Non-tariff barriers and consumer prices: Evidence from Brexit

Jan David Bakker
Bocconi, RFB & CEPR

Nikhil Datta
Warwick & CEP

Richard Davies
LSE & CEP

Josh De Lyon
CEP

Banda d'Italia
October 2026

Motivation

- Protectionist policies & geopolitical fragmentation becoming more common
- Tariffs are the most common tool and well understood academically
- Changes in non-tariff barriers also increasing but are less well understood

This paper

- Use a historic rise in NTBs (Brexit) to quantify their effect on prices & welfare

This paper

1. Model of costly NTB compliance
   - NTB cost depends on accumulated compliance capability
   - Capacity building uses shared inputs with production
   - Capacity takes time to build $\rightarrow$ Expectations of future NTBs affect today's cost

2. Empirics: Food more exposed to EU imports had higher price growth after Brexit
   - Prices increase from the 2019 election, stronger after TCA ($\approx$ 12% over 3 years)
   - Driven by products with high NTBs
   - High but imperfect pass-through (57–92%)

3. Quantification: Large, regressive welfare cost
   - Consumer loss £14.8bn (£536/household); deadweight loss £1.5bn
   - Hits low-income households hardest (higher food budget share)

Literature

- **Price effects and pass-through of tariffs & exchange rates**

  Amiti et al (2019), Fajgelbaum et al (2020), Flaaen et al (2020), Burstein & Gopinath (2014), Breinlich et al (2022)

- **Non-tariff barriers**

  Dhingra et al (2021), Conconi et al (2018), Carballo et al (2021), Atkin et al (2022), Conconi et al (2026)

- **Economics of disintegration / Brexit**

  Breinlich et al (2020, 2022), Bloom et al (2019), Costa et al (2024), Freeman et al (2024), Born et al (2019), Dhingra & Sampson (2022), Conconi et al (2026)

- **Costs of protectionism & populism**

  Amiti, Redding & Weinstein (2019), Fajgelbaum et al (2020), Funke et al (2023)

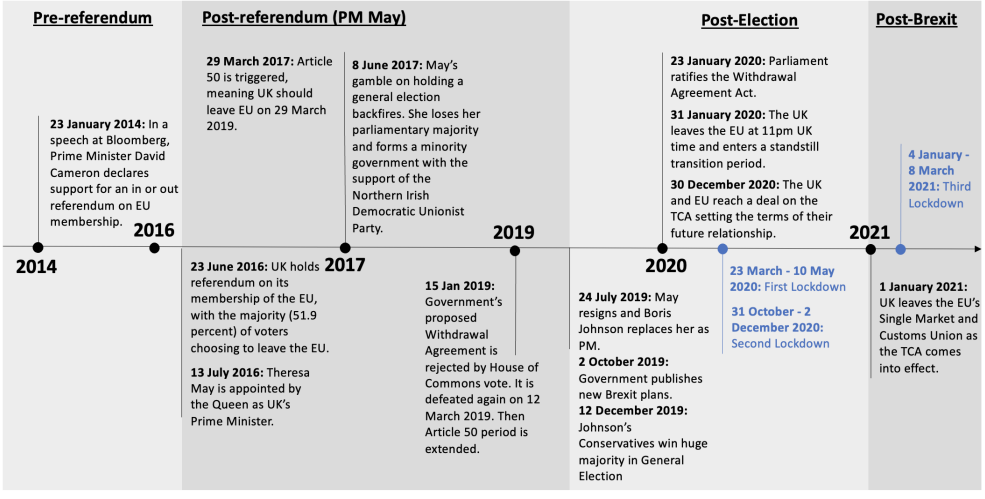
Road Map

1. The Brexit shock
2. Conceptual framework
3. Data and empirical analysis
4. Mechanism and welfare analysis

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Brexit timeline



Firms invested before barriers took effect

- From 2019: governments & industry urge firms to ready for NTBs
- Complying needs *capability* – staff, software, certification
  - Built over time, draws on shared managerial & IT resources
- Hard evidence of early investment (2019–2020):
  - $\sim$20% of exposed Irish SMEs hired customs agents by 2019
  - $\sim$60% of customs intermediaries committed resources by mid-2020
  - Food-industry warehouse space $\approx$ doubled, 2019$\rightarrow$2020
- After 2021, repeated changes in NTB introduction: Sanitary and Phytosanitary (SPS) checks delayed until 2024

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Framework: complying with NTBs needs capability

- Firms hold a stock of compliance & logistical capability CP_t

$$CP_{t+1} = (1 - \delta)\, CP_t + a_t$$

  - δ: depreciation of capabilities
  - a_t: Investment in capabilities at time t

- Convex costs in shared resources for output and logistical capability $(q_t + a_t)$:

$$C(q_t, a_t) = w\,(q_t + a_t) + \tfrac{\chi}{2}(q_t + a_t)^2 + \tfrac{\psi}{2}\, a_t^2$$

  - Key: $\dfrac{\partial^2 C}{\partial q_t\, \partial a_t} = \chi > 0 \quad \rightarrow$ building capability raises marginal cost of output

Framework: the firm's problem

- After Brexit implementation ($t \geq T$): NTB cost per unit $\tau(CP_t)$, $(\partial\tau/\partial CP_t < 0)$
  - More capability $\rightarrow$ lower NTB cost
- Before Brexit implementation ($t \leq T$): news shifts beliefs θ about *future* NTBs
  - Dec 2019 election $\rightarrow$ "hard" Brexit becomes likely
- Firm maximises discounted profits:

$$V(CP_t; \Omega_t) = \max_{q_t,\, a_t \geq 0} \Big\{ P_t(q_t)\, q_t - C(q_t, a_t; \theta) - \tau(CP_t)\, \mathbf{1}\{t \geq T\}\, q_t + \beta\, \mathbb{E}_t\big[V(CP_{t+1})\big] \Big\}$$

$\rightarrow$ Firms react to changes in beliefs θ and NTBs τ

Optimal capability investment (a_t)

$$\underbrace{w + \chi(q_t + a_t) + \psi a_t}_{\text{marginal cost of effort today}} = -\theta g'(CP_t)\mathbb{1}\{t \geq \widetilde{T}\}q_t + \beta(1-\delta)\mathbb{E}_t[V_{CP}(CP_{t+1}; \Omega_{t+1})]\,.$$

Additional assumptions

- Let beliefs about regime severity and implementation timing be independent
- Let the marginal saving in NTB costs be constant over time ($\bar{\lambda} \equiv -\bar{\theta}g'(CP)q$)

$$w + \chi(q_t + a_t) + \psi a_t = \frac{\bar{\lambda}\nu_t}{1 - \beta(1-\delta)}, \qquad \nu_t \equiv \pi_t \mathbb{E}_t\left[\beta^{\widetilde{T}-t}(1-\delta)^{\widetilde{T}-t-1}\right]$$

Predictions

1. **Anticipation**: Capability-building effort and prices increase before NTBs do
2. **Gradualism**: Capability-building effort and prices increase more rapidly closer to the NTB implementation date.

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Data

- CPI microdata from ONS (Davies 2021)
- Import quantities by product-country, 2015 (UN Comtrade, HS6)
- Three NTB measures:
  - NTB AVE – World Bank (unilateral EU)
  - NTB AVE – GTAP (EU–Canada)
  - SPS measure counts (UNCTAD TRAINS)
- Match trade $\leftrightarrow$ price: 70 HS6 $\leftrightarrow$ 194 CPI items
  - E.g. “Honey; natural” $\leftrightarrow$ “Honey jar/bottle 340g”
  - $\approx$ 8% of consumer expenditure
- Why food? Clean match, mostly directly consumed (81%), high & variable NTBs

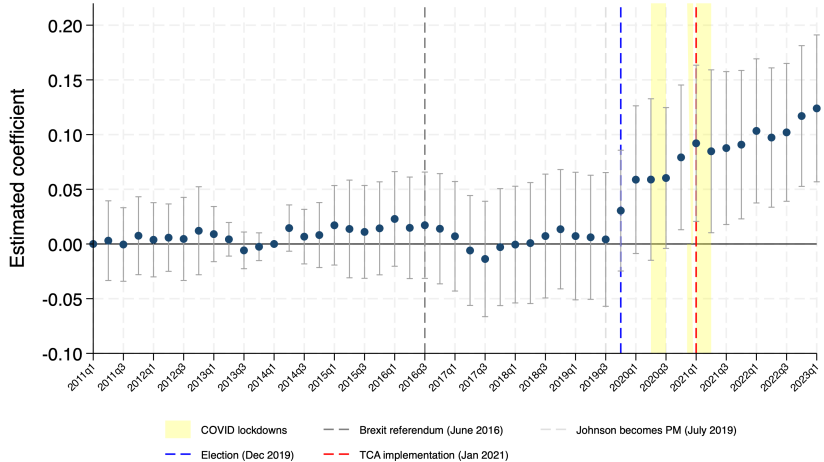
Event study: specification

Regression specification:

$$\log(P_{it}) = \sum_{k \notin J} \beta^k \log\left(\frac{M^{EU}_{i,2015}}{M^{Total}_{i,2015}}\right) \times \mathbb{1}\{t = k\} + \alpha_i + \tau_t + \varepsilon_{it}$$

- $\frac{M^{EU}_{i,2015}}{M^{Total}_{i,2015}}$: EU import share (2015, quantity)
- α_i: product FE τ_t: year-month FE
- Normalised to Jan 2011 & Jan 2014
- Full spec adds HS2 pre-trend & controls X_{it}

Event study: price break at the 2019 election



- No pre-trend; break after Dec 2019, larger after the TCA

▸ Details

Diff-in-diff specification

$$\log(P_{it}) = \beta^E \times Post_t^E \times \log\left(\frac{M_{i,2015}^{EU}}{M_{i,2015}^{Total}}\right) + \beta^B \times Post_t^B \times \log\left(\frac{M_{i,2015}^{EU}}{M_{i,2015}^{Total}}\right) + \gamma X_{it} + \alpha_i + \tau_t + \varepsilon_{it}$$

- $Post_t^E$: post-election (Dec 2019 – Dec 2020)
- $Post_t^B$: post-Brexit / TCA (from Jan 2021)
- Controls X_{it} address identification concerns:
  - EU export price – EU-wide food inflation
  - Exchange rate deviation – Sterling movements
  - Brexit trade uncertainty – expected tariffs
  - Perishability $\times$ post – stockpiling
  - UK MFN tariff $\times$ post – tariff threat

Diff-in-diff results

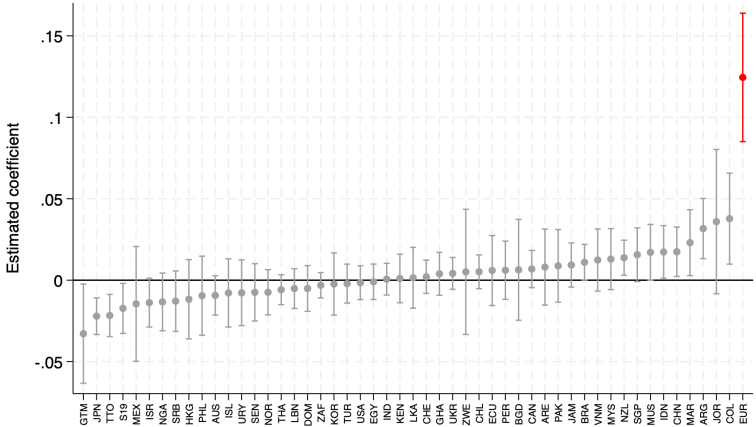
	(1) Log Price	(2) Log Price	(3) Log Price	(4) Log Price
Log EU Share × Post Brexit	0.0904***	0.0701***	0.0895***	0.124***
	(0.0230)	(0.0121)	(0.0243)	(0.0199)
Log EU Share × Post Election	0.0562**	0.0366***	0.0548**	0.0816***
	(0.0251)	(0.0131)	(0.0265)	(0.0228)
Observations	9388	9388	9388	8418
Trend	Yes	No	Yes	Yes
Additional controls	No	No	No	Yes
Year-Month FE	Yes	Yes	Yes	Yes
Product FE	Yes	Yes	No	No
Product-Month FE	No	No	Yes	Yes

- Doubling EU import share $\Rightarrow$ +12% price post-TCA (+8% post-election)

Robustness checks

- Covid not driving it — ▸ Lockdown ▸ Supply chain ▸ Exclude Covid
- Not EU imported inflation — ▸ EU prices
- Robust to level (not log) exposure — ▸ Level
- Not just the anticipation window — ▸ Exclude window
- Uncorrelated with GBP–EUR — ▸ Exchange rate
- Placebo: other origins — ▸ Falsification
- Event study robust — ▸ No trend ▸ With controls ▸ Controls table

Falsification: EU exposure is the outlier



- Re-estimate replacing the EU share with each other origin's share
- Placebo coefficients centre on zero; EU (red) is a clear outlier

▸ Post-election

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Mechanism: Do high NTB products drive the increase in prices?

$$\begin{aligned}\log(P_{it}) = \quad & \beta_H^E \left(Post_t^E \times S_i \times H_i\right) + \beta_L^E \left(Post_t^E \times S_i \times L_i\right) \\ & + \beta_H^B \left(Post_t^B \times S_i \times H_i\right) + \beta_L^B \left(Post_t^B \times S_i \times L_i\right) \\ & + \alpha_i + \tau_t + \gamma X_{it} + \varepsilon_{it}\end{aligned}$$

- S_i: log EU import share
- H_i, L_i: high / low NTB (median split)
- Mechanism predicts $\beta_H^B > \beta_L^B$ (and $\beta_H^E > \beta_L^E$)
- Pre-trend & controls included

Mechanism: price rise driven by high-NTB products

	(1) Log Price	(2) Log Price	(3) Log Price	(4) Log Price
High NTB × Post-Brexit × Log(EU share)	0.135***	0.0956***	0.134***	0.139***
	(0.0149)	(0.0115)	(0.0157)	(0.0176)
Low NTB × Post-Brexit × Log(EU share)	-0.0227	-0.00734	-0.0254	0.0423
	(0.0301)	(0.0246)	(0.0312)	(0.0443)
High NTB × Post-Election × Log(EU share)	0.101***	0.0623***	0.0995***	0.102***
	(0.0185)	(0.00751)	(0.0196)	(0.0193)
Low NTB × Post-Election × Log(EU share)	-0.0496*	-0.0343*	-0.0525**	-0.0133
	(0.0255)	(0.0188)	(0.0265)	(0.0348)
Observations	9388	9388	9388	8418
Trend	Yes	No	Yes	Yes
Add. controls	No	No	No	Yes
Year-Month FE	Yes	Yes	Yes	Yes
Product FE	Yes	Yes	No	No
Product-Month FE	No	No	Yes	Yes

- Price effects concentrated among high NTB products

▸ GTAP ▸ SPS counts

Welfare: consumers

Upper nest: quasi-linear over non-food C & food value V_t

$$U = C + \Gamma(V_t) \qquad \Rightarrow \text{ no income effects}$$

Lower nest: logit sub-utility across food products g

$$u_{gt} = \delta_g - \alpha p_{gt} + \varepsilon_{gt}, \qquad p_{gt} = \log P_{gt}, \quad \alpha > 0$$

- Welfare loss $=$ compensating variation
- α from IV (EU exposure) $\Rightarrow$ demand elasticity -1.74

▸ Details

Welfare: producers

- Domestic supply inelastic at this horizon: $S_t^D \approx \bar{S}^D$
  - Multi-year production cycles; post-Brexit labour shortages
  - Imports vs consumption: no differential adjustment
- Producer surplus gain $= \Delta P \times \bar{S}^D$
- Deadweight loss $=$ consumer loss $-$ producer gain
  - Larger than under tariffs (no government revenue)

Welfare: quantities & expenditure fall

	(1)	(2)	(3)	(4)
Panel A: Log Quantity				
Log EU Share × Post Brexit	-0.159***	-0.146***	-0.158***	-0.222***
	(0.0435)	(0.0309)	(0.0458)	(0.0444)
Log EU Share × Post Election	-0.120***	-0.107***	-0.118***	-0.175***
	(0.0340)	(0.0236)	(0.0360)	(0.0366)
Observations	9228	9228	9216	8271
Panel B: Log Expenditure				
Log EU Share × Post Brexit	-0.0692*	-0.0756**	-0.0689*	-0.100**
	(0.0382)	(0.0298)	(0.0401)	(0.0465)
Log EU Share × Post Election	-0.0645**	-0.0700**	-0.0645*	-0.0949**
	(0.0325)	(0.0288)	(0.0342)	(0.0391)
Observations	9228	9228	9216	8271
Trend	Yes	No	Yes	Yes
Additional controls	No	No	No	Yes
Year-Month FE	Yes	Yes	Yes	Yes
Product FE	Yes	Yes	No	No
Product-Month FE	No	No	Yes	Yes

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

- More-exposed products: sizeable falls in quantity & expenditure

Welfare: the costs of Brexit

- Consumer surplus loss: **£14.8bn** (£536 per household)
- Producer surplus gain: £13.3bn (inelastic domestic supply)
- Deadweight loss: £1.5bn (no tariff revenue, no quality gain)
- Regressive: cost-of-living rise 52% larger for bottom vs. top decile
  - Poorer households spend more on food

Conclusion

- NTBs different from tariffs: NTB uncertainty potentially costlier
  - Firms invest in compliance capability before barriers bind
  - Forward guidance of policy essential
- EU-exposed food prices rose after the 2019 election & the TCA
  - 12% over three years
  - Driven by high-NTB products
- Large, regressive welfare cost: £14.8bn (£536/household)

Appendix

Appendix: mechanism — NTB AVE (GTAP)

	(1) Log Price	(2) Log Price	(3) Log Price	(4) Log Price
High NTB × Post-Brexit × Log(EU share)	0.136***	0.0844***	0.136***	0.148***
	(0.0141)	(0.0109)	(0.0147)	(0.0135)
Low NTB × Post-Brexit × Log(EU share)	0.0365	0.0489*	0.0342	0.0772**
	(0.0287)	(0.0254)	(0.0298)	(0.0315)
High NTB × Post-Election × Log(EU share)	0.102***	0.0529***	0.102***	0.117***
	(0.0196)	(0.00798)	(0.0202)	(0.0152)
Low NTB × Post-Election × Log(EU share)	0.00280	0.0153	-0.000110	0.0196
	(0.0258)	(0.0210)	(0.0267)	(0.0299)
Observations	9388	9388	9388	8418
Trend	Yes	No	Yes	Yes
Add. controls	No	No	No	Yes
Year-Month FE	Yes	Yes	Yes	Yes
Product FE	Yes	Yes	No	No
Product-Month FE	No	No	Yes	Yes

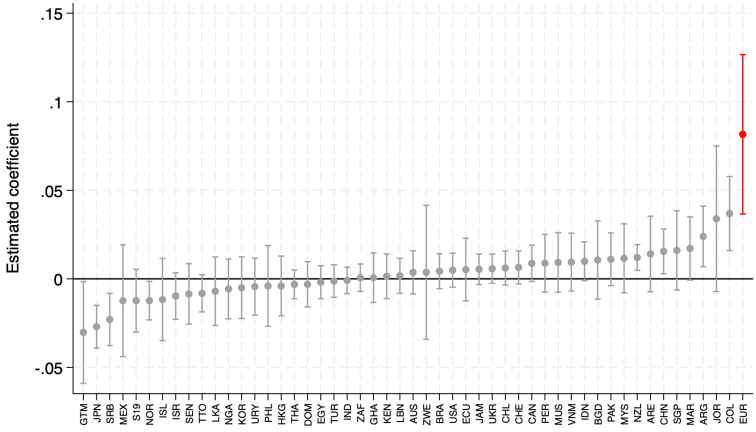
back

Appendix: mechanism — SPS measure counts

	(1) Log Price	(2) Log Price	(3) Log Price	(4) Log Price
High SPS × Post-Brexit × Log(EU share)	0.111***	0.0726***	0.110***	0.127***
	(0.0220)	(0.0101)	(0.0233)	(0.0216)
Low SPS × Post-Brexit × Log(EU share)	0.0472	0.0563	0.0460	0.119***
	(0.0357)	(0.0365)	(0.0375)	(0.0308)
High SPS × Post-Election × Log(EU share)	0.0905***	0.0523***	0.0891***	0.102***
	(0.0233)	(0.00990)	(0.0249)	(0.0223)
Low SPS × Post-Election × Log(EU share)	-0.00555	0.00341	-0.00734	0.0433
	(0.0267)	(0.0260)	(0.0283)	(0.0292)
Observations	9388	9388	9388	8418
Trend	Yes	No	Yes	Yes
Add. controls	No	No	No	Yes
Year-Month FE	Yes	Yes	Yes	Yes
Product FE	Yes	Yes	No	No
Product-Month FE	No	No	Yes	Yes

back

Appendix: falsification — post-election



back

Appendix: demand estimation & welfare (CV)

	Log Price (1)	δ_{gt} (2)
Log EU Share × Post Brexit	0.0931***	
	(0.0235)	
Log Price		-1.7546***
		(0.4734)
Observations	8,369	8,369
Trend	Yes	Yes
Year-Month FE	Yes	Yes
Product-Month FE	Yes	Yes

- First stage: EU exposure shifts prices (col 1); IV $\Rightarrow \alpha$, elasticity -1.74 (col 2)

Welfare loss = compensating variation:

$$CV = \frac{1}{\alpha}\left[\log\sum_g e^{\delta_g^1 - \alpha p_g^1} - \log\sum_g e^{\delta_g^0 - \alpha p_g^0}\right]$$

δ^0 pre-, δ^1 post-Brexit mean utilities; $p_g = \log P_g$

back

Appendix: Covid lockdown control

	(1) Log Price	(2) Log Price	(3) Log Price	(4) Log Price
Log EU Share × Post Brexit	0.0912***	0.0709***	0.0907***	0.126***
	(0.0227)	(0.0122)	(0.0239)	(0.0199)
Lockdown × Log EU Share × Post Brexit	-0.00672	-0.00680	-0.0102	-0.0111
	(0.0132)	(0.0132)	(0.0140)	(0.0157)
Log EU Share × Post Election	0.0571**	0.0377***	0.0559**	0.0829***
	(0.0246)	(0.0128)	(0.0261)	(0.0224)
Lockdown × Log EU Share × Post Election	-0.00407	-0.00481	-0.00466	-0.00550
	(0.00595)	(0.00568)	(0.00533)	(0.00522)
Observations	9388	9388	9388	8418
Trend	Yes	No	Yes	Yes
Additional controls	No	No	No	Yes
Year-Month FE	Yes	Yes	Yes	Yes
Product FE	Yes	Yes	No	No
Product-Month FE	No	No	Yes	Yes

back

Appendix: supply-chain pressure (GSCPI) control

	(1) Log Price	(2) Log Price	(3) Log Price	(4) Log Price
Log EU Share × Post Brexit	0.0895***	0.104***	0.124***	0.137***
	(0.0243)	(0.0208)	(0.0199)	(0.0208)
Log EU Share × Post Election	0.0548**	0.0635***	0.0816***	0.0898***
	(0.0265)	(0.0230)	(0.0228)	(0.0200)
Log EU Share × Supply Chain Pressure		-0.00501		-0.00428
		(0.00400)		(0.00422)
Observations	9388	9388	8418	8418
Trend	Yes	Yes	Yes	Yes
Additional controls	Yes	Yes	Yes	Yes
Year-Month FE	Yes	Yes	Yes	Yes
Product FE	No	No	No	No
Product-Month FE	Yes	Yes	Yes	Yes

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

back

Appendix: excluding Covid periods

	(1) Log Price	(2) Log Price	(3) Log Price	(4) Log Price
Log EU Share × Post Brexit	0.124***		0.137***	0.150***
	(0.0199)		(0.0171)	(0.0218)
Log EU Share × Post Election	0.0816***	0.0747**	0.0708**	0.0736**
	(0.0228)	(0.0306)	(0.0303)	(0.0307)
Observations	8418	6116	6646	6247
Sample	Baseline	exc. 03/2020+	exc. 03/2020-05/2022	exc. 03/2020-11/2022
Trend	Yes	Yes	Yes	Yes
Additional controls	Yes	Yes	Yes	Yes
Year-Month FE	Yes	Yes	Yes	Yes
Product FE	No	No	No	No
Product-Month FE	Yes	Yes	Yes	Yes

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

back

Appendix: controlling for EU consumer prices

	(1) Log Price	(2) Log Price	(3) Log Price	(4) Log ($Price^{UK}$ / $Price^{EU}$)
Log EU Share × Post Brexit	0.0895***	0.0896***	0.103***	0.0898***
	(0.0243)	(0.0228)	(0.0208)	(0.0200)
Log EU Share × Post Election	0.0548**	0.0562**	0.0653***	0.0593***
	(0.0265)	(0.0244)	(0.0235)	(0.0203)
Log Price EU27		0.325**		
		(0.159)		
Observations	9388	9388	9388	9388
Trend	Yes	Yes	Yes	Yes
Year-Month FE	Yes	Yes	Yes	Yes
Product FE	No	No	No	No
Product-Month FE	Yes	Yes	Yes	Yes
EU Price Control	No	Yes	No	No
Country-specific Price Controls	No	No	Yes	No

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

back

Appendix: level (not log) EU-share exposure

	(1) Log Price	(2) Log Price	(3) Log Price	(4) Log Price
EU Share × Post Brexit	0.158**	0.148***	0.155**	0.243***
	(0.0647)	(0.0466)	(0.0677)	(0.0737)
EU Share × Post Election	0.0695	0.0603	0.0649	0.133*
	(0.0590)	(0.0388)	(0.0618)	(0.0684)
Observations	9388	9388	9388	8418
Trend	Yes	No	Yes	Yes
Additional controls	No	No	No	Yes
Year-Month FE	Yes	Yes	Yes	Yes
Product FE	Yes	Yes	No	No
Product-Month FE	No	No	Yes	Yes

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

back

Appendix: excluding post-ref / pre-election window

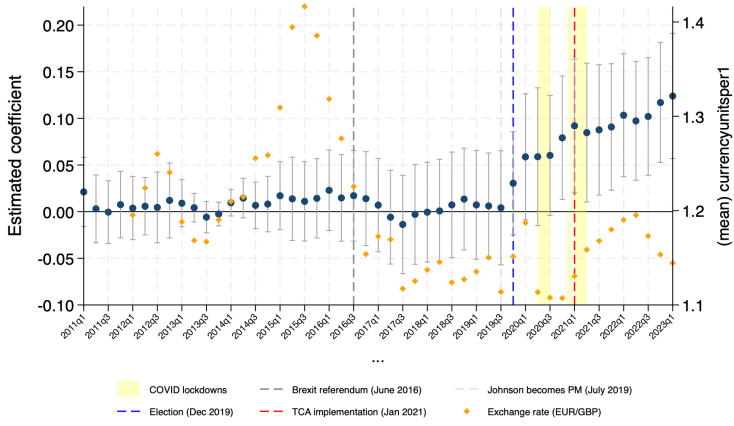
	(1) Log Price	(2) Log Price	(3) Log Price	(4) Log Price
Log EU Share × Post Brexit	0.0860***	0.0769***	0.0858***	0.133***
	(0.0275)	(0.0170)	(0.0293)	(0.0234)
Log EU Share × Post Election	0.0517*	0.0429**	0.0511*	0.0902***
	(0.0286)	(0.0199)	(0.0306)	(0.0253)
Observations	6671	6671	6671	5736
Trend	Yes	No	Yes	Yes
Additional controls	No	No	No	Yes
Year-Month FE	Yes	Yes	Yes	Yes
Product FE	Yes	Yes	No	No
Product-Month FE	No	No	Yes	Yes

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

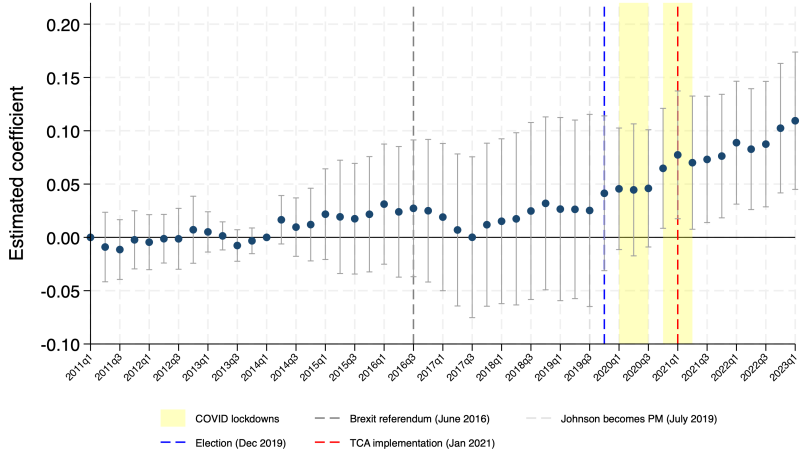
back

Appendix: GBP–Euro exchange rate



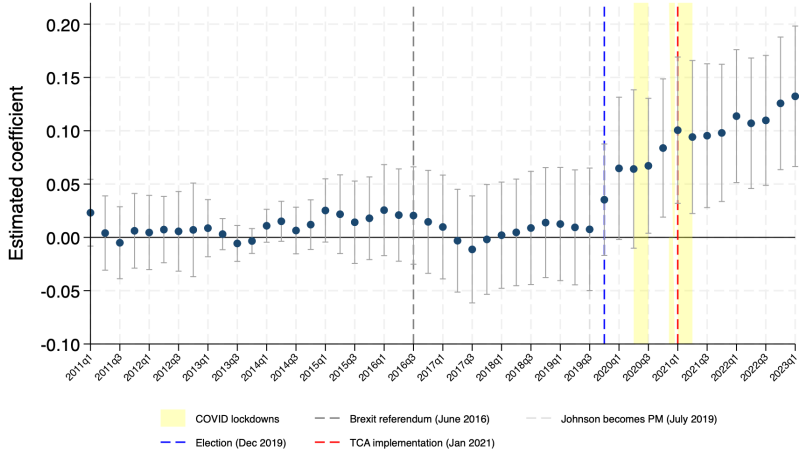
back

Appendix: event study without time trend



back

Appendix: event study with controls



back

Appendix: additional controls (added individually)

	(1) Log Price	(2) Log Price	(3) Log Price	(4) Log Price	(5) Log Price	(6) Log Price	(7) Log Price	(8) Log Price
Log EU Share × Post Brexit	0.0895***	0.0952***	0.0915***	0.110***	0.0942***	0.0895***	0.0914***	0.124***
	(0.0243)	(0.0224)	(0.0234)	(0.0217)	(0.0247)	(0.0237)	(0.0241)	(0.0199)
Log EU Share × Post Election	0.0548**	0.0604**	0.0564**	0.0702***	0.0556**	0.0548**	0.0578**	0.0816***
	(0.0265)	(0.0236)	(0.0267)	(0.0235)	(0.0272)	(0.0255)	(0.0260)	(0.0228)
Brexit trade uncertainty		-11.40***						-11.44***
		(2.577)						(2.344)
EU export price			0.0218***					0.0187***
			(0.00473)					(0.00446)
Log exchange rate deviation				0.168***				0.172***
				(0.0475)				(0.0459)
Post Brexit=1 × Perishable (strict)=1					-0.0297			-0.0262
					(0.0344)			(0.0322)
Post election=1 × Perishable (strict)=1					-0.0000381			-0.000456
					(0.0309)			(0.0297)
Post Brexit=1 × Perishable=1						0.0160		
						(0.0373)		
Post election=1 × Perishable=1						0.0267		
						(0.0338)		
Post Brexit=1 × UK posted MFN tariff							0.00133	0.000653
							(0.00105)	(0.000956)
Post election=1 × UK posted MFN tariff							0.00204**	0.00169**
							(0.000860)	(0.000826)
Observations	9388	8567	9211	8673	9388	9388	9388	8418
Trend	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Product FE	No	No	No	No	No	No	No	No
Product-Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

back