In Hot Water: Clarifying the Price Effects of Brexit*

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Abstract

Non-trade-policy barriers remain key in explaining patterns of trade and their presence motivates many deep trade agreements. Their nature and welfare effects, however, remain poorly understood. We quantify how non-trade-policy barriers between the EU-UK changed following the introduction of the Trade and Cooperation Agreement (TCA). Focusing on the bottled water industry, which was not subject to changing trade policy barriers, we find that UK consumer prices of imported bottled water rose by 17% relative to consumer prices of the same products in continental Europe. We attribute this to rising transport costs as freight rates on UK-bound routes also rose by 30% relative to non-UK routes. Finally, we leverage a partial equilibrium model of the bottled water industry to quantify the contribution of the rise of freight rates to the rise in the final consumer prices of bottled water. Our findings explain how changes in a complementary market facilitating goods trade can lead to market fragmentation in the absence of changes in trade-policy barriers.

JEL codes: F13, F15, F61, L66, R41
Keywords: Brexit, Consumer prices, Non-trade-policy barriers, Freight rates

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1 Introduction

Isolationist sentiments are on the rise (Colantone, Ottaviano, and Stanig, 2022). In response, countries have instigated tariff wars (Fajgelbaum et al., 2020) or, like the United Kingdom (UK), have turned away from agreements fostering deep international integration (Sampson, 2017; Dhingra and Sampson, 2022). Whereas the effects of tariff hikes are relatively well understood, studying the dissolution of deep trade agreements is much harder. Not only is the termination of deep trade agreements a rare occurrence but the return of a multitude of poorly measured non-tariff barriers also makes them intricate to study.

In this light, it is unsurprising that the Brexit vote has spurred a burgeoning literature on the impact of reversing deep trade integration. For instance, the sharp depreciation of the GBP has been leveraged to study the effects of FX fluctuations on border and consumer prices (e.g. Corsetti, Crowley, and Han (2022) and Breinlich et al. (2022)). In addition, a growing literature has tried to disentangle the news effect from the uncertainty effect of the referendum on trade flows (e.g. Graziano, Handley, and Limão (2021)) labor market outcomes (Javorcik et al., 2024), the stock market (e.g. Breinlich et al. (2018) and Hassan et al. (2024)) and income per capita (Born et al., 2019; Broadbent et al., 2024) among other outcomes.

However, this literature has so far almost exclusively studied the period before the introduction of the Trade and Cooperation Agreement (TCA), which governs current trading relations between the European Union (EU) and the UK. Although this focus has been useful in providing new insights into, for instance, the economic effects of trade policy uncertainty, it has precluded the literature from assessing whether trade costs between the EU and the UK have changed and from quantifying the importance of different non-tariff barriers prices and welfare.

This paper fills that gap. In particular, we estimate how trade costs from the EU to the UK have changed and quantify the importance of one non-tariff barrier, namely changes in freight rates for trucking services. To this end, we focus on the bottled water industry and link data on final consumer prices from household-level scanner data in Belgium, France and the UK to route-level freight rates and assess the relative change in consumer prices and freight rates between different locations following the introduction of the TCA. Using a partial equilibrium model of the bottled water industry, we map the spatial distribution of changes in consumer prices to changes in marginal costs and quantify the importance of changes in freight rates in explaining changes in marginal costs.

We focus the analysis on the bottled water industry for two reasons. First, to estimate how the introduction of the TCA impacted the trading environment, one needs to separate the change in trade costs from the endogenous adjustment undertaken by firms to soften the impact of the policy change. For instance, in response to a change in trade costs, firms might relocate production between locations that are differentially impacted by the policy change (e.g. Flaaen, Hortaçsu, and Tintelnot (2020)). However, because bottled water is differentiated by the particular water source from which the water is drawn, relocation between production plants is not possible. This implies that the relative adjustment of prices and marginal costs between locations cannot be driven by changes in the allocation of production across plants. Second, bottled water is an appealing product to disentangle different drivers of trade costs for two reasons. On the one hand, it is unlikely that trade policy uncertainty and newly imposed tariffs are responsible for relative price movements before and after the introduction of the TCA respectively. This is because the average Most Favored Nations (MFN) tariff for bottled water is close to zero.[1] Also, as water brands are tied to their water source, proving that the rules-of-origin conditions for tariff- and quota-free trade under the TCA are met, is straightforward. On the other hand, bottled water has a relatively simple value chain. After the water is extracted, it is bottled close to the source, shipped on trucks and locally distributed. Such a simple value chain reduces the number of relevant cost factors and allows us to zoom in on the importance of freight rates as a non-tariff barrier.

We start our analysis by showing that consumer prices of bottled water in the UK rose following the introduction of the TCA. To this end, we estimate a difference-in-difference model in which we compare the evolution of consumer prices in the UK to the evolution of consumer prices in Belgium and France. We find that consumer prices in the UK closely tracked prices in Belgium and France before the introduction of the TCA, but they diverged sharply afterwards. In our preferred specification, in which we control for persistent variety-level price differences between destinations and for variety-level changes over time that are common across destinations, we estimate that consumer prices of bottled water are 18% higher in the UK in 2022 relative to Belgium and France.

On top of an absent pre-trend in relative prices and a sharp increase following the enactment of the TCA, we believe that our results provide a causal estimate of the TCA on relative consumer prices for three reasons. First, by comparing how relative consumer prices change between country pairs whose trading relations are affected by the TCA, e.g. France and the UK, to country pairs unaffected by the TCA, e.g. France and Belgium, our control group is much less susceptible to being affected by the treatment compared to a strategy that compares the consumer price evolution of imported varieties to locally produced water. Intriguingly, UK consumer prices of British water also rose relative to prices of Belgian and French water in Belgium and France respectively in as much that UK consumer prices of imported varieties and locally produced water did not significantly diverge after the introduction of the TCA. Second, when we only look at how UK consumer prices for products that are imported into the UK changed relative to consumer prices of those same products in Belgium and France, we recover very similar estimates as before. Finally, we consider a placebo experiment by comparing the evolution of consumer prices in Belgium to the prices of the same products in France and we find a precisely estimated zero effect.

After establishing that relative consumer prices diverged substantially after the introduction of the TCA, we examine how freight rates changed following the implementation of the TCA. We focus on freight rates for two reasons. First, freight rates represent an important cost component given the relatively low cost of production for bottled water and the simple value chain. Second, the departure from the European Single Market (ESM) resulted in several regulatory changes, such

[1] MFN tariffs on unflavored bottled water are zero and they are 10% for flavored water. However, unflavored water represents the bulk of exported water to the UK, making the average MFN tariff close to zero.

as cabotage restrictions and separate compliance with the UK market. To proxy the actual variation in freight that underlies the consumer price data as closely as possible, we gather route-level freight rates for trucking services such that the origins cover the ZIPcodes where most bottled water sold in our sampled countries is produced and the destinations are the most populous ZIPcodes in the NUTS2 regions present in our price data. Comparing the evolution of freight rates on routes with UK destinations to routes with Belgian or French destinations, we find that the freight rate on routes with UK destinations rose by roughly 850 EUR relative to non-UK destinations. Like with consumer prices, our results are very similar when we only focus on routes with non-UK origins. In addition, a placebo experiment that compares freight rates for routes with Belgian destinations to routes with French destinations confirms that the effect is driven by changes for routes with UK destinations. Whereas freight rates for domestic UK routes, i.e. routes with a UK origin and destination, also increased relative to domestic Belgian and French routes, foreign routes into the UK changed by much more, which stands in contrast to the results for consumer prices.

Even though the reduced-form evidence is suggestive of increased non-tariff barriers following the implementation of the TCA, it is limited in three respects. First, changes in consumer prices stem from changes in marginal costs and from changes in markups. To estimate how much trade costs changed following the introduction of the TCA, we need to disentangle changes in marginal costs from changes in markups. Second, at this point, we have only established a qualitative relationship between changes in final consumer prices and freight rates. To quantify the contribution of freight rates to the changes in non-tariff barriers, we require an estimate of the cost function that governs the supply of bottled water to different markets. Finally, UK consumer prices for locally produced water responded sharply increased as well. However, it is unclear whether this is due to increased production and shipment costs or because local producers increased their markups following the reduction in foreign competitive pressure.

To make progress, we turn to a partial equilibrium model of the bottled water industry. On the demand side, we consider a model of consumer preferences in which consumers make a discrete choice out of the set of water varieties that are available. The supply side assumes that consumer prices are the result of a simultaneous Nash-Bertrand game among manufacturers. This allows for endogenous changes in the equilibrium markups for both local and imported varieties.

We leverage the model to address the aforementioned issues as follows. First, after estimating the model, we combine data on prices and quantities with first-order conditions for optimal consumer prices to back out marginal costs. Second, using the model-implied estimates for marginal costs, we estimate a flexible cost function for supplying bottled water to different markets. Marginal costs depend on local distribution costs, trade costs and production costs subject to arbitrary returns to scale or scope. The trade cost vector depends on both transport costs and other border-related trade costs that capture other non-tariff barriers that might have increased following the enactment of the TCA. In turn, we quantify the contribution of the changes in freight to trade costs by considering a counterfactual scenario in which freight rates on routes with UK destinations evolved similarly to routes with non-UK destinations after the implementation of the TCA. Finally, using the same counterfactual exercise, we decompose the change in UK consumer prices for locally produced bottled water into changes in markups, changes in transportation costs and changes in production costs.

[Work in progress] The equilibrium model yields the following insights. First, we estimate that trade costs following the TCA rose by [insert number]. Comparing this result to the reduced-form evidence for consumer prices implies that endogenous markup adjustment by exporters limited pass-through into final consumer prices by [insert number]. Second, by comparing the increase in the marginal costs for imported water varieties into the UK with and without the change in freight rates, we find that the change of freight rates explains [insert number] of the increase in non-tariff barriers after the introduction of the TCA. Given that trucking services are complementarity to a much wider set of traded goods than just bottled water, this result implies that the endogenous response of the trucking industry is likely a primary driver of the change in the overall change non-tariff associated with Brexit. Finally, following the implementation of the TCA, we find that both markups and marginal costs increased for locally produced British water. On the one hand, consistent with the small increase in freight for local UK routes, the increase in marginal cost is mostly driven by an increase in production costs. On the other hand, the increase in markups is responsible for [insert number] of the prices. This highlights that Brexit might have reversed pro-competitive gains from trade as well.

Related literature This paper contributes to three different strands of literature. First, this paper connects to a nascent literature that exploits detailed spatial price dispersion to assess the level of market integration and the efficacy of various policies in improving integration. For instance, Shiue and Keller (2007) leverages historical time series of commodity prices to understand the level of market integration in Western Europe and China in preindustrial times. Donaldson (2018) shows how the construction of railroads in India substantially lowered trade costs and improved consumer welfare. Also, Chatterjee (2023) demonstrates how restrictions to cross-regional trade in India distort surplus division between farmers and intermediaries. This literature predominantly relies on within-country price dispersion to domestic integration of regional markets. This paper complements this literature by exploiting time variation in cross-country price dispersion to estimate how trade costs changed following Britain's disintegration from the EU.

Second, this paper contributes to the growing literature that exploits the Brexit referendum in different ways. For instance, the surprising outcome of the referendum has been leveraged as a source of unanticipated variation in the GBP. Fernandes and Winters (2021) and Breinlich et al. (2022) study the exchange rate pass-through into border and consumer prices and Chen, Chung, and Novy (2022) and Corsetti, Crowley, and Han (2022) consider the role of heterogeneity in the currency of invoicing in international transactions in explaining changes in the UK's inflation and terms-of-trade. Whereas Breinlich et al. (2018), Davies and Studnicka (2018), and Fisman and Zitzewitz (2019) study the joint effect of news and uncertainty about future policies and conditions on stock market returns, (Born et al., 2019; Broadbent et al., 2024; Hassan et al., 2024) try to disentangle the relative contribution of these two channels. Relatedly, (Steinberg, 2019; Graziano, Handley, and Limão, 2021; Ahmad et al., 2023) study the effect of trade policy uncertainty, measured as the variation across products in the potential MFN-tariffs that might be applied if no trade agreement would have been reached, on trade flows. We contribute to this literature in two ways. First, apart from Bakker et al. (2022) and Freeman et al. (2024), all these papers focus on the period before the introduction of the TCA. We focus on the period after the implementation of the TCA and provide the first estimate of the change in non-tariff barriers induced by the policy change. Second, we quantify the contribution of one particular non-tariff barrier, i.e. the endogenous change in freight rates, and find that it explains [insert number] of the change in non-tariff barriers.

Third, opening up the black box of non-tariff barriers is key to better understanding why market integration is limited (Gopinath et al., 2011; Hoste and Verboven, 2024) and which types of protection interest groups and governments may resort to Trefler (1993) and Goldberg and Maggi (1999). In response, recent research assesses the trade-reducing effects of non-tariff barriers in general Bradford (2003) and Kee, Nicita, and Olarreaga (2009) and of specific non-tariff barriers such as rules of origin (Conconi et al., 2018), time delays due to customs checks (Martincus, Carballo, and Graziano, 2015) and product standards (Chen and Novy, 2011; Fontagné et al., 2015). Like the latter set of papers, this paper focuses on one particular non-tariff barrier. In contrast to this literature, we focus on changes in the transportation sector which has received relatively little attention to date.

2 Data and motivational evidence

In this section, we first introduce the scanner data and the data on the freight rate we use. Hereafter, we briefly discuss the timeline of Brexit. Doing so, we show that before the introduction of the TCA, prices and freight rates were relatively stable. From January 2021 onwards, we document a sharp increase in UK consumer prices for bottled water and freight rates with UK destinations relative to consumer prices and freight rates in Belgium and France.

2.1 Data sources

2.1.1 Scanner data

We obtain bottled water consumption from household-level scanner data. In each country, these data are gathered by a market research firm that equips households with a scanning device to register the product's barcode, the store in which the product was bought, the number of units they bought and the tax-inclusive amount expressed in local currency units (LCU). By combining information from barcode descriptions with the data on the number of units and volume sold and the expenditure, we compute the quantity consumed in liters and prices per liter. We study the period from 2010 until 2022 which covers over 7 million transactions involving bottled water (Table 1).

Water varieties and firms. We define bottled water varieties as an interaction of a brand, its water source, whether the water is flavored or not, whether the water is packaged in a glass, plastic or other

Table 1: Sample overview

Variable	Overall	BEL	FRA	UK
Nr. Products				
· All	657	358	325	224
· Local	-	32	261	143
· Foreign	-	272	23	44
Nr. Production locations				
· All	122	70	67	47
· Local	-	10	57	35
Nr. Households				
· NARTD	53,122	5,303	17,915	29,904
· Water	40,219	4,662	16,326	19,231
Importance of water				
· Uncond. value share	0.26	0.26	0.34	0.14
· Cond. value share	0.36	0.33	0.41	0.31
· Inside good share	0.72	0.81	0.83	0.44
Transactions ('1,000)	7,319	1,014	3,293	3,012
Prices				
· Local (LCU)	-	0.54	0.28	0.28
· Foreign (LCU)	-	0.34	0.34	0.59
· Local (EUR)	-	0.54	0.28	0.33
· Foreign (EUR)	-	0.34	0.34	0.71
Origin (volume share)				
· Belgium	0.039	0.211	0.001	0.000
· France	0.656	0.473	0.902	0.075
· UK	0.150	0.000	0.000	0.743
· Other	0.064	0.103	0.066	0.021
· Unknown	0.091	0.213	0.031	0.161

Notes: This table provides summary statistics for the sample that removed purchases of fringe products and in stores that account for few purchases. We provide summary statistics for the overall sample and for country separately. The number of products is obtained by counting the number of products defined as the interaction of a brand, a source, whether the product is flavored, the bottle size and the package type. When we have been able to retrieve the source, we can further distinguish between local and foreign varieties. The number of production locations is the count of the number of distinct production locations we were able to identify. The number of households is computed as the average number of distinct households that bought either bottled water ("water") or within the Non-Alcoholic Ready-To-Drink (NARTD) categories, which includes bottled water, soft drinks and juices, in a given year. For the importance of bottled water, the value share is the average expenditure share of bottled water in the NARTD industry, computed based on all households ("uncond.") or based on households that purchased water in that year ("cond."). The inside good share is computed as the share in the population accounted for by households that purchased water at least once in a given quarter. In doing so, we weight households at their population weight. Prices are computed using population weights interacted with purchased volume. The share accounted for by different origins is computed as the share in overall purchased volume sourced from that particular origin.

package and its package size in milliliters, e.g. a 500ml plastic bottle of unflavored Evian water. We further elaborate on the product definition.

First, we include both branded and private-label waters. This is because private-label water typically accounts for around of bottled water consumption in terms of volume. To account for multi-product and multi-brand firms, we associate each variety with a firm identifier that we obtain by matching data from GS1 at the barcode level.[2]

Second, apart from the water brand and source, we also account for whether the variety is flavored or not. This implies that we aggregate over two additional dimensions of horizontal differentiation. First, we do not define varieties at the level of particular flavors. Table A.4 shows the unadjusted R^2 of regressions of the final consumer prices on fixed effects that capture different levels of horizontal product differentiation. This shows that a dummy capturing whether the variety is flavored or not already captures most of the variation in prices along the flavor dimension. Second, given that Table A.4 also demonstrates that the carbon dioxide content of the water does not explain variation in consumer prices conditional on the other product characteristics, we also do not distinguish between sparkling and still waters.

Finally, the bottle size and the package are key dimensions of differentiation. For instance, Table A.3 shows that, conditional on other product characteristics, medium-sized bottles and large bottles are respectively 40% and 80% cheaper compared to small bottles. At the same time, Table A.4 illustrates that dummies for small ($\leq 750ml$,), medium $(750ml, 1500ml)$ and large bottles ($\geq 1500ml$) are not sufficient to capture a significant share of the variation in final consumer prices induced by horizontal differentiation stemming from differences in bottle sizes. Regarding different package types, Table A.3 shows that bottled water sold in glass bottles are 25% more expensive compared to plastic bottles. Therefore, we incorporate the package type as an additional source of differentiation.

Throughout the paper, we include varieties in the sample if they satisfy at least one of the following conditions. First, we include all varieties that attract a volume-based market share of 0.1% or more. We also include varieties that are sold in at least two national markets and that are sold in at least 10 quarters in either market. Table A.2 shows that the final sample covers 95% of the total quantity sold and more than 92% of the total number of transactions.

Production locations. We complement the scanner data with variety-level information on production locations. This information is key to estimating how trade barriers changed following the enactment of the TCA. This is because international trade is dominated by multinational firms (Antràs et al., 2024) that can serve markets as a pure exporter (Melitz, 2003), through a local affiliate (Helpman, Melitz, and Yeaple, 2004) or via export platforms (Tintelnot, 2016). Without information on the production location, it is impossible to disentangle the change in trade frictions from the endogenous adjustment of supply chains.

To this end, we rely on two institutional features of the bottled water industry. First, Directive

[2] GS1 is a consortium that coordinates the allocation of barcodes between firms, ensuring that barcodes identify unique products.

2009/54/EC administers the branding and distribution of bottled water in the ESM that requires manufacturers to disclose the water source from which the water is drawn very visibly on the water bottle. Second, to concord with mineral and sanitary information disclosed to the national health and safety authorities and to avoid the need for specialized shipping, bottled water is typically bottled close to the reported water source on the product's label. Importantly, although the regulation we leverage to determine production locations pertains to the ESM, which the UK has left, they remain in place. At the time of writing, the UK has not changed its regulatory stance on food and safety considerations concerning products coming from Europe. In addition, the UK government has yet to introduce sanitary or phytosanitary measures for products for human consumption flowing into the UK.

We leverage these two features and hand-collect production locations for as many water varieties as possible. Table 1 shows that we can determine the production location for over 90% of the total volume sold. We are unable to determine the production location for a small set of private-label water varieties.[3] Figure 1 plots the spatial distribution of production locations. Panel A shows the distribution when we pool across all destinations such that the dots are weighted by the total volume that is consumed from each location. Panel B focuses on consumption by UK households and illustrates that if varieties are imported into the UK that they are predominantly sourced from France and Italy.

Figure 1: Production locations

(a) All consumption **(b)** UK consumption

Countries. The dataset comprises three European countries. In addition to the UK, we also include Belgium and France for two reasons. First, Table 1 shows that more or less 10% of the total volume of bottled water purchased by UK households originates from abroad of which roughly 75% originates

[3]Unlike A-level brands, which use their particular source as a source of differentiation, private-label varieties tend to be more homogeneous and low-cost (see Table A.3). This gives retail chains more flexibility in terms of choosing from where to source their water, making it sometimes impossible to pinpoint the production location.

from France. Given that French water brands that are exported to the UK, such as Evian, Volvic and Vittel, are also sold in the French market, we construct a quasi-natural experiment in which we can compare the evolution of UK consumer prices to French consumer prices of the same products. Second, Table 1 shows that a little over 43% of bottled water sold in Belgium originates from France as well. Moreover, a considerable share of bottled water varieties that are exported to the UK, are also exported to Belgium. By also including data from Belgium, we can complement the quasi-experimental variation with a placebo experiment in which we compare how relative prices between a country pair that no longer trades under the ESM framework, i.e. the UK and France, evolved differently from a country pair that remained part of the ESM, i.e. Belgium and France.

Other dimensions. In addition to product-level information, transactions also identify households and retail chains. First, households report how many individuals live in the household, the age of the household head, the income bracket of the household, and the ZIP code and NUTS2 region in which the household resides. Additionally, the market research firm reports a population weight to ensure that the data is representative, which we use whenever we aggregate over the household dimension. To achieve comparability across destinations, we define 18 consumer types which we elaborate on in Appendix XXX. Second, the data cover purchases from hypermarkets to small convenience stores. We restrict attention to retail chains with a volume-based market share above 0.1% and aggregate over different store formats employed by the same retail chain. Table A.1 shows that this restriction is relatively innocuous as the main sample covers 97% of the total volume sold.

2.1.2 Freight rates

A key contribution of this paper is to relate the change in relative consumer prices between different destinations to the change in relative freight rates. Although the scanner data is very rich in many dimensions, it does not record the transport costs that were incurred to deliver the product to the consumer. For this reason, we turn to freight data from Upply.[4] In particular, we obtain route-level freight rates at the monthly level from 2018, the startup year of Upply, until 2023.

To proxy the transport costs as closely as possible, we take the following strategy. First, like most food items, bottled water is almost exclusively transported on trucks. Given that the bottles are atmospherically sealed, they do not require special transportation. For this reason, we focus on freight rates for fully loaded tautliner trucks that move general cargo and food.[5] Second, we focus on routes that depart in ZIP codes that account for the lion's share of water production in our data and finish in one of the ZIP codes that are most populous in a given NUTS2 region present in our price data. The route from Evian-les-Bains, France to Leeds, United Kingdom is one such route. Finally, as shippers typically employ third-party carriers to cover shipments on the margin, we focus on spot prices that include fuel surcharges. We believe this choice is innocuous as contracted freight rates moved very similarly around the introduction of the TCA.

[4]Upply is a private company that provides benchmarking and matching services for carriers and shippers.

[5]Tautliner trucks are trucks to which trailers are attached that have sides made from plastic curtains or solid materials.

2.1.3 Other data sources

Spatial data sources, ONS and Eurostat data on wages in the retail sector

2.2 Brexit

Timeline. Following a surprising and narrow victory for the Leave vote on 23 June 2016, the UK decided to leave the EU. The precise reasons why people voted in favor of leaving the EU are still unclear (Becker, Fetzer, and Novy, 2017). Nevertheless, substantial austerity-induced welfare reforms following the 2008 financial crisis (Fetzer, 2019) and global competitive pressure on UK labor markets (Colantone and Stanig, 2018) have both been cited as significant contributors, especially where they interacted with weak socio-economic fundamentals (Goodwin and Heath, 2016; Becker, Fetzer, and Novy, 2017).

The Leave vote was subsequently followed by a period mired with uncertainty about the UK's future stance on relations with the EU. Both so-called "hard" and "soft" Brexit scenarios were openly discussed, each with their respective projected effects (e.g. Reenen (2016), Dhingra et al. (2017), and Head and Mayer (2019)). However, on 23 January 2020, the European Union Withdrawal Agreement Act 2020 received Royal Assent and on 31 January 2020 the UK entered a transition period before finally leaving the EU on 31 December 2020.

By agreeing on the Trade and Cooperation Agreement (TCA), i.e. the free trade agreement (FTA) that governs the current EU-UK international trade environment, the EU and UK effectively agreed on a "soft" Brexit. Although the TCA stipulates tariff- and quota-free trade if the trading partners can certify that they satisfy the rules of origin requirement set out in the agreement, it no longer provides market access to service providers or free movement of persons. Particularly relevant to our setting is that qualifications of truck drivers ceased to be automatically recognized in the UK and that unlimited trucking service provision under EU cabotage rules by foreign truck drivers was discontinued. Under the current market access provisions for trucking services, foreign truck drivers can only make two trips in the UK before having to return to the EU.

Consumer prices. To understand whether final consumer prices adjusted following the inception of the TCA, we start by comparing the aggregate price evolution of consumer prices of bottled water between Belgium, France and the UK. To this end, we aggregate over individual transactions and plot the aggregate evolution of final consumers of bottled water at the monthly frequency expressed in LCU in Figure 2. We denote the period from the referendum to the exit of the UK in grey and signify key dates with vertical dashed lines. We make the following observations.

First, whereas UK consumer prices were on an upward trend, they were trending downward in the period between the Leave Vote and the UK leaving the EU. This is interesting for two reasons. On the one hand, aggregate UK consumer prices for bottled water expressed in local currency did neither respond to the sharp depreciation of the British Pound (GBP) relative to the Euro (EUR) on impact nor did they adjust down the line. As shown in Figure 3 where we show the evolution for foreign and domestic varieties separately, this is not only because consumer prices for local varieties did not respond but also because UK prices of foreign varieties did not change markedly after the depreciation. When we express UK final consumer prices in EUR in Figure A.1, we find that UK UK consumer prices in EUR sharply fell. Taken together, this suggests that bottled water prices are likely set in local currency which we assume throughout the analysis. On the other hand, in the period between the Leave Vote and the secession from the EU, UK consumer prices were mostly on a downward trend. Figure 3a demonstrates that this is because prices for local varieties were trending downward and because UK prices for imported varieties did not deviate from their gentle pre-depreciation trend (see Figure 3b). As MFN tariffs on bottled water trade between the UK and the EU are low and certifying that rules of origin apply is easy, this evidence is consistent with a limited role for trade policy uncertainty as in (Graziano, Handley, and Limão, 2021; Ahmad et al., 2023) in the intermediate period.

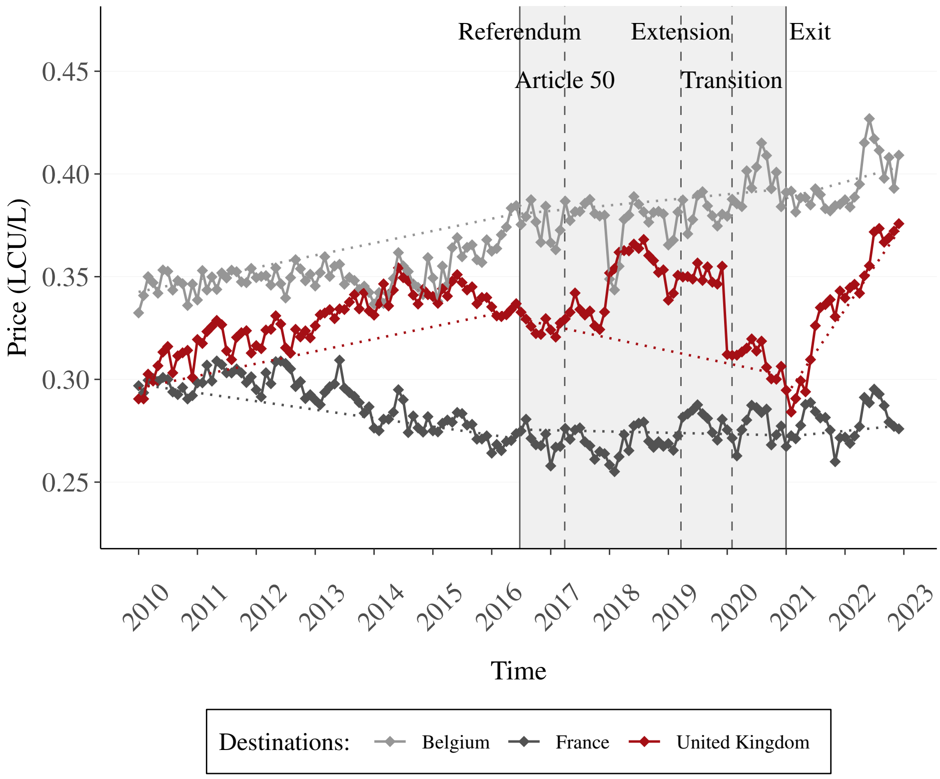
Second, Figure 2 shows that, in contrast to Belgium and France, consumer prices for bottled water sharply rose after the UK left the EU. Final consumer prices in Belgium and France were quite stable, especially after 2021 when the TCA was introduced. Hence, we are unable to detect a clear break in the evolution of consumer prices following the enactment of the TCA in Belgium and France. This stands in sharp contrast to the UK. Figure 2 reveals that UK consumer prices, on average, rose from 0.29£per liter to roughly 0.38£per liter. Moreover, not only did UK prices for imported varieties rise sharply and substantially (see Figure 3b) but so did prices for local water varieties (see Figure 3a).

Altogether, a first look at the data indicates that the evolution of UK consumer prices for bottled water was relatively stable before the UK seceded from the EU. Yet, UK consumer prices abruptly rose following the onset of the TCA and this is true for both local and foreign varieties.

Freight rates. Given the simple value chain of bottled water and the changes in the regulatory framework of service provision and movement of persons between the EU and the UK, we next document how freight rates evolved. Figure 4 plots the evolution of freight rates averaged across routes with their destination in Belgium, France and the UK respectively. Like before, we denote the period from 2018, which marks the start of the freight data, to the exit of the UK in grey and signify key dates with vertical dashed lines.

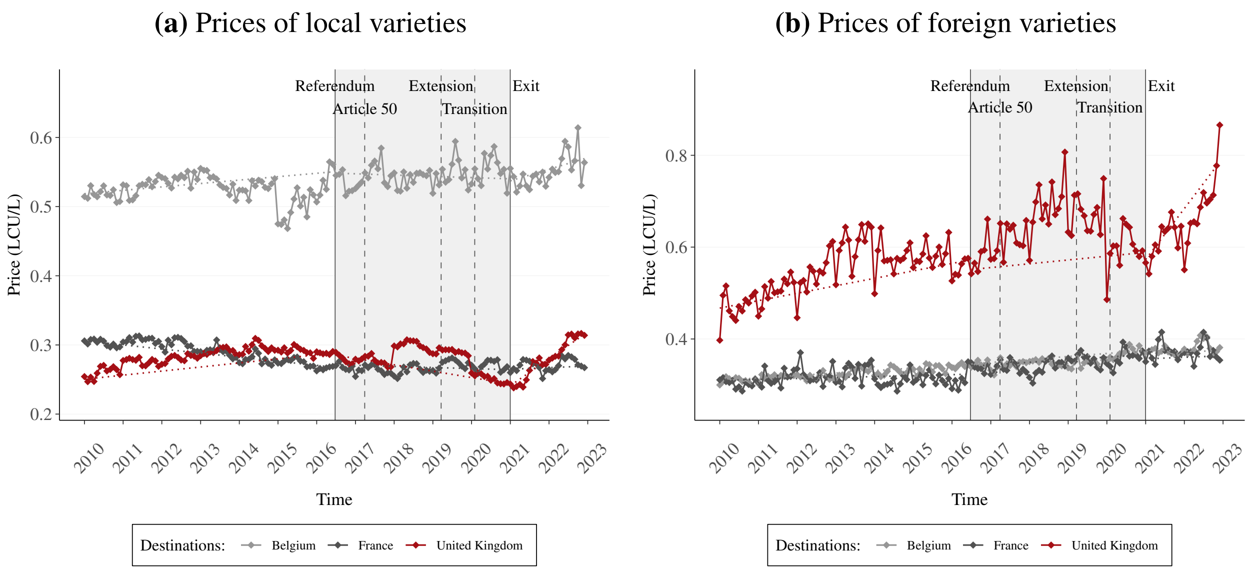
Before the UK seceded from the EU, freight rates for routes into Belgium and France were on a relatively flat trajectory and they were trending slightly upward for UK destinations. However, freight rates for routes with UK destinations abruptly rose immediately when the TCA came into force. Figure 4 indicates that freight rates for routes with UK destinations increased from roughly 2.300 EUR to a little over 3000 EUR or a 30% increase on average. Although freight rates for routes with destinations non-UK destinations started trending upwards somewhat from 2022 onwards, they did not discontinuously increase around January 2021 and mirrored the stability of non-UK consumer prices for bottled water.

Figure 2: Evolution of consumer prices (LCU)



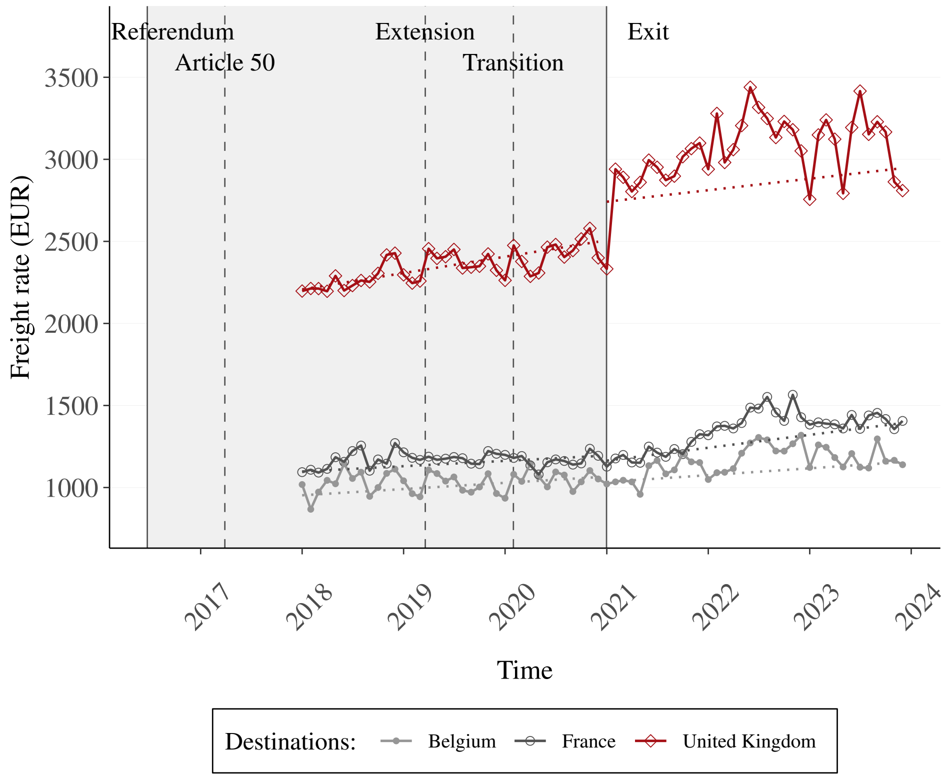
Notes: This figure plots the aggregate evolution of consumer prices for bottled water across Belgium, France, and the UK expressed in local currency units at a monthly frequency. We compute these series by aggregating over households, stores and bottled water varieties by weighting transaction-level unit prices using the interaction of population weights and volumes.

Figure 3: Evolution of consumer prices



Notes: This figure plots the aggregate evolution of consumer prices for bottled water across Belgium, France, and the UK expressed in local currency units at a monthly frequency separately for foreign and local varieties. We define local varieties as varieties that are sourced in the same country as they are consumed; foreign varieties are defined as the antecedent to local varieties. We compute these series by aggregating over households, stores and bottled water varieties by weighting transaction-level unit prices using the interaction of population weights and volumes.

Figure 4: Evolution of freight rates



Notes: This figure shows the evolution of the average freight rates for Belgium, France and the UK separately at the monthly frequency. We associate freight rates with a given country when the destination of the route is in that specific country. We aggregate over routes by taking a simple average.

3 Effect of Brexit on prices and freight rates

The evolutions of consumer prices for bottled water and freight rates on routes with UK destinations relative to evolutions in Belgium and France are suggestive of changing trade costs. Nevertheless, the relative change in average consumer prices could also be driven by compositional changes in the set of available varieties. This section establishes that the relative changes in prices and freight rates we documented earlier are driven by within-variety and -route variation between destinations.

3.1 Effect of Brexit on consumer prices

We substantiate this claim by estimating a series of difference-in-differences models. In particular, we estimate the following model:

$$\ln\left(p_{i,dt}\right) = \sum_{t} \beta_t \left(T_{i,dt} \times \mathbb{1}\left(t \neq 2019\right)\right) + \boldsymbol{\Gamma}'\boldsymbol{X}_{i,dt} + \varepsilon_{i,dt} \tag{1}$$

where in $p_{i,dt}$ is the final consumer price of variety i, sold in destination d at time t, $T_{i,dt}$ is an indicator function that is one for the group of treated observations, $\mathbb{1}\left(t \neq 2019\right)$ is an indicator function that is one whenever the period is 2019 and $\boldsymbol{X}_{i,dt}$ summarizes different sets of fixed effects we include and on which we elaborate below. The coefficients over interest are β_t which estimate how prices in the treatment group evolved differently before and after 2019 relative to the control group. Given that the sample period for the price data starts well before 2019, we collect the estimates before 2016 into one estimate.

Table 2 shows the results from estimating Equation (1) for different sets of controls and definitions of the treatment group using data at the yearly frequency. We estimate each specification using a weighted OLS estimator where the weights are the interaction between population weights and the volume sold. The results are qualitatively similar when we consider population weights as weights or we do not weigh at all (see Table B.1 and B.2 respectively). We cluster standard errors at the variety level and account for correlation in $\varepsilon_{i,dt}$ over time and across destinations within a given variety.

Baseline results. Columns (1)-(3) present the results when we include all varieties in the sample and define the treatment group as UK consumer prices and use consumer prices in Belgium and France as the control group, i.e. $T_{i,dt}$ is one when the destination is the UK. To interpret these results as causal, we require that prices in Belgium and France were unaffected by the UK's secession from the EU. Below, we provide supporting evidence. Column (1) reports the results when we include variety and time fixed effects. In this way, we control for the cross-sectional heterogeneity in consumer prices across varieties, for instance due to persistent quality or cost differences, and the aggregate evolution of consumer prices for bottled water in our sample. First, before 2019 UK consumer prices were falling relative to Belgian and French consumer prices. This is consistent with the aggregate evolution of UK consumer prices relative to Belgian and French consumer prices exhibited in Figure 2 and reflected in the significantly positive treatment effects between 2016 and 2018. Nevertheless, in 2020, the year before the introduction of the TCA, UK consumer prices were, on average, no longer higher compared to their Belgian and French counterparts. Second, from 2021 onwards, UK consumer prices significantly diverge from Belgian and French consumer prices. In particular, UK consumer prices are 6.7% and 16.4% higher in 2021 and 2022 relative to consumer prices in Belgium and France.

Columns (2) and (3) consider the robustness of these results in terms of the included set of fixed effects. First, in addition to time fixed effects, column (2) now also includes variety-destination fixed effects, which subsumes the treatment indicator $T_{i,dt}$. In this case, we recover quantitatively similar results in terms of the pre-2019 downward trajectory of UK consumer prices relative to Belgium and France. Also, the consumer price response following the inception of the TCA is similarly estimated at 6% and 15.4% in 2021 and 2022 respectively. Second, column (3) keeps the variety-destination fixed effects but replaces the time fixed effects with variety-time fixed effects. By including variety-time fixed effects, this specification fully controls for the evolution of variety-level consumer prices shared between destinations, e.g. due to changes in production costs. Because of this, the treatment effect is purely identified from variation between destinations within varieties. In this specification, we recover a stronger response as UK consumer prices rose by 13.6% and 17.6% relative to consumer prices in Belgium and France. In addition, the variety-time fixed effects also fully account for the fact that consumer prices in the UK appeared to be on a downward trend relative to the other countries; the only statistically significant treatment effects are the ones after 2020.

In column (4), we examine whether the consumer price response is driven by the change in UK consumer prices for varieties imported into the UK as suggested by Figure 3b. To this end, we restrict the sample to only include varieties that are imported into the UK. By doing so, we ensure that the treatment effects are identified purely from the variation between destinations in consumer prices of varieties that are exported to the UK. Importantly, an inspection of the treatment effects before 2020 shows that the evolution of consumer prices of exported products to the UK did not differ between destinations. However, UK consumer prices of foreign varieties rose statistically significantly by 12% and 18.8% in 2021 and 2022 respectively.

We complement the yearly results presented in Table 2 with higher frequency graphical evidence presented in Figure 5. In particular, Figure 5 presents the results when we estimate Equation (5) at the monthly level, including only varieties imported into the UK and defining UK consumer prices as the treatment group. In this case, we estimate the treatment effects relative to December 2019. In line with the results presented in column (4), we find that UK consumer prices of imported varieties were closely tracking their Belgian and French counterparts. However, from the middle of 2021 onwards, we observe that UK consumer prices sharply increase relative Belgian and French consumer prices and remain at a permanently higher level between 15% and 20%.

Complementary results. We now consider a set of alternative specifications. The first two are geared towards providing supporting evidence that the previously reported estimates have a causal interpretation. The second two compares our approach of exploiting variation between destination markets to an approach that would use variation between product origins.

First, to support the internal validity of our approach, column (5) displays the results from a placebo experiment. In this specification, we still only focus on varieties that are imported into the UK but only include Belgian and French consumer prices. By counterfactually allocating Belgian consumer prices as the treatment group and keeping French consumer prices in the control group, we estimate whether Belgian consumer prices diverged from French consumer prices after 2021 like UK consumer prices did. As the introduction of the TCA should have only affected UK consumer prices, finding that Belgian consumer prices did not rise relative to prices in France provides additional credence that the rise in UK consumer prices was due to the inception of the TCA. Although Belgian prices were somewhat larger in 2018 and 2020 compared to 2019, Column (5) shows that Belgian and French consumer prices of varieties imported into the UK did not diverge after 2021.

Second, in addition to a difference-in-differences model, we also consider a triple difference-in-differences model. In this case, we limit the control group to only include French consumer prices and examine how Belgian and UK consumer prices changed (first treatment group) and solely UK consumer prices (second treatment group) changed relative to French consumer prices. Figure B.1 when we implement this approach using data at a monthly frequency. Reassuringly, Figures B.1a and B.1b confirm that UK consumer prices rose relatively to French and Belgian prices in the full sample

Table 2: Difference-in-differences - Consumer prices

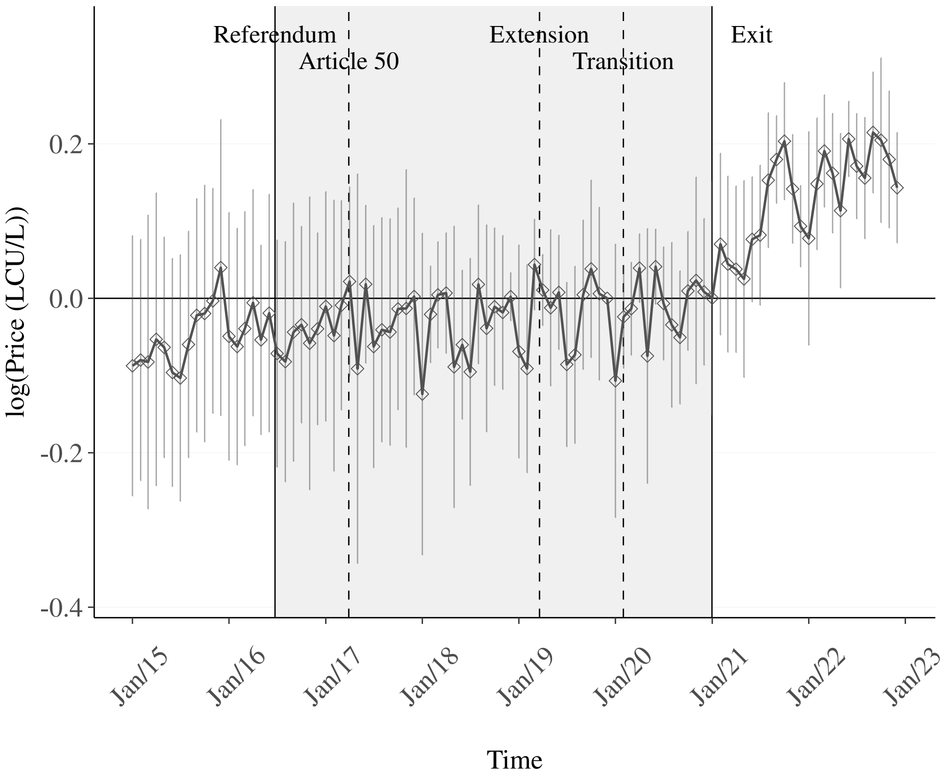
	All			Foreign	Placebo	Domestic DiD	Local
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$T_{i,d} \times \mathbb{1}\,(t \leq 2015)$	0.0431^{*}	0.0344	-0.0328	-0.05	-0.0547^{*}	-0.0603	0.0484
	(0.0261)	(0.0261)	(0.0496)	(0.0534)	(0.0322)	(0.0516)	(0.0334)
$T_{i,d} \times \mathbb{1}\,(t = 2016)$	0.0604^{***}	0.0529^{***}	-0.0139	-0.0175	0.0151	-0.0661^{*}	0.0774^{***}
	(0.0198)	(0.0198)	(0.0308)	(0.0376)	(0.0116)	(0.0364)	(0.0246)
$T_{i,d} \times \mathbb{1}\,(t = 2017)$	0.0473^{***}	0.0425^{***}	-0.0063	-0.00318	0.00917	-0.0413^{*}	0.0628^{***}
	(0.0139)	(0.0135)	(0.0287)	(0.0366)	(0.012)	(0.023)	(0.0168)
$T_{i,d} \times \mathbb{1}\,(t = 2018)$	0.0338^{**}	0.0318^{**}	-0.0214	-0.0171	0.0491^{**}	-0.00692	0.0356^{***}
	(0.0136)	(0.0135)	(0.018)	(0.0211)	(0.0201)	(0.0105)	(0.0104)
$T_{i,d} \times \mathbb{1}\,(t = 2019)$	-	-	-	-	-	-	-
$T_{i,d} \times \mathbb{1}\,(t = 2020)$	-0.0132	-0.0117	0.00145	0.00848	0.062^{***}	0.0131	-0.0151
	(0.0144)	(0.0141)	(0.0119)	(0.0171)	(0.0185)	(0.024)	(0.0156)
$T_{i,d} \times \mathbb{1}\,(t = 2021)$	0.0672^{***}	0.0596^{***}	0.136^{***}	0.12^{***}	0.0355	0.0409	0.0431^{*}
	(0.0206)	(0.0206)	(0.0211)	(0.0207)	(0.0323)	(0.0297)	(0.0237)
$T_{i,d} \times \mathbb{1}\,(t = 2022)$	0.164^{***}	0.154^{***}	0.176^{***}	0.188^{***}	0.0119	0.0128	0.138^{***}
	(0.0256)	(0.0256)	(0.0247)	(0.0289)	(0.0162)	(0.0344)	(0.0294)
$T_{i,d}$	-0.213^{***}	-	-	-	-	-	-
	(0.0725)						
θ_i	✓						
$\theta_{i,d}$		✓	✓	✓	✓	✓	✓
λ_t	✓	✓				✓	✓
$\lambda_{i,t}$			✓	✓	✓		
R^2	0.009	0.009	0.005	0.064	0.300	0.012	0.017
No. obs	7,355	7,355	7,355	1,104	786	1,605	3,776

Notes: This table shows the results from estimating Equation (1) for different sets of controls and definitions of the treatment group using data at the yearly frequency. Columns (1)-(3) include both locally produced UK and varieties imported into the UK. In addition, column (1) includes variety and time fixed effects, column (2) includes variety-destination and time fixed effects and column (3) includes variety-destination and variety-time fixed effects. Column (4) includes variety-destination and variety-time fixed effects but focuses exclusively on varieties imported into the UK. Column (5) considers the same sample as column (5) but excludes UK consumer prices and considers a placebo experiment by defining the treatment group as consumer prices in Belgium. Columns (6) and (7) both include variety-destination and time fixed effects but differ in the sample and the definition of the treatment group. Column (6) only includes UK consumer prices on locally produced UK and varieties imported into the UK and defines the treatment group as UK consumer prices of imported varieties. Column (7) only includes consumer prices of locally sourced varieties in Belgium, France and the UK and defines the treatment group as consumer prices of locally sourced UK varieties. We estimate each specification using a weighted OLS estimator where the weights are the interaction between population weights and the volume sold. We cluster standard errors at the variety level and denote statistical significance at the $p < 0.1^{*}$,$p < 0.05^{**}$ or $p < 0.01^{***}$ level.

of varieties and in the sample that restricts attention to varieties imported into the UK respectively.

Third, we compare the results from our approach that exploits price variation between destinations to an approach that relies on price variation across products within a given destination. For instance, to understand the effect of Trump tariffs, Flaaen, Hortaçsu, and Tintelnot (2020) compare the price evolution of washing machines to the evolution for ranges and Fajgelbaum et al. (2020) exploit variation between targetted and untargeted products. This approach uncovers the true effect of the policy change as long as untargeted products are not indirectly affected, for instance through industry or general equilibrium effects. Column (6) shows the results of estimating one version of this approach. More specifically, in column (6), we restrict attention to UK consumer

Figure 5: Difference-in-differences: Consumer prices - Foreign products



Notes: This figure plots the results when we estimate Equation (1) using data at the monthly level, we only include consumer prices of varieties that are imported into the UK and when we define the treatment group to be UK consumer prices. In this case, we estimate the treatment effects relative to December 2019. Like before, we weigh observations using population weights interacted with purchased volumes. We cluster standard errors at the variety level and report 95% confidence intervals along the point estimates.

prices only and define imported and locally produced varieties as the treated and control group respectively. Before 2021, there is weak evidence that UK consumer prices of foreign varieties were rising relative to consumer prices of locally sourced varieties. However, we find a precisely estimated null effect and therefore we cannot reject the null hypothesis that UK consumer prices of foreign and local varieties changed similarly after 2021.

Finally, column (7) reveals that an important driver of this result is that UK consumer prices of locally sourced bottled water varieties rose substantially after 2021 as well. To establish this point, we confine the sample to consumer prices of only locally produced and consumed varieties in each country. In turn, we compare how UK consumer prices of varieties produced in the UK evolved relative to Belgian and French prices of varieties produced in Belgium and France varieties respectively. As this approach identifies the treatment effects based on price evolutions of different varieties, it is less ideal but it provides insight into how prices for locally produced varieties evolved. Column (7) illustrates that UK consumer prices of locally produced varieties were on a downward trajectory prior to 2019. In line with the results from column (6), UK consumer prices of locally produced varieties significantly increased relative to consumer prices of locally produced varieties in other countries after 2020. These final two results are unable to speak whether the considerable rise in UK consumer prices of locally produced varieties is due to industry equilibrium effects such as reduced competitive pressure as in (Crowley, Han, and Prayer, 2024; Amiti and Heise, 2024) or due to general equilibrium effects that affected input prices as suggested by Born et al. (2019) and Broadbent et al. (2024). They do, however, underscore the need to leverage variation between destinations instead of variation across products within the UK to estimate the effects of the UK's secession on consumer prices.

3.2 Effect of Brexit on freight rates

Next, we investigate whether the sudden increase in freight rates on routes with UK destinations was driven by variation between destinations as well. To this end, we estimate a similar difference-in-difference model as in the previous section:

$$t_{od,t} = \sum_{t} \beta_t \left(T_{od,t} \times \mathbb{1}\left(t \neq 2019\right)\right) + \mathbf{\Gamma}' \boldsymbol{X}_{od,t} + \varepsilon_{od,t} \tag{2}$$

where $t_{od,t}$ is the freight rate on route with origin o and destination d at time t, $T_{i,dt}$ is an indicator function that is one for the group of treated observations, $\mathbb{1}\left(t \neq 2019\right)$ is an indicator function that is one whenever the period is 2019 and $\boldsymbol{X}_{i,dt}$ summarizes different sets of fixed effects we include. Like before, the coefficients over interest are β_t which capture how prices in the treatment group evolved differently before and after 2019 relative to the control group. In contrast to the estimation for consumer prices, we estimate how the *absolute level* of freight rates on routes with UK destinations changed relative to routes with non-UK destinations. We take this approach as there is substantial literature that argues that freight rates are best modeled as additive trade costs (Hummels and Skiba, 2004; Hummels, Lugovskyy, and Skiba, 2009; Irarrazabal, Moxnes, and Opromolla, 2015; Ishikawa and Tarui, 2018). For this reason, we believe that examining how freight rates changed in absolute levels is more suitable.

Like before, Table 2 shows the results from estimating Equation (2) for different sets of controls and definitions of the treatment group using data at the yearly frequency. The results are obtained by using an unweighted OLS estimator and we cluster standard errors at the route level and account for correlation in $\varepsilon_{i,dt}$ over time.

Baseline results. Columns (1)-(3) present the results when we include all routes in the sample and define the treatment group as routes with UK destinations, i.e. $T_{i,dt}$ is one when the destination is the UK. We define routes with Belgian and French destinations as the control group and, thus, necessitate that routes to Belgium and France be unaffected by the UK's departure from the EU. Column (1) reports the results when we include destination fixed effects, which subsume the treatment indicator, and time fixed effects. The inclusion of destination fixed effects controls for persistent differences in freight rates between destinations, for instance, due to their specific geography or local demand for transportation services (see Brancaccio, Kalouptsidi, and Papageorgiou (2020)). Adding time fixed controls for changes in freight rates that are shared across routes, such as changes in fuel prices.

Column (1) shows that in 2018 freight rates on routes with UK destinations were on average €79 cheaper relative to 2019 and €56 more expensive in 2020. These small pre-TCA differences in freight rates are, nonetheless, dwarfed by the post-TCA relative response of freight rates on routes with UK destinations relative to non-UK destinations. More precisely, freight rates on routes with UK destinations were respectively €486, €585 and €581 higher in 2021, 2022 and 2023 compared to routes with non-UK destinations. These results suggest that freight rates on routes with UK-destination did not change markedly before 2021 but that they suddenly changed after the TCA came into force.

Columns (2) and (3) consider increasingly demanding specifications in terms of the included fixed effects. Column (2) replaces the destination fixed effects with route-level fixed effects to fully account for persistent differences in freight rates at the route level. This specification yields quantitatively very similar results as column (1). On top of accounting for heterogeneity at the route level, Column (3) also accounts for changes in freight rates over time that are shared amongst routes with the same destination. This is our preferred specification as the treatment effects are now identified solely using variation in freight rates between destinations within a given route. Relative to the specification in columns (1) and (2), column (3) shows that this approach yields relatively similar results before the introduction of the TCA but that the relative response of freight rates after 2020 is much stronger. In this instance, we find that freight rates on routes with UK destinations are respectively €756, €907 and €862 higher in 2021, 2022 and 2023.

We further corroborate these results in column (4) and Figure 6. First, column (4) constrains the sample to only include routes with non-UK origins. In this setup, the treatment effects are estimated purely from relative changes in freight rates on routes with different destinations but with the same non-UK origin. Indeed, column (4) confirms that the majority of the effect reported in column (3) is driven by changes in freight rates on routes coming into the UK as we recover quantitatively very similar results. The sharp and immediate increase in freight rates following the inception of the TCA becomes even clearer when we estimate the treatment effects at a higher frequency. Figure 6 plots the results from estimating the specification that underlies column (4) at the monthly frequency where the effects are normalized to December 2019. We document a slight upward trend in freight rates on routes with UK destinations relative to routes with non-UK destinations before 2021 at the monthly frequency as well. Nevertheless, this figure also illustrates how relative freight rates suddenly broke away from their pre-2021 trend and almost immediately transitioned to a level that is a little under €1,000 higher.

Complementary results. We now provide additional evidence that supports a causal interpretation of the results presented so far and investigate whether freight rates on routes with a UK origin and destination were affected as well.

First, a causal interpretation of the results warrants that the control group, i.e. routes with non-UK destinations, were not affected following the introduction of the TCA. To this end, we examine whether freight rates on routes with the same origin changed differently when the destination was

Table 3: Difference-in-difference - Freight rates

	All			Foreign	Placebo	Domestic DiD	Local
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$T_{od} \times \mathbb{1}\,(t = 2018)$	-79.7^{***}	-79.7^{***}	-114^{***}	-117^{***}	28.6^{***}	-97.4^{***}	-21^{***}
	(4.69)	(4.66)	(4.79)	(4.78)	(3.09)	(5.74)	(2.3)
$T_{od} \times \mathbb{1}\,(t = 2019)$	-	-	-	-	-	-	-
$T_{od} \times \mathbb{1}\,(t = 2020)$	56.2^{***}	56.2^{***}	97.8^{***}	102^{***}	56^{***}	116^{***}	-0.914
	(4.91)	(4.88)	(3.82)	(3.5)	(2.78)	(4.7)	(1.99)
$T_{od} \times \mathbb{1}\,(t = 2021)$	486^{***}	486^{***}	756^{***}	773^{***}	66.2^{***}	698^{***}	110^{***}
	(22.8)	(22.7)	(15.2)	(14.5)	(4.67)	(18.1)	(5.96)
$T_{od} \times \mathbb{1}\,(t = 2022)$	585^{***}	585^{***}	907^{***}	915^{***}	-34^{***}	864^{***}	156^{***}
	(36.5)	(36.2)	(24.3)	(24.4)	(12.7)	(40.3)	(13.3)
$T_{od} \times \mathbb{1}\,(t = 2023)$	551^{***}	547^{***}	862^{***}	867^{***}	-56.8^{***}	818^{***}	124^{***}
	(37.3)	(33)	(22.6)	(22.6)	(12.1)	(35.3)	(12.7)
θ_d	✓						
θ_{od}		✓	✓	✓	✓	✓	✓
λ_t	✓	✓				✓	✓
$\lambda_{o,t}$			✓	✓	✓		
R^2	0.013	0.324	0.787	0.809	0.131	0.551	0.306
No. obs	3,756	3,756	3,756	2,681	1,648	1,814	2,008

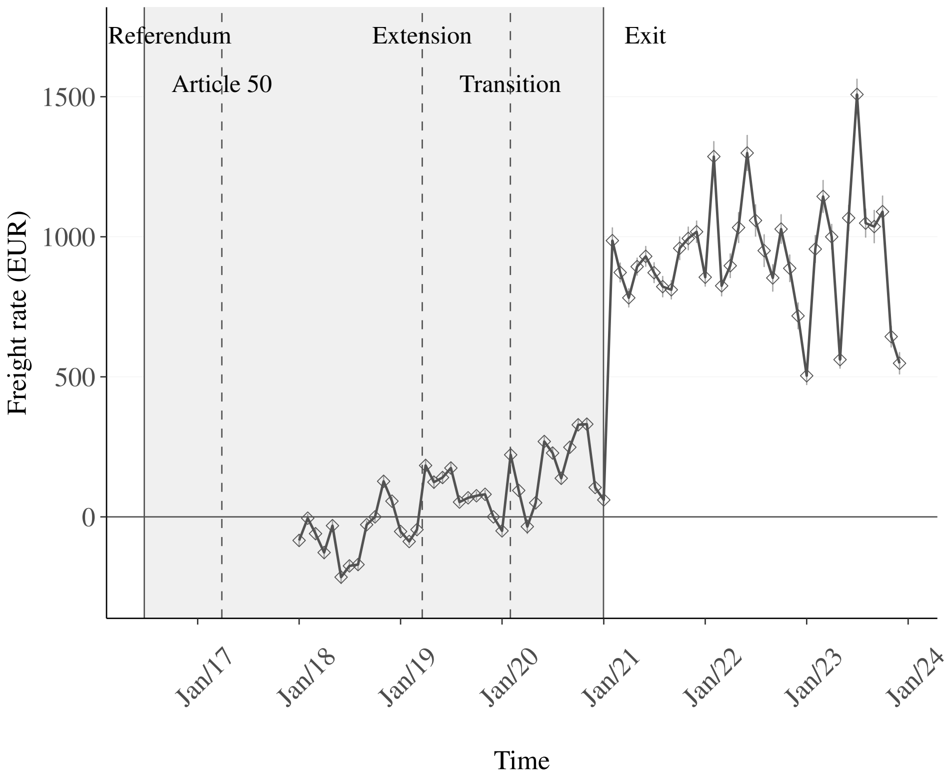
Notes: This table shows the results from estimating Equation (2) for different sets of controls and definitions of the treatment group using data at the yearly frequency. Columns (1)-(3) include freight rates on routes with domestic UK origins and foreign origins. In addition, column (1) includes destination and time fixed effects, column (2) includes origin-destination and time fixed effects and column (3) includes origin-destination and origin-time fixed effects. Column (4) includes origin-destination and origin-time fixed effects but confines the sample to freight rates on routes with non-UK origins. Column (5) considers the same sample as column (5) but excludes freight rates with UK destinations and considers a placebo experiment by defining the treatment group as freight rates on routes with a destination in Belgium. Columns (6) and (7) both include origin-destination and time fixed effects but differ in the sample and the definition of the treatment group. Column (6) only includes freight rates on routes with UK destinations and defines the treatment group as freight routes on routes with a non-UK origin. Column (7) only includes freight rates on local routes, i.e. routes with an origin and destination in the same country and defines the treatment group as freight rates on UK domestic routes. We estimate each specification using an unweighted OLS estimator, cluster standard errors at the route level and denote statistical significance at the $p < 0.1^{*}$,$p < 0.05^{**}$ or $p < 0.01^{***}$ level.

Belgian versus when the destination was French. Column (5) validates that freight rates on routes with Belgian destinations stayed relatively close to freight rates on routes with French destinations both before and after 2021. Coupled with the relatively flat profile of average freight rates on routes with Belgian and French destinations depicted in Figure 4, especially from 2021 until 2022, this provides additional support that the sudden increase in freight rates was caused by the UK's secession from the EU.

Second, to address the slightly upward trend in freight rates with UK destinations relative to non-UK destinations, we have estimated a triple difference-in-differences model as well. In this exercise, we define the control group as freight rates on routes with French destinations, the first treatment group to be freight rates with Belgian and UK destinations and the second treatment group as freight rates on routes with UK routes. Thus, this specification estimates the differential change in freight rates on routes with UK destinations while allowing for a differential evolution in freight rates that is shared amongst routes with Belgian and UK destinations relative to routes with French destinations. Figures B.3a and B.3b implement this for the sample of all routes and the subsample of routes with non-UK origins. In both cases, we find a much weaker upward trend in pre-2021 freight rates with UK destinations. At the same time, the large and sudden response after 2021 remains unaffected.

Finally, we study whether freight rates on domestic UK routes increased after 2021 as well. Column (7) shows the results from estimating Equation (2) when we limit the sample to routes with UK destinations only and when we compare the evolution of freight rates on routes with non-UK origins to freight rates on routes with UK origins. In contrast to the results for consumer prices, we find relatively similar albeit somewhat smaller results. In particular, freight rates on routes with UK routes were, on average, a little over €800 higher compared to routes with UK origins in 2023. Yet, column (8) shows that freight rates on local UK routes did rise by €110 and €150 depending on the horizon relative to local routes in France and Belgium. Although the equilibrium effect on the local market seems to be less severe compared to the price response, there seems to have been a response on the market for purely local UK routes as well.

Figure 6: Difference-in-difference - Freight rates



Notes: This figure plots the results when we estimate Equation (2) using data at the monthly level, we only include freight rates on routes with non-UK origins and when we define the treatment group to be freight rates on routes with UK destinations. In this case, we estimate the treatment effects relative to December 2019. The results are estimated using an unweighted OLS estimator, we cluster standard errors at the route level and report 95% confidence intervals along the point estimates.

Taking stock. This section established that UK consumer prices of bottled water increased substantially after the introduction of the TCA in 2021. This seems to be caused by an increase in the consumer prices of locally sourced and imported varieties. One key reason appears to be the sudden and large increase in freight rates for routes with UK destinations. This increase in freight rates can be driven by regulation-induced reduction in the supply of trucking services on routes with UK destinations. However, it can also be driven by a reduction in the demand for trucking services in the UK leading to more idling and a less efficient market for trucking services in the UK. In the next part of the paper, we take this increase in freight rates as given and quantify how much of the increase in consumer prices is due to this increase in freight rates.

4 Quantitative framework

This section describes the equilibrium model of demand and supply of the bottled water industry. Deriving this equilibrium model serves two purposes. First, we combine the model-implied elasticities of substitution with assumptions about how consumer prices are determined to estimate how marginal costs changed following the introduction of the TCA. This allows us to estimate the importance of freight rates in determining destination-specific marginal costs of selling bottled water. Second, we combine the estimated demand model with the estimated cost parameters to quantify the impact of changes in freight rates on non-tariff trade barriers, consumer prices and consumer welfare.

4.1 Preferences for bottled water

We assume that consumers have random utility preferences over bottled water varieties and that they make a static discrete choice. First, assuming that demand is determined by a discrete choice of which variety to consume provides a natural way to account for the fact that not all consumers will purchase bottled water. In particular, Table 1 shows that the share of consumers that buy bottled water varies substantially across countries, potentially due differences in the perceived quality of tap water. Second, we abstract from dynamic decision making on the part of consumers. Because bottled water is a storable good, ignoring such dynamic behavior could in principle bias the estimated substitution patterns Hendel and Nevo (2006).[6] To accomodate this concern, we aggregate the data to the quarterly level. At the quarterly level, roughly 90% of the households in countries, in which bottled water is appealing relative to the outside option, buy bottled water each period (Table 1).

Formally, we assume that consumers $i \in 1, \ldots, N_{lt}$ in market t, where the market is defined as a quarter t in a location l, make a static discrete choice over the set of bottled water varieties available in their regional market, which is denoted by $\mathcal{J}_{lt}$. With this in mind, consumers choose the variety

[6] Ignoring such dynamic concerns typically leads to an overestimating of demand elasticities and an underestimation of the degree to which manufacturers will want to raise prices above marginal costs.

$j \in \mathcal{J}_{lt}$ that maximizes their indirect utility $V_{ij,lt}$ given by:

$$V_{ij,lt} = \alpha_i P_{j,lt} + \boldsymbol{\beta}_i^{'} \boldsymbol{X}_{j,lt} + \lambda_{lt} + \xi_{j,lt} + \varepsilon_{ij,lt}$$

where $P_{j,lt}$ is the price of a variety j in market t, $\boldsymbol{X}_{j,lt}$ is the vector of variety-specific product characteristics, λ_{lt} are market-specific effects that capture variation in the importance of the outside good and $\xi_{j,lt}$ is an unobserved demand shifter which is potentially correlated with consumer prices. We allow for consumer-level heterogeneity in the price sensitivity and the preferences for product characteristics, as indicated by α_i and $\boldsymbol{\beta}_i^{'}$ respectively. We follow the literature in normalizing the indirect utilities by setting the indirect utillity of the outside good to zero in all markets. Finally, $\varepsilon_{ij,lt}$ captures idiosyncratic tastes for products that are individually and independently distributed across products and markets and are drawn from an EV(1) distribution. This last assumption implies that the model-implied market shares, $\sigma_{j,lt}$, take the following form:

$$\sigma_{j,lt} = \int_{-\infty}^{\infty} \frac{\alpha_i P_{j,lt} + \boldsymbol{\beta}_i^{'} \boldsymbol{X}_{j,lt} + \lambda_{lt} + \xi_{j,lt}}{1 + \sum_{j \in \mathcal{J}_{lt}} \alpha_i P_{j,lt} + \boldsymbol{\beta}_i^{'} \boldsymbol{X}_{j,lt} + \lambda_{lt} + \xi_{j,lt}} d\boldsymbol{F}\left(\alpha_i, \boldsymbol{\beta}_i^{'}\right) \tag{3}$$

where $\boldsymbol{F}\left(\alpha_i, \boldsymbol{\beta}_i^{'}\right)$ is the cumulative distribution of consumer-specific preferences. The definition of the choice set implies that consumers only choose among varieties available in their regional market. However, the border between Belgium and France is not subject to formal checks. Hence, consumers are, in principle, free to engage in cross-border shopping.[7] We abstract from cross-border shopping for two reasons. First, bottled water is an inexpensive, voluminous and heavy product which makes engaging in arbitrage for bottled water not very profitable. Hence, in case water was purchased abroad, it is likely that it would be bought alongside other products. Second, cross-border shopping is marginal in the data. For Belgium and France, the share of cross-border transactions in the total number of transactions is smaller than 2%.

4.2 Market structure and marginal costs

To go from consumer prices to destination-specific marginal costs, we assume that consumer prices are determined as the equilibrium of a simultaneous move Bertrand game in which manufacturers choose conusmer prices to maximize profits. Doing so, consumer prices are determined as the solution to the following system of first-order conditions:

$$\boldsymbol{p}_{lt} = -\left(\boldsymbol{\Delta}_{lt} \odot \boldsymbol{\Omega}_{lt}^{r}\right)^{-1} \cdot \boldsymbol{\sigma}_{lt}(\boldsymbol{p}^{r}; \boldsymbol{\Theta}^{d}) + \boldsymbol{c}_{lt} \tag{4}$$

In this expression, the term $\left(\boldsymbol{\Delta}_{lt} \odot \boldsymbol{\Omega}_{lt}\right)^{-1} \cdot \boldsymbol{\sigma}_{lt}(\boldsymbol{p}; \boldsymbol{\Theta}^{d})$ is the vector of markups charged by manufacturers. This depends on the matrix of first-order derivatives of demand relative to consumer

[7]Recently, Auer et al. (2023) investigates how the incidence of the appreciation of Swiss Franc differs between consumers that live close to and far away from the country's borders.

prices $\boldsymbol{\Delta}_{lt}$, the ownership matrix $\boldsymbol{\Omega}_{lt}$ that internalizes substitution towards other varieties sold by the same manufacturer and the vector of market shares, $\boldsymbol{\sigma}_{lt}(\boldsymbol{p}; \boldsymbol{\Theta}^d)$, which depends on the demand parameters $\boldsymbol{\Theta}^d$. The vector $\boldsymbol{c}_{lt}$ is the vector of destination-specific marginal costs.

Equation 4 shows that the assumptions about consumer preferences and how consumer prices are determined in equilibrium, allows one to back out destination-specific marginal costs. To quantify the contribution of changes in freight rates on changes in non-tariff barriers and marginal costs, we parameterize the destination-specific marginal costs as follows:

$$\boldsymbol{c}_{lt} = \gamma t_{s(j),lt} + \beta W_{lt} + \tau_B \mathbb{1}\left(\text{Border}\right)_{s(j)l} + \omega_{j,t} + \eta_{j,lt} \tag{5}$$

This cost function accounts for three sources of destination-specific marginal costs. First, destination-specific marginal costs may differ between destinations when local distribution costs differ (Burstein, Eichenbaum, and Rebelo, 2005; Crucini, Telmer, and Zachariadis, 2005; Parsley and Wei, 2007). We account for differences in distribution costs by including W_{lt} which are labor unit costs in the retail sector, expressed in Euro per hour, and which are allowed to vary over time and by destination market. Second, destination-specific marginal may differ when there are positive cross-border trade frictions $\tau_B \mathbb{1}\left(\text{Border}\right)_{s(j)l}$ as captured by a border effect. Finally, differences in destination-specific marginal costs will arise from differences transport costs, given by $t_{s(j)l,t}$. In fact, section 3 showed that freight rates on routes with UK increased substantially after the introduction of the TCA. The main parameter of interest is, therefore, γ as it captures the share accounted for by freight rates in the total destination-specific marginal cost of bottled water provision. Besides these three sources of destination-specific marginal costs, the cost function captures two additional sources of variation: production costs are captured through $\omega_{j,t}$ and finally $\eta_{j,lt}$ which is an unobserved variety- and market-specific cost shifter that varies over time.

Two features of this parameterization stand out. First, having data on variety-level production locations and observing the same variety being consumed in multiple locations allows us to fully and flexibly account for the marginal costs of production through variety-time fixed effects. For this reason, this specification allows for estimating the trade cost vector under arbitrary returns to scale and scope. Second, to arrive at this specification, we have implicitly that the production function of bottled water takes the Leontief form in which water bottles, local labor and transportation costs all enter as perfect complements. In the bottled water industry, these assumptions are quite natural as both transport and distribution are indispensable to be able to deliver bottled water to the final consumer. Moreover, assuming that distribution costs and transport costs enter the cost function additively are standard in the international trade literature (Corsetti and Dedola, 2005; Parsley and Wei, 2007; Irarrazabal, Moxnes, and Opromolla, 2015).

5 Quantitative results

[In progress]

6 Conclusion

Although the need for augmenting tariff barriers with non-tariff barriers to fit trade patterns is well known, their nature is poorly understood. Additionally, their presence is often used to motivate the conclusion of deep trade agreements but the gains from deep trade agreements are often hard to quantify. We make progress by studying the introduction of the TCA that governs trade relations between the UK and the EU from 2021 onwards and focusing on the bottled water industry.

Because bottled water was not subject to tariff uncertainty or new tariffs under the TCA's rule of origin and manufacturers cannot adjust the production locations, our setting is ideally suited to evaluate the effects of retracting from deep trade agreements and shed new light on the nature of non-tariff barriers. To this end, we build a new dataset of final consumer prices of bottled water in the UK, Belgium and France. In addition, we gather data on route-level freight rates for road transport between the most important production locations and consumption destinations.

We find that UK consumer prices rose by roughly 17% relative to consumer prices for the same products in Europe following the introduction of the TCA. We focus on changes in freight rates for trucking services as an important component of newly erected non-tariff barriers by the UK's secession from the EU. Using route-level variation, we show that routes with UK destinations became 30% more expensive relative to routes with destinations in continental Europe.

While we take the change in freight rates as given, our paper does provide novel evidence for the interplay between changes in the trading environment for goods and the price for complementary services such as transportation and how non-tariff barriers can be endogenously determined.

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Catchy title

ONLINE APPENDIX

A Data and motivating evidence

A.1 Data construction

Table A.1: Store selection

Variable	Overall	BEL	FRA	UK
Transactions (count)				
·Included	7,662,402	1,040,485	3,524,775	3,097,142
·Excluded	276,764	49,278	126,511	100,975
Transactions (share)				
·Included	0.965	0.955	0.965	0.968
·Excluded	0.035	0.045	0.035	0.032
Liters (liters)				
·Included	52,354,103	9,541,668	32,302,062	10,510,372
·Excluded	1,631,999	543,285	877,058	211,655
Liters (share)				
·Included	0.970	0.946	0.974	0.980
·Excluded	0.030	0.054	0.026	0.020

Notes: This table shows the sample selection in terms of stores we include. We show for each country separately and overall how many transactions and consumed volume in liters we include and exclude.

Table A.2: Product selection

Variable	Overall	BEL	FRA	UK
Transactions (count)				
·Included	7,318,542	1,014,102	3,292,681	3,011,759
·Excluded	620,624	75,661	358,605	186,358
Transactions (share)				
·Included	0.922	0.931	0.902	0.942
·Excluded	0.078	0.069	0.098	0.058
Liters (liters)				
·Included	51,294,884	9,423,531	31,517,680	10,353,673
·Excluded	2,691,218	661,422	1,661,440	368,355
Liters (share)				
·Included	0.950	0.934	0.950	0.966
·Excluded	0.050	0.066	0.050	0.034

Notes: This table shows the sample selection in terms of which products we include. We show for each country separately and overall how many transactions and consumed volume in liters we include and exclude.

Table A.3: Hedonic regression

	Raw sample		Clean sample	
$\ln(p_{i,dt})$	(1)	(2)	(3)	(4)
$\mathbb{1}\,(\text{Sparkling})_j$	0.057	0.0159	0.084^{*}	0.0216
	(0.040)	(0.026)	(0.044)	(0.030)
$\mathbb{1}\,(\text{Flavored})_j$	0.527^{***}	0.569^{***}	0.484^{***}	0.555^{***}
	(0.046)	(0.032)	(0.055)	(0.044)
$\mathbb{1}\,(\text{Glass bottle})_j$	0.434^{***}	0.336^{***}	0.252	0.31^{**}
	(0.112)	(0.072)	(0.237)	(0.141)
$\mathbb{1}\,(\text{Other package})_j$	0.456^{***}	0.104	0.484^{***}	0.0331
	(0.060)	(0.101)	(0.068)	(0.121)
$\mathbb{1}\,((750\text{ml}, 1500\text{ml}))_j$	-0.401^{***}	-0.456^{***}	-0.359^{***}	-0.434^{***}
	(0.051)	(0.029)	(0.058)	(0.035)
$\mathbb{1}\,(\geq 1500\text{ml})_j$	-0.965^{***}	-0.893^{***}	-0.918^{***}	-0.877^{***}
	(0.053)	(0.027)	(0.056)	(0.034)
$\mathbb{1}\,(\text{Private label})_j$	-0.4^{***}		-0.426^{***}	
	(0.040)		(0.046)	
Region-Time FEs	✓	✓	✓	✓
Brand FEs		✓		✓
$Adj.R^2$	0.60	0.79	0.65	0.82
No. obs	546,972	546,972	370,031	370,031

Notes: This table provides the results from regressing tax-inclusive consumer prices at the variety-NUTS-quarterly level on product characteristics. We aggregate transaction-level prices from the transaction level to the variety level using population weights interacted with volume sold to ensure that prices are representative. We cluster standard errors at the variety level and report significance levels at the $p < 0.1^{*}$,$p < 0.05^{**}$ and $p < 0.01^{***}$ levels.

Table A.4: Product characteristics: R^2

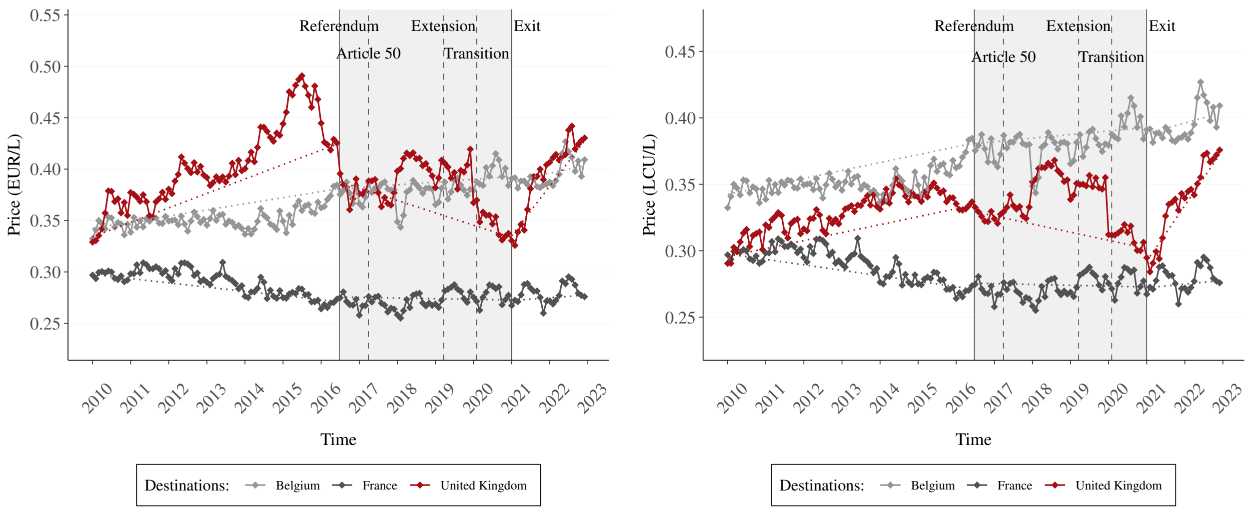
$p_{j,lt}$	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
PANEL (A): RAW DATA									
R^2	0.455	0.455	0.531	0.505	0.664	0.624	0.700	0.708	0.708
N	959,024	959,024	959,024	959,024	959,024	959,024	959,024	959,024	959,024
No. FEs	4,348	4,350	4,587	4,352	4,406	4,355	4,424	4,427	4,427
PANEL (B): CLEANED SAMPLE									
R^2	0.446	0.446	0.534	0.503	0.694	0.653	0.735	0.743	0.743
N	730,476	730,476	730,476	730,476	730,476	730,476	730,476	730,476	730,476
No. FEs	3,960	3,962	4,103	3,964	3,987	3,967	4,004	4,009	4,008
·Region × Time	✓	✓	✓	✓	✓	✓	✓	✓	✓
·Brand	✓	✓	✓	✓	✓	✓	✓	✓	✓
·Carbonated		✓	✓	✓	✓	✓	✓	✓	✓
·Flavor			✓						
·$\mathbb{1}$ (Flavored)				✓	✓	✓	✓	✓	✓
·Bottle size					✓		✓	✓	✓
·Binned Bottle size						✓			
·Bottles per pack							✓	✓	✓
·Package type								✓	
·Binned Package type									✓

Notes: This table provides the results from regressing tax-inclusive consumer prices on fixed effects capturing various levels of variation in the data. To conduct these estimations. For each of the eight regressions, I show the resulting adjusted R^2, the number of observations included in the regression, which of the fixed effects are included and the total number of included fixed effects.

A.2 Evolution of consumer prices

Figure A.1: Evolution of consumer prices

(a) Prices in EUR **(b)** Prices in LCU

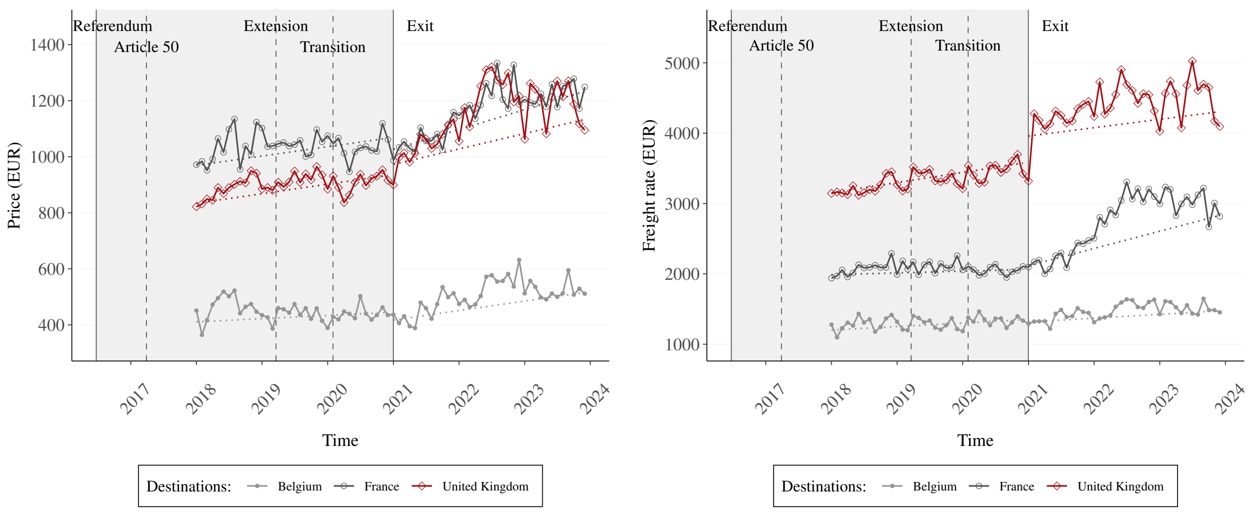


Notes:

A.3 Evolution of freight rates

Figure A.2: Evolution of freight rates

(a) Freight rates of local routes **(b)** Freight rates of foreign routes



Notes:

B Additional results Reduced-form results

B.1 Consumer prices

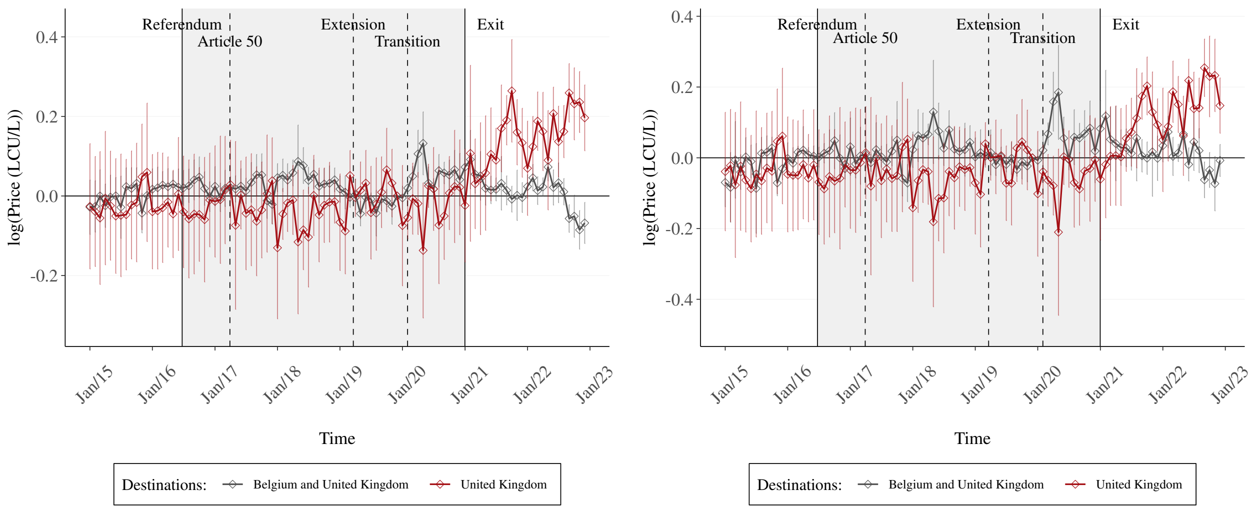
Table B.1: Difference-in-differences - Consumer prices - Population weights

	All			Foreign	Placebo	Domestic DiD	Local
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$T_{i,d} \times \mathbb{1}(t \leq 2015)$	0.011	0.0109	-0.00771	-0.0264	-0.0751^{***}	-0.0244	0.0331
	(0.0236)	(0.0229)	(0.0643)	(0.067)	(0.0208)	(0.0403)	(0.0302)
$T_{i,d} \times \mathbb{1}(t = 2016)$	0.0301^{*}	0.0301^{*}	-0.0182	-0.0271	0.0256^{*}	-0.031	0.0553^{**}
	(0.0165)	(0.0162)	(0.0401)	(0.0424)	(0.0136)	(0.0294)	(0.0242)
$T_{i,d} \times \mathbb{1}(t = 2017)$	0.0275^{**}	0.0283^{**}	-0.0261	-0.0295	0.0195	-0.0304	0.057^{***}
	(0.0132)	(0.0131)	(0.0335)	(0.0363)	(0.0148)	(0.0199)	(0.0171)
$T_{i,d} \times \mathbb{1}(t = 2018)$	0.0193^{**}	0.0204^{**}	-0.0353^{**}	-0.0342^{*}	0.0434^{**}	-0.00951	0.0325^{***}
	(0.0081)	(0.00803)	(0.0157)	(0.0179)	(0.0183)	(0.0105)	(0.00993)
$T_{i,d} \times \mathbb{1}(t = 2019)$	-	-	-	-	-	-	-
$T_{i,d} \times \mathbb{1}(t = 2020)$	-0.00377	-0.000669	0.000666	0.00404	0.0603^{***}	-0.00851	-0.0133
	(0.018)	(0.0179)	(0.0122)	(0.0149)	(0.0138)	(0.0181)	(0.0116)
$T_{i,d} \times \mathbb{1}(t = 2021)$	0.0703^{***}	0.0652^{**}	0.113^{***}	0.104^{***}	0.0354^{*}	0.0352	0.038
	(0.0265)	(0.0267)	(0.0209)	(0.0227)	(0.0193)	(0.0334)	(0.0307)
$T_{i,d} \times \mathbb{1}(t = 2022)$	0.187^{***}	0.181^{***}	0.166^{***}	0.169^{***}	0.0534^{**}	-0.0108	0.154^{***}
	(0.0278)	(0.0281)	(0.036)	(0.039)	(0.0213)	(0.0375)	(0.0327)
$T_{i,d}$	-0.231^{***}	-	-	-	-	-	-
	(0.0685)						
θ_i	✓						
$\theta_{i,d}$		✓	✓	✓	✓	✓	✓
λ_t	✓	✓				✓	✓
$\lambda_{i,t}$			✓	✓	✓		
R^2	0.029	0.023	0.009	0.067	0.345	0.004	0.024
No. obs	7,355	7,355	7,355	1,104	786	1,605	3,776

Notes: This table shows the results from estimating Equation (1) for different sets of controls and definitions of the treatment group using data at the yearly frequency. Columns (1)-(3) include both locally produced UK and varieties imported into the UK. In addition, column (1) includes variety and time fixed effects, column (2) includes variety-destination and time fixed effects and column (3) includes variety-destination and variety-time fixed effects. Column (4) includes variety-destination and variety-time fixed effects but focuses exclusively on varieties imported into the UK. Column (5) considers the same sample as column (5) but excludes UK consumer prices and considers a placebo experiment by defining the treatment group as consumer prices in Belgium. Columns (6) and (7) both include variety-destination and time fixed effects but differ in the sample and the definition of the treatment group. Column (6) only includes UK consumer prices on locally produced UK and varieties imported into the UK and defines the treatment group as UK consumer prices of imported varieties. Column (7) only includes consumer prices of locally sourced varieties in Belgium, France and the UK and defines the treatment group as consumer prices of locally sourced UK varieties. We estimate each specification using a weighted OLS estimator where the weights are population weights and the volume sold. We cluster standard errors at the variety level and denote statistical significance at the $p < 0.1^{*}$,$p < 0.05^{**}$ or $p < 0.01^{***}$ level.

Figure B.1: Triple Difference-in-difference

(a) All products **(b)** Foreign products

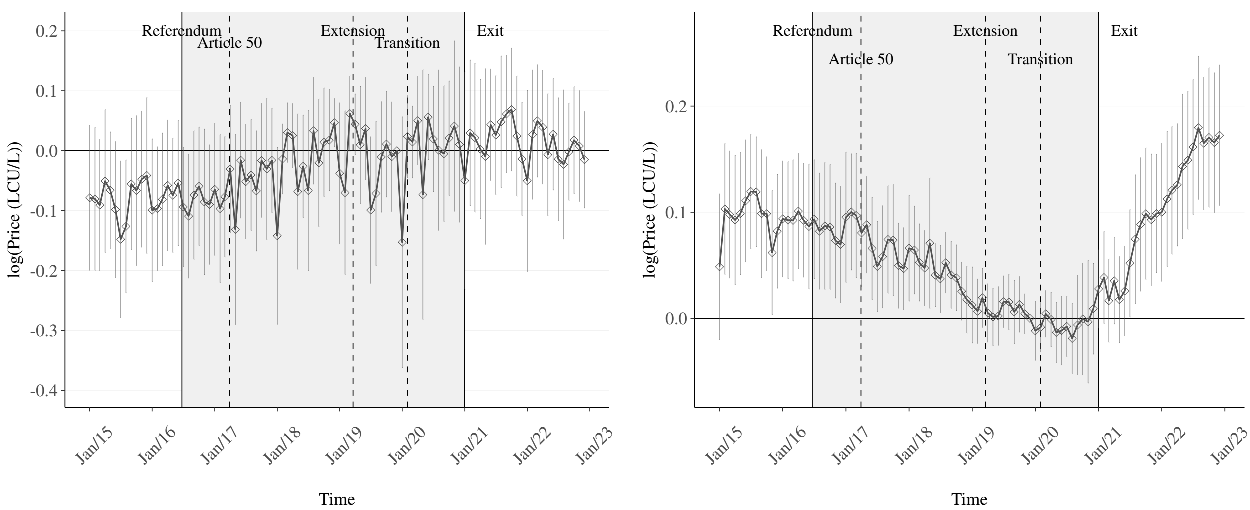


Notes: We estimate the following model:

$$\ln\left(p_{i,dt}\right) = \sum_t \beta_t^1 \left(T_{i,d}^1 \times \mathbb{1}\left(t \neq 2019M12\right)\right) + \sum_t \beta_t^2 \left(T_{i,d}^2 \times \mathbb{1}\left(t \neq 2019M12\right)\right) + \theta_{i,d} + \lambda_{i,t} + \varepsilon_{i,dt}$$

Figure B.2: Difference-in-difference - Consumer prices

(a) UK: Foreign versus Local varieties **(b)** Local products



Notes: We estimate the following model:

$$\ln\left(p_{i,dt}\right) = \sum_t \beta_t \left(T_{i,d} \times \mathbb{1}\left(t \neq 2019M12\right)\right) + \theta_{i,d} + \lambda_t + \varepsilon_{i,dt}$$

Table B.2: Difference-in-differences - Consumer prices - No weights

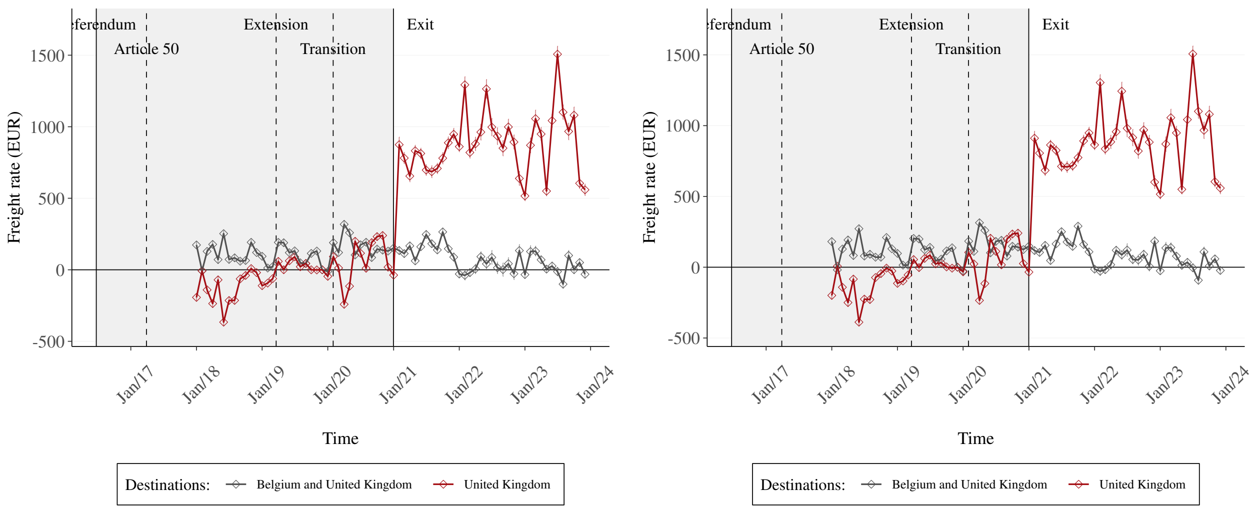
	All			Foreign	Placebo	Domestic DiD	Local
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$T_{i,d} \times \mathbb{1}(t \leq 2015)$	0.0812^{***}	0.0636^{**}	0.0957	0.0873	-0.0992^{**}	-0.00146	0.0534
	(0.0301)	(0.0292)	(0.069)	(0.063)	(0.0381)	(0.0595)	(0.0373)
$T_{i,d} \times \mathbb{1}(t = 2016)$	0.0137	0.0142	0.000933	0.0259	0.00603	-0.0523	0.0374
	(0.0231)	(0.0223)	(0.0494)	(0.0561)	(0.038)	(0.0462)	(0.0285)
$T_{i,d} \times \mathbb{1}(t = 2017)$	0.022	0.0187	0.0435	0.0713	-0.0311	-0.0256	0.0263
	(0.026)	(0.0255)	(0.0415)	(0.0458)	(0.0501)	(0.0457)	(0.034)
$T_{i,d} \times \mathbb{1}(t = 2018)$	0.00154	0.00157	0.00401	0.0376	-0.00831	-0.000854	0.00469
	(0.0194)	(0.0191)	(0.035)	(0.0332)	(0.0359)	(0.037)	(0.025)
$T_{i,d} \times \mathbb{1}(t = 2019)$	-	-	-	-	-	-	-
$T_{i,d} \times \mathbb{1}(t = 2020)$	0.0273	0.0203	-0.00832	0.0201	0.0749	-0.00881	0.027
	(0.0251)	(0.0249)	(0.0434)	(0.0348)	(0.0488)	(0.0406)	(0.0352)
$T_{i,d} \times \mathbb{1}(t = 2021)$	0.0144	0.0141	0.06	0.0812	0.0296	0.0618	-0.0174
	(0.0394)	(0.0396)	(0.0513)	(0.0548)	(0.0373)	(0.0603)	(0.0548)
$T_{i,d} \times \mathbb{1}(t = 2022)$	0.0893^{**}	0.0816^{*}	0.204^{***}	0.197^{***}	0.0454	0.102	0.0432
	(0.0453)	(0.0455)	(0.0491)	(0.0446)	(0.0391)	(0.0694)	(0.0632)
$T_{i,d}$	-0.156^{**}	-	-	-	-	-	-
	(0.061)						
θ_i	✓						
$\theta_{i,d}$		✓	✓	✓	✓	✓	✓
λ_t	✓	✓				✓	✓
$\lambda_{i,t}$			✓	✓	✓		
R^2	0.011	0.004	0.010	0.026	0.133	0.004	0.004
No. obs	7,355	7,355	7,355	1,104	786	1,605	3,776

Notes: This table shows the results from estimating Equation (1) for different sets of controls and definitions of the treatment group using data at the yearly frequency. Columns (1)-(3) include both locally produced UK and varieties imported into the UK. In addition, column (1) includes variety and time fixed effects, column (2) includes variety-destination and time fixed effects and column (3) includes variety-destination and variety-time fixed effects. Column (4) includes variety-destination and variety-time fixed effects but focuses exclusively on varieties imported into the UK. Column (5) considers the same sample as column (5) but excludes UK consumer prices and considers a placebo experiment by defining the treatment group as consumer prices in Belgium. Columns (6) and (7) both include variety-destination and time fixed effects but differ in the sample and the definition of the treatment group. Column (6) only includes UK consumer prices on locally produced UK and varieties imported into the UK and defines the treatment group as UK consumer prices of imported varieties. Column (7) only includes consumer prices of locally sourced varieties in Belgium, France and the UK and defines the treatment group as consumer prices of locally sourced UK varieties. We estimate each specification using an unweighted OLS estimator. We cluster standard errors at the variety level and denote statistical significance at the $p < 0.1^{*}$,$p < 0.05^{**}$ or $p < 0.01^{***}$ level.

B.2 Freight rates

Figure B.3: Triple Difference-in-difference - Freight rates

(a) All products **(b)** Foreign products

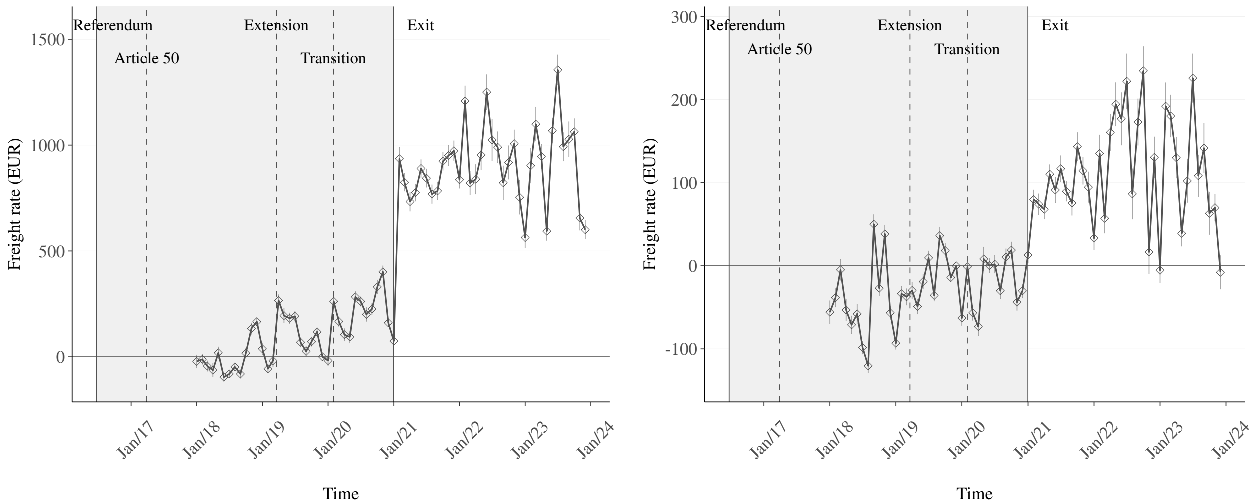


Notes: We estimate the following model:

$$\ln(p_{od,t}) = \sum_t \beta_t^1 \left(T_{od}^1 \times \mathbb{1}\left(t \neq 2019M12\right)\right) + \sum_t \beta_t^2 \left(T_{od}^2 \times \mathbb{1}\left(t \neq 2019M12\right)\right) + \theta_{od} + \lambda_{o,t} + \varepsilon_{od,t}$$

Figure B.4: Difference-in-difference - Freight rates

(a) UK: Foreign versus local routes **(b)** Local routes



Notes: We estimate the following model:

$$\ln(p_{od,t}) = \sum_t \beta_t \left(T_{od} \times \mathbb{1}\left(t \neq 2019M12\right)\right) + \theta_{od} + \lambda_t + \varepsilon_{od,t}$$

C Comments

C.1 CEP Trade Policy Workshop (14-15/05/2024)

Some comments concerning the introduction

- Add the following papers on FDI and multinational relocation after Brexit: Breinlich, Leromain, Novy, and Sampson (EER, 2020), Crowley, Domenech-Palacios, Faragli, and Gianniritsarou (2024), Breinlich and Magli (2024)
- The model of the bottled water industry worked very well.
- Even if rules-of-origin are easy to prove, the MFN tariff on unflavored water is 0% anyhow. So, rules of origin do not even need to be declared.

Some details about the trucking industry:

- Daniel Sturm, Esther Bohler, and Thomas Sampson: what other products can get moved with those trucks? NTBs on those products could lead to reduced demand for trucking. Is there heterogeneity we could exploit in terms of freight rates and different products being subject to different NTBs
- Esther Bohler: Could you use Feodoro Tati's work on NTBs?
- Daniel Sturm: who needs to prepare the paperwork for the load? Is that the carrier or the shipper?
- Catherine Thomas: Who owns the trucks? How about the spot versus the contracted rates
- Paola Conconi: What is the market structure in this market, and how concentrated is this market? (No special truck is needed, so carriers are likely quite substitutable)

Broader implications:

- Catherine Thomas and Kalina Manova: The complementarity between trade in goods and services in services is key and will give external validity.

Empirics

- Liang Bai: You could consider a Triple DiD to get rid of the pre-trend in the prices given that the FR-UK and FR-BE suffer from the same issue
- Banu Demir: You should normalize the price and freight rates graph at the same point to be able to properly compare.
- Mathieu Parenti: What is going on with this tapering off with the log level effects for the freight rates.

What could drive the changes in prices in the model

- Holger Breinlich: Customs declarations changed (But UK only starting checking from April 2024 onwards)
- Banu Demir: Transport rates will be determined in equilibrium
- Mathieu Parenti: Did demand for foreign products change after Brexit?
- Banu Demir: What is the contracting horizon between retailers and manufacturers? Maybe, retailers simply took the blow (typically contracts are negotiated on a yearly basis and they knew the TCA was coming so it seems likely prices were re-negotiated.)

Setting boundaries of the paper:

- Mathieu Parenti: taking freight rates as exogenous is fine as long as demand in the bottled water industry does not depend on the amount that is being sold (e.g. through a quantity discount)
- Emily Blanchard: I would like to see a better focus in terms of what drove the changes in the transport sector: (1) either consider them as given (2) try to distinguish between regulatory changes or pure changes in demand which makes the trucking industry less efficient.