

# Brexit, Trade in Intermediates, and Global Value Chains: Beyond the UK and the EU

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- 6 Unpacking Measures of GVC
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# Introduction

## Motivation

- Effect of higher trade costs.
- Future trade relations between the UK and the EU.
- Impact of Brexit on Rest of the World (henceforth, ROW). [▶ Key Facts S3](#)

## Primary Research Questions:

- What are the welfare effects and the magnitude of gains from trade under different potential post-Brexit trade policy scenarios?
- How do these possible post-Brexit scenarios affect global value chain patterns?

## Why Global Value Chains (GVCs)?

- Multi-stage production (GVCs) vs traditional gravity models.
- Cost of trade barriers, growth in GVCs, and welfare gains. [▶ Key Facts S3](#)

[▶ Key Facts S4](#)

# Introduction

## What I Do: Methodology

### Build static general equilibrium:

- Multi-country multi-sector model, Armington model.
- Model features 33 countries, UK, EU27, 30 selected countries that trade most with the UK, and ROW. [▶ Key Facts](#)
- 12 sectors, 11 tradable sectors, and a single service sector.
- Input-output linkages and trade policy shock.

### Quantitative analysis:

- Calibrate the model to match 2015 Eora input-output matrix (no-Brexit equilibrium).

### Compare no-Brexit equilibrium to counterfactual:

- Potential post-brexit scenarios: hard brexit, soft brexit, UK-EU FTA (current: TCA), UK-US FTA, and UK-EU-US FTA.
- Hard: UK loses single market access to EU (WTO MFN tariff and high rise in NTBs). Soft: UK retains single market access to EU (zero tariff but small rise in NTBs).

# Introduction

## What I find: Preview of Results

### Welfare

- Hard: welfare losses from 0.01 to 3.06% in total consumption of households. Average of 1.61% (except India and South Korea). Countries affected most (Japan, Kenya, Mauritius, Bangladesh).
- UK-EU FTA: loses from 0.01 to 2.04%, with an average of 0.79%.
- Soft: least harmful case except for UK, Iceland, and Mauritius.
- UK-USA FTA: near negative zero for the USA, and UK ( $-0.04\%$ ).
- UK-EU-USA FTA: UK ( $-0.03\%$ ) and USA ( $-0.05\%$ ).
- More losses under the Hard-Brexit and UK-EU FTA scenarios, and relatively minor losses under the Soft-Brexit scenario.

### GVC

- GVC changes under Soft and Hard Brexit, with significant changes in countries other than the UK and EU27. Some countries affected most are Singapore, China, Japan, South Korea, Kenya, Indonesia, and Hong Kong.

▶ [Related Literature](#)

# Model Environment

## Multi-Country Multi-Sector

- Agents: Households (consume) and firms (produce, sector-level).
- Goods are imperfect substitutes by way of their country origin and CES preferences.
- Inelastic labor is supplied to the market.
- One factor of production (labor) and one composite intermediate good.
- All goods and factor markets are perfectly competitive.
- Mobile labor across sectors and immobile across countries.
- Costly trade in goods with iceberg trade costs " $d$ " and import tariffs " $\tau$ ".

# Model

## Household's Problem

- The representative household in each country  $j$ , has a CES preference  $C_j$  and solves the utility max problem:

$$\max_{c_{ji}^s} \quad U_j = C_j = \prod_{s=1}^S [C_j^s]^{\alpha_j^s}$$

$$\text{where } C_j^s = \left[ \sum_{i=1}^N (c_{ji}^s)^{\frac{\sigma^s-1}{\sigma^s}} \right]^{\frac{\sigma^s}{\sigma^s-1}}; \quad (1)$$

$$\text{s.t. } \sum_{s=1}^S \sum_{i=1}^N [p_{ji}^s c_{ji}^s] = Y_j$$

$$Y_j = w_j \bar{L}_j + T_j; \quad c_{ji}^s \geq 0; \quad \sum_{s=1}^S \alpha_j^s = 1$$

# Model

## Technology and Firms Problem

- Roundabout input production, where input is either used for final consumption or as intermediate input. Production technology of a good produced in country  $i$  sector  $s$ :

$$q_i^s = A_i^s l_i^s \beta_i^s M_i^{1-\beta_i^s}$$

$$\text{where } M_i = \prod_{s=1}^S \left[ \sum_{i=1}^N m_{ij}^s \frac{\rho^s - 1}{\rho^s} \right]^{\frac{\rho^s}{\rho^s - 1}} \gamma_i^{sr} \quad (2)$$

$$\text{where } \sum_{s=1}^S \gamma_i^{sr} = 1 - \beta_i^s$$

Tractability assumption:  $\sigma^s = \rho^s$

- Firms in country  $i$  maximizes zero profit.



# Model

## Pricing

- Tradable intermediate goods subject to transportation cost and import tariffs.
- The cost of producing a unit of good in country  $i$  sector  $s$  is given by:  $p_i^s = \left(\frac{\text{cost}_i^s}{A_i^s}\right)$ , where  $\text{cost}_i^s$  is the cost of labor and intermediate inputs.

$$\text{cost of input bundle : } \text{cost}_i^s = \eta_i^s w_i^{\beta_i^s} \left[ \prod_{r=1}^S (P_i^s \gamma_i^{sr}) \right]^{1-\beta_i^s} \quad (3)$$

$$\text{where : } \eta_i^s = (\beta_i^s)^{-\beta_i^s} (1 - \beta_i^s)^{-(1-\beta_i^s)} \left[ \prod_{r=1}^S (\gamma_i^{sr})^{-\gamma_i^{sr}} \right]^{(1-\beta_i^s)}$$

# Model

## Pricing

- With iceberg cost, the cost of good at the destination to be consumed is given by:  $p_{ji}^s = (1 + \tilde{d}_{ji}^s)p_i^s$ .
- With import tariff, the cost of good at the destination to be consumed is given by:  $p_{ji}^s = (1 + \tilde{\tau}_{ji}^s)p_i^s$ .
- Iceberg:  $d_{ji}^s = 1 + \tilde{d}_{ji}^s$ .
- Tariff:  $\tau_{ji}^s = 1 + \tilde{\tau}_{ji}^s$ .
- Combined trade cost:  $\kappa_{ji}^s = d_{ji}^s \tau_{ji}^s$ .
- Price of good at destination country:  $p_{ji}^s = \kappa_{ji}^s p_i^s$ .

# Model

## GE: Market Clearing Condition

Goods market:

$$Q_j^s = F_{ij}^s + \sum_{s=1}^S X_{ij}^{rs}, \quad \text{where } r, s = 1, \dots, S \quad (4)$$

Labor market:

$$\bar{L}_j = \sum_{s=1}^S l_j^s, \quad \text{where } j = 1, \dots, N \quad (5)$$

# Model

## Brexit Trade Policy Effect in Model

### Brexit trade policy effect due to changes in trade costs:

- Tariff and Non-tariff trade barriers (NTBs); a fraction of iceberg trade cost denoted by  $\xi$ .
- NTBs:  $\xi_{ji}^r = (1 + \tilde{\xi}_{ji}^r)$ .

### Pricing in the state of Brexit: Without Model Flexibility

$$P_j^r = \left[ \sum_{i=1}^N \{ (\tau_{ji}^r) (\xi_{ji}^r) (d_{ji}^r - \xi_{ji}^r) p_i^r \}^{1-\sigma^r} \right]^{\frac{1}{1-\sigma^r}} \quad (6)$$

# Data

- Eora Global MRIO Database (2015) (189 countries, 26 sectors).
- WTO-IDB: Bilateral MFN tariff  $\tau$ .
- 2015 UN COMTRADE (Bilateral trade flows between UK and all others).
- UNCTAD TRAINS: Bilateral applied effective tariff  $\tau$ .
- Penn world table (Employment and Population data, 2015).
- 33 regions = UK, EU27, 30 large regions, and the ROW, which is the remaining smaller regions.
- 26 sectors, 11 tradable sectors, and 15 service sectors, aggregated into a single service sector. [▶ Sector Aggregation](#)

# Calibration and Quantitative Analysis

## Calibration: Strategy

- Assign standard parameters (trade elasticity) from an external source.
- Calibrate value-added and expenditure shares directly from the data.
- Calibrate the technology parameter from the input-output matrix using the estimated shares above.
- Calibrate the remaining parameters from the model so that the model's general equilibrium matches the 2015 EORA input-output matrix.

# Calibration and Quantitative Analysis

## Calibration: Assigned Parameters

- Armington elasticities (Giri et al., 2020)

Sector	Sector Code	Elasticity
Agriculture	AG	8.11
Fishing	FSH	8.11
Mining and Quarrying	MINQ	15.72
Food & Beverages	FDB	3.57
Textiles and Wearing Apparel	TWAP	4.43
Wood and Paper	WOPA	5.81
Petroleum, Chemical and Non-Metallic Mineral Products	PECH	11.21
Metal Products	METP	7.01
Electrical and Machinery	EMCH	3.27
Transport Equipment	TPEQ	4.47
Other Manufacturing	OTHM	5
Services	SERV	5

# Calibration and Quantitative Analysis

## Data Calibrated Parameters

- Parameters calibrated from data and exogenous variables

Parameter	Definition	Data Moments
$\beta_j^s$	Value-added shares	$\frac{VA}{GO}$
$\alpha_j^s$	Sector-share final demand	Final use/Total final use
$\gamma_j^s$	Sector-share intermediate input	Input use/total input
$A_j^s$	TF Productivity	Gross Value of production function
$L_i$	Labor endowment	Employment



# Calibration and Quantitative Analysis

## GE: Tariff Estimation

- Base on Applied Effective tariff schedules for 6-digit HS industries.
- 26 sectors, 11 tradables and 15 services, latter aggregated into single service sector.
- Estimated weighted average tariffs using the applied UNCTAD TRAINS tariff, and weighed by import share using COMTRAD data.
- Estimated weighted average tariff is the no-Brexit equilibrium tariff.

# Calibration and Quantitative Analysis

## GE: Iceberg Trade Calibration

- Calibrate iceberg  $d_{ji}^f$  to match 2 data moments to model moments (input and final good) in over-identified estimation.
- Data moments (2015 Eora MRIO matrix): (1) the intermediate input values and (2) the final demand values.
- Model moments: Total import values for 1)input and 2)final good.

# Calibration and Quantitative Analysis

GE: Iceberg Calibration

## Aggregated Sector-level trade cost calibrated from the model

<b>Sector</b>	<b>Benchmark Iceberg (<math>d_{ji}^c</math>)</b>
AG	2.73
FSH	2.06
MINQ	1.81
FDB	6.89
TWAP	2.87
WOPA	2.61
PECH	1.83
METP	2.02
EMCH	7.69
TPEQ	4.59
OTHM	2.57
SERV	7.86

Source: Two targeted data moments: the intermediate input and final demand.

► Welfare Results

# Calibration and Quantitative Analysis

## Post-Brexit Scenarios: Tariff and non-Tariff Trade Barriers(NTB)

### Assumptions: Five Possible Scenarios and Simulation Approach

- Hard Brexit: MFN tariff and simulate 50% increase in NTB for UK and all countries. [▶ Simulation Approach Table](#)
- Soft Brexit with FTA: Exit single market. Zero tariff between UK and EU27 but simulate 25% increase in NTBs. Assume that tariff and NTBs exists between UK and other countries.
- UK-EU FTA: Exit single market and custom union. Zero tariff for trade between UK and EU27. Increase NTB by 40% for UK-EU trade.
- UK-US FTA: Simualte a 25% decrease in tariff and NTBs for UK-USA trade ceteris paribus.
- UK-EU-US FTA: Eliminate tariff for trade between UK-EU-USA, and reduce NTBs for UK-EU-USA trade largely. I simulate a 50% decrease in NTB.
- NTB is 20% of calibrated iceberg trade cost from the model.

# Quantitative Results

## Welfare

### Total Consumption of Households:

- Measure welfare in consumption equivalence using utility function.
- Welfare gains from trade is the difference between before and after welfare:

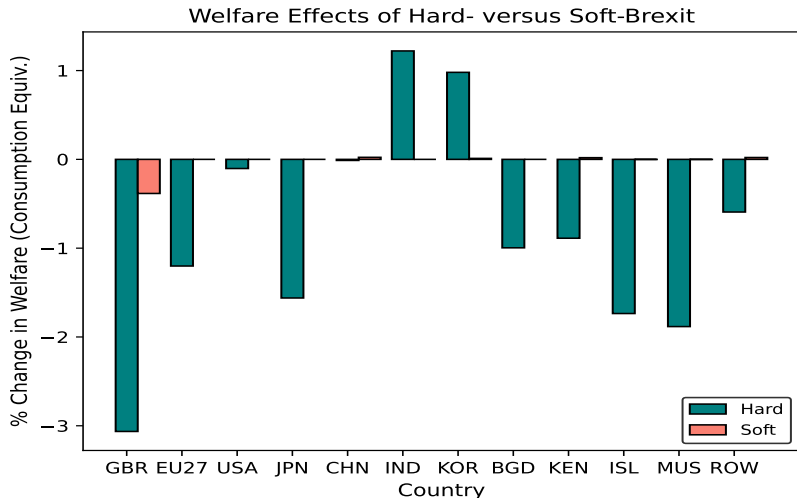
$$\hat{W} = \left( \frac{C'}{C} - 1 \right) * 100 \quad (7)$$

- where  $C'$  is welfare at no-Brexit (before) equilibrium and  $C$  is the welfare for post-Brexit scenarios (after).

# Quantitative Results

Welfare Gains from Trade: Baseline Case is Hard Brexit

▶ Iceberg calibration

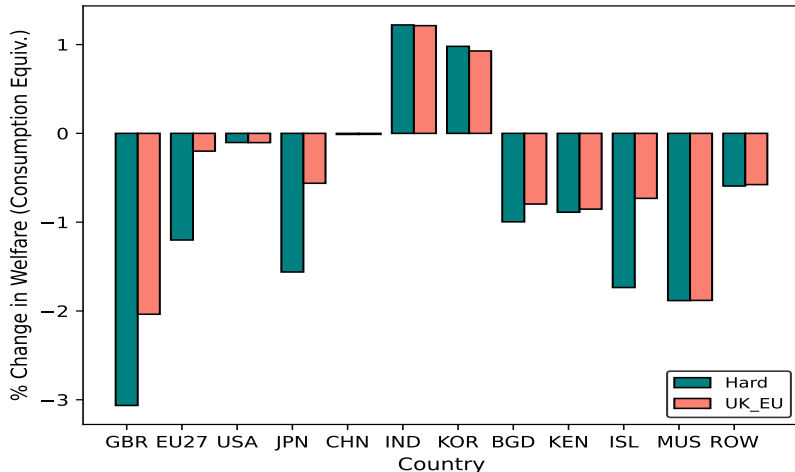


# Quantitative Results

Welfare Gains from Trade: Baseline Case is Hard Brexit

▶ Iceberg calibration

Welfare Effects of Hard versus UK-EU FTA

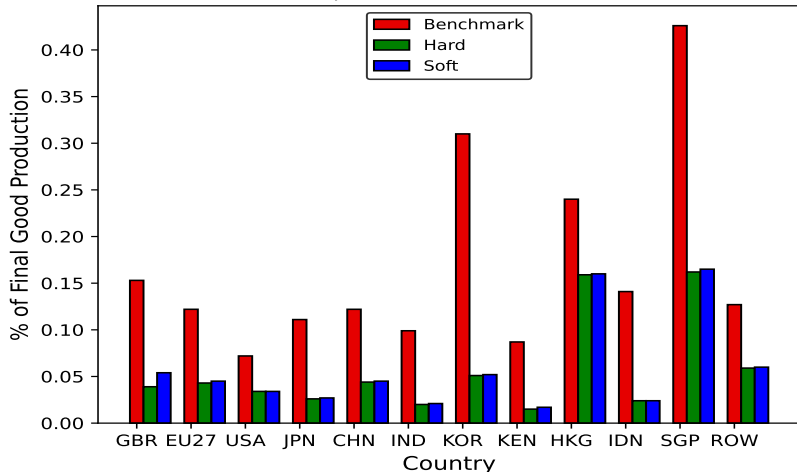


# Unpacking Measures of GVC

## GVC Participation Implication: Backward Participation

▶ GVC participation

Backward Participation: Benchmark vs Hard and Soft

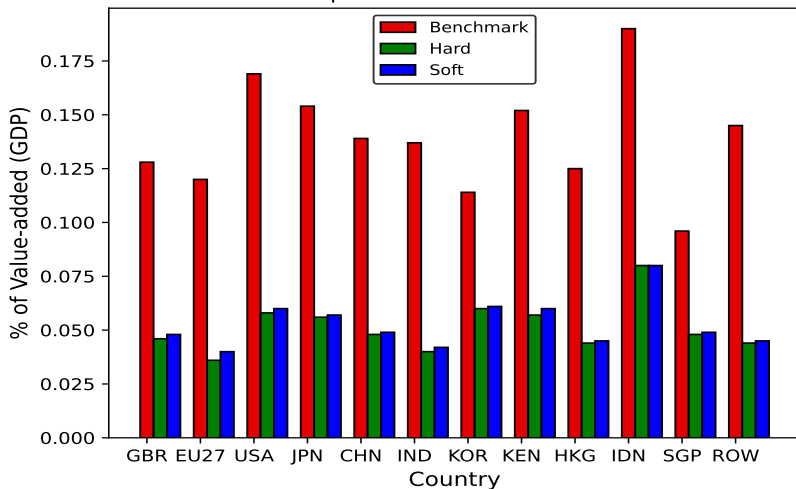




# Unpacking Measures of GVC

## GVC Participation Implication: Forward Participation

Forward Participation: Benchmark vs Hard and Soft



# Unpacking Measures of GVC

## GVC Positioning Implications

### GVC Positioning: Upstreamness and Downstreamness

Country	Upstream			Downstream		
	Calibrated	Hard	Soft	Calibrated	Hard	Soft
GBR	1.957	1.782	1.810	1.907	1.766	1.769
EU27	2.040	1.978	1.978	2.079	1.992	1.995
USA	1.826	1.762	1.762	1.819	1.788	1.789
JPN	1.959	1.854	1.854	1.966	1.812	1.812
CHN	2.696	2.491	2.491	2.740	2.516	2.516
KEN	1.694	1.609	1.611	1.649	1.548	1.549
KOR	2.989	2.721	2.722	2.959	2.495	2.497
IND	1.962	1.851	1.851	1.976	1.837	1.838
ROW	1.888	1.733	1.733	1.835	1.773	1.775

► GVC positioning

# Conclusion

▶ UKUSA

▶ UKEUUSA

- Significant impact on the welfare of other third countries, with more losses under hard-Brexit scenario and UK-EU FTA, and relatively minor losses under the Soft-Brexit.
- Hard Brexit is the worst-case scenario, on the other hand, soft Brexit is the least detrimental.
- GVC participation and positioning changes following soft and hard Brexit, with significant changes in countries other than UK and EU27.
- NTBs are the trade costs that will affect welfare, trade patterns, and production patterns most in a world with Brexit, relative to tariffs.
- Also, the magnitude of the impact will depend on the trade agreement the UK negotiates after Brexit.

# Appendix: Backup Slides

## GVC Participation Index

- Wang et al. (2017) and Antras and Chor (2017).
- Index is the ratio of backward participation (FVA) and forward participation (DVA) to gross exports.
- Upstream participation (DVA) and Downstream participation (FVA).

$$\text{Backward Participation Index} = \frac{\text{FVA}}{\text{Gross Exports}} \quad (8)$$

$$\text{Forward Participation Index} = \frac{\text{DVA}}{\text{Gross Exports}} \quad (9)$$

▶ GVC participation results

# Appendix: Backup Slides

## GVC Positioning Measure

### Upstream Positioning Measures ▶ GVC positioning results

- Upstreamness of a country sector is relative to final demand.
- Final-use to Gross Output (FUGO).
- Antras and Chor (2013) measure, considers production staging distance from final use.

$$a_{ij}^{sr} = \frac{X_{ij}^{sr}}{Q_j^s} \quad (10)$$

$$U_i^r = 1 * \frac{F_i^r}{Q_i^r} + 2 * \frac{\sum_{s=1}^S \sum_{j=1}^N a_{ij}^{sr} F_j^s}{Q_i^r} + 3 * \frac{\sum_{s=1}^S \sum_{j=1}^N \sum_{t=1}^S \sum_{k=1}^N a_{ij}^{sr} a_{jk}^{st} F_k^t}{Q_i^r} + \dots \quad (11)$$

- where  $U_i^r \geq 1$

# Appendix: Backup Slides

## GVC Positioning Measure

### Downstream Positioning Measures

- Downstreamness of a country sector is close to primary factors.
- Value-added to Gross Output (VAGO).
- Antras and Chor (2013) measure, considers production staging distance from primary factors of production.

$$b_{ij}^{sr} = \frac{X_{ij}^{sr}}{Q_i^s} \quad (12)$$

$$D_j^s = 1 * \frac{VA_j^s}{Q_j^s} + 2 * \frac{\sum_{s=1}^S \sum_{j=1}^N b_{ij}^{sr} VA_i^r}{Q_j^s} + 3 * \frac{\sum_{r=1}^S \sum_{i=1}^N \sum_{t=1}^S \sum_{k=1}^N b_{ki}^{tr} b_{ij}^{sr} VA_k^t}{Q_j^s} + \dots \quad (13)$$

- where  $D_j^s \geq 1$

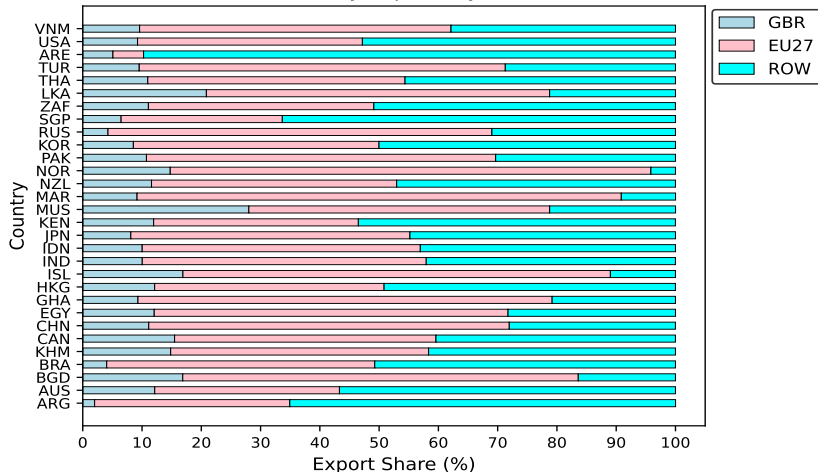
# Appendix: Backup Slides

## Selected Country Exports (EORA MRIO, 2015)

▶ Introduction S1

▶ Introduction S2

### Selected Country Exports by Destination

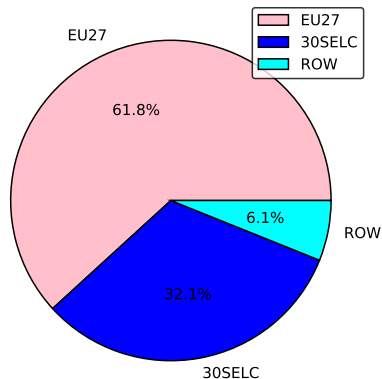


# Appendix: Backup Slides

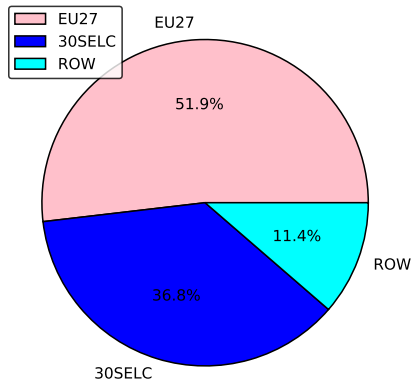
## Aggregate Trade Flows (EORA MRIO, 2015)

▶ Introduction

Exports to the UK



Imports from the UK

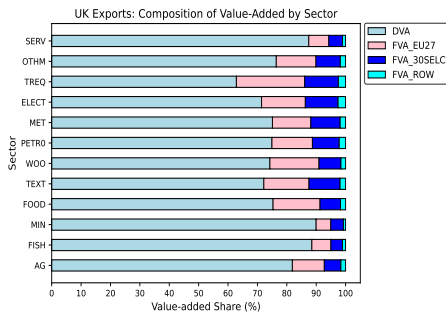
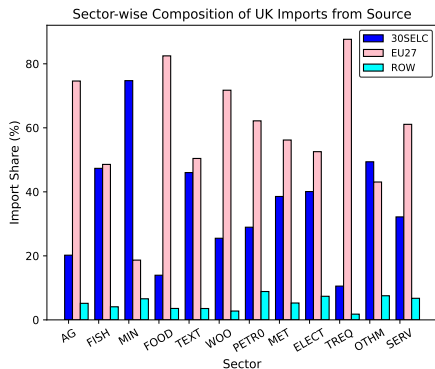




# Appendix: Backup Slides

## Sector-level: UK Imports and Value-added Composition of Exports (EORA MRIO,2015)

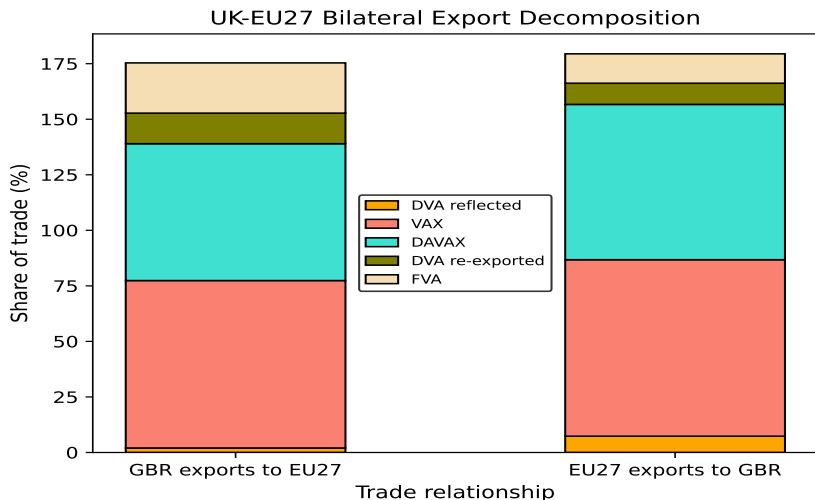
### Introduction S1



# Appendix: Backup Slides

## GVC: Decomposition of UK-EU Bilateral Exports (EORA MRIO,2015)

▶ Introduction



# Appendix: Backup Slides

## Literature Review and Contribution

- **Economic impact of Brexit:** Steinberg (2019); McGrattan and Waddle (2020), Dhingra et al. (2017), Dhingra et al. (2016b); Ebell et al. (2016); Baker et al. (2016)). Extends beyond UK and EU.
- **Impact of trade policy reforms:** many countries, many sectors, and input-output, Caliendo and Parro (2015); Costinot and Rodríguez-Clare (2014); Giri et al. (2021).
- **GVC measures:** Yi (2003); Yi (2010); Johnson and Noguera (2012); Fally (2012); Antràs et al. (2012); Antràs and Chor (2013); Fally and Hillberry (2018); Johnson and Moxnes (2013); Alfaro et al. (2019); Miller and Temurshoev (2017); Wang et al. (2017); Antràs and De Gortari (2020).
- **Sector-wise:** Brexit to have a heterogeneous impact on sectors of an economy (IMF, 2018). Interrelationship between industries and countries (Caliendo and Parro, 2015). [▶ Introduction S4](#)

# Appendix: Backup Slides

## Eora MRIO Input-Output Table Structure

		UK	UK	...	UK	EU27	EU27	...	EU27	...	...	C_N	ROW	ROW	...	ROW	UK	EU27	...	C_N	ROW	Gross Output
		S_1	S_2	...	S_5	S_1	S_2	...	S_5	...	...	S_5	S_1	S_2	...	S_5	Household	Household	...	Household	Household	
UK	Sector 1	Intermediate Goods Transaction (T Matrix)															Final Demand Block (FD Matrix)				Total Output Demanded	
UK	Sector 2																					
...	...																					
UK	Sector 5																					
EU27	Sector 1																					
EU27	Sector 2																					
...	...																					
EU27	Sector 5																					
...	...																					
...	...																					
C_N	Sector_5																					
ROW	Sector 1																					
ROW	Sector 2																					
...	...																					
ROW	Sector 5																					
		Primary Inputs or Value Added (VA Matrix)																				
UK	Tax Revenue	Taxes on Production (includes tariffs) - Subsidies on Production																				
EU27	Tax Revenue																					
...	...																					
C_N	S_5																					
ROW	Tax Revenue																					
UK	Wages & Salaries	Compensation to employees + Net operating surplus + Net mixed income + Consumption of fixed capital																				
EU27	Wages & Salaries																					
...	...																					
C_N	S_5																					
ROW	Wages & Salaries																					
Total Input		Total Inputs Used in Production																				

# Appendix: Backup Slides

## Visual Display of Model in EORA Table

		Intermediate Input												Final demand use				Gross Output				
		UK	UK	...	UK	EU27	EU27	...	EU27	N	ROW	ROW	...	ROW	UK	EU27	...		N	ROW		
		S_s1	S_s2	...	S_s	S_s1	S_s2	...	S_s	...	S_s	S_s1	S_s2	...	S_s	Household	Household		Household	Household		
UK	Sector r1	X_uusr1				X_eusr1				X_dusr1											Q_ur1	
UK	Sector r2		X_uusr2			X_eusr2				X_dusr2						F_uur1	F_eur2	F_dur2	F_wur2		Q_ur2	
...	...																				...	
UK	Sector S																				Q_us	
EU27	Sector r1																				Q_er1	
EU27	Sector r2	....	....	....		....	....	....	....	....	....	....	....	....	....	....	....	....	....		Q_er2	
...	...																				...	
EU27	Sector S																				Q_er2	
...	...																					
N	Sector S																					
ROW	Sector r1																					
ROW	Sector r2																					
...	...																					
ROW	Sector S	X_uusS	X_uuS	....		X_euS	X_euS	....		X_duS	X_duS			X_wuS	X_wuS			F_uuS	F_euS	F_duS	F_wuS	Q_js
Valued -added																						
		VA_us1	VA_us2	....	VA_us	VA_es1	VA_es2	....	VA_es	....	VA_js	....										VA_NS
Total input		Q_us1	Q_us2	....		Q_es1	Q_es2	....														Q_js

input = output

# Appendix: Backup Slides

## Sector Aggregation

Sector No.	Sector Description	Eora Sector Codes	Author's Codes
1	Agriculture	AG	AG
2	Fishing	FSH	FSH
3	Mining and Quarrying	MIN	MINQ
4	Food & Beverages	FOOD	FDB
5	Textiles and Wearing Apparel	TEXT	TWAP
6	Wood and Paper	WOO	WOPA
7	Petroleum, Chemical and Non-Metallic Mineral Products	PETRO	PECH
8	Metal Products	MET	METP
9	Electrical and Machinery	ELECT	EMCH
10	Transport Equipment	TREQ	TPEQ
11	Other Manufacturing	OTHM	OTHM
12	Recycling	RECY	
13	Electricity, Gas and Water	UT	
14	Construction	CONST	
15	Maintenance and Repair	MAINT	
16	Wholesale Trade	WHOT	
17	Retail Trade	RETAIT	
18	Hotels and Restaurants	HOTEL	
19	Transport	TRANSP	SERV
20	Post and Telecommunications	TELEC	
21	Financial Intermediation and Business Activities	FINAN	
22	Public Administration	PUB	
23	Education, Health and Other Services	EDU	
24	Private Households	PRIVH	
25	Others	OTH	
26	Re-export & Re-import	REI	

▶ Data

# Appendix: Backup Slides

## General Equilibrium Tariff Estimation

### Aggregated Sector-level weighted average Applied and MFN tariff

Sector	APP Tariff	MFN Tariff
AG	1.0484	1.0468
FSH	1.0466	1.0455
MINQ	1.0430	1.0442
FDB	1.0482	1.0499
TWAP	1.0412	1.0426
WOPA	1.0468	1.0480
PECH	1.0444	1.0453
METP	1.0445	1.0453
EMCH	1.0444	1.0451
TPEQ	1.0430	1.0447
OTHM	1.0521	1.0534
SERV	1.0458	1.0466

# Appendix: Backup Slides

## Post-Brexit Scenarios: Tariff and non-Tariff Trade Barriers(NTB)

### Five Potential Post-Brexit Scenarios and Simulation Approach

Post-Brexit Scenarios	Trade Costs	
	Tariff ( $\tau$ )	NTBs ( $\xi$ )
<b>(a) Hard Brexit</b>		
UK-EU27	MFN	50% Increase
UK-30SELC	MFN	50% Increase
UK-ROW	MFN	50% Increase
<b>(b) Soft Brexit</b>		
UK-EU27	0%	25% Increase
UK-30SELC	APP	Unchange
UK-ROW	APP	Unchange
<b>(c) UK-EU FTA</b>		
UK-EU27	0%	40% Increase
UK-30SELC	APP	Unchange
UK-ROW	APP	Unchange
<b>(d) UK-USA FTA</b>		
UK-EU27	APP	25% Increase
UK-USA	25% Decrease in APP	25% Decrease
UK-ROW	APP	Unchange
UK-30SELC	APP	Unchange
<b>(e) UK-EU-USA FTA</b>		
UK-EU27	0%	50% Decrease
UK-USA	0%	50% Decrease
USA-EU27	0%	50% Decrease
UK-30SELC	APP	Unchange
UK-ROW	APP	Unchange

Note: MFN is the WTO-governed tariff, and APP is the applied effective tariff that countries trade on if they have a preferential trade agreement. I assume the UK replicates the EU agreement or negotiates a better deal with third countries under a soft Brexit.

► Potential Post-Brexit Scenarios

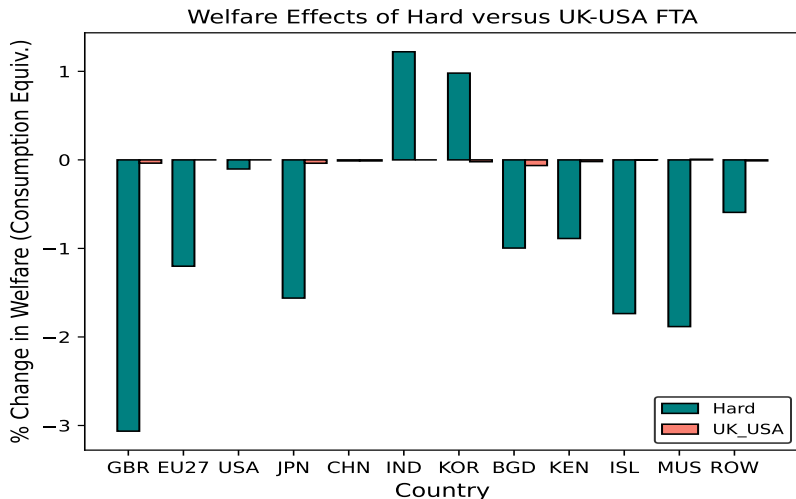


# Appendix: Backup Slides

## Welfare Gains from Trade: Baseline Case is Hard Brexit

▶ Iceberg calibration

▶ Conclusion



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