The Economic and Social Review, Vol. 55, No. 2 Summer 2024, pp. 217-244

Belgian Trade After Brexit

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Abstract: This study examines the impact of Brexit on Belgian trade with the United Kingdom. No evidence was found that uncertainty effects led to a significant decline in Belgian exports after the Brexit vote in 2016. However, the UK's departure from the EU's Single Market in 2021 caused a major decline in Belgium's trade with the UK by about 25 per cent. In addition, I find that imports from the UK significantly dropped below the baseline after the election of Boris Johnson. The study also explores heterogeneous adjustments on the margins of trade and on different products and industries.

I INTRODUCTION

The Brexit Referendum on 23 June 2016 set in motion a complex process of unravelling the United Kingdom's (UK) ties with the world's most comprehensive economic integration agreement. Following extensive negotiations, the formal departure of the UK from the EU was completed on 31 January 2020. However, the legal basis of the trade relationship did not change until the start of 2021 with the adoption of the UK-EU Trade and Cooperation Agreement (TCA).[1]

This study zooms in on the effects of Brexit on bilateral trade between Belgium and the UK, thereby making three contributions to the literature. First, the study provides new evidence on the effects of Brexit from the perspective of Belgium, a

Acknowledgements: I am grateful to the Editor, the anonymous referee, Jozef Konings, Glenn Magerman, and seminar participants at the Irish Economic Association Annual Conference and the Annual Conference of the Austrian Economic Association for helpful comments and suggestions. The author is solely responsible for the content and the views expressed.

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[1] See Figure A.1 in the appendix for a detailed overview of key Brexit milestones.

small open economy with historically tight trading links to the UK.[2] Second, it sheds light on the heterogeneous effects of Brexit on different types of goods and industries. Third, it proposes a new algorithm to adjust product-level trade data to account for structural breaks in product classifications over time.

The primary challenge in isolating the causal effect of Brexit on trade flows between Belgium and the UK is the immense number of potential confounding factors. To mitigate these, the analytical framework employs a comprehensive set of fixed effects and control variables within a difference-in-differences set-up. Furthermore, the analysis is complemented by a series of robustness checks, with a particular focus on the COVID-19 pandemic. The main quantitative results summarise as follows: First, Belgian exports to the UK do not suffer in comparison to the rest of the world (RoW) prior to the TCA taking effect. Second, Belgian imports from the UK started to decline much earlier, coinciding with the election of Boris Johnson. Third, Belgian exports do relatively better than imports overall, particularly for intermediate goods.

The study relates principally to the extensive literature examining the impacts of preferential trade agreements. Head and Mayer (2014) provide a comprehensive review of how PTAs are evaluated using structural gravity models. There has been little research on assessing anticipatory effects associated with trade agreements, a notable exception being the work by Freund and McLaren (1999). Furthermore, the disintegration of trade agreements has also received little attention, primarily due to its rarity in recent decades. One exception is the study by Head *et al.* (2010), which investigates the effect of independence on post-colonial trade.

In part due to the Brexit referendum, renewed interest was placed in the role of uncertainty within the realm of international trade. In their seminal paper, Handley and Limão (2017) propose a theoretical framework to study announcement and uncertainty effects in the face of incomplete policy changes. In related work, Limão and Maggi (2015) and Carballo *et al.* (2018) demonstrate that trade agreements serve as mechanisms to diminish policy uncertainty. Complementary research by Osnago *et al.* (2015) show that policy uncertainty can have an impact comparable to tariffs ranging between 1.7 per cent to 8.7 per cent. The unexpected outcome of the Brexit referendum spurred numerous studies aiming to quantify the influence of uncertainty and the anticipatory effects of announcements. Dhingra and Sampson (2022) provide a comprehensive review of this maturing literature.

My study expands on the research exploring Brexit's impact on trade. I employ similar empirical methodologies as in Ayele *et al.* (2021c) and Freeman *et al.* (2022) to assess the effects of Brexit on trade between Belgium and the UK. In contrast, neither study identifies significant effects of uncertainty between the Brexit referendum and the implementation of the TCA on UK-EU trade. The work by

[2] In 2015, the year prior to the Brexit referendum, the UK was the fifth and seventh most important trading partner of Belgium for exports and imports, respectively.

Schmitz (2019) is also closely related, it studies the influence of Brexit's uncertainty on Belgian trade with the UK, but the analysis does not extend to the period following the TCA's enactment. Further related work includes Du *et al.* (2023), de Lucio *et al*. (2024) and Kren and Lawless (2024).

Other related research includes the work of Graziano *et al.* (2021) who demonstrate that UK trade experiences disruptions even before the Brexit referendum, with a more pronounced impact on products subject to higher EU Most Favoured Nation (MFN) tariffs. Complementary research by Crowley *et al.* (2020) use EU MFN tariffs as an indicator of Brexit vulnerability, revealing that the referendum caused a 5 per cent decrease in new firm entries and a 6.2 per cent rise in firm exits attributable to the uncertainty surrounding Brexit. Douch and Edwards (2021) reveal that the anticipation of Brexit led to a downturn in UK exports to the EU. In contrast, Steinberg (2019) reports a minimal impact from Brexit in a dynamic trade model which assesses the uncertainty of the UK's continued participation in the EU's Single Market.

The rest of the paper is organised as follows. Section II discusses the economic context of Brexit. Section III details the data and outlines the algorithm to adjust for modifications in product codes. Section IV presents the empirical strategy and discusses potential challenges to the validity of my findings. Section V reports my findings. Section VI conducts a series of robustness tests and Section VII concludes.

II ECONOMIC CONTEXT

The study builds on the argument of Head and Mayer (2014) as put forward in Freeman *et al*. (2022) that bilateral trade flows are principally determined by i) supply conditions in the exporting country; ii) demand conditions in the importing country; and iii) bilateral trade conditions. Consequently, shocks to bilateral trade conditions, as in the case of Brexit for trade between the EU and the UK, should translate into changes in bilateral trade flows between Belgium and the UK. In addition, substantial changes in bilateral trade conditions may lead to secondary effects by endogenous adjustments in supply and demand conditions in the affected countries. Additional indirect adjustments may take place via general equilibrium effects.

Adopting this analytical framework, I define four principal phases within the Brexit timeline, each characterised by its distinct economic environment. Initially, the period preceding the referendum represents the baseline scenario, with the UK integrated into the EU's Single Market and Customs Union. Goods and services flow freely between the EU and the UK, unimpeded by any legal trade barriers, and a common external trade regime towards the rest of the world (RoW). Subsequently, the time extending from the Brexit vote to the end of the premiership of Theresa May constitutes the 'soft' phase. The succession of Boris Johnson as premier of the UK until the formal adoption of the TCA in January 2021 marks the

'hard' phase. Both the 'soft' and 'hard' phases are characterised by multiple shocks to expectations about future trade and economic policy (Bloom *et al*., 2018). Nevertheless, expectations towards future trade policy diverged markedly between these phases. Theresa May pursued a strategy aimed at preserving economic ties with the EU, with a preference for minimal disruption to business and trade. In contrast, Boris Johnson favoured a more decisive break from the EU. Finally, with the TCA taking effect, actual trade conditions changed, whilst the uncertainty surrounding future trade policy somewhat subsided.

While the TCA facilitates trade by eliminating any tariffs and quotas, the agreement does not address non-tariff barriers; for example, Customs and sanitary checks (Ayele *et al*., 2021a). Moreover, to benefit from tariff- and quota-free trade under the TCA, products must adhere to rules of origin requirements. Generally, this entails a certain proportion of the product's production to occur within the UK (see Conconi *et al*., 2018). However, the process of providing proof of compliance is often challenging and can involve considerable costs. A study by Ayele *et al.* (2021b) shows that within the first seven months after the TCA's implementation, about a third of UK exports to the EU were subjected to tariffs which could have been avoided under the TCA. This highlights the substantial difficulties and costs involved in compliance. In addition, uncertainty persists about when the UK Customs borders will be fully operational. Most importantly, the status of Northern Ireland remains politically contentious.

Following Freeman *et al*. (2022), I attribute the impact of Brexit on trade between the EU and the UK to three distinct responses. Firstly, a reaction to the uncertainty surrounding future trade conditions. Secondly, anticipatory actions in response to expected future trade conditions and thirdly, adjustments to actual changes in trade provisions. Considering Brexit's timeline, I expect that the first two factors are predominantly influential during the 'soft' and 'hard' phases. In contrast, after the implementation of the TCA, I expect uncertainty and anticipatory effects to phase out, and the adoption of the new trade provisions to become the driving force. Nevertheless, residual uncertainty and anticipatory effects remain even after the adoption of the TCA.

III DATA

The study uses monthly data on merchandise trade spanning from January 2013 to December 2022. Monthly flows were aggregated to quarterly frequency to safeguard against measurement noise and lumpiness in monthly trade data. Thus, the dataset encompasses 14 quarters preceding the Brexit referendum (Q1 2013-Q2 2016), 12 quarters during the 'soft' Brexit phase (Q3 2016-Q2 2019), six quarters throughout the 'hard' Brexit phase (Q3 2019-Q4 2020), and eight quarters following the implementation of the TCA (Q1 2021-Q4 2022).

The raw data were sourced from three primary databases. The first source, Eurostat's Comext database, provides monthly statistics on EU trade values in euros, broken down by partner country and categorised according to the 8-digit Combined Nomenclature (CN) product classification. The second source offers monthly bilateral trade values between the US and its trading partners, detailed at the 10-digit level of the Harmonized Tariff Schedule (HTS) and reported in US dollars, as maintained by the US Census Bureau's Monthly International Trade Dataset. The third source, provided by the Japanese Ministry of Finance, contains monthly trade values per partner country in yen which are classified according to the 9-digit Customs Classification, as reported by the Statistics Bureau of Japan.

I process the raw data by omitting: (i) products classified at non-standard levels of aggregation;[3] (ii) transactions involving countries with ambiguous codes;[4] (iii) suppressed or undisclosed trade flows;[5] (iv) non-monetary gold transactions;[6] and (v) trade flows recorded with non-positive values.

3.1 Changes in Product Classification

Products in Eurostat's Comext database are reported in the Combined Nomenclature (CN) classification, which is the 8-digit EU extension of the international 6-digit Harmonized System (HS). The classification of products within both the CN and HS systems is subject to change over time, reflecting modifications in parent categories, adjustments in statistical reporting criteria or the addition of entirely new products. There are minor annual adjustments and more substantial changes about every five years, for example, transitioning from the HS 2012 to the HS 2017 system. Correctly handling these issues is important in empirical work. It allows researchers to expand the time dimension in their analysis across structural breaks and avoid spurious entry/exit in firms' (countries') product mix, see Magerman (2022) and Van Beveren *et al.* (2012) for further research of this issue.

I develop a simple adjustment algorithm to correct for changes in product codes within EU trade data. First, I gather information from Eurostat's RAMON database on annual CN product codes and the modifications in product codes from one year to the next. Subsequently, I classify each product code change into one of the following: i) singular; ii) one-to-many; iii) many-to-one; and iv) many-to-many; see Table A.1 in the appendix for a detailed summary of all annual alterations from 2013 to 2022. Next, for any trade flows which are subject to a change in product code from one time period t to the next ($t + 1$), I adjust the trade values by assuming that the distribution of the new product codes in the period $t + 1$ also holds for the

[3] For example: Trade flows with the product code 'TOTAL'.

[4] For example: Trade flows with the partner 'High Seas'.

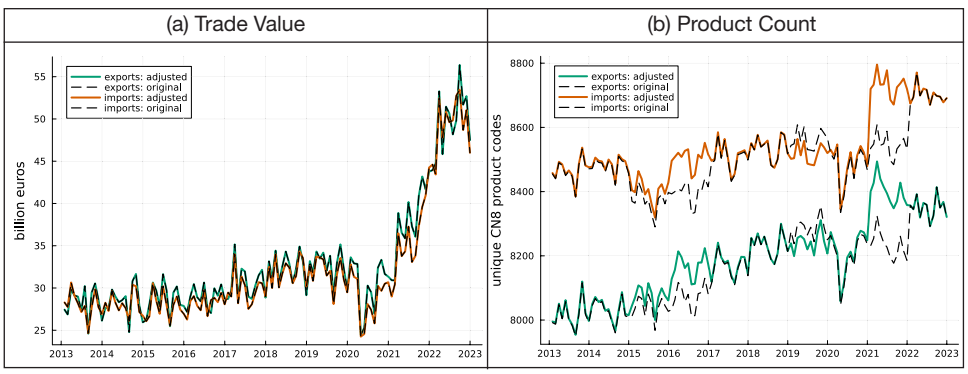
[5] For example: Trade with partners to preserve the identity of the underlying firm.

[6] Non-monetary gold product codes: 71081100, 71081200, 71081310, 71081380 (EU); 7108110000, 7108121013, 7108121017, 7108121020, 7108125010, 7108125050, 7108131000, 7108135500, 7108137000 (US). I could not find specific 9-digit codes for Japan, therefore I drop all products within the international 6-digit HS codes of non-monetary gold: 710811, 710812, 710813.

corresponding monthly data in the period t.[7] In instances where a product is not traded with the same partner country in the next period, I revert to using the relative proportions of total trade. If the product is not traded at all in the period $t + 1$, I drop the corresponding observations altogether. The algorithm is applied to each year, thus iterating the product classification forward to the newest system for which an entire year of data is available.

The left-hand side panel of Figure 1 demonstrates the effectiveness of the algorithm to closely match trade values, with a maximum discrepancy of approximately €9 million and €7 million per month for exports and imports, respectively. This level of accuracy is somewhat expected since the algorithm excludes observations only if the corresponding product ceases to be traded altogether in a subsequent year. On the right-hand side, the panel shows the total number of products traded per month, comparing the original dataset with the adjusted one. It is important to recognise that the total number of product codes fluctuates annually (see Table A.1), and the algorithm updates these codes to align with the 2022 classification system. Therefore, a greater or lesser number of products does not indicate a better or worse match. Instead, Figure 1 gives an accurate picture of the evolution of the extensive margin in a unified product space across time. The precise loss statistics of the adjustment algorithm are documented in Table A.2. With a total of 1,099 observations and €96.7 million worth of trade disappearing, I consider this an acceptable compromise to ensure a consistent product classification across the entire dataset. Table A.3 in the appendix provides summary statistics of the final adjusted dataset.

Figure 1: Product Code Adjustment Algorithm



Source: Author's analysis.

Note: Figures are calculated from Belgian trade with the entire world.

[7] The assumption is only necessary for products which are split into many ('one-to-many', 'many-to-many'). Products which are of type 'singular', and 'many-to-one' are simply carried forward.

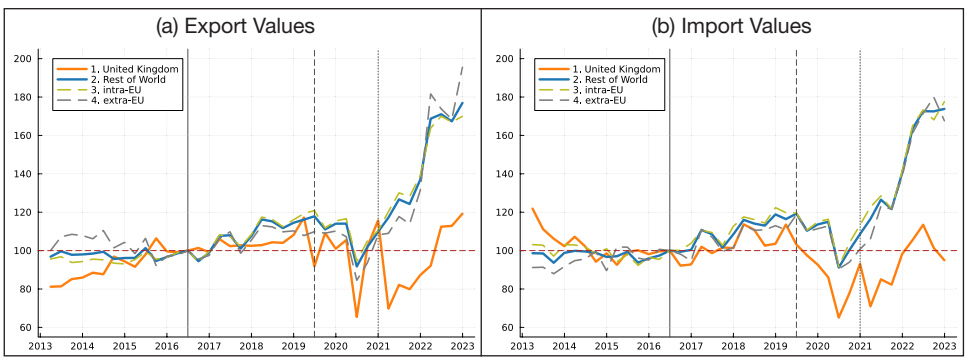
Nevertheless, it is crucial to acknowledge the potential bias of the product code adjustment algorithm. Consider a scenario where Belgium exports €100 worth of apples to Ireland in September 2016, and by 2017, the classification of apples has evolved to distinguish between 'ripe' and 'unripe' apples. The algorithm introduces a potential bias when retrospectively fitting the annual distribution of ripe and unripe apples to the exports of apples from September 2016 because: (i) annual proportions change with time as countries specialise; (ii) applying annual proportions to monthly flows might understate seasonality; and (iii) using total trade proportions might bias country-specific trade.

Despite these concerns, utilising product-level trade data without accounting for product code changes can lead to forbidden comparisons as in the example above. As of now, there is no universally accepted method to address revisions in product classification systems. I believe that my approach, despite its potential for introducing some bias, enables an effective comparison of corresponding products over time.

3.2 Descriptive Evidence

Before the Brexit referendum, the UK was one of the most important trading partners for Belgium, accounting for approximately 10 per cent and 7 per cent of Belgium's total exports and import in 2015, respectively. Figure 2 illustrates the quarterly trade flows between Belgium and the UK from 2013 to 2022, in comparison with trade aggregates of (i) EU countries; (ii) non-EU countries; and (iii) the rest of the world (RoW). Trade values are normalised to a baseline of 100 in Q2 2016, which I identify as the final quarter preceding the Brexit referendum, marked by a solid vertical line. Additionally, a dashed line splits the 'soft' and the 'hard' Brexit phase at the end of Q2 2019, and a dotted line illustrates the transition to the TCA at the start of Q1 2021. I keep these conventions throughout the analysis.

Figure 2: Belgian Trade 2013-2022



Source: Author's analysis.

Notes: The figure excludes trade in 'natural gas' (CN 27112100) for which imports increased massively following the Russian invasion of Ukraine.

Before the Brexit referendum, trade patterns between the UK and the RoW were largely analogous. A noticeable decline in trade flows below the baseline of Q2 2016 only starts in the second quarter of 2019, aligning with the election of Boris Johnson as leader of the Conservative Party and his subsequent appointment as Prime Minister on 24 July 2019. With the exception of Q4 2021, imports consistently remained below this baseline thereafter. The onset of the first COVID-19 wave led to a dramatic drop in Belgium's exports to the UK by nearly 40 per cent, a figure notably higher than the 20 per cent decrease observed in trade with the RoW. Belgium's imports from the UK and the RoW experienced a similar decline of about 20 per cent during this period. However, by the end of 2020, trade flows had recovered, with exports even slightly surpassing the pre-Brexit baseline.

Following the implementation of the TCA at the start of 2021, Belgium witnessed a severe decline in its trade relations with the UK. Exports to the UK plummeted by 33 per cent, while imports decreased by 23 per cent. In stark contrast, Belgium's trade with the RoW not only rebounded from its trough during the COVID-19 pandemic but also continued to thrive. Despite a gradual recovery in the subsequent months, the trade revival with the UK failed to match the pace seen in trade with the RoW. The severe initial drop can partly be explained by the strategic accumulation of stocks before the transition period ended. Additionally, Figure 2 points to a potentially transitory impact of the TCA on Belgian imports from the UK. In contrast, the collapse in Belgian exports to the UK was more pronounced and, over time, the disparity between trade with the UK and the RoW not only persisted but expanded.

Belgium and the United Kingdom both possess substantial expertise in the chemical and pharmaceutical sectors, with Pfizer's production of its COVID-19 vaccine in Belgium serving as a prime example.[8] In consequence, trade between the two nations may have been particularly influenced by the COVID-19 pandemic. Figure A.2 in the appendix excludes COVID-19 related products as classified by the EU.[9] Despite the removal of these products, the overarching trends mirror those depicted in Figure 2.

IV EMPIRICAL STRATEGY

The objective of the study is to evaluate how Brexit influences bilateral trade openness between Belgium and the United Kingdom. I adopt a version of the difference-in-differences event study design proposed by Freeman *et al*. (2022). Two key modifications are implemented: first, employing a multi-country control group instead of an aggregate control group, and second, including trade with Japan

[8] https://ec.europa.eu/commission/presscorner/detail/en/statement_21_1929 (accessed 28.03.2024).
[9] https://ec.europa.eu/eurostat/documents/6842948/11003521/Corona+related+products+by+categories.pdf (accessed 28.03.2024).

(JP) as an alternative control variable. By employing a multi-country control group instead of an aggregate one, the specification can account for variations across countries more effectively. In addition, trade with Japan is arguably less susceptible to general equilibrium effects compared to trade with the EU, thereby reducing potential endogeneity concerns.

The empirical framework assesses the evolution of Belgium's trade with the UK over time, against Belgium's trade flows with the RoW using the estimator by Sun and Abraham (2021). The baseline analysis is performed at the HS 4-digit (HS4) product level and at a quarterly frequency to guard against measurement noise. Thus, the baseline specification for Belgian exports (imports) writes as:

$$\ln X_{pct}^{BE} = \Sigma_t \beta_t D_t UK + \gamma \ln X_{pct}^{US} + \delta \ln X_{pct}^{JP} + \alpha_{pc} + \alpha_{pt} + \varepsilon_{pct} \quad (1)$$

The outcome variable is the log of Belgian exports (imports) per product p, partner country c and quarter t. The estimates of interest are the quarter-specific coefficients β_t interacted with time dummies and a treatment indicator for trade with the UK. Standard errors are clustered at the product-country level to accommodate potentially correlated supply and demand shocks.

The empirical specification in Equation 1 includes a stringent set of fixed effects and controls to help isolate the causal effect of Brexit on Belgium's trade with the UK. First, product-country pair fixed effects (α_{pc}) absorb permanent differences in product demand (supply) between the UK and the RoW. Second, product-time fixed effects (α_{pt}) control for global trends in product-specific supply and demand conditions, such as the worldwide disruptions triggered by the COVID-19 pandemic in 2020 and 2021. Furthermore, under the assumption that export supply (import demand) conditions are independent of the destination (source) country, these fixed effects also control for supply (demand) conditions in Belgium, including during the COVID-19 period.

In addition, I follow Freeman *et al*. (2022) by including two additional control variables to account for differential changes in product-specific demand (supply) conditions in the UK and the RoW. Therefore, Equation 1 includes exports (imports) at the product-country level from the US and Japan. The rationale behind selecting the US and Japan follows from their respective size in the world economy and the wide variety of products in their trade portfolio. Additionally, during the period under study, neither the US nor Japan distinguished between the EU and the UK in their trade policies. Even though a new EU-JP trade agreement took effect in 2018, identical provisions were carried forward by the UK-JP Comprehensive Economic Partnership Agreement (CEPA) in 2021 after the UK left the EU's Single Market.[10]

A key strength of the model proposed by Freeman *et al*. (2022) lies in its flexibility; it does not restrict the analysis to predefined time frames. Instead, the

[10] https://lordslibrary.parliament.uk/uk-japan-comprehensive-economic-partnership-agreement/ (accessed 28.03.2024).

estimates of β_t reveal the dynamics of Belgium's trade with the UK and quantify the adjustments of trade flows, irrespective of the underlying causes. As such, this model can capture both shifts in expectations and actual changes in trade costs. Nevertheless, based on the discussion in the previous sections, I expect that shifts in expectations likely played a more pronounced role during the initial 'soft' and 'hard' Brexit phases, whereas actual changes to trade costs became the driving force following the adoption of the TCA.

The difference-in-differences methodology, while adept, also relies upon strict assumptions for drawing causal inference. The most critical among these is the parallel trends assumption positing that, in the absence of the intervention, the average outcomes for both the treated and untreated would have followed identical trajectories over time. Roth *et al*. (2023) provide a comprehensive review of the current state of the literature, highlighting the intricacies and debates surrounding the main assumptions. Examination of Figure 2 suggests potential pre-trends for Belgium's trade with the UK before Q3 2014 for exports and imports, respectively. Following the discussion by Rambachan and Roth (2023) about the potential concerns in testing for pre-trends, I resort to testing the sensitivity of my results to violations of the parallel trends assumption instead.

To analyse the significance and magnitude of the estimates requires establishing a reference point for comparison. I select to benchmark against the quarter immediately preceding the Brexit referendum, Q2 2016, which allows for a direct comparison of trade patterns before and after the referendum. However, David Cameron already promised an 'in or out' referendum about EU membership before his re-election as Prime Minister on 7 May 2015. This leaves room for a potential violation of another crucial assumption for inference in a difference-in-differences framework, namely the no-anticipation assumption.[11] The no-anticipation assumption entails that the intervention exerts no causal influence before its actual implementation; otherwise, changes in the outcome may reflect not just the causal effect of treatment but also the anticipatory effect (Roth *et al*., 2023). Despite the prevailing view that a vote to leave the EU was highly unlikely leading up to the referendum, Graziano *et al.* (2021) find evidence suggesting that trade flows already started to adjust before the UK voted to leave the EU. To address this I perform time placebo tests, artificially applying the treatment at times before it occurred to test the sensitivity of my results.

Another potential concern is that the difference-in-differences methodology inherently assumes the Stable Unit Treatment Value Assumption (SUTVA), which presumes that there are no spillover effects from the treated to the control units. In my context, where EU countries are part of the control group, this assumption might

[11] The no-anticipation assumption only concerns anticipatory effects occurring before the treatment. This is not to be confused with 'anticipatory effects' after the treatment in response to Brexit. The empirical specification is designed to capture post-treatment anticipatory effects as one type of adjustment, as described in Section II.

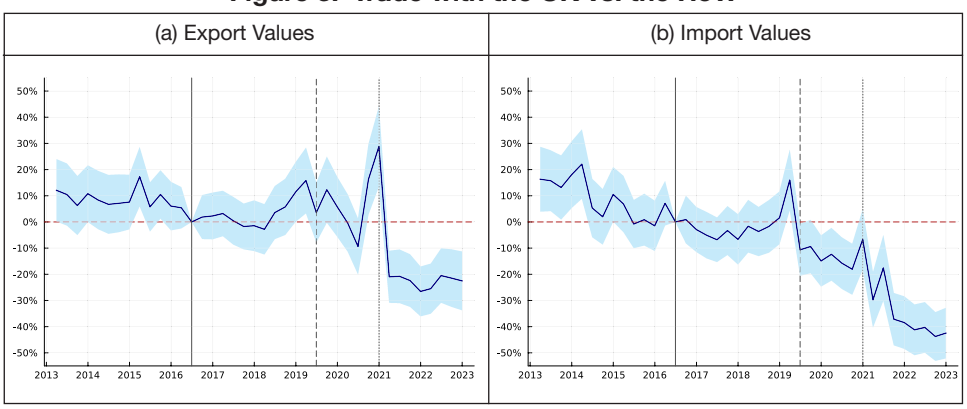
be particularly challenging to uphold. Given Belgium's tight integration within the EU's Single Market, it is plausible that trade adjustments following Brexit did not merely result in trade adjustments concerning the UK but also led to trade diversion towards other EU Member States. To mitigate the risk of incorrectly attributing such effects to changes in bilateral trade conditions between Belgium and the UK, I perform several robustness exercises using different compositions for the control group. In addition, I check for potential spillover effects using unit placebo tests.

Finally, the empirical strategy is unable to account for general equilibrium effects; yet it is anticipated that modifications in bilateral trade agreements would trigger indirect responses. Nevertheless, the presence of highly specialised production chains and buyer-supplier networks potentially mitigates the role of general equilibrium effects. This lower substitutability between trading partners should be particularly prominent in the short run and predominantly affect the trade of intermediate goods (Freund *et al*., 2022). I test this hypothesis by grouping products into capital, consumption and intermediate goods according to the United Nations' Broad Economic Categories (BEC) classification system.

V RESULTS

The baseline specification of Equation 1 compares the trade of Belgium with the UK and the RoW, aggregating products to the HS4 level at a quarterly frequency. Throughout the paper, I present my results using graphs that illustrate the percentage equivalent of the estimates for the coefficient of interest β_t (the dark blue line), along with 95 per cent confidence intervals (the light blue shaded area).[12] Following the discussion above, the second quarter of 2016 is set to zero, therefore estimates are interpreted relative to this baseline period. Figure 3 represents the results for the baseline specification and highlights three main features.

Figure 3: Trade with the UK vs. the RoW



Source: Author's analysis.

[12] Percentage changes are computed as $(e^{\beta_t} - 1) * 100$.

First, I do not find robust evidence suggesting immediate disruptions in Belgian trade flows with the UK following the Brexit referendum. This stands in contrast to existing research, such as Egger *et al.* (2022), which documents positive trade effects following the announcement of nearly finalised trade agreements, which would suggest adverse effects in the event of an announcement of a separation. In contrast, I do not find a significant negative impact on Belgian exports; a robust decline in imports from the UK emerges only about three years after the Brexit referendum. The beginning of the downward trend in Belgian imports aligns with the rise of Boris Johnson to the premiership of the UK. Johnson advocated for a decisive break from the EU and a commitment to 'getting Brexit done'. This could suggest that the downward trend of Belgian imports from the UK starting from the third quarter of 2019 might be attributed not to the uncertainty of the future EU-UK relations but rather to renewed clarity about the terms of the impending split from the EU.

Second, Figure 3 shows that, during the initial wave of the COVID-19 pandemic (Q1 2020-Q2 2020), Belgian trade with the UK did not do significantly worse than compared to the RoW. However, a substantial discrepancy emerges in the latter part of 2020 when Belgian exports to the UK significantly exceed those to the RoW. This period coincides with the steep recovery in international trade observed worldwide after the first COVID-19 wave. Nevertheless, I suspect that the relatively better performance of exports to the UK is a sign of British firms' anticipatory stockpiling, aimed at buffering against potential disruptions anticipated from the adoption of the TCA at the beginning of 2021. I lean towards this interpretation, as the model seems to effectively account for the disruptions caused by COVID-19 on exports for the first wave and on imports for both waves.

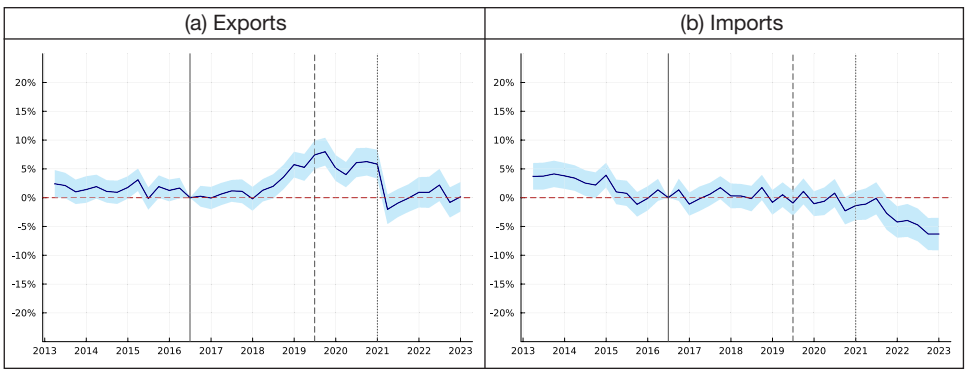
Third, following the implementation of the TCA, both Belgian exports to and imports from the UK fare significantly worse, with exports stabilising at a lower level and imports remaining on a downward trend. Several factors might explain this. To begin with, the UK has yet to establish an effective Customs procedure for trade with the EU. Consequently, exporting from Belgium to the UK might be relatively less costly compared to importing from the UK. Furthermore, trade policy was previously administered by the EU, with numerous free trade agreements with third countries. Even though the UK streamlined trade agreements – modelled on existing EU arrangements – with the most important trading partners, importers from the UK still face a new regulatory landscape with third countries. This might hinder the substitution away from the EU and lead to more persistent exports from Belgium to the UK. In addition, the geographical proximity to and the economic size of the EU mean that the fixed costs incurred by the UK for accessing the EU market might be relatively more beneficial for the UK. Belgium has the flexibility to replace goods formerly obtained by the UK with products from other EU Member

States without incurring extra trade costs, whilst this might not be the case for the UK with respect to other third countries.[13]

5.1 Trade Margins

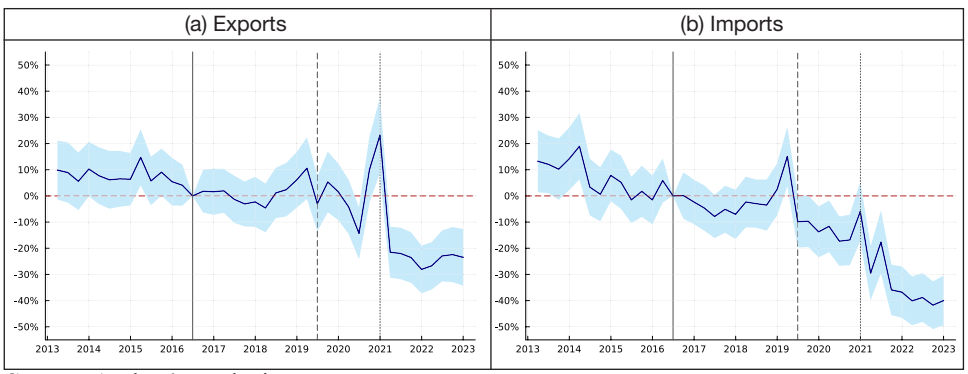
In a subsequent exercise, I examine the extensive and intensive margin of trade. I define the intensive margin as the average trade value per product and the extensive margin as the number of unique 8-digit CN product codes.[14] Adjusting the dependent variable in the model of Equation 1 allows me to distinguish whether the observed changes in Figure 3 are primarily driven by changes in the value of trade (the intensive margin) or the diversity of products being traded (the extensive margin).

Figure 4: Extensive Margin



Source: Author's analysis.

Figure 5: Intensive Margin



Source: Author's analysis.

[13] The UK has concluded only a handful of new trade agreements outside of partnerships previously established via the EU in my sample period; for example with Australia and New Zealand.

[14] As I compare the UK with the RoW I cannot compare the number of partner countries a product is traded with, another aspect of the extensive margin.

The analysis reveals that beginning in the second half of 2018, Belgium started to export a greater variety of products to the UK than in comparison to the RoW, without a significant adjustment in the trade volume per product. Therefore, the increase in overall exports to the UK as depicted in Figure 3 is attributable to adjustments on the extensive margin. Following the implementation of the TCA, the extensive margin drops back to the baseline level before the referendum, whereas the intensive margin experiences a more sizable decline.

For imports, I do not find any significant adverse effects on the extensive margin of trade until the start of 2022, one year after the adoption of the TCA. The adjustments in Figure 3 during the 'hard' phase are entirely driven by the intensive margin. One possible explanation might be that Belgian importers started to divest away from UK suppliers by reducing the volume for imports, but not severing supplier linkages entirely. This cautious behaviour should be particularly pronounced for trade in intermediate input goods.

Contrary to expectations, it seems that the variety of products imported by Belgium did not suffer immediately after the TCA took effect. This counter-intuitive result may not directly stem from Brexit but rather be a result of disruptions in the global shipping industry surrounding that period. The pivotal role of the Port of Antwerp as a major gateway for non-EU produced goods could understate the effect of Brexit due to several concurrent disruptions, in particular the China-Australian Trade Dispute and the obstruction of the Suez Canal by the Ever Given in March 2021. These events likely constrained the availability of certain goods in Belgium and the EU from the RoW (see Figure A.3 in the appendix), compelling firms to pivot towards the UK for alternative sourcing via the Port of Antwerp. This shift could be supported by preparatory stockpiling of UK firms or a decline in demand following the introduction of the TCA.

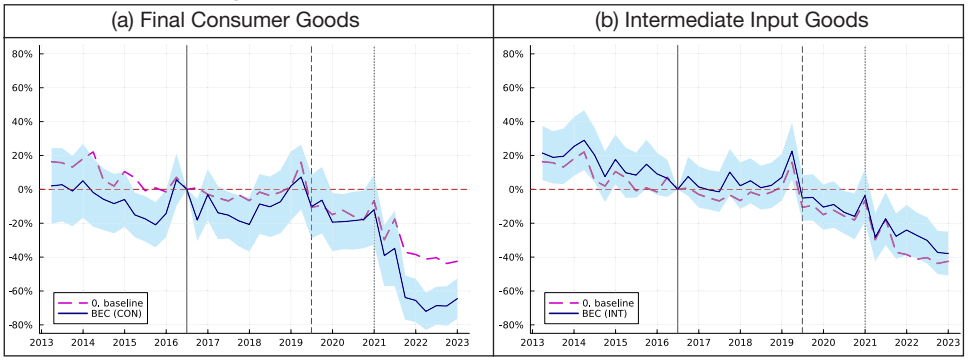
I see evidence for this in the portfolio of Belgium's imports from the UK during this period. Most products which were imported from the UK in Q2 2021, but not in Q1 2021, were machinery and electronic intermediate inputs (HS84, HS85), for example, electronic circuits. Typically, these goods are imported from outside the EU, with China being a key supplier, which lay at the heart of the supply chain disruptions. Figure A.4 in the appendix performs the analysis for the electrical and machinery equipment industry, and further corroborates this claim.

5.2 Product Heterogeneity

To produce additional insights about the effects of Brexit on Belgium's trade, I categorise products into three main groups following the United Nations' Broad Economic Categories (BEC) classification: (i) capital goods; (ii) final consumption goods; and (iii) intermediate inputs.[15]

[15] I use the mapping between the CN and the BEC classifications directly provided Eurostat's Comext database, this minimises potential concerns of double counting as there exists a one-to-one mapping.

Figure 6: Import Values – BEC Classification



Source: Author's analysis.

Figure 6 compares the results for import values for final consumption and intermediate input goods. Although the general downward trend holds for both product categories starting with the premiership of Boris Johnson, intermediate inputs are generally much less affected than consumer goods. The same also holds for capital goods. Moreover, we see the same picture for exports as well as for the extensive and intensive margin.[16] This pattern aligns with existing research, such as the study by Conconi *et al*. (2018), which demonstrates that trade barriers are generally more targeted at final consumption goods than intermediate inputs. Freeman *et al*. (2022) also find evidence thereof, using variation in tariff and non-tariff barriers before the referendum in a triple difference set-up. Furthermore, even though the pound sterling depreciated substantially after the referendum (see Figure A.5 in the appendix), I find only modest evidence for a significantly different adverse effect of Belgian imports from the UK in final consumption goods. This stands in contrast to evidence presented by Broadbent *et al*. (2023), who show that activity in the tradeable sector expanded for a brief period after the referendum in the UK.

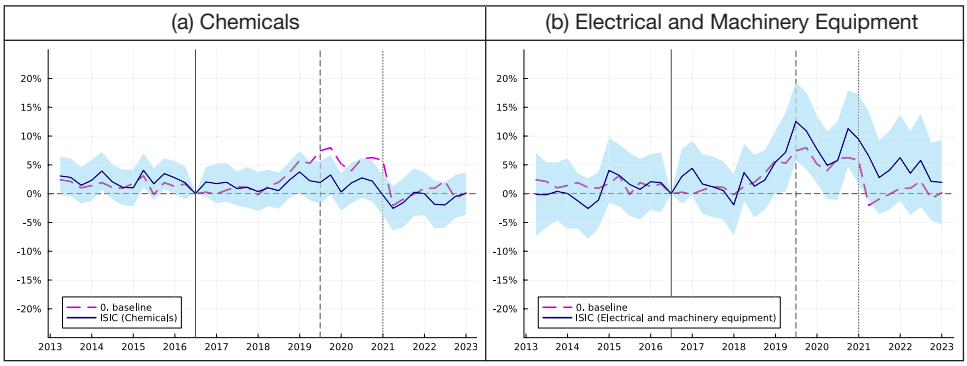
In a related exercise, I employ a correspondence table prepared by the OECD to align 6-digit HS product codes with the fourth revision of the United Nations International Standard Industrial Classification of All Economic Activities (ISIC) classification.[17] The correspondence between product and industry classification is not unique, thus I am unable to obtain an exact decomposition of the overall effects as products are in some cases double-counted. Nevertheless, I obtain results for 14 different industries (see Table A.4 in the appendix for a list of all industries), from which I can draw some conclusions about the industries driving the overall results.

Generally, the overall picture remains the same for most industries throughout the sample period. Yet notable differences emerge, as illustrated in Figure 7, which

[16] Further details are available on request.

[17] The correspondence table from the OECD can be found here (accessed 01.03.2024): https://www.oecd.org/sti/ind/ConversionKeyBTDIxE4PUB.xlsx.

Figure 7: Export – Extensive Margin



Source: Author's analysis.

compares results for the extensive margin of exports in the 'chemicals' industry with the 'electrical and machinery equipment' industry. The counter-intuitive result of increased exports during the 'hard' phase can be mainly attributed to the 'electrical and machinery equipment' industry. Furthermore, the 'chemicals' industry which includes pharmaceuticals, does not exhibit significant deviations amidst the COVID-19 pandemic, which lends further credibility that the empirical framework is sufficiently robust to account for disruptions during this time.

VI ROBUSTNESS

The methodology section acknowledged several potential shortcomings of the empirical strategy; thus I conduct a series of robustness checks which systematically support my baseline results.[18] In a first exercise, I vary the control group to include: i) only EU Member States and ii) only non-EU countries, to guard against potential anticipatory and spillover effects which are arguably more likely in the case of EU countries. Moreover, Freeman *et al*. (2022) use aggregate trade flows rather than bilateral trade flows to individual countries. Replicating their set-up leads to wider confidence intervals, which can be ascribed to the aggregate control's inability to account for country characteristics.[19] Otherwise, results remain the same.

The choice of frequency presents another source of potential bias. Performing the analysis on a monthly basis or utilising a three-month moving average does not change my findings. In addition, the baseline results are not sensitive to using a balanced panel nor weighting trade flows by their relative shares in 2015, the last full year before the Brexit referendum. Conducting the analysis at the 6-digit level also does not alter the results. Moreover, dropping both covariates of Equation 1,

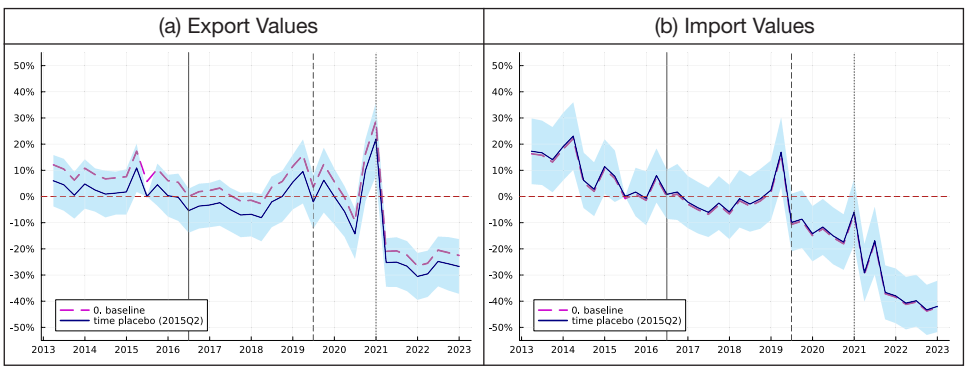
[18] Further details are available on request.

[19] For example, market size, geographical distance, institutions, cultural similarity and bilateral trade openness.

which makes it possible to perform the analysis at the 8-digit CN level, or using a standard event study set-up, does not produce significantly different results either.

Testing the empirical set-up during the COVID-19 pandemic is particularly important due to the tight overlap with the exit of the UK from the EU and the introduction of the TCA. In Figure A.6 in the appendix, I re-do the exercise excluding all products that were considered essential during the COVID-19 pandemic. By isolating non-essential products, the results presented in the appendix demonstrate that my findings are not driven by the COVID-19 pandemic. Furthermore, it shows the robustness of the empirical framework to effectively account for disruptions caused by the pandemic. In a related exercise, I include exchange rates as an additional control variable to address the potential bias from not taking into account the stark depreciation of the pound sterling following the Brexit referendum. For trade with the RoW, I use a trade-weighted index of effective exchange rates with the Euro Area's most important trading partners (EER).[20] However, including exchange rates as additional control does not produce significantly different results.

Figure 8: Time Placebo Test – Treatment Timing Q3 2015



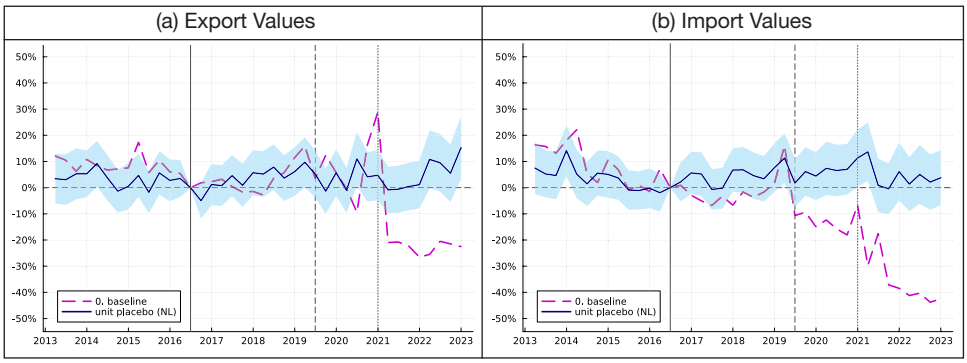
Source: Author's analysis.
Notes: Treatment timing set to Q3 2015 to account for potential anticipatory effects from the election of David Cameron who promised an 'in or out' referendum on EU membership.

Some researchers find anticipatory effects before the Brexit referendum (e.g. Graziano *et al.,* 2021); therefore I adjust the treatment timing to the third quarter of 2015, the first quarter after the Conservative party's electoral success which promised an 'in or out' referendum. Figure 8 reveals similar dynamics to the benchmark findings. Negative impacts on exports are observed only after the implementation of the TCA, whilst the results for Belgian imports from the UK

[20] Exchange rates are sourced from the ECB's Statistics Data Warehouse. The EER (12, 18, 41) includes the pound sterling. Using a self-computed trade-weighted exchange rate index from OECD data for the largest trading partners does not alter the results.

remain consistent. This suggests that the baseline specification may attribute minor anticipatory effects to the Brexit referendum for Belgian exports to the UK.

Figure 9: Unit Placebo Test – Netherlands



Source: Author's analysis.
Notes: Applies the treatment to the Netherlands instead, excludes trade with the UK in the control group.

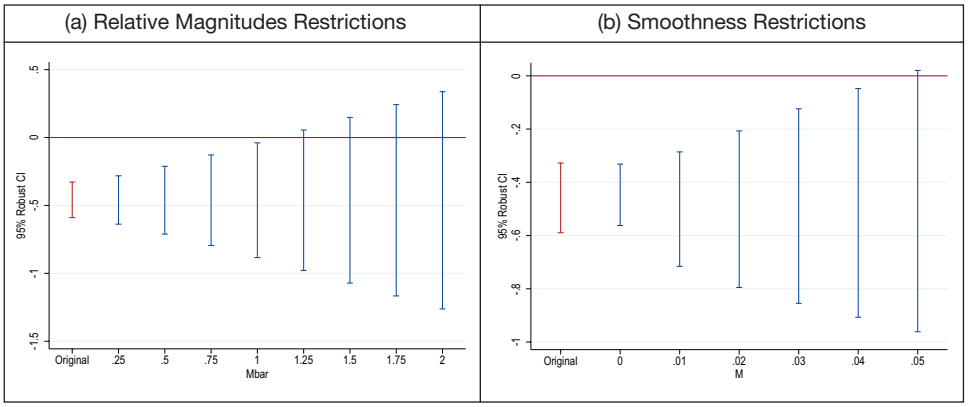
To further test for potential spillover effects and a violation of the SUTVA assumption I perform unit placebo tests, wherein the treatment is hypothetically applied to a country other than the UK. Figure 9 presents the baseline specification with the treatment applied to the Netherlands instead. Throughout the sample period, I only find scarce evidence of a differential evolution of exports or imports for the Netherlands in comparison to the RoW, also during the time of the COVID-19 pandemic. The absence of widespread significant effects underlines the effectiveness of the empirical framework to single out the changes in bilateral trade conditions between Belgium and the United Kingdom.

Testing for pre-treatment trends is equivalent to testing whether all of the pre-treatment coefficients are statistically insignificant. This is usually interpreted as supporting the validity of the research design because it indicates that the parallel trends assumption was likely satisfied before the treatment. However, recent studies have highlighted several limitations relying solely on pre-treatment tests (see Roth *et al*., 2023 for a comprehensive discussion). Rambachan and Roth (2023) propose two sensitivity checks based on the intuition that the counterfactual post-treatment trends cannot be substantially different from the pre-trends.[21]

Inspecting my baseline results in Figure 3 indicates some potential violation of parallel trends, particularly imports were significantly higher before the first half of 2014. Figure 10 shows sensitivity analysis for import values. The left-hand-side panel of Figure 10 reveals that my results are robust to violations of parallel trends up to an equally strong violation in the pre-treatment period. The right-hand-side

[21] See for an application in Stata https://github.com/mcaceresb/stata-honestdid (accessed 04.03.2024).

Figure 10: Sensitivity Analysis – Import Values



Source: Author's analysis.

panel of Figure 10 shows a breakdown value of 0.05, meaning that I can reject a null effect unless I am willing to allow for the linear extrapolation across consecutive periods to be off by more than 0.05 percentage points. Figure A.7 in the appendix reports sensitivity tests for exports, with a breakdown value of 1.5 and 0.05, respectively. Therefore, exports seem slightly more robust to a potential violation of the parallel trends assumption than imports, as already suggested by pre-treatment estimates.

VII CONCLUSION

This paper investigates the impact of Brexit on Belgian goods trade with the UK using a difference-in-differences event study design. The study finds no statistically significant decline in Belgian exports to the UK relative to the RoW before the implementation of the TCA. However, Belgian imports start to significantly decline earlier, coinciding with Boris Johnson's election as UK Prime Minister. Results of the extensive margin suggest Belgium exported more product varieties to the UK as early as 2018. This suggests that the UK adapted to a more uncertain trading environment by increasing its demand for product varieties, serving as a precautionary measure against possible future trade barriers. Conversely, Belgian firms started to diversify their supply chains away from the UK mainly via the intensive margin of trade.

Transitioning to the TCA results in an immediate and substantial decline in trade between Belgium and the UK relative to the RoW. Both exports and imports experience a sharp drop, estimated at 25 per cent even though the TCA does not formally introduce new trade barriers. The analysis suggests that the intensive margin predominantly drives the results, indicating that firms on both sides of the

channel reduced trade volume in response to new trade barriers. Nevertheless, I expect that trade flows will take several years to fully adjust to Brexit. The study only covers the first two years of the new EU-UK trade relationship, with considerable short-term noise, exacerbated by the supply chain disruptions following the COVID-19 pandemic and Russia's invasion of Ukraine.

Future research should be directed to better understand the consequences of non-tariff barriers for the European Union's trade with the United Kingdom. Current evidence points towards substantial adjustments in goods trade attributable to Brexit, nevertheless the underlying provisions driving these results remain elusive. In addition, trade in services and the effects of Brexit on firm performance require further attention in the literature.

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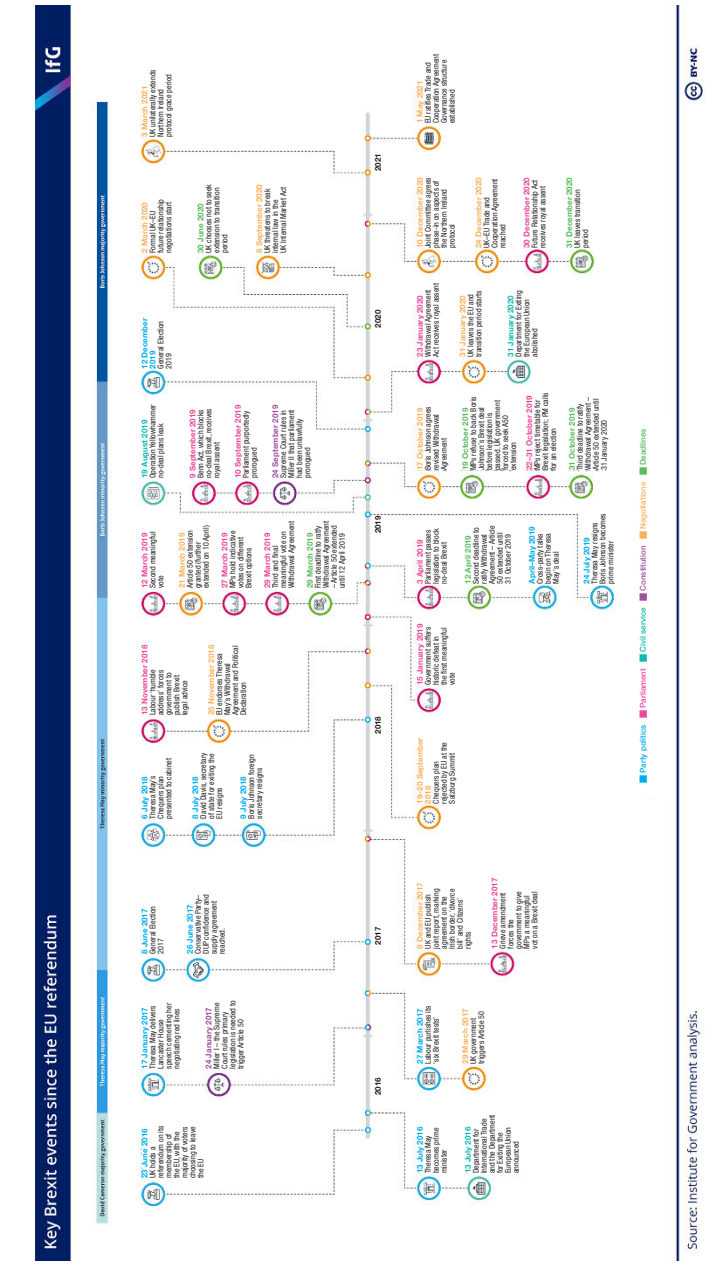
APPENDIX

Figure A.1: Brexit Timeline Pre-2021, Main Events



Source: Accessed from https://www.instituteforgovernment.org.uk/ (05.01.2023).

Table A.1: CN8 Product Code Updates 2013-2022

year	*products*	*unchanged*	*changed*	*singular*	*non-singular*	*one-to-many*		*many-to-one*		*many-to-many*	
						t – 1	*t*	*t – 1*	*t*	*t – 1*	*t*
2013	9,376	9,340	0.4%	1	35	5	14	32	16	5	5
2014	9,379	9,336	0.5%	2	41	9	22	17	8	12	11
2015	9,386	9,361	0.3%	0	25	5	14	4	2	9	9
2016	9,414	9,359	0.6%	0	55	15	51	7	2	5	2
2017	9,528	8,652	9.2%	133	743	119	294	155	60	359	389
2018	9,533	9,515	0.2%	0	18	5	13	6	3	2	2
2019	9,533	9,524	0.1%	0	9	0	0	4	2	5	7
2020	9,483	9,429	0.6%	1	53	4	9	81	31	18	13
2021	9,494	9,474	0.2%	0	20	9	20	0	0	0	0
2022	9,736	8,967	7.9%	135	634	121	280	33	16	246	338

Source: Author's analysis.

Table A.2: Product Code Adjustment Algorithm – Loss Statistics for Belgium

t	*t+1*	*Observation*	*Value*	*t*	*t+1*	*Observation*	*Value*
2013	2014	0	0				
2013	2015	0	0				
2013	2016	0	0				
2013	2017	0	0	2016	2017	0	0
2013	2018	0	0	2016	2018	117	0.38
2013	2019	0	0	2016	2019	20	1
2013	2020	0	0	2016	2020	0	0
2013	2021	0	0	2016	2021	0	0
2013	2022	0	0	2016	2022	763	72.76
2014	2015	0	0	2017	2018	0	0
2014	2016	0	0	2017	2019	0	0
2014	2017	174	22.29	2017	2020	0	0
2014	2018	0	0	2017	2021	0	0
2014	2019	0	0	2017	2022	0	0
2014	2020	0	0	2018	2019	0	0
2014	2021	0	0	2018	2020	0	0
2014	2022	0	0	2018	2021	0	0
2015	2016	0	0	2018	2022	0	0
2015	2017	0	0	2019	2020	0	0
2015	2018	0	0	2019	2021	0	0
2015	2019	0	0	2019	2022	0	0
2015	2020	0	0	2020	2021	0	0
2015	2021	0	0	2020	2022	0	0
2015	2022	0	0	2021	2022	25	0.27
					Total	1,099	96.7

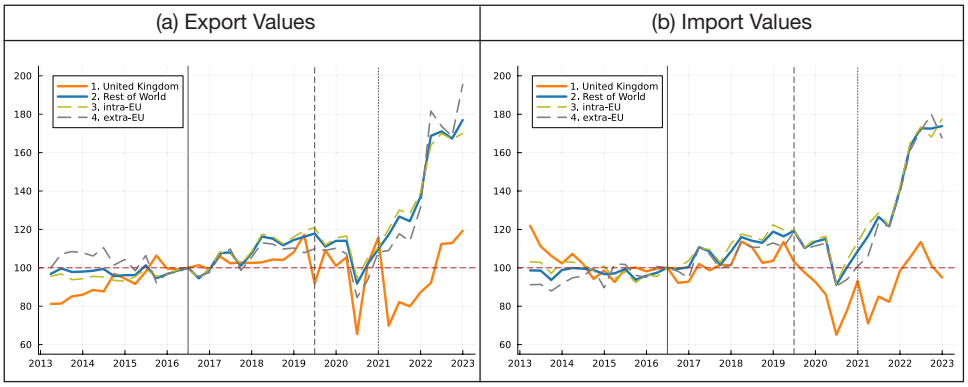
Source: Author's analysis.
Notes: Values expressed in € million.

Table A.3: Summary Statistics

		Mean	*Std.*	*Min*	*Median*	*Max*
(1)	Export Values	1.4	22.4	0	0.2	11,197
(2)	Import Values	2.8	38.7	0	0.4	8,057
(3)	Exported Products	312	306	1	212	1,170
(4)	Imported Products	159	260	1	31	1,173

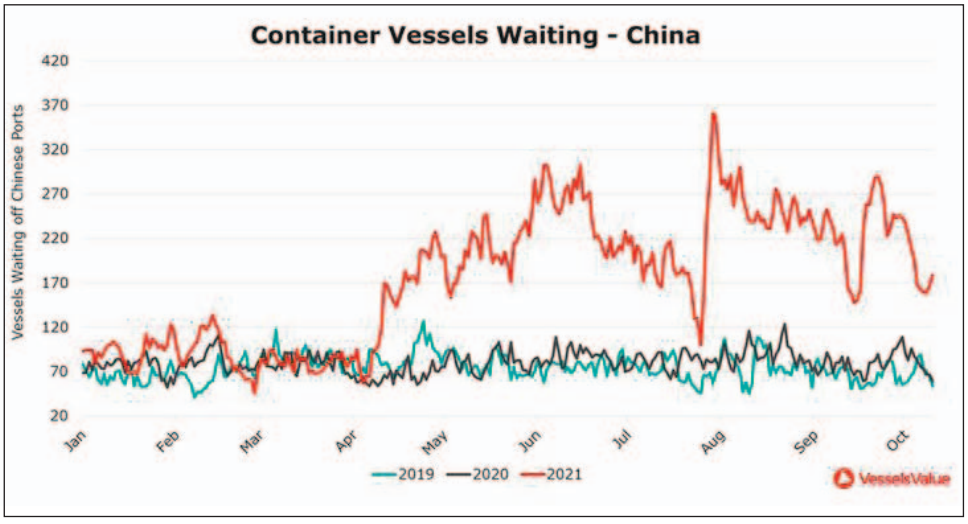
Source: Author's analysis.
Notes: This table provides summary statistics for the HS4-country-quarter adjusted dataset. Rows (1) and (2) present Belgium's export and import values in € million. Rows (3) and (4) show the number of HS4 varieties that Belgium exports and imports.

Figure A.2: Belgian Trade 2013-2022 COVID-19 Adjusted



Source: Author's analysis.

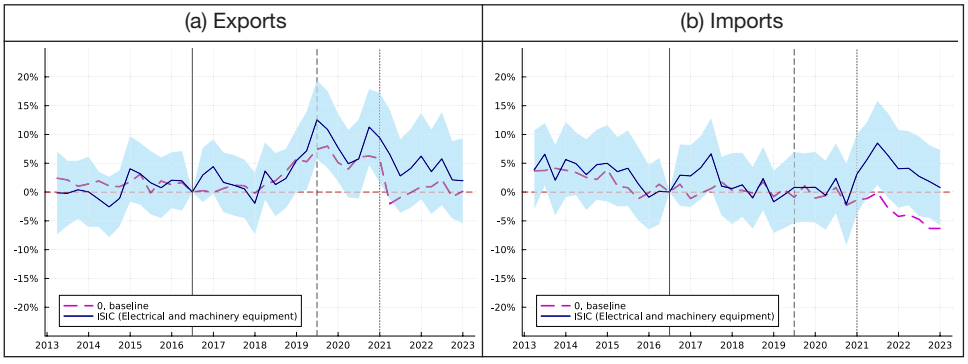
Figure A.3: Daily Container Vessels Waiting off Chinese Ports



Source: https://www.rivieramm.com/opinion/opinion/2021-port-congestion-report-68402 (accessed 01.03.2024).

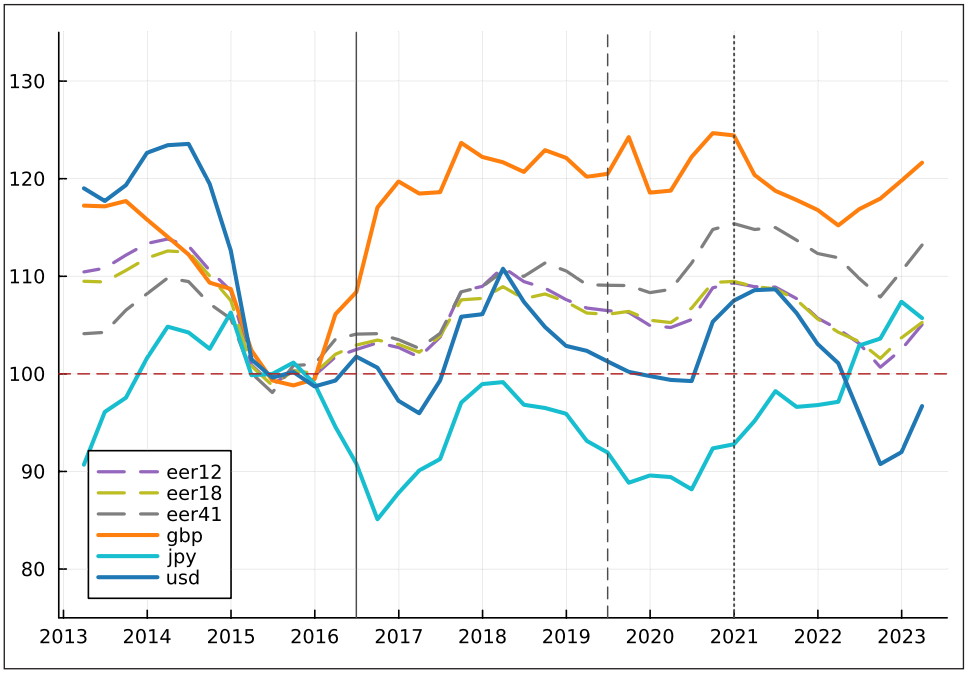
Notes: Figure shows a year-on-year comparison of container vessels waiting off Chinese ports, back to pre-COVID-19 2019 levels. Shipping from China to Belgium takes approximately 30 days (https://www.sino-shipping.com/freight-china-belgium/, accessed 01.03.2024).

Figure A.4: Extensive Margin – Electrical and Machinery Equipment



Source: Author's analysis.

Figure A.5: Quarterly Nominal Exchange Rates against the Euro



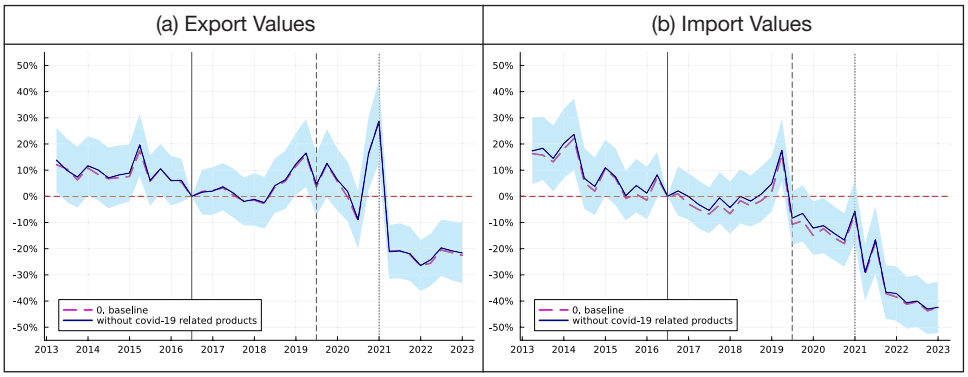
Source: ECB.

Notes: Exchange rates have been normalised to 100 for the average rate in 2015. The Effective Exchange Rates (EER-18, EER-41) are constructed by weighting a basket of currencies by their respective trade weight.

Table A.4: Industry Codes

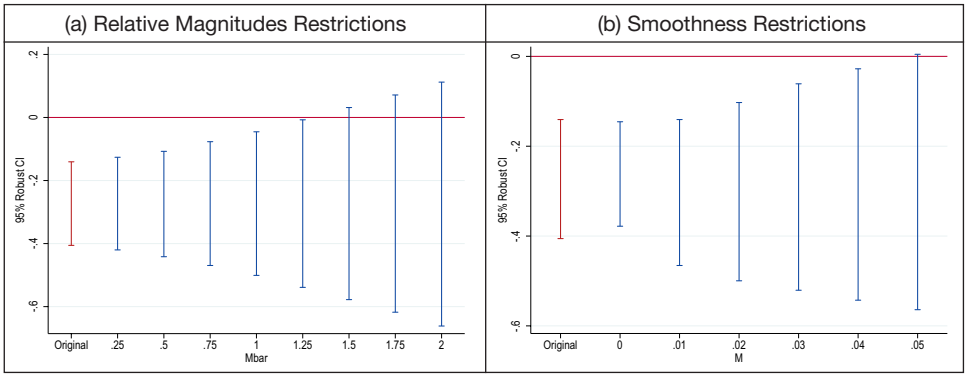
Industry Code	*Industry Label*
C1	Agriculture, fishing and forestry
C2	Mining and quarrying
C3	Food, beverages and tobacco products
C4	Textiles and leather products
C5	Wood and paper products
C6	Chemicals (incl. pharmaceuticals)
C7	Metal products
C8	Computer, electronic and optical products
C9	Electrical and machinery equipment
C10	Transport equipment
C11	Furniture and other manufacturing
C12	Electricity, gas, steam and air conditioning supply
C13	Waste
C14	Publishing

Figure A.6: Trade with the UK vs. the RoW COVID-19 Adjusted



Source: Author's analysis.

Figure A.7: Sensitivity Analysis – Export Values



Source: Author's analysis.