In Hot Water: Clarifying British Prices in the Wake of Brexit

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Motivation

- Brexit presents a rare instance of **economic disintegration** (Sampson, 2017)

- **Prior research** has studied
  - the origins of Brexit (Fetzer, 2019; Dippel et al., 2022)
  - the inflationary effects of the referendum (Breinlich et al., 2022)
  - the uncertainty effects of Brexit (Born et al., 2019; Graziano, Handley, and Limão, 2021; Broadbent et al., 2024)

  BUT: the effect on the EU-UK trading environment is poorly understood

- Estimating how trade costs changed following Brexit is **empirically challenging**:
  - Data typically does not allow to separate shock (e.g. trade cost change) from response (e.g. multinational relocation)
  - Constructing a counterfactual is hard as Brexit changed the macroeconomic environment (Born et al., 2019; Broadbent et al., 2024)

Focus of this paper

We make progress by focusing on the **bottled water industry**. Two reasons:

- Institutional context allows us to isolate the shock to trade costs and understand its deeper sources:
  - *Regulation*: Disclosure of source is mandatory by law
  - *Technology*: Bottled at the source, shipped to and distributed in the destination market

- Intriguing as trade policy considerations are unlikely to be at play:
  - EU MFN-tariff on unflavored water is 0%.
  - Rules of origin are easy to prove.

Approach of this paper

We take three steps:

- Estimate how UK prices changed relative to EU
  - Multi-country country dataset on bottled water consumption
  - Compare UK prices of imported water to EU
- Focus on changes in freight rates as a source of changes in trade costs:
  - Multi-country route-level freight data
  - Compare freight rates into the UK to freight rates to other EU destinations
- Estimate empirical model of bottled water industry to map consumer prices to marginal costs
  - to distinguish between changes in (1) transport costs, (2) distribution costs, and (3) other trade frictions
  - to estimate effect on local competitors
  - to understand effect on consumer welfare

(Preliminary) findings

We find that:

- UK consumer prices rose sharply after formal Brexit in Jan. 2021:
  - Consumer prices of imported varieties rose by 15-20% relative to prices in the EU
  - Consumer prices of local varieties increased as well

- Freight rates rose sharply after Brexit formal Brexit in Jan. 2021:
  - EU freight rates into the UK rose by 20%
  - UK freight rates into the EU remained flat

Related literature on trade costs

We contribute to three literatures:

- **Economic effects of Brexit**: Born et al. (2019), Fernandes and Winters (2021), Graziano, Handley, and Limão (2021), Breinlich et al. (2022), and Broadbent et al. (2024)
  - have mostly focused on quantifying the uncertainty and FX effects of the referendum
  - *This paper* investigates the changes in trade costs and its sources
- **Prices and trade costs**: Atkin and Donaldson (2015), Donaldson (2018), Flaaen, Hortaçsu, and Tintelnot (2020), Fajgelbaum et al. (2020) and Chatterjee (2023)
  - exploit within-country price data to understand the effects of infrastructure investment, tariff changes, and regulatory changes
  - *This paper* exploits multi-country price data to estimate the change in trade costs following Brexit
- **Endogenous trade costs**: Hummels, Lugovskyy, and Skiba (2009), Behrens and Picard (2011), Pascali (2017), Ishikawa and Tarui (2018), Brancaccio, Kalouptsidi, and Papageorgiou (2020) and Wong (2022)
  - consider the joint determination of trade flows and freight rates in equilibrium
  - *This paper* illustrates that Brexit changed equilibrium transport costs

Related literature on international pricing

The exchange rate disconnect puzzle is one of the six great puzzles of international economics:

- prices of imported goods, measured in the local currency of an importing country, are excessively stable relative to bilateral exchange rates.

Classical economic explanation (Krugman 1986 and Dornbusch 1987):

- firms adjust their export prices (in their own currency) in response to time-varying shifts in local demand or marginal cost to keep import prices in local currency stable – they price-to-market.

Price-setting by firms in the global economy

Firms with more market power adjust their markups in response to exchange rates or trade policy, confirming a role for pricing-to-market, but the magnitudes of estimates vary.

- Belgium (Amiti, Itskhoki, Konings, 2014),
- Brazil (Chatterjee, Dix-Carneiro, and Vichyanond, 2013),
- India (deLoecker, Goldberg, Khandelwal, and Pavcnik, 2016),
- Ireland (Fitzgerald and Haller, 2014, 2018), and
- France (Berman, Martin, and Mayer, 2012)
- United Kingdom (many studies - next slide)

Industry-specific structural estimation quantifies contributions to excessive consumer price stability from exchange rates ($\approx$ cost shocks), producer markup adjustment, distribution margin adjustment, retail markup adjustment, etc.

- European Auto Prices (Goldberg and Verboven, 2001)
- American imported beer prices (Goldberg and Hellerstein, 2013)

What do we know about British prices & exchange rates?

- **Foreign exporters' pricing to the UK**:
  - Irish manufacturers price-to-market (PTM): Fitzgerald and Haller (2014)
  - Portuguese firms PTM: In SR, (euro) prices fall 2.5 to 5% relative to a depreciation of 10% Fernandes and Winters (2021).

- **British import pricing and currency**: ERPT varies by currency.
  - Chen, Chung, and Novy (2021): Two-year horizon ERPT is 41% averaged over all currencies; 70% for PCP and 0% for LCP.
  - Corsetti, Crowley, and Han (2022): ERPT exceeded 100% 1.5 years after Brexit for all currencies.

- **British consumer pricing**:
  - Brexit depreciation raised consumer prices 2.9% Breinlich et al. (2022)

What is the big picture story with prices?

- **Exchange rates**:
  - Consumer price impacts were relatively muted 2016 - 2018.
  - Exporters absorbed exchange rate shocks into markups in SR.
  - But some evidence that European exporters maintain relative markups across markets at longer horizons (Fitzgerald and Haller (2014), Corsetti, Crowley, and Han (2022)).
- **Exchange rates vs. trade policy changes**:
  - Exporters' participation is more responsive to trade policy than to exchange rate shocks (Fitzgerald and Haller (2018)).
  - Trade policy changes can affect exporters' participation, hence market competition, hence prices and markups (Crowley, Han, and Prayer (2024)).

Exchange rate, trade policy, and regulatory changes can hit different parts of the production, delivery and retail chain, with temporary cost shocks often absorbed into markups along the chain. Brexit offers a unique mix of short-lived and permanent shocks that allow us to investigate the contributions of different components to consumer price changes.

Outline

- Dataset
- Motivational evidence
- Proposed model + Counterfactuals
- Conclusion

DATASET

Data - Overview

We combine three data sources:

1. **Household-level scanner data** on non-alcoholic beverages from GfK and Kantar
   - SPATIAL: BEL, FRA, and UK (GER and NLD could be added)
   - TIME: Daily from 2010 until 2022
   - WATER VARIETY: A combination of brand-source-flavored-package-bottle size

2. Based on Directive 2009/54/EC, we hand-collect **production locations** of bottled water

3. Different sources of trade costs:
   - Route-level **freight rates** from 2017 until 2024.
   - **Labor unit costs** in retail constructed from the EU-SILC and ONS database

Data - Consumption data

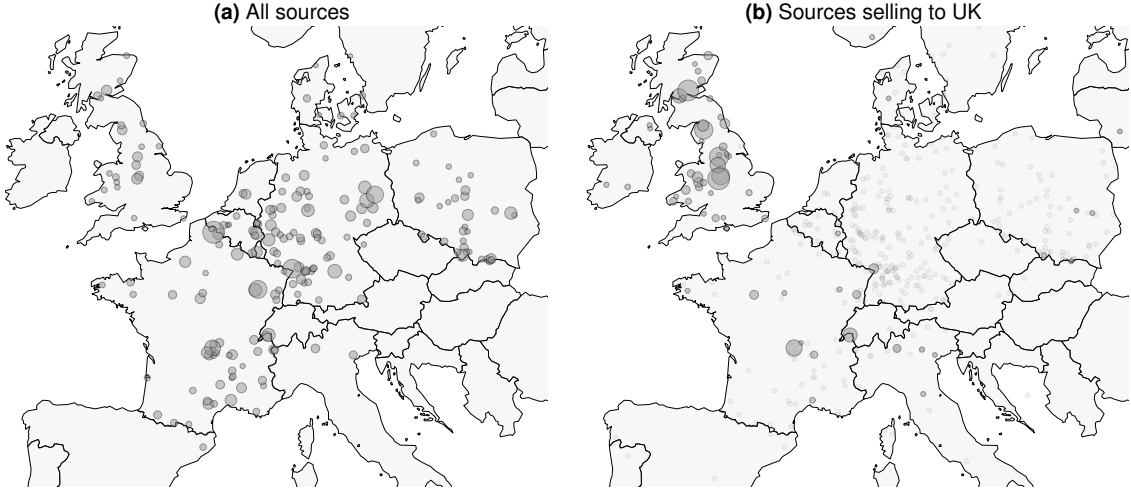
Table 1: Sample overview

Variable	Overall	BEL	FRA	UK
Regions	74	11	22	41
All sources	122	70	67	47
Local sources	-	10	57	35
Firms	63	34	27	33
Brands	148	61	66	73
Products	522	269	250	214
Stores	38	16	17	15
Households - Water	140,741	19,502	63,321	57,918
Transactions ('1,000')	7,319	1,014	3,293	3,012
Unit price (LCU)	0.30	0.37	0.27	0.34
Unit price (EUR)	0.32	0.37	0.27	0.40

Notes: Unit price (LCU) is the average unit price in local currency units and Unit price (EUR) is the average unit price in Euro.

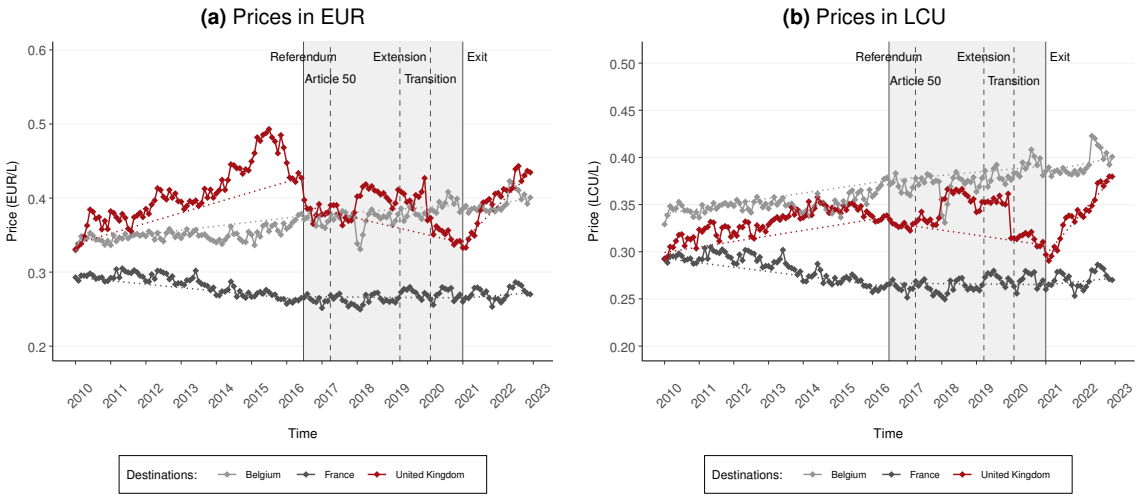
Data - Production locations

Figure 1: Production locations



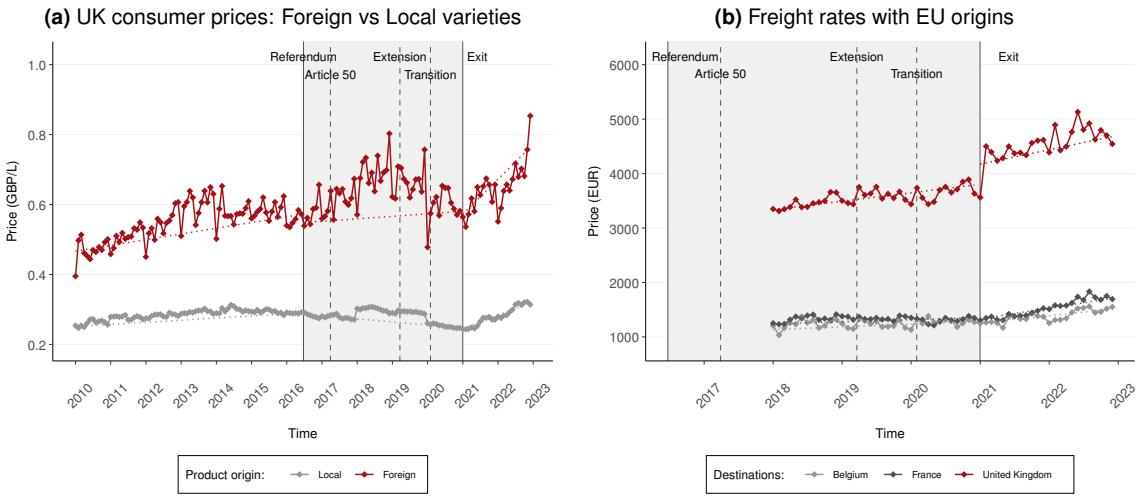
Evolution of water prices: EUR vs LC prices

Figure 2: Price evolution



The story of the paper in two graphs

Figure 3: Price evolution



REDUCED-FORM EVIDENCE

Estimating the effect of Brexit: Methodology

To estimate the effect of Brexit on consumer prices, consider the following difference-in-difference specifications:

- **Domestic DiD**: comparing UK prices of imported versus domestic varieties:

$$p_{i,t} = \sum_t \beta_t \left(\mathbb{1} \left(i = \text{Foreign} \right) \times \mathbb{1} \left(t \neq 2016Q2 \right) \right) + \theta_i + \lambda_t + \varepsilon_{i,t}$$

  where

  - θ_i are product fixed effects
  - λ_t are time fixed effects

- **Trade DiD**: Comparing UK prices to FR prices for imported varieties in the UK

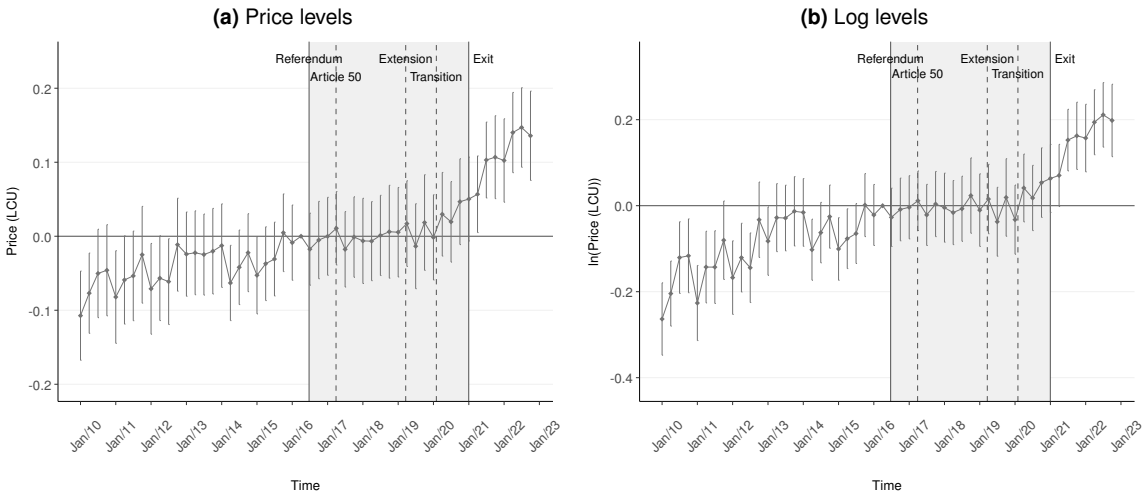
$$p_{i,dt} = \sum_t \beta_t \left(\mathbb{1} \left(d = UK \right) \times \mathbb{1} \left(t \neq 2016Q2 \right) \right) + \theta_{i,d} + \lambda_{i,t} + \varepsilon_{i,dt}$$

  where

  - $\theta_{i,d}$ are product-destination fixed effects
  - $\lambda_{i,t}$ are product-time fixed effects

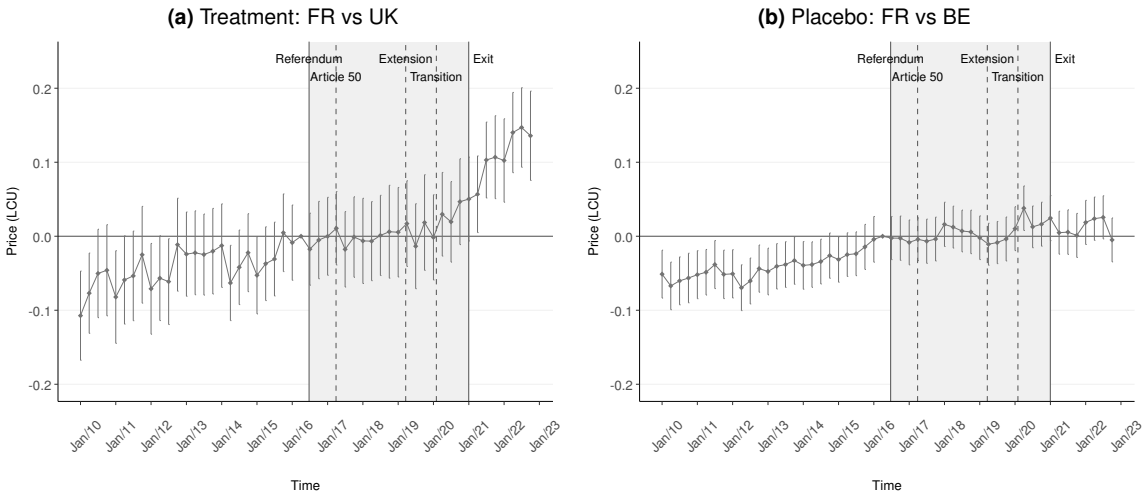
DiD: Effect of Brexit on consumer prices

Figure 4: Trade DiD - Treatment: FR vs UK



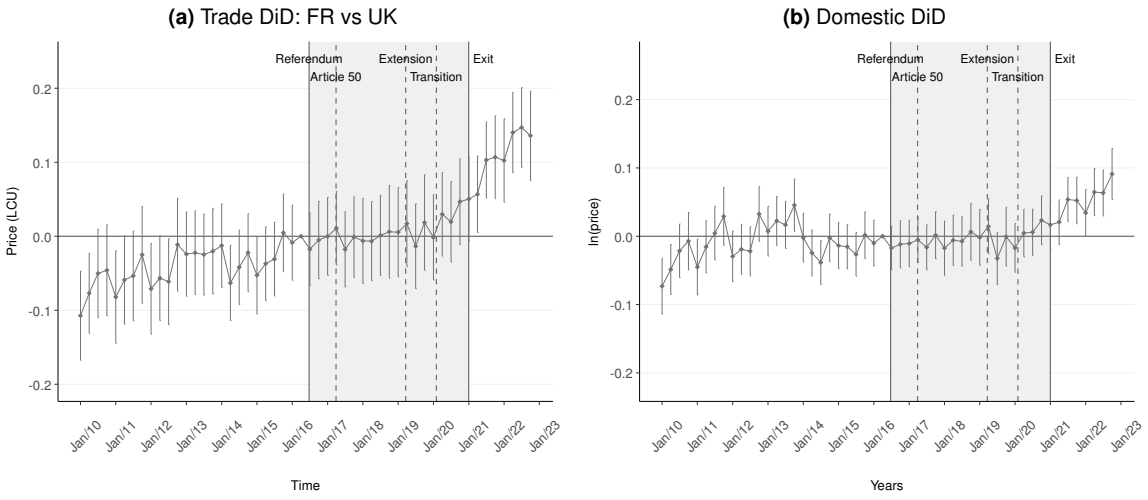
DiD: Effect of Brexit on consumer prices

Figure 5: Trade DiD



DiD: Different approaches

Figure 6: Different DiDs



DiD for freight rates: Methodology

To estimate the effect of Brexit on freight, consider the following difference-in-difference specifications:

- **Domestic DiD**: comparing UK freight rates between foreign and domestic origins:

$$t_{o,dt} = \sum_t \beta_t \left(\mathbb{1} \left(o = \text{Foreign} \right) \times \mathbb{1} \left(t \neq 2020M12 \right) \right) + \theta_{o,d} + \lambda_t + \varepsilon_{o,dt}$$

  where

  - $\theta_{i,d}$ are origin-destination fixed effects
  - λ_t are time fixed effects

- **Trade DiD**: comparing UK to FR freight rates for origins of imported water varieties

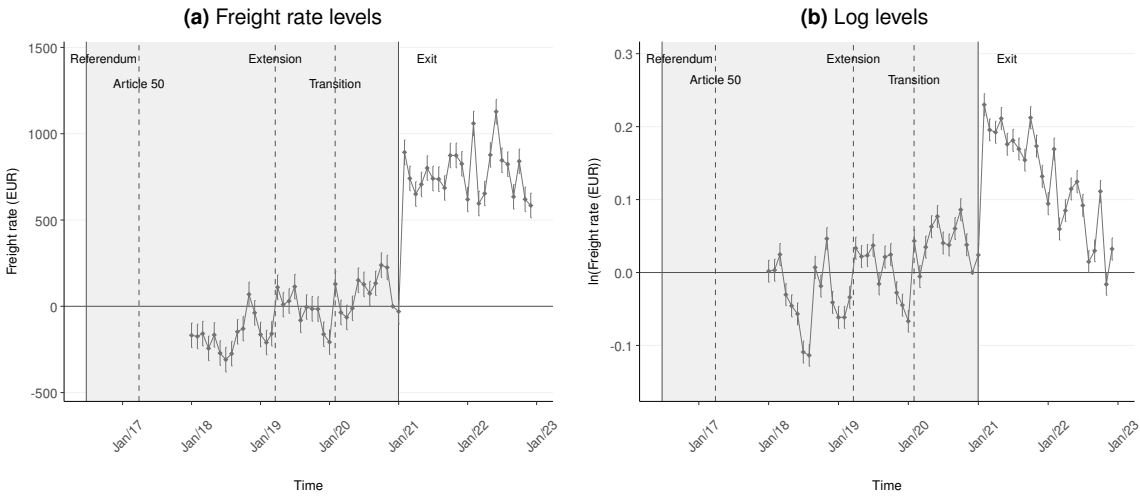
$$t_{o,dt} = \sum_t \beta_t \left(\mathbb{1} \left(d = UK \right) \times \mathbb{1} \left(t \neq 2020M12 \right) \right) + \theta_{o,d} + \lambda_{o,t} + \varepsilon_{o,dt}$$

  where

  - $\theta_{o,d}$ are origin-destination fixed effects
  - $\lambda_{o,t}$ are origin-time fixed effects

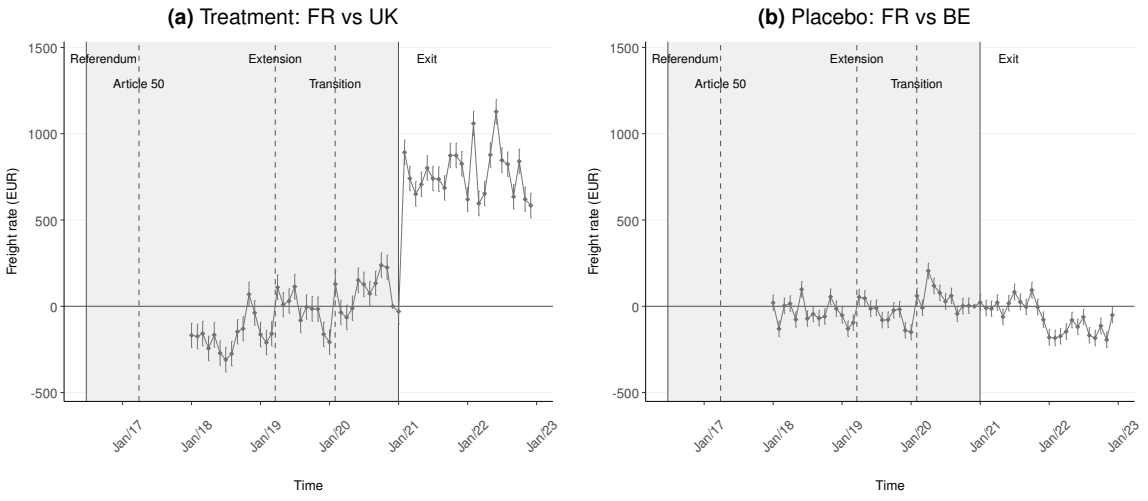
DiD: Effect of Brexit on freight rates

Figure 7: Trade DiD: FR vs UK



DiD: Effect of Brexit on freight rates

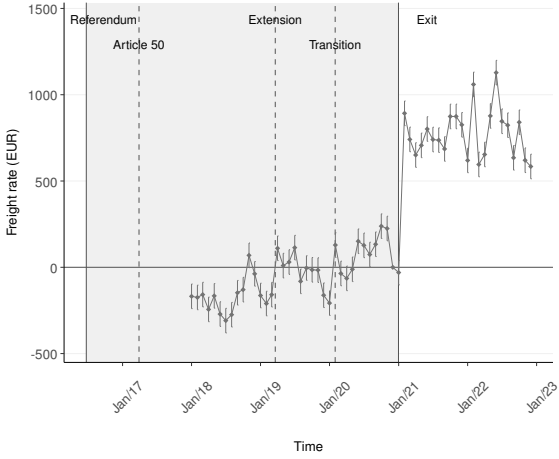
Figure 8: Trade DiD



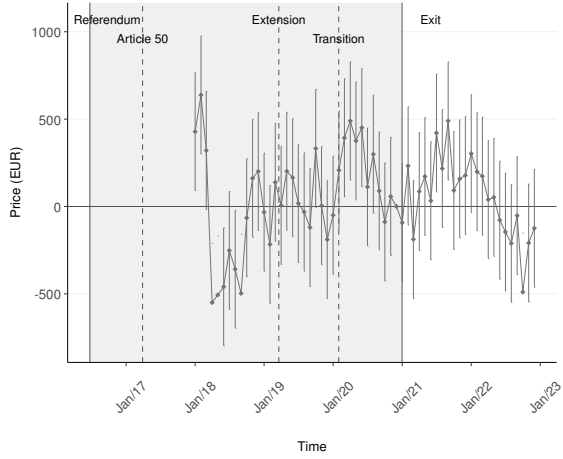
DiD: Different approaches

Figure 9: Different DiDs

(a) Trade DiD: FR vs UK



(b) Domestic DiD



Summary and observations

1. Surprisingly little action in water prices and freight rates before 2021. Consistent with...
   - ..oligopolistic exporters engaging in pricing-to-market, i.e., bottler is setting price in GBP and absorbing short run exchange rate fluctuations into markup.
   - ...no trade policy uncertainty on tariffs.
   - ...little/no risk of health and safety regulatory changes.
2. Increase in freight rates from 2021 suggests
   - Transportation regulations under TCA (cabotage restrictions) had substantive impacts on supply of lorries serving EU to UK routes.
3. Increase in consumer prices may reflect...
   - ...pass through of freight rate increases
   - ...increased retail costs coming from Brexit labour market policy
   - ...long-run stabilisation of relative markup of UK to EU sales for EU-based bottlers.

Purpose of the model

Evidence on consumer prices and freight rates is suggestive, we leverage the structural model

- to estimate **change in trade costs**
  - by separating changes in markups from changes in marginal costs
  - which provides insight into whether pro-competitive gains from trade were reversed
- to **decompose** changes in trade costs into
  - changes in local distribution costs
  - changes in transport costs
  - changes in border-related trade frictions ($\sim$ residual)
- to understand the contribution of changes in trade costs on consumer welfare through **counterfactual exercises**

Flavor of the model

The structural model has the following building blocks

- **Preferences**: Consumers make a static discrete choice about which water to consume
- **Market structure**: Prices are determined along a vertical chain:
  - Downstream RETAILERS compete as oligopolists and set final consumer prices
  - Upstream RETAILERS compete as oligopolists and set upstream wholesale prices
- **Technology**: Production of bottled water is Leontief in:
  - Local distribution costs
  - Trade costs which consist of (1) transport costs and (2) border-related frictions
  - Production costs which can have arbitrary returns to scale and scope

Uses of the model

This structure allows us to:

- Using the FOCs, we **separate markups from marginal costs**:

$$\underbrace{\boldsymbol{c}^r_{lt} + \boldsymbol{c}^m_{lt}}_{\text{Marginal cost}} = \underbrace{\boldsymbol{p}^r_{lt}}_{\text{Retail price}} + \underbrace{\left(\boldsymbol{\Delta}_{lt} \odot \Omega^r_{lt}\right)^{-1} \cdot \boldsymbol{s}_{lt}(\boldsymbol{p}^r; \Theta^d)}_{\text{Retail markup}} + \underbrace{\left(\mathbf{PT}_{lt} \cdot \boldsymbol{\Delta}_{lt} \odot \Omega^w_{lt}\right)^{-1} \cdot \boldsymbol{s}_{lt}(\boldsymbol{p}^r; \Theta^d)}_{\text{Manufacturer markup}}$$

- After parameterizing back-out marginal costs, we **decompose changes in marginal costs**:

$$\underbrace{c^r_{j,lt} + c^m_{j,lt}}_{\text{Marginal costs}} = \underbrace{\gamma w^r_{l,t} + \lambda_{c(j),t}}_{\text{Retail cost}} + \underbrace{\beta t_t^{s(j)l} + \beta_{B,t}\text{Border}^{s(j)l} + \omega^m_{j,t}}_{\text{Trade + prod. cost}} + \eta_{j,lt}$$

- Compute counterfactual consumer prices and welfare by keeping $t_t^{s(j)l}$ at pre-Brexit levels

THANK YOU!

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