Estimating the Trade and Welfare Effects of Brexit: A Panel Data Structural Gravity Model

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Introduction and motivation

Since 29th of March 2017 the UK and EU are negotiating the terms for UK's withdrawal from the EU but until today failed to achieve any significant progress.

Some studies already provide ex-ante estimates of the trade and welfare effects of Brexit (e.g., Brakman *et al.* 2017; Felbermayr *et al.* 2017).

This paper adds to this literature by ...

- ▶ applying a panel data Constrained Poisson Pseudo Maximum Likelihood Estimator (CPPMLE).
- ▶ accounting for full endowment general equilibrium effects (Yotov *et al.* 2016).
- ▶ allowing for phasing-in effects of counterfactual policy scenarios (Bergstrand *et al.* 2015).
- ▶ relying on a different dataset which allows to more accurately identify trade policy effects.

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The CPPML estimator and FEGEE

Constrained Poisson Pseudo Maximum Likelihood Estimator:

- ▶ Exploits the general equilibrium constraints imposed by the system of multilateral resistances. ⇒
- ▶ Allows to calculate theory consistent confidence intervals via the delta method.
- ▶ Accurately adresses and solves the incidental parameter problem. ⇒
- ▶ Allows to fully control for unobserved heterogeneity across country pairs.

Full endowment general equilibrium effects:

- ▶ Allow endogenous adjustments of gross productions and expenditures as a response to counterfactual changes in mill prices.
- ▶ For estimation, production and expenditure shares are observed and are taken as given.
- ▶ The solutions of counterfactual scenarios fully respect their endogenous adjustment.

Gravity model: Empirical specifications

Specification (1):

$$
\begin{aligned}
s_{ijt} &= \exp\left(\alpha_1 B_{ij} t + \alpha_2 B_{ij} contig_{ij} t + \alpha_3 B_{ij} \log(dist_{ij}) t + \alpha_4 D_{GR}\right) \\
&\quad * \quad \exp\left(\sum_{k=0}^{2} \alpha_{5+k} B_{ij} CU_{ij,t-3k} + \sum_{k=0}^{2} \alpha_{8+k} B_{ij} FTA_{ij,t-3k} + \mu_{ij} + \beta_{it} + \gamma_{jt}\right) + \varepsilon_{ijt}
\end{aligned}
$$

Specification (2):

$$
\begin{aligned}
s_{ijt} &= \exp\left(\alpha_1 B_{ij} t + \alpha_2 B_{ij} contig_{ij} t + \alpha_3 B_{ij} \log(dist_{ij}) t + \alpha_4 D_{GR}\right) \\
&\quad * \quad \exp\left(\sum_{k=0}^{2} \alpha_{5+k} B_{ij} RTA_{ij,t-3k} + \mu_{ij} + \beta_{it} + \gamma_{jt}\right) + \varepsilon_{ijt}
\end{aligned}
$$

Data

Data for Bilateral goods trade, gross-production, total export and imports for total manufacturing for 65 countries.

The total value of exports of a single country adds-up to its production value and the value of imports to its expenditures.

Domestic trade is defined as gross production minus total exports.

We cover the time period from 1994 to 2012 in three-year intervals.

Sources:
Bilateral trade: OECD's STAN database and Nicita and Olarreaga's (2007) database.

Production and total trade: STAN, UNIDO, CEPII and WIOD

A few data points have been interpolated (Robustness).
Distance and contiguity: Mayer and Zignago (2011)
Trade policies: Mario Larch's Regional Trade Agreements Database (Egger and Larch 2008).

Estimation results

	Specification (1)		Specification (2)	
	Parameter-estimate	t-value	Parameter-estimate	t-value
Border*time	0.17	4.75***	0.20	5.48***
Border*contiguity*time	0.02	1.20	0.02	1.53
Border*(log) distance*time	−0.01	−1.82*	−0.01	−2.50**
Great recession 2009	−0.19	−4.87***	−0.19	−4.55***
Customs union	0.13	1.99**		
Custums union (t-3)	0.33	4.24***		
Custums union (t-6)	0.03	0.45		
FTA	−0.07	−1.36		
FTA (t-3)	0.25	3.64***		
FTA (t-6)	0.11	1.67*		
RTA			−0.06	−1.24
RTA (t-3)			0.25	3.49***
RTA (t-6)			0.14	1.90*
Total customs unions effect	0.50	5.39***		
Total FTA effect	0.29	3.90***		
Total RTA effect			0.33	4.31***

Robustness checks

1. No imputed data.

2. WIOD database for 2000 to 2012.

3. Non-linear border-time effects.

4. Time-constant border effects (Bergstrand *et al.* (2015). specification).

COUNTERFACTUAL BREXIT SCENARIOS

1. **Soft Brexit** (Specification 1):
   - ▶ UK leaves the customs unions.
   - ▶ A free trade agreement with the EU is established.
   - ▶ All third-country trade agreements of UK remain unaffected.

2. **Hard Brexit** (Specification 1):
   - ▶ A free trade agreement with the EU <u>cannot</u> be established.
   - ▶ All all exiting trade agreements of UK with third countries are abolished. ⇒ **UK trades under WTO rules**.

3. **Soft Brexit** (Specification 2):
   - ▶ The RTA indicator is set to zero for trade between UK and the EU members
   - ▶ All third-country trade agreements of UK remain unaffected.

4. **Hard Brexit** (Specification 2):
   - ▶ All RTAs are set to zero. ⇒
   - ▶ **UK trades under WTO rules**.

Brexit impact on international trade I
Full endowment general equilibrium

		Soft Brexit			Hard Brexit		
		%-change	CI lower	CI upper	%-change	CI lower	CI upper
Specification 1							
UK-EU	t	-18.06	-27.68	-8.44	-37.40	-47.59	-27.21
	t+3	-17.19	-26.96	-7.41	-36.26	-46.54	-25.98
	t+6	-16.81	-26.41	-7.21	-35.53	-45.71	-25.34
EU-UK	t	-14.42	-22.04	-6.80	-30.28	-38.89	-21.67
	t+3	-13.87	-21.80	-5.93	-29.55	-38.33	-20.76
	t+6	-13.78	-21.69	-5.88	-29.41	-38.19	-20.62
EU-EU	t	0.39	-0.08	0.85	1.13	0.51	1.75
	t+3	0.40	-0.08	0.89	1.17	0.54	1.81
	t+6	0.43	-0.07	0.92	1.23	0.58	1.88
UK-ROW	t	2.21	0.71	3.71	-3.21	-5.81	-0.62
	t+3	2.64	0.86	4.41	-3.88	-6.65	-1.11
	t+6	3.07	1.03	5.12	-2.84	-5.64	-0.04
ROW-UK	t	5.83	1.91	9.74	5.79	2.14	9.45
	t+3	5.88	1.93	9.83	4.64	0.97	8.31
	t+6	5.99	1.98	10.00	4.86	1.12	8.59
EU-ROW	t	0.73	0.27	1.19	1.60	0.96	2.25
	t+3	0.71	0.26	1.17	1.51	0.89	2.13
	t+6	0.71	0.26	1.15	1.50	0.89	2.11
ROW-EU	t	-0.14	-0.19	-0.08	-0.20	-0.36	-0.05
	t+3	-0.11	-0.16	-0.06	0.06	-0.15	0.27
	t+6	-0.08	-0.13	-0.03	0.12	-0.10	0.35

Brexit impact on international trade II
Full endowment general equilibrium

		Soft Brexit			Hard Brexit		
		%-change	CI lower	CI upper	%-change	CI lower	CI upper
Specification 2							
UK-EU	t	-26.12	-36.02	-16.23	-25.57	-35.28	-15.87
	t+3	-25.56	-35.30	-15.81	-24.95	-34.47	-15.43
	t+6	-25.00	-34.59	-15.41	-24.33	-33.68	-14.99
EU-UK	t	-20.91	-29.19	-12.63	-20.36	-28.34	-12.39
	t+3	-20.80	-29.05	-12.55	-20.23	-28.17	-12.28
	t+6	-20.67	-28.89	-12.44	-20.06	-27.96	-12.15
EU-EU	t	0.71	0.17	1.25	0.67	0.14	1.20
	t+3	0.75	0.19	1.31	0.71	0.16	1.25
	t+6	0.79	0.22	1.36	0.74	0.18	1.29
UK-ROW	t	3.15	1.26	5.05	-4.42	-6.41	-2.44
	t+3	3.88	1.64	6.12	-3.67	-5.47	-1.87
	t+6	4.61	2.02	7.20	-2.91	-4.58	-1.25
ROW-UK	t	9.07	4.62	13.51	1.01	0.03	1.98
	t+3	9.22	4.70	13.73	1.19	0.10	2.28
	t+6	9.40	4.79	14.01	1.41	0.19	2.64
EU-ROW	t	1.06	0.54	1.57	1.11	0.58	1.64
	t+3	1.04	0.54	1.55	1.10	0.57	1.63
	t+6	1.03	0.53	1.53	1.09	0.57	1.62
ROW-EU	t	-0.20	-0.26	-0.13	-0.07	-0.22	0.07
	t+3	-0.15	-0.22	-0.08	-0.02	-0.18	0.13
	t+6	-0.11	-0.19	-0.04	0.02	-0.15	0.19

Brexit impact on domestic trade
Full endowment general equilibrium

		Soft Brexit			Hard Brexit		
		%-change	CI lower	CI upper	%-change	CI lower	CI upper
Spec. 1							
UK	t	7.94	2.44	13.45	19.66	10.91	28.42
	t+3	8.46	2.58	14.34	21.60	12.05	31.15
	t+6	9.03	2.77	15.30	23.17	12.92	33.42
EU	t	-0.03	-0.11	0.05	1.14	0.51	1.76
	t+3	-0.04	-0.12	0.05	1.18	0.54	1.82
	t+6	-0.04	-0.12	0.04	1.23	0.58	1.89
ROW	t	0.21	0.19	0.22	0.27	0.14	0.39
	t+3	0.20	0.18	0.23	0.39	0.23	0.56
	t+6	0.20	0.17	0.23	0.39	0.23	0.56

Welfare effects of Brexit

Full endowment general equilibrium

		Soft Brexit			Hard Brexit		
		%-change	CI lower	CI upper	%-change	CI lower	CI upper
Specification 1							
UK	t	-1.29	-2.29	-0.28	-3.05	-4.85	-1.24
	t+3	-1.37	-2.45	-0.29	-3.32	-5.33	-1.32
	t+6	-1.46	-2.61	-0.30	-3.55	-5.73	-1.36
EU	t	-0.03	-0.11	0.05	-0.12	-0.22	-0.01
	t+3	-0.04	-0.12	0.05	-0.12	-0.23	-0.02
	t+6	-0.04	-0.12	0.04	-0.13	-0.24	-0.02
ROW	t	0.05	0.05	0.05	0.04	0.02	0.07
	t+3	0.05	0.04	0.05	0.04	0.02	0.07
	t+6	0.05	0.04	0.05	0.05	0.02	0.07

Notes: The value of σ is chosen as 6.858 follwing Bergstrand *et al.* (2013, Table 1)

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Main findings: 6 years after Brexit

UKs (EUs) exports of goods to the EU (UK) are likely to decline within a range between 7.2% and 45.7% (5.9% and 38.2%).

The soft (hard) Brexit scenario of Specifiction (1) fosters UK domestic trade by 9.0% [2.8%, 15.3%] (23.2% [12.9%, 33.4%]).

Trade effects for the ROW a relatively small but more important for the relationship with the UK.

Specifiction (2) produces larger (smaller) effects for the soft (hard) Brexit scenarios.

For the UK, a hard Brexit likely induces a decline in UKs real income by around 3.6%.

The estimated welfare effects for the EU are negligible in magnitude and statistically not different from zero.

Some concluding remarks

This paper empirically assesses the trade and welfare effects from Brexit concentrating on goods trade by exploiting the system of multilateral resistances for calculating confidence intervals.

We provide a meaningful and theory consistent bandwidth for the possible general equilibrium trade effects for the UK, the EU and the ROW.

The estimates suggest that the largest adverse trade and welfare effects are to be expected in case of a hard Brexit in which UK would only trade under WTO rules.

The "Global Britain' strategy would most likely be able to only dampen these negative effects.

⇒ The expected decline in bilateral trade will be much more damaging for the UK as compared to the EU.

The provided estimates might be considered as only a lower bound of the potential economic costs involved in the Brexit.

Thank you very much for your attention!!

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Structural panel data gravity model I

Gravity equation:

$$\frac{x_{ijt}}{Y_{t,W}} = t_{ijt}^{1-\sigma}\kappa_{it}\Pi_{it}^{\sigma-1}P_{jt}^{\sigma-1}\theta_{jt}e^{\mu_{ij}}\eta_{ijt} := e^{z'_{ijt}\alpha+\beta_{it}(\alpha)+\gamma_{jt}(\alpha)+\mu_{ij}}\eta_{ijt}.$$

Multilateral trade resistances enter the model in normalized form as
$e^{\beta_{it}(\alpha,\mu)} = \kappa_{it}\Pi_{it}(\alpha,\mu)^{\sigma-1}$ and $e^{\gamma_{jt}(\alpha,\mu)} = \theta_{jt}P_{jt}(\alpha,\mu)^{\sigma-1}$.

For $i,j = 1,...,C$ and period t the system of trade resistances can be
compactly written as

$$\kappa_{it} = \sum_{j=1}^{C} e^{z'_{ijt}\alpha+\beta_{it}(\alpha,\mu)+\gamma_{jt}(\alpha,\mu)+\mu_{ij}}, \ i = 1,...,C-1,$$

$$\theta_{jt} = \sum_{i=1}^{C} e^{z'_{ijt}\alpha+\beta_{it}(\alpha,\mu)+\gamma_{jt}(\alpha,\mu)+\mu_{ij}}, \ j = 1,...,C.$$

In case of $\alpha = 0$, $\mu_{ij} = 0$, one may set $\Pi_{it}(0) = c_t$ and $P_{jt}(0) = 1/c_t$, where
c_t is a time-specific constant so that $e^{\beta_{it}(\alpha)} = c_t\kappa_{it}$ and $e^{\gamma_{jt}(\alpha)} = \theta_{jt}/c_t$.

Structural panel data gravity model II

The country pair fixed effects need to be normalized as well:

$$\begin{aligned}
\widetilde{\beta}_{it} &= \beta_{it}(\alpha,\mu) - \beta_{Ct}(\alpha,\mu) + \mu_{ii}, \\
\widetilde{\gamma}_{jt} &= \gamma_{jt}(\alpha,\mu) + \beta_{Ct}(\alpha,\mu) + \mu_{jj}, \\
\widetilde{\mu}_{ij} &= \mu_{ij} - \mu_{ii} - \mu_{Cj}.
\end{aligned}$$

Under this parametrization it follows that $\widetilde{\beta}_{Ct} = 0$, $\widetilde{\mu}_{ii} = 0$ and $\widetilde{\mu}_{Cj} = 0$.

For estimation rewrite the structural gravity with additive disturbances:

$$s_{ijt} = m_{ijt}(\vartheta_C) + \varepsilon_{ijt}, \quad \varepsilon_{ijt} = m_{ijt}(\vartheta_C)\left(\eta_{ijt} - 1\right),$$

where $m_{ijt}(\vartheta_C) = e^{z'_{ijt}\alpha + \beta_{it}(\alpha,\mu) + \gamma_{jt}(\alpha,\mu) + \mu_{ij}}$, $\vartheta_C = [\phi_C(\alpha,\mu)', \mu_{ij}]'$, $\phi_C = [\alpha', \beta'_C(\alpha,\mu), \gamma'_C(\alpha,\mu)]'$.