad (2)$$

where D_t is an indicator variable that turns one if the analyzed quarter is t.

This flexible specification enables us to analyze the evolution of the difference between exports of firm f of product k to the UK and another market in the second quarter of 2016 (first difference) relative to any other quarter included in the sample (second difference). We select 2016Q2 as the reference quarter, as the Brexit referendum took place at the end of that quarter (23 June 2016).

Finally, we analyze whether the UK-EU trade disintegration had an impact on the probability of a Spanish firm entering or exiting the UK market. We analyze entry at the firm×destination rather than the firm×destination×product level because there are computational limits to manage the universe of options in the latter case. The specification to analyze the extensive margin of trade is defined as follows:

$$\begin{aligned} Y_{fct} = \beta_1 (UK_c \times PostReferendum_t) + \beta_2 (UK_c \times Official_t) + \beta_3 (UKc \times TCA_t) \\ + \alpha_1 \ln RER_{ct} + \alpha_2 \ln RGDP_{ct} + \gamma_{ft} + \gamma_c + \epsilon_{fct} \end{aligned} \quad (3)$$

where Y_{fct} turns one if firm f did not export to c at time $t-1$ and exported to c at time t.

To reduce the sparsity of firm-level trade flows when high-frequency time data is used, in Equation (3) t denotes the first or the second half of a year. The specification includes a firm×time fixed effect and a destination fixed effect. The first controls for firm-level time-varying factors, such as marginal costs, which may facilitate a firm's entry into a new market. The second controls for all time-invariant factors that make a destination easier or more difficult to enter by a firm. It is important to stress that, for each half of the year and destination, the estimation sample only includes the firms that did not export to destination c at time $t-1$.

We use the same specification to analyze the exit of a firm from destination c. In this latter analysis, Y_{fct} turns one if firm f was exporting to c at $t-1$ but did not export to

c at t. The exit estimation sample only includes, for each destination and half year, the firms that were exporting at $t-1$.

3 Baseline results

This section presents the baseline results on the impact of the withdrawal of the UK from the EU's single market and customs union on Spanish firms' exports and imports to the UK. First, we present the regression results for the intensive margin of trade and, then we comment on the estimates for the extensive margin of trade. The section finishes discussing some additional analyses to assess the robustness of our results.

3.1 Intensive-margin-of-trade analyses

Table 2 presents the estimates of the impact of trade disintegration on Spanish firms' trade flows with the UK. Columns 1 to 3 present the estimates for exports and columns 4 to 6 the ones for imports. We cluster standard errors at the destination level.

Some scholars (e.g. Fernandes and Winters (2021)) consider that the nominal depreciation of the pound against the euro that happened right after the referendum should be considered as an effect of Brexit (see Figure 1). Hence, in column 1, instead of controlling for bilateral real exchange rates, we only control for differences in prices between Spain and the destination country, that we denote as $RelativeCPI$. In this specification, the impact on exports of the variation in the nominal euro-pound exchange rate that occurred between the pre-referendum period and the rest of Brexit stages will be captured by the Post-referendum, Official, and TCA coefficients.

As expected, column 1 shows that Spanish firms export more to destinations with a larger GDP. However, surprisingly, we find that a raise in prices in the destination of Spanish exports, relative to Spanish prices, reduces the value of Spanish exports. The Post-referendum coefficient is negative and statistically significant: a Spanish firm's exports to the UK decreased, relative to other countries, by 4.1% ([exp(-0.042)-1]*100) after the referendum. Our coefficient is in line with the result of Fernandes and Winters (2021) using Portuguese data and a post-referendum period that only covered the 12 months after the referendum.[10] The Official coefficient is also negative and statistically significant, but smaller in magnitude than the Post-referendum coefficient (-0.031). The TCA coefficient is negative, statistically significant, and large in absolute terms. According to this coefficient, firm-level exports to the UK after the TCA decreased by 24.5% ([exp(-0.281)-1]*100) relative to the pre-referendum period. Our estimates indicate that

[10] Our specification differs from Fernandes and Winters (2021) in using export levels rather than year-to-year differences and applying more detailed fixed effects.

Table 2: Impact of Brexit on Spanish firms' trade flows with the UK

	Exports			Imports		
	(1)	(2)	(3)	(4)	(5)	(6)
Post-referendum	-0.042^a	-0.019^c	-0.019^c	-0.057^a	-0.075^a	-0.074^a
	(0.008)	(0.010)	(0.009)	(0.007)	(0.015)	(0.015)
Official	-0.031^b	-0.006	-0.005	-0.066^b	-0.083^b	-0.082^b
	(0.013)	(0.014)	(0.013)	(0.027)	(0.032)	(0.032)
TCA	-0.281^a	-0.266^a	-0.266^a	-0.304^a	-0.313^a	-0.312^a
	(0.021)	(0.020)	(0.020)	(0.027)	(0.028)	(0.028)
ln Real GDP	0.504^a	0.501^a	0.509^a	0.500^a	0.552^a	0.555^a
	(0.123)	(0.120)	(0.121)	(0.141)	(0.136)	(0.138)
ln Relative CPI	-0.130^c			0.236^a		
	(0.066)			(0.060)		
ln Real exchange rate		0.205^a	0.209^a		-0.167	-0.168
		(0.067)	(0.066)		(0.109)	(0.108)
ln Uncertainty			0.000			-0.001
			(0.003)			(0.003)
Observations	4411725	4411725	4382243	2592774	2592774	2582526
Adj.-R2	0.791	0.791	0.791	0.755	0.755	0.755
Firms	48702	48702	48702	72407	72407	72407
Countries	44	44	44	44	44	44
Products	7802	7802	7802	8192	8192	8192

Note: The dependent variable is the (log) value of exports in columns 1 to 3 and the (log) value of imports in columns 4 to 6. All estimations include a firm×country×product fixed effect, a firm×product×quarter fixed effect, and a constant. Standard errors clustered at destination level are in parentheses. a, b, and c: statistically significant at 1%, 5%, and 10%, respectively.

the UK's withdrawal from the EU's single market and customs union had a much larger negative effect on Spanish exports to the UK than the British decision to leave the EU (Post-referendum) and the official separation of the UK from the EU (Official).

We introduce the real bilateral exchange rate in column 2 to neutralize the effect that the depreciation of the pound against the euro may had on Spanish exports. The real exchange rate coefficient has the expected positive sign: an increase in the Spanish real exchange rate (e.g., a real depreciation of the euro relative to other currencies) increases the value of Spanish exports. The Post-referendum coefficient remains negative and significant, but its point estimate is smaller, in absolute terms, than that reported in column 1. According to the new coefficient, a Spanish firm's exports to the UK decreased, relative to its exports to other countries, by 1.9% ([exp(-0.019)-1]*100) after the referendum. This result indicates that more than half of the reduction in Spanish exports to the UK during Post-referendum was explained by the nominal depreciation of the pound against the euro. The Official coefficient is statistically insignificant. However,

as shown later, the zero value of this coefficient is explained by the surge in Spanish exports to the UK in the last quarter of 2020, in anticipation of the increase in trade costs due to the TCA in January 2021. If we removed the last quarter of 2020 from the sample, the Official coefficient would become negative, statistically significant, and similar in magnitude to the Post-referendum coefficient. Finally, the TCA coefficient remains negative, statistically significant, and large in absolute terms. According to this coefficient, firm-level exports to the UK after the new trade agreement was signed decreased by 23.3% ([exp(-0.266)-1]*100) relative to the pre-referendum period.

In column 3 we introduce Ahir et al.'s (2022) country-level uncertainty index. The coefficient is statistically insignificant and its introduction in the regression equation alters minimally the rest of coefficients. This result is in line with Freeman et al. (2022), who argue that once a firm has paid the sunk costs of entering a foreign market, it will not adjust its current behavior substantially even if it anticipates a future increase in trade costs. Only when trading costs materialize will the firm adjust its trade flows.

Columns 4 to 6 of Table 2 show the impact of Brexit on Spanish firm-level imports from the UK. The negative impact of Brexit on import flows became larger as the UK advanced along the three stages: during the post-referendum period, the value of imports decreased by 5.5%; during the Official period by 6.4%; and during the TCA period by 26.2%. These percentages increase when we control for bilateral real exchange rates (column 5): 7.2%, 8.0%, and 26.9% in the Post-referendum, Official, and TCA stages, respectively. Hence, the depreciation of the pound against the euro moderated the negative impact of Brexit on imports. Results are minimally altered when we introduce the uncertainty index (column 6). Since uncertainty is statistically insignificant, we decided to drop this variable in the rest of regressions.

Comparing the coefficients of the Brexit stages in column 6 with those in column 3, we observe that the magnitude of the effect is larger for imports than for exports. This difference is particularly salient in the first two Brexit stages. As explained later, this effect can be explained by the fact that imports from the UK were decreasing before the referendum. Hence, the Post-referendum and Official stages could be capturing this downward trend. Furthermore, as shown later, the results for the first two stages are sensitive to the sample of countries used as a control group.

To sum up, our results show that the TCA had large negative effects on Spanish exports and imports to the UK. The first result is in line with Freeman et al. (2022), who found that TCA had a persistent negative effect on UK's imports to the EU. However, they showed that the negative effect of the TCA on UK exports to the EU may have been transitory, while we find that 18 months after the TCA the negative effect of Spanish imports from the UK persists.

The Post-referendum, Official, and TCA coefficients reported in Table 2 are stage

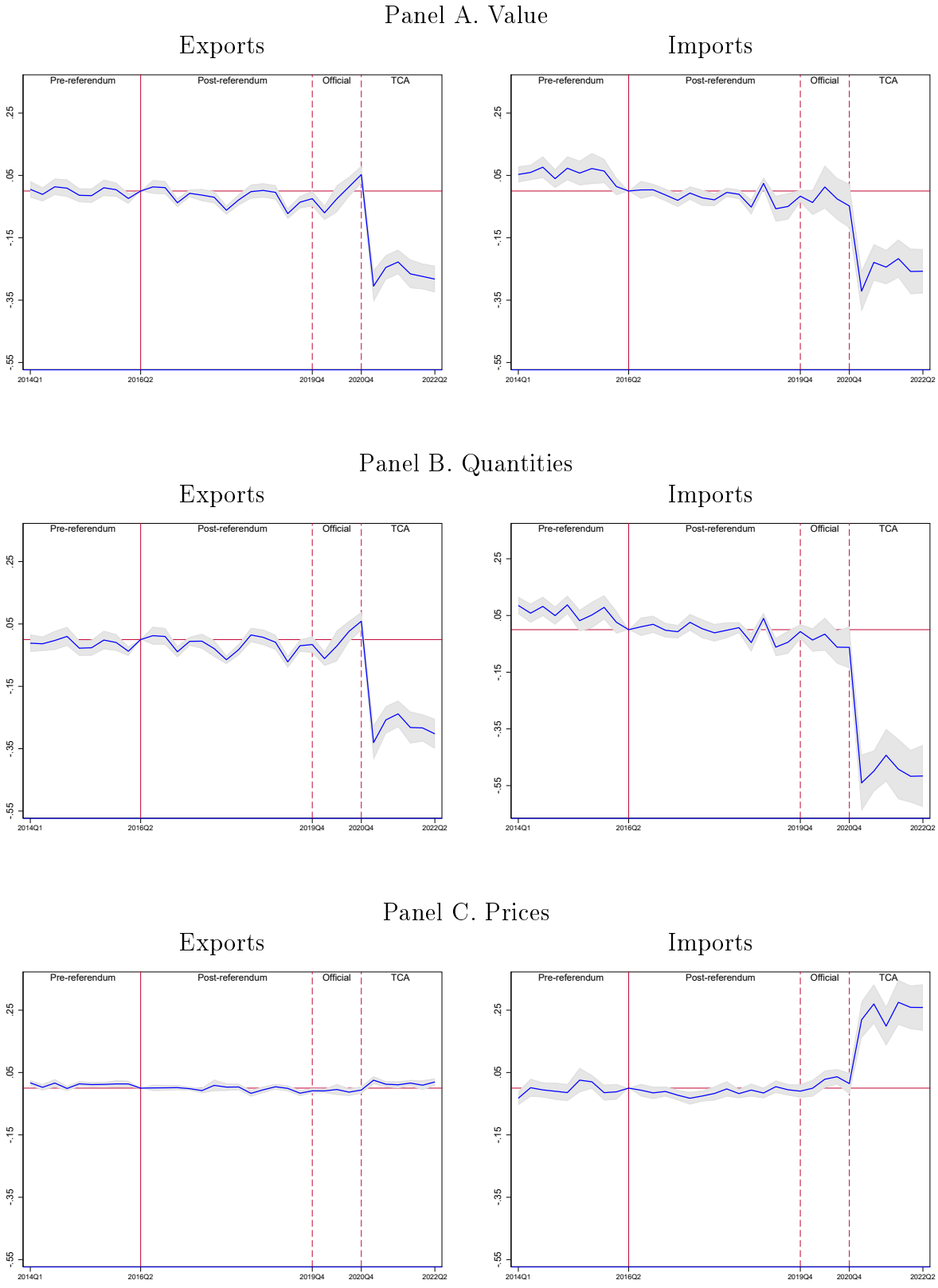
averages. However, the impact of Brexit could be different throughout the stage. To explore this possibility, we estimate Equation (2). Furthermore, we decompose the effect of the three Brexit stages on trade value into quantity and price. Panels A, B, and C of Figure 2 plot the quarterly UK interaction coefficient for value, quantity, and price, respectively. In addition to the point estimate, we draw the 95% confidence interval for each coefficient. The reference quarter is 2016Q2.

Panel A of Figure 2 shows that before the Brexit referendum, Spanish firms' exports to the UK were not statistically different, at 5%, from those to other countries. After the referendum, we observe a mild negative trend in the UK coefficient. Notwithstanding, there are many point estimates that are statistically not different from zero during this period. In the last quarter of 2020, when Brexit was already official, there is a substantial increase in the point estimate. This increase suggests that exporters were moving forward their sales in anticipation of larger trade costs after the introduction of the TCA. There is a massive drop in the point estimate in the first quarter of the TCA stage. Although coefficients become less negative in the following quarters, their values are still much lower than in the previous Brexit stages. This indicates that the large decrease in exports to the UK after the TCA remained for, at least, the following five quarters.

Spanish firm-level imports from the UK where slightly larger in the pre-referendum period relative to the quarter in which the referendum was held. Furthermore, imports began to decrease before the referendum took place. As mentioned above, this may explain the negative Post-referendum and Official coefficients reported in columns 4 to 6 of Table 2. We do not observe any increase in imports in the last quarter of 2020 in anticipation of the larger trade costs after the TCA. There is a large drop in the point estimate in the quarter in which the TCA was implemented. Coefficients remain large and negative during the following quarters.

Exported quantities (panel B) follow a trend similar to the one of values (panel A). However, we observe a magnification in the drop of imported quantities during the TCA period. This is explained by the large increase in import prices after the TCA (panel C). Export prices are similar in the Pre-referendum, Post-referendum, and Official periods; however, they slightly increase after the TCA. In contrast, there was a large increase in import prices when the TCA was implemented. Since imports are valued CIF (cost, insurance, and freight included), this result suggests that the increase in prices is capturing the rise in transportation and other logistic costs after the TCA. The fact that exports are measured FOB (free on board) may explain why we do not observe any change in export prices after the TCA.

Figure 2: Spanish firm-level trade flows with the UK, relative to other countries, along the Brexit stages



Note: The figures report the point estimate and the 95% confidence interval of the quarter coefficients estimated in Equation (2). The excluded category is 2016-Q2.

3.2 Extensive-margin-of-trade analyses

This subsection analyzes whether the EU-UK trade disintegration had an impact on a Spanish firm's probability of entering and exiting the UK. This country's disengagement from EU's single market and customs union introduced a break in the series recording the number of Spanish exporters and importers to the UK. Since there are no border controls in the EU members' trade, to quantify trade flows within the EU, firms must fill in a declaration each month, denominated Intrastat, which records all firms' exports and imports with EU members. However, in the case of Spain, since 2015, only firms that have accumulated a value of exports (imports) with EU members of 400,000 euros in the current year or in the previous year must fill the Intrastat declaration. Once the UK leaves the EU's single market and customs union, Spanish customs records all transactions above 1,000 euros with the UK. This leads to a large increase in the number of Spanish firms trading with the UK from 2021 onward: many firms that were absent from trade statistics before 2021 because they had no obligation to fill the Intrastat declaration appear now in customs records. To address the break in the series, we perform the entry and exit analyses with a sample of firms whose trade flows with the UK were recorded between 2014 and 2020.

We use Equation (3) to estimate the impact of each Brexit stage on Spanish firms' entry and exit into the UK. Columns 1 and 2 of Table 3 report the estimates for entry and columns 3 and 4 for exit. Spanish firms reduced their probability of entering the UK after the Brexit referendum by 0.6 percentage points relative to the pre-referendum period (column 1). During the Official period, there is an increase of 2.4 percentage points in the entry rate. As shown later, this rise is explained by Spanish firms moving forward their sales at the last quarter of 2020 to avoid the costs introduced by the new trade agreement. Finally, the entry rate decreases sharply during the TCA period: 5.7 percentage points. In the case of imports, the TCA also led to a 7.4 percentage points decrease in the probability of beginning to import from the UK (column 2).

Spanish firms' probability of ceasing to export to the UK increased by 5.1 percentage points after the TCA (column 3). The probability of ceasing to import from the UK increased massively after the TCA: 21.4 percentage points (column 4).

To analyze how firms' entry and exit from the UK behaved along each Brexit stage, we estimate the entry and exit coefficients for each half year included in our sample using an equation similar to (2). The left-hand side of panel A of Figure 3 shows that Spanish exporters' probability of entering the UK was declining before the Brexit referendum. Spanish exporters were less likely to enter the UK than other markets until 2018. However, the trend shifted afterwards. It is noteworthy the increase in the probability of entering the UK during the second half of 2020. As mentioned above, this increase may reflect

Table 3: Impact of Brexit on Spanish firms' entry and exit in the UK

	Entry		Exit	
	(1)	(2)	(3)	(4)
	Exports	Imports	Exports	Imports
Post-referendum	-0.006^a	-0.005^a	0.005^b	0.001
	(0.001)	(0.001)	(0.002)	(0.003)
Official	0.024^a	0.014^a	0.004	-0.002
	(0.001)	(0.001)	(0.003)	(0.002)
TCA	-0.057^a	-0.074^a	0.051^a	0.214^a
	(0.001)	(0.001)	(0.003)	(0.006)
ln Real GDP	0.009	0.008	-0.062^a	-0.013
	(0.010)	(0.008)	(0.023)	(0.020)
ln Real exchange rate	0.006^c	0.002	-0.050^a	0.006
	(0.003)	(0.004)	(0.012)	(0.013)
Observations	5656823	5500785	1256334	717428
Adj.-R2	0.076	0.080	0.182	0.097
Firms	16590	26174	16812	19405
Countries	44	44	44	44

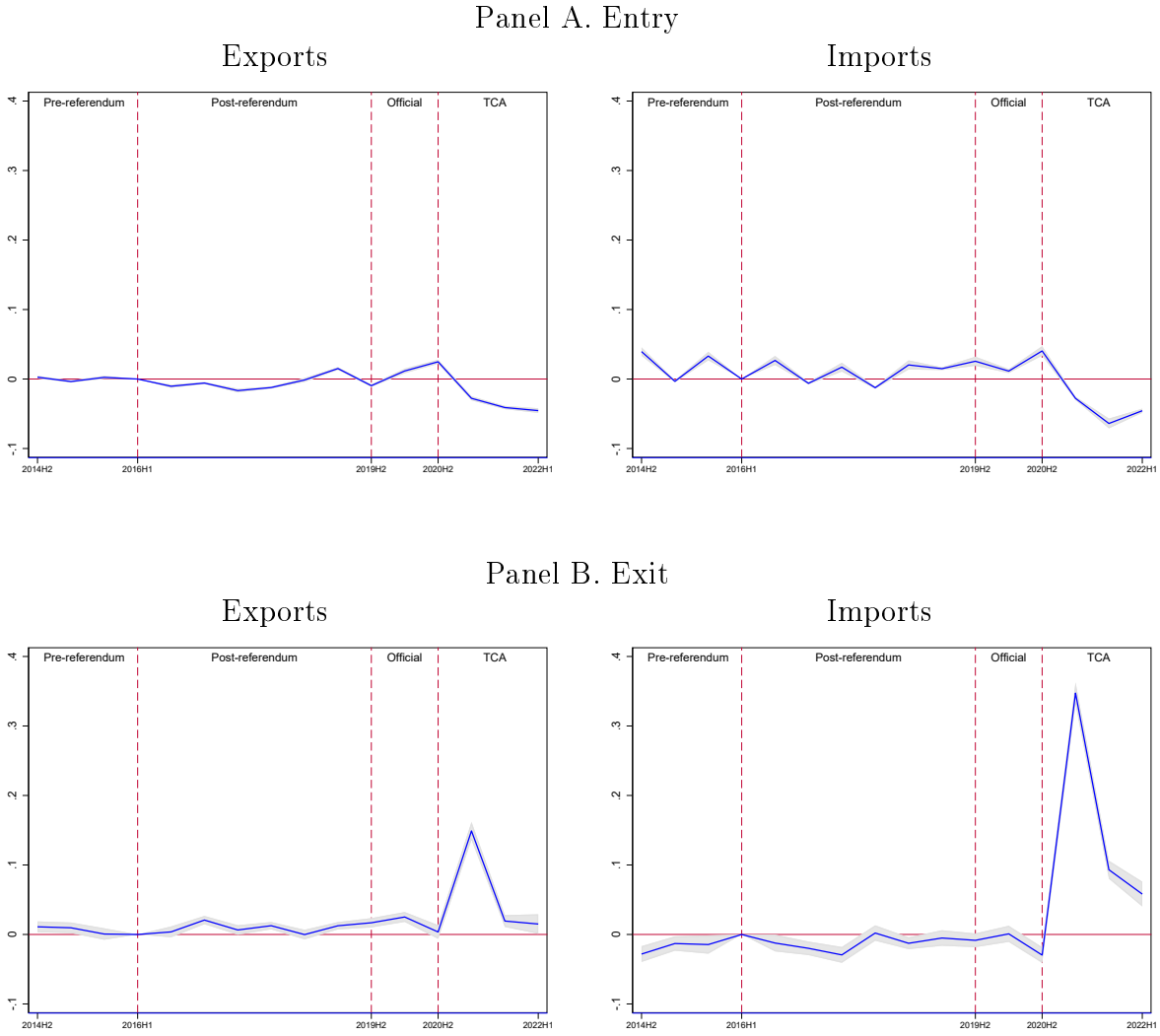
Note: In column 1 (column 2) the dependent variable turns one if firm f that did not export (import) at $t-1$ began exporting (importing) at t. In column 3 (column 4) the dependent variable turns one if firm f exported (imported) at $t-1$ ceased to export (import) at t. All estimations include a firm×time fixed effect, a destination fixed effect, and a constant. Standard errors clustered at destination level are in parentheses. a, b, and c: statistically significant at 1%, 5%, and 10%, respectively.

firms advancing their exports to the UK in anticipation of larger trade costs following the TCA. There is a large decrease in the probability of entering the UK after the TCA. In the case of imports, we observe an increase in the probability of entering the UK from 2018 until the end of the Official period. There is a large drop in the probability of entering the UK after the TCA. Panel B of Figure 3 shows that the probability of exiting the UK market rose sharply after the TCA for Spanish exporters and importers, being more intense for the latter.

3.3 Robustness

We perform four additional exercises to assess the robustness of our baseline results. First, we present the intensive and extensive-margin-of-trade estimates for alternative control groups in Table A.2 to A.4 in Appendix A. In column 1 of Table A.2, we select EU countries as a control group. This enables us to compare the impact of the TCA relative to countries that remained within the EU's single market and customs union. In addition, the majority Spanish shipments to the EU and the UK are transported by road, so our estimates will not be contaminated by the variation in the modes of transport

Figure 3: Spanish firms' entry and exit in the UK market



Note: The figures report the point estimate and the 95% confidence interval of the quarter coefficients estimated in Equation (1). The excluded category is 2016-H1.

across destinations.

The negative impact of the TCA on exports and imports is larger than in the baseline estimates. In columns 2 and 3 we divide the sample of EU countries among those that share the euro and those that keep their own currency. We find robust results for the negative impact of the TCA, although the magnitude of the effect is larger for euro countries than for non-euro countries, especially with regards to imports.

We do not find robust results for the Post-referendum and Official periods. For example, the Post-referendum period had a significant negative effect on exports and imports to the UK relative to other EU countries, but not relative to non-euro EU countries. The Official coefficient is negative and significant in exports for the sample of EU countries, but it becomes statistically insignificant, or positive and significant, in the sample of euro

and non-euro countries.

Tables A.3 and A.4 in Appendix A confirm that the TCA led to a reduction in the probability of entering the UK and increased the probability of exiting the UK when we use the EU, euro and the non-euro (EU) samples.

Second, we analyze whether results for the intensive margin of trade are robust to using a sample that only includes firms that exported to the UK in all the years covered in our database: 2014-2022. Column 1 of Table A.5 shows that the first two Brexit stages had no impact on regular exporters' revenue in the UK. Contrarily, the TCA had a large negative effect on exports. All Brexit stages had a negative effect on regular importers' purchases from the UK (column 2). The largest negative effect occurred when the TCA was implemented.

Third, coinciding with the entering into force of the TCA, the UK reduced the most-favored-nation (MFN) tariff on many products. This reduction made EU products less competitive relative to third country products in the UK market. Hence, the large negative TCA coefficient for Spanish exports reported in the baseline analysis may be explained not only by the new trade costs introduced by the TCA, but also by the lower competitiveness of Spanish products in the UK market. To neutralize the effect of the change of the MFN tariff, we re-estimate the model using a sample of products whose MFN tariff did not change after the 1st of January of 2021 (2,144 over 5,381 products).[11] Column 3 of Table A.5 shows that the TCA coefficient for Spanish exports, -0.318, is larger than the one estimated for the whole sample, -0.267 (column 2 of Table 2). These results suggests that the TCA coefficient reported in the baseline analysis was not biased downward due to the loss of competitiveness of Spanish exports caused by the reduction of UK's MFN tariff on third countries.

Fourth, our sample includes firms operating in different sectors: agriculture, mining, manufacturing, and wholesale. Manufacturing is the activity that accounts for the bulk of Spanish trade in goods. We assess whether results are robust to using a sample that only includes firms operating in this industry. To determine the activity of firms, we merge the Customs database with the SABI database from Bureau Van Dijk using the correspondence explained in de Lucio et al. (2018). SABI provides financial and accounting records of firms that deposited their accounts in the Spanish Business Register. In addition, it provides the 4-digit NACE classification of the economic activity of the firm. We select all firms whose economic activity lies between NACE code 1000 and 3200. We only select firms that have 10 or more employees. This reduces the sample of firms from 48,702 to 7,225 in exports and from 72,407 to 6,630 in imports. Nevertheless, these firms still account for 59% and 40% of all Spanish exports and imports, respectively.

[11] These products are evenly distributed across the HS chapters.

Table A.6 in Appendix A presents the results. The TCA coefficient for exports and imports' value is negative, large in absolute terms, and highly significant. However, the point estimates for manufacturing firms are lower than the ones estimated for the whole sample of firms. Furthermore, the PostReferendum and Official point estimates are larger (in absolute) terms than those estimated in the baseline analysis. The TCA reduces the probability of Spanish traders of entering the UK and increases the probability of exiting the UK. These point estimates are also lower (in absolute terms) than those estimated in the baseline analysis.

4 Heterogeneity analyses

This section analyzes whether the EU-UK trade disintegration had heterogeneous effects across products and firms.

4.1 Differences across products

Our previous analyses concluded that the TCA had a large negative effect on Spanish firm-level exports and imports to the UK. Our narrative is that the UK's withdrawal from the EU's single market and customs union generated new trade barriers in the EU-UK trade, leading to a decline in trade flows among these partners. We expect some of these new trade barriers to have a larger negative impact on some products than others.

First, since the implementation of the TCA, the EU requested SPS, such as certificates and inspections, on animals, plants, and their products arriving from the UK. Although the UK had also planned to introduce SPS on EU imports, by the second quarter of 2022, the last quarter included in our sample, they were not required yet. We define an indicator variable, SPS, that turns one if a product is classified between Chapters 1 and 16 (both included) of the HS classification.[12] We multiply the SPS variable by each Brexit stage interaction variable and add them to Equation (1).

Columns 1 and 2 of Table 4 present the results for exports and imports, respectively. Although all regressions include log real GDP and log real bilateral exchange rate variables, to save on space, their coefficients are not reported in the tables. The negative impact of the TCA on Spanish exports to the UK was similar for SPS and non-SPS products (column 1). This result is in line with expectations since the UK had not implemented any SPS after the TCA. In line with expectations, we discover that imports of SPS products from the UK were more negatively affected by the TCA than imports of non-SPS products (column 2). Specifically, whereas imports of non-SPS products de-

[12]The animal, plants, and their products subjected to health certificates and controls are listed in EU Commission's Regulations 2019/2072 and 2021/632.

Table 4: Impact of Brexit by products

	SPS		Rules of Origin	
	(1)	(2)	(3)	(4)
	Exports	Imports	Exports	Imports
Post-referendum	-0.012	-0.072[a]	-0.038[a]	-0.070[a]
	(0.011)	(0.015)	(0.011)	(0.014)
Post-referendum x SPS	-0.039[b]	-0.036		
	(0.016)	(0.028)		
Post-referendum x High-RoO			0.038[a]	-0.014
			(0.012)	(0.019)
Official	0.007	-0.080[b]	-0.037[b]	-0.076[b]
	(0.013)	(0.035)	(0.014)	(0.031)
Official x SPS	-0.072[a]	-0.040		
	(0.026)	(0.062)		
Official x High-RoO			0.065[a]	-0.016
			(0.021)	(0.024)
TCA	-0.274[a]	-0.304[a]	-0.236[a]	-0.288[a]
	(0.022)	(0.031)	(0.020)	(0.030)
TCA x SPS	0.044	-0.213[b]		
	(0.029)	(0.102)		
TCA x High-RoO			-0.067[a]	-0.099[a]
			(0.021)	(0.033)
Observations	4411725	2592774	4370856	2573395
Adj.-R2	0.791	0.755	0.792	0.756
Firms	48702	72407	48554	72245
Countries	44	44	44	44
Products	7802	8192	7799	8191

Note: The dependent variable is the (log) value of exports or imports. All estimations include a log real GDP and a log real bilateral exchange rate variable, a firm×country×product fixed effect, a firm×product×quarter fixed effect, and a constant. Standard errors clustered at destination level are in parentheses. a, b, and c: statistically significant at 1%, 5%, and 10%, respectively.

creased by 26% after the TCA, imports of SPS products declined by 40%. This represents a 54% increase in the negative impact of the TCA for SPS products.

Since the UK was still part of the EU's single market and customs union until the TCA, we expected the first two Brexit stages to have no differential impact on SPS products. This expectation is confirmed for imports. However, the interaction coefficients for SPS products are negative for exports.

Second, we expect exports and imports of products with more stringent RoO to be more negatively affected by the TCA. Using the information contained in the TCA, we build a product-level measure on the stringency of the TCA's RoO. Appendix B explains

the procedure to calculate the RoO stringency index. We define an indicator variable that turns one if the stringency of the RoO is above the median. As above, we extend Equation 1 multiplying the high-RoO dummy by each Brexit stage interaction variable. As expected, we find that products with more stringent RoO experienced a larger decline in exports and imports after the TCA. In particular, the decrease in exports and imports of high-RoO products after the TCA was 24% and 38% larger, respectively than that of low-RoO products.

Finally, regarding technical standards, the major change will be the introduction of the UK Conformity Assessed (UKCA) marking for products to be placed in the UK (except Northern Ireland). When this paper was written, the UK had extended the deadline for the compulsory use of the UKCA marking until 31 December 2024, so firms could still use the CE marking in the UK until that date.[13] The UKCA marking will be required for a set of products similar to those regulated by the CE marking and the requirements to obtain the UKCA marking will be close to those demanded for the CE marking.[14] Since technical standards between the EU and the UK had not diverged during our period of analysis, we do not expect a heterogeneous impact of the TCA across products because of this variable.

4.2 Differences across firms

This subsection explores whether the impact of the EU-UK trade disintegration was heterogeneous across firms. First, we analyze whether the effect of Brexit was similar for small and large traders. We identify a firm as a high trader if its total exports (imports) in 2015, the year before the Brexit referendum, was above the median. We extend equation (1) interacting each Brexit stage with a high-trader dummy.

The standard model of trade with firm heterogeneity, Melitz (2003), predicts that a raise in trade costs leads to the same relative reduction in export (import) revenue for small and large firms, if firms continue to operate in the foreign market. In addition, the reduction in revenue will make it more difficult for firms to make the profits needed to cover the costs of operating in a foreign market. Since small firms are closer to this break-even point, they are more likely to exit, and less likely to enter, a foreign market after an increase in trade costs than large firms.

Table 5 presents the results. The Post-referendum and Official stages had similar effects on Spanish small and large exporters (column 1). However, the negative effect of the TCA was stronger for large than small exporters. Whereas the TCA reduced the export revenue of small exporters in the UK by 9.8%, the export revenue of large

[13] See https://www.gov.uk/guidance/using-the-ukca-marking.
[14] https://www.ies.co.uk/news/what-does-brexit-mean-for-ce-marking-.

exporters decreased by 23.7%. This result indicates that large firms were more sensitive to a rise in trade costs than small firms. This latter finding is in line with Fitzgerald and Haller (2018) who found that the revenue of large Irish exporters was more sensitive to tariffs than that of small ones. It is also in line with Bricongne et al. (2022), who discovered that large French exporters were more sensitive to the negative demand shock generated by Covid-19 than small firms.

Table 5: Impact of Brexit on small and large traders

	Value		Entry		Exit	
	(1)	(2)	(3)	(4)	(5)	(6)
	Exports	Imports	Exports	Imports	Exports	Imports
Post-referendum	-0.032^{b}	0.023	-0.029^{a}	-0.014^{a}	0.009	-0.011
	(0.015)	(0.043)	(0.001)	(0.001)	(0.012)	(0.007)
Post-referendum x Large trader	0.014	-0.099^{b}	0.029^{a}	-0.001	-0.005	0.017^{b}
	(0.015)	(0.040)	(0.002)	(0.001)	(0.015)	(0.007)
Official	-0.000	0.007	0.024^{a}	-0.003^{b}	-0.000	0.002
	(0.023)	(0.057)	(0.001)	(0.001)	(0.006)	(0.006)
Official x Large trader	-0.003	-0.088^{c}	-0.039^{a}	0.005^{a}	0.006	0.001
	(0.021)	(0.046)	(0.001)	(0.001)	(0.005)	(0.007)
TCA	-0.103^{a}	-0.365^{a}	-0.044^{a}	-0.039^{a}	0.051^{a}	0.234^{a}
	(0.027)	(0.058)	(0.001)	(0.001)	(0.005)	(0.007)
TCA x Large trader	-0.168^{a}	0.052	0.027^{a}	-0.020^{a}	-0.007	-0.034^{a}
	(0.026)	(0.070)	(0.001)	(0.001)	(0.005)	(0.008)
Observations	4226051	2469956	5296201	5104130	1210562	688169
Adj.-R2	0.791	0.755	0.071	0.075	0.175	0.090
Firms	35592	49218	14530	22420	14609	16135
Countries	44	44	44	44	44	44
nprod	7744	8147				

Note: The dependent variable is the (log) value of exports and imports in columns 1 and 2, respectively. In column 3 (column 4) the dependent variable turns one if firm f that did not export (import) at $t-1$ began exporting (importing) at t. In column 5 (column 6) the dependent variable turns one if firm f exported (imported) at $t-1$ ceased to export (import) at t. All estimations include a log real GDP and a log real bilateral exchange rate variable. In columns 1 and 2 estimations include a firm×country×product fixed effect, a firm×time fixed effect, and a constant. In columns 3 to 6, estimations include a firm×time fixed effect, a country fixed effect, and a constant. Standard errors clustered at country level are in parentheses. a, b, and c: statistically significant at 1%, 5%, and 10%, respectively.

To confirm this argument, we identify four categories of traders: (i) traders below or equal to the median; (ii) traders above the median and equal or below the 75th percentile; (iii) traders above the 75th percentile and equal or below the 90th percentile; and (iv) traders above the 90th percentile. The left-hand side of panel A of Figure 4 plots the

coefficient of the interaction of each firm-size category with the TCA coefficient. The reference category is the group of firms below or equal to the median (the point estimate equals zero). The coefficient becomes more negative as the size of an exporter increases, confirming the positive relationship between the elasticity of export revenue to trade costs and exporter size.

We find that the first two Brexit stages had a stronger negative impact on large than small importers (column 2 of Table 5). However, the impact of the TCA was similar for large and small importers. The right-hand side of Panel A of Figure 4 shows that the 95% interval of all large firm categories' coefficients include the zero value. This confirms that the negative impact of the TCA on imports was similar for all firm-size categories.

Next, we analyze whether the withdrawal of the UK from the EU's single market and customs union impact had similar effects on the extensive margin for small and large firms. The TCA reduced the probability of beginning to export to the UK particularly for small firms (column 3 of Table 5). The left-hand side of panel B of Figure 4 shows that the entry coefficients become bigger for large exporters, relative to exporters equal or below the median. The probability to begin importing from the UK after the TCA is lower for large importers (column 4) and this difference is significant even for the largest importers (right-hand side figure of panel B of Figure 4).

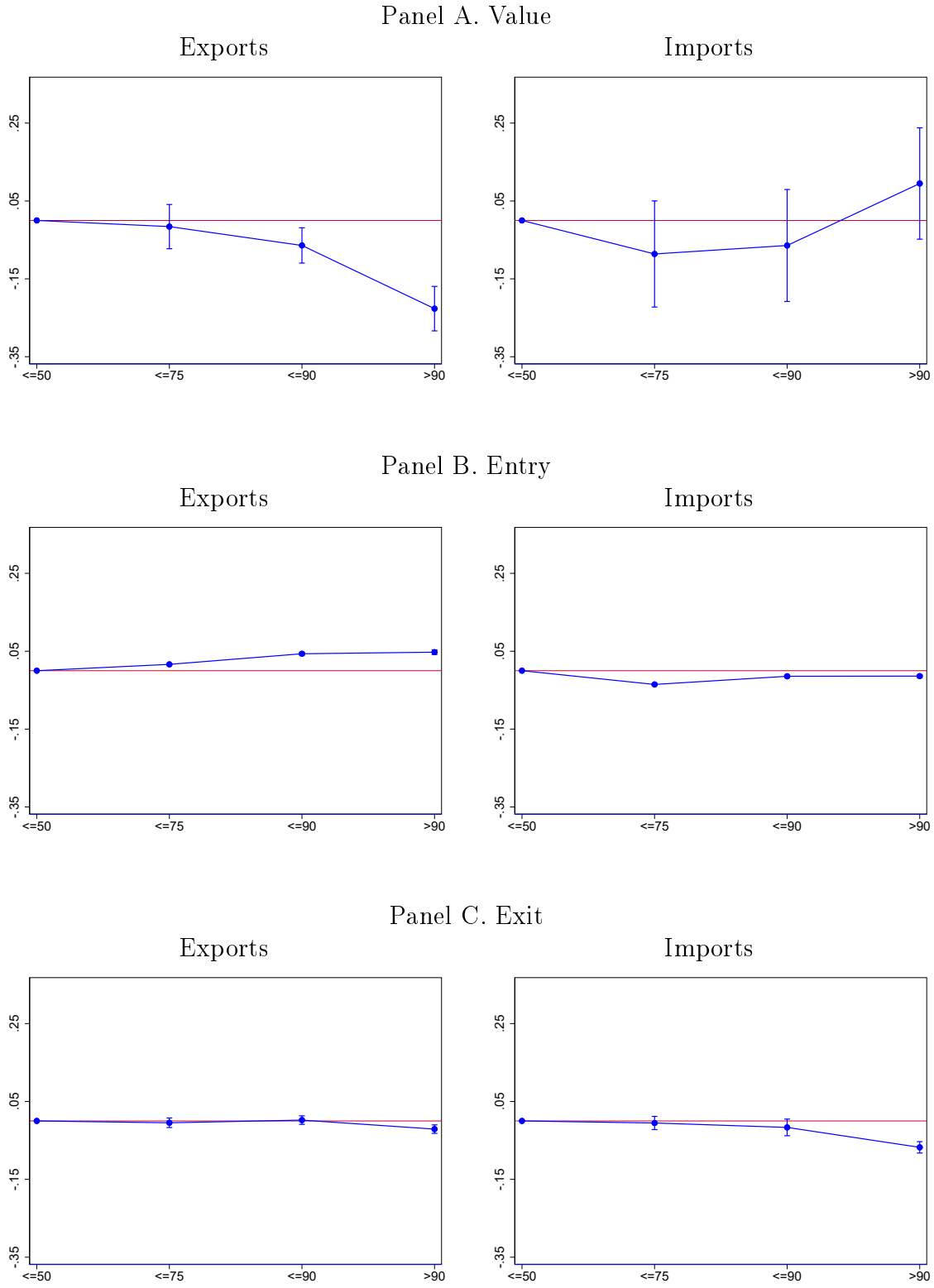
We find no difference between small and large exporters in the probability of exiting the UK in all Brexit stages. However, panel C of Figure 4 shows that the probability of exiting the UK after the TCA was lower for the largest exporters (>90 percentile). The probability of ceasing to import from the UK was slightly lower for large importers after the TCA (column 6). As in exports, the lower probability of exiting the UK is more salient for the largest traders (right-side figure of panel C of Figure 4).

Second, we analyze whether the impact of trade disintegration was larger for high-productivity traders than for low-productivity ones. We define a firm as highly productive if its TFP is above the median TFP. As before, we enlarge Equation (1) interacting the high-TFP dummy variable with each Brexit stage. We can only estimate TFP for the subsample of firms that we can merge with SABI (see above), operate in manufacturing, and have more than 10 employees. We calculate Total Factor Productivity (TFP) using Levinsohn and Petrin's (2003) methodology.[15]

Table 6 shows that the negative impact of the TCA on the value of exports was larger for high-TFP firms than for low-TFP ones (column 1). However, we find that the negative impact of the TCA on imports was similar for high and low-TFP firms

[15]We estimate a separate production function for each 4-digit NACE rev 2 industry using all firms with complete information about output, materials, tangible assets, and employment. Output is deflated using 4-digit NACE rev 2 industrial prices. Materials and tangible assets are deflated using 2-digit NACE rev 2 input and capital prices, respectively. We use the Stata routine `levpet` to estimate the production coefficients using intermediate inputs (materials) to proxy unobservable productivity shocks.

Figure 4: Impact of the TCA on trade value by firm size



Note: The figures report the point estimate and the 95% confidence interval of the $UK_j \times TCA_t \times Dfirmsize_f$ coefficient estimated with an extension of Equation (1). Firms whose total exports (imports) are equal to or below the median is the reference category.

(column 2). These results are in line with those presented in Table 5. We find that the probability of beginning to export and import to the UK decreased more for high-TFP firms than low-TFP firms after the TCA (columns 3 and 4). Finally, we find that high-TFP firms had a lower probability to cease importing from the UK. The TCA coefficient for export exit is zero. However, when we define more detailed firm categories as in Figure 4, we find that the probability of exiting the UK after the TCA was smaller for the group of very-high TFP firms (>90th percentile).

Table 6: Impact of Brexit on low and high-productive firms

	Value		Entry		Exit	
	(1)	(2)	(3)	(4)	(5)	(6)
	Exports	Imports	Exports	Imports	Exports	Imports
Post-referendum	-0.046^a	-0.057^b	-0.009^a	0.002	0.005^c	-0.006
	(0.009)	(0.023)	(0.001)	(0.001)	(0.003)	(0.005)
Post-referendum x High-TFP	0.013^c	-0.030	0.003^a	-0.003^a	0.009^a	0.026^a
	(0.007)	(0.020)	(0.001)	(0.001)	(0.003)	(0.005)
Official	-0.114^a	-0.070^c	-0.012^a	-0.004^a	0.007	0.004
	(0.013)	(0.036)	(0.002)	(0.001)	(0.004)	(0.007)
Official x High-TFP	0.047^a	-0.042^b	0.019^a	0.007^a	-0.002	-0.016^c
	(0.012)	(0.019)	(0.001)	(0.001)	(0.004)	(0.009)
TCA	-0.170^a	-0.235^a	0.005^a	-0.022^a	0.021^a	0.178^a
	(0.015)	(0.056)	(0.001)	(0.001)	(0.005)	(0.009)
TCA x High-TFP	-0.041^a	-0.032	-0.031^a	-0.011^a	0.006	-0.037^a
	(0.013)	(0.046)	(0.002)	(0.002)	(0.005)	(0.011)
Observations	2114269	912526	2036986	1531110	670680	264641
Adj.-R2	0.799	0.761	0.067	0.075	0.149	0.081
Firms	7225	6630	4973	5021	4980	3847
Countries	44	44	44	44	44	44
Products	6469	7166				

Note: The dependent variable is the (log) value of exports and imports in columns 1 and 2, respectively. In column 3 (column 4) the dependent variable turns one if firm f that did not export (import) at $t-1$ began exporting (importing) at t. In column 5 (column 6) the dependent variable turns one if firm f exported (imported) at $t-1$ ceased to export (import) at t. All estimations include a log real GDP and a log real bilateral exchange rate variable. In columns 1 and 2 estimations include a firm×country×product fixed effect, a firm×time fixed effect, and a constant. In columns 3 to 6, estimations include a firm×time fixed effect, a country fixed effect, and a constant. Standard errors clustered at country level are in parentheses. a, b, and c: statistically significant at 1%, 5%, and 10%, respectively.

5 Conclusion

The UK is the only country that has left the EU and has withdrawn from its single market and customs union. This paper has analyzed the impact of this transition from deep to shallow integration on Spanish firm-level trade with the UK.

We use the universe of firm-level export and import transactions for Spanish firms at a quarterly frequency. Applying an event-study methodology, we compare the difference of a firm's export (import) of a particular product between the UK and another market before Brexit and after the UK's withdrawal from the EU's single market and customs union. We find that trade disintegration led to a large negative effect on trade flows: exports and imports decreased by 23% and 27%, respectively. Furthermore, Spanish firms reduced their probability to enter the UK and increased their probability to exit the UK after trade disintegration.

Products more affected by SPS and more stringent rules of origin experienced a larger decrease in trade flows after the new trade agreement between the EU and the UK entered into force. We find that the export revenue of large exporters was more negatively affected by trade disintegration than the one of small exporters. However, we find no difference in the impact on the intensive margin of trade between small and large importers.

Our paper shows that trade disintegration has a large negative effect on trade flows. Furthermore, these negative effects occur even if previously integrated partners reach a new trade agreement that includes no tariffs or quotas. This result vindicates the need for deep integration to maximize the benefits of international trade.

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Appendix A Additional regression analyses

Table A.1: Countries included in the sample

Argentina	Germany	New Zealand
Australia	Greece	Norway
Austria	Hungary	Poland
Belgium	Iceland	Portugal
Brazil	India	Romania
Bulgaria	Indonesia	Russian Federation
Canada	Ireland	Slovakia
Chile	Israel	Slovenia
China	Italy	South Africa
Croatia	Japan	Sweden
Czech Republic	Korea, Rep.	Switzerland
Denmark	Latvia	Turkey
Estonia	Lithuania	United Kingdom
Finland	Mexico	United States
France	Netherlands	

Table A.2: Alternative samples. Value of trade flows

	EU		Eurozone		Non-euro EU	
	(1)	(2)	(3)	(4)	(5)	(6)
	Exports	Imports	Exports	Imports	Exports	Imports
Post-referendum	-0.051^a	-0.056^b	-0.044^c	-0.044	-0.005	-0.033
	(0.017)	(0.021)	(0.023)	(0.032)	(0.024)	(0.034)
Official	-0.042^b	-0.072	-0.045	-0.075	0.089^c	0.081
	(0.019)	(0.043)	(0.026)	(0.058)	(0.044)	(0.119)
TCA	-0.303^a	-0.316^a	-0.310^a	-0.326^a	-0.280^a	-0.224^b
	(0.024)	(0.040)	(0.022)	(0.040)	(0.071)	(0.087)
ln Real GDP	0.505^b	0.415	0.271^a	-0.028	1.407^a	2.326^b
	(0.180)	(0.361)	(0.064)	(0.121)	(0.287)	(0.731)
ln Real exchange rate	-0.014	0.070	0.014	0.106	0.096	0.068
	(0.138)	(0.160)	(0.210)	(0.285)	(0.152)	(0.151)
Observations	3333252	1747489	2631888	1409344	658076	151420
Adj.-R2	0.814	0.762	0.820	0.760	0.805	0.778
Firms	35717	45127	35180	44027	18301	19113
Countries	24	24	16	16	9	9
Products	7581	8062	7549	8025	6043	6210

Note: In odd columns the dependent variable is the (log) value of exports and in even columns the (log) value of imports. All estimations include a firm×country×product fixed effect, a firm×product×quarter fixed effect, and a constant. Standard errors clustered at destination level are in parentheses. a, b, and c: statistically significant at 1%, 5%, and 10%, respectively.

Table A.3: Alternative samples. Entry

	EU		Eurozone		Non-euro EU	
	(1)	(2)	(3)	(4)	(5)	(6)
	Exports	Imports	Exports	Imports	Exports	Imports
Post-referendum	0.010^a	0.007	0.014^b	0.010	0.005	-0.002
	(0.003)	(0.004)	(0.005)	(0.007)	(0.006)	(0.011)
Official	0.015^a	0.016^a	0.016^a	0.017^a	-0.013	-0.003
	(0.002)	(0.002)	(0.004)	(0.004)	(0.014)	(0.013)
TCA	-0.095^a	-0.091^a	-0.105^a	-0.099^a	-0.093^a	-0.091^a
	(0.010)	(0.009)	(0.013)	(0.011)	(0.009)	(0.010)
ln Real GDP	-0.016	0.008	-0.012	0.030	-0.161	-0.148
	(0.014)	(0.020)	(0.013)	(0.027)	(0.096)	(0.095)
ln Real exchange rate	-0.013	-0.004	-0.001	0.008	-0.031	-0.029
	(0.013)	(0.022)	(0.028)	(0.039)	(0.029)	(0.061)
Observations	204238	190851	142149	140726	54378	45635
Adj.-R2	0.742	0.758	0.717	0.737	0.663	0.679
Firms	16443	25821	16393	25639	16071	24701
Countries	24	24	16	16	9	9

Note: In odd (even) columns the dependent variable turns one if firm f that did not export (import) at $t-1$ began exporting (importing) at t. All estimations include a firm×time fixed effect, a destination fixed effect, and a constant. Standard errors clustered at destination level are in parentheses. a, b, and c: statistically significant at 1%, 5%, and 10%, respectively.

Table A.4: Alternative samples. Exit

	EU		Eurozone		Non-euro EU	
	(1)	(2)	(3)	(4)	(5)	(6)
	Exports	Imports	Exports	Imports	Exports	Imports
Post-referendum	-0.000	-0.014[a]	-0.004	-0.025[a]	0.006	-0.014
	(0.002)	(0.004)	(0.003)	(0.007)	(0.003)	(0.008)
Official	0.014[a]	0.008	0.013[a]	0.006	0.008	-0.028
	(0.002)	(0.005)	(0.002)	(0.006)	(0.006)	(0.021)
TCA	0.029[a]	0.185[a]	0.032[a]	0.192[a]	0.031[a]	0.191[a]
	(0.002)	(0.006)	(0.003)	(0.007)	(0.003)	(0.010)
ln Real GDP	-0.016	-0.047	-0.017	-0.057	-0.043	-0.275
	(0.013)	(0.044)	(0.016)	(0.058)	(0.039)	(0.187)
ln Real exchange rate	-0.014	-0.055	-0.043	-0.140[c]	0.012	0.007
	(0.011)	(0.041)	(0.027)	(0.067)	(0.012)	(0.031)
Observations	634351	359902	494902	305104	167552	60019
Adj.-R2	0.291	0.370	0.275	0.356	0.239	0.274
Firms	16168	17853	16130	17794	14770	15580
Countries	24	24	16	16	9	9

Note: In odd (even) columns the dependent variable turns one if firm f that exported (imported) at $t-1$ ceased to export (import) at t. All estimations include a firm×time fixed effect, a destination fixed effect, and a constant. Standard errors clustered at destination level are in parentheses. a, b, and c: statistically significant at 1%, 5%, and 10%, respectively.

Table A.5: Robustness. Regular traders with the UK, and products with no change in the MFN tariff

	Regular		No change in MFN	
	(1)	(2)	(3)	(4)
	Exports	Imports	Exports	Imports
Post-referendum	0.007	-0.066^a	0.042^b	-0.113^a
	(0.011)	(0.023)	(0.017)	(0.026)
Official	0.003	-0.097^a	0.123^a	-0.118^a
	(0.015)	(0.031)	(0.023)	(0.038)
TCA	-0.256^a	-0.319^a	-0.344^a	-0.342^a
	(0.020)	(0.029)	(0.031)	(0.037)
ln Real GDP	0.589^a	0.477^a	0.801^a	0.423^a
	(0.164)	(0.139)	(0.212)	(0.155)
ln Real exchange rate	0.241^a	-0.145	0.327^a	-0.425^a
	(0.077)	(0.154)	(0.116)	(0.150)
Observations	2414330	956821	1284014	747816
Adj.-R2	0.806	0.764	0.818	0.762
Firms	3822	2500	21425	38743
Countries	44	44	44	44
Products	6330	6902	2141	2239

Note: Regulars traders are those firms that exported (imported) to the UK in each of the years covered in the sample (2014-2022). Products with no change in the MFN are those in which the UK did not change the MFN tariff parallel to the implementation of the TCA in January 2021. The dependent variable is the (log) value of exports in the odd columns and the (log) value of imports in the even columns. All estimations include a firm×country×product fixed effect, a firm×product×quarter fixed effect, and a constant. Standard errors clustered at destination level are in parentheses. a, b, and c: statistically significant at 1%, 5%, and 10%, respectively.

Table A.6: Robustness. Manufacturers

	Value		Entry		Exit	
	(1)	(2)	(3)	(4)	(5)	(6)
	Exports	Imports	Exports	Imports	Exports	Imports
Post-referendum	-0.039^a	-0.073^a	-0.007^a	0.000	0.010^a	0.007^b
	(0.008)	(0.017)	(0.001)	(0.001)	(0.002)	(0.004)
Official	-0.087^a	-0.091^a	-0.002	-0.001	0.006	-0.004
	(0.012)	(0.032)	(0.001)	(0.001)	(0.004)	(0.005)
TCA	-0.194^a	-0.252^a	-0.011^a	-0.028^a	0.024^a	0.158^a
	(0.017)	(0.041)	(0.001)	(0.001)	(0.005)	(0.006)
ln Real GDP	0.447^a	0.557^a	0.013	0.012	-0.063^b	0.002
	(0.111)	(0.180)	(0.009)	(0.008)	(0.025)	(0.023)
ln Real exchange rate	0.205^a	0.018	0.005	0.006	-0.039^a	0.042^b
	(0.054)	(0.121)	(0.004)	(0.005)	(0.012)	(0.017)
Observations	2114269	912526	2036986	1531110	670680	264641
Adj.-R2	0.799	0.761	0.067	0.075	0.149	0.081
Firms	7225	6630	4973	5021	4980	3847
Countries	44	44	44	44	44	44
Products	6469	7166				

Note: The dependent variable is the (log) value of exports and imports in columns 1 and 2, respectively. In column 3 (column 4) the dependent variable turns one if firm f that did not export (import) at $t-1$ began exporting (importing) at t. In column 5 (column 6) the dependent variable turns one if firm f exported (imported) at $t-1$ ceased to export (import) at t. All estimations include a log real GDP and a log real bilateral exchange rate variable. In columns 1 and 2 estimations include a firm×country×product fixed effect, a firm×time fixed effect, and a constant. In columns 3 to 6, estimations include a firm×time fixed effect, a country fixed effect, and a constant. Standard errors clustered at country level are in parentheses. a, b, and c: statistically significant at 1%, 5%, and 10%, respectively.

Appendix B Construction of the rules of origin stringency index

We use Trade and Cooperation Agreement's (TCA) Annexes 2, 3, and 5 to identify the rules of origin (RoO) applied to each (HS) good. The TCA uses ten different RoO categories. Borrowing from the ITC-WCO-WTO Rules of Origin Facilitator and Annex 2 of the TCA, Table B.1 list the RoO categories and their definitions.

Table B.1: Rules of origin categories used by the TCA

Category	Definition
WO	"The good is wholly obtained or manufactured in one country without using any non-originating materials."
CC	"Any non-originating material used in the production of the product must be classified under a chapter (2-digit level of the Harmonized System) other than that of the product (i.e. a change in Chapter)."
CTH	"Any non-originating material used in the production of the product must be classified under a heading (4-digit level of the Harmonized System) other than that of the product (i.e. a change in heading)."
CTSH	"Any non-originating material used in the production of the product must be classified under a subheading (6-digit level of the Harmonised System) other than that of the product (i.e. a change in subheading)."
RVC	"A good obtains originating status if a defined regional value content percentage has been reached".
RVP	"A good obtains originating status if a defined regional value content percentage on a part or parts has been reached."
RQP	"A good obtains originating status if a defined regional quantity content percentage on a part or parts has been reached."
SP	"A good originates in the country where a defined technical requirement, i.e. a specific working or processing, has taken place."
Other	"Origin criteria other than related to wholly obtained, CTC, value (quantity) content, or specified process."
ECT	"The originating status cannot be conferred to a good if the non-originating inputs are from HS codes listed under exception."

Source: authors own elaboration using definitions provided by Annex 2 of the TCA (available at http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:22021A0430(01)&from=EN)and ITC-WCO-WTO Rules of Origin Facilitator (available at http://findrulesoforigin.org).

We use a methodology similar to Estevadeordal (2000) to calculate the stringency of each RoO category. We rank the stringency of the RoO categories, from the bottom to the top, in the following order: Other, SP, RQP & RVP, RVC, CTSH, CTH, CC, and WO. The stringency of each category corresponds to its position in the rank. For example, the stringency of Other is 1, whereas the stringency of WO is 8. The stringency of a product corresponds to the stringency of its maximum-stringency RoO category. If a product has the option to select among some RoO categories, we take the value of the category with the minimum stringency. If the product has exceptions, we add 0.5 points to the stringency index.

Table B.2: Number of products by RoO stringency index

RoO stringency	No. of products	% of products
0	219	4.06
1	22	0.41
2	1,418	26.29
2.5	20	0.37
3	13	0.24
4	1,754	32.52
4.5	228	4.23
5	37	0.69
6	795	14.74
6.5	172	3.19
7	1	0.02
7.5	35	0.65
8	654	12.13
8.5	25	0.46
Total	5,393	100.00

Table B.2 lists the number of products for each stringency index. Category 4 concentrates most of products (32.5%), followed by categories 2, 6, and 8. Note that the top two stringency indexes account for a non-negligible percentage of products (12.6%). These indexes correspond to animals, plants, and food products. Finally, a 4% of products are not subject to any RoO.

Interested readers can download a Stata file with the RoO stringency index for each HS 6-digit product from `https://paginaspersonales.deusto.es/aminondo/Research.htm`.