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Brexit Referendum's Trade Impacts at the Regional Level: The Case of French and UK Regions

Konstantinos Syrengelas, Angela Cheptea, and Marilyne Hucket

Selected presentation for the International Agricultural Trade Research Consortium's (IATRC's) 2023 Annual Meeting: The Future of (Ag-) Trade and Trade Governance in Times of Economic Sanctions and Declining Multilateralism, December 10-12, 2023, Clearwater Beach, FL.

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IATRC 2023 Annual Meeting

Clearwater Beach, Florida

11/12/2023

Research Question

What is the impact of the decision to leave the European Union (EU) on the agri-food trade flows of United Kingdoms' (UK) and French regions?

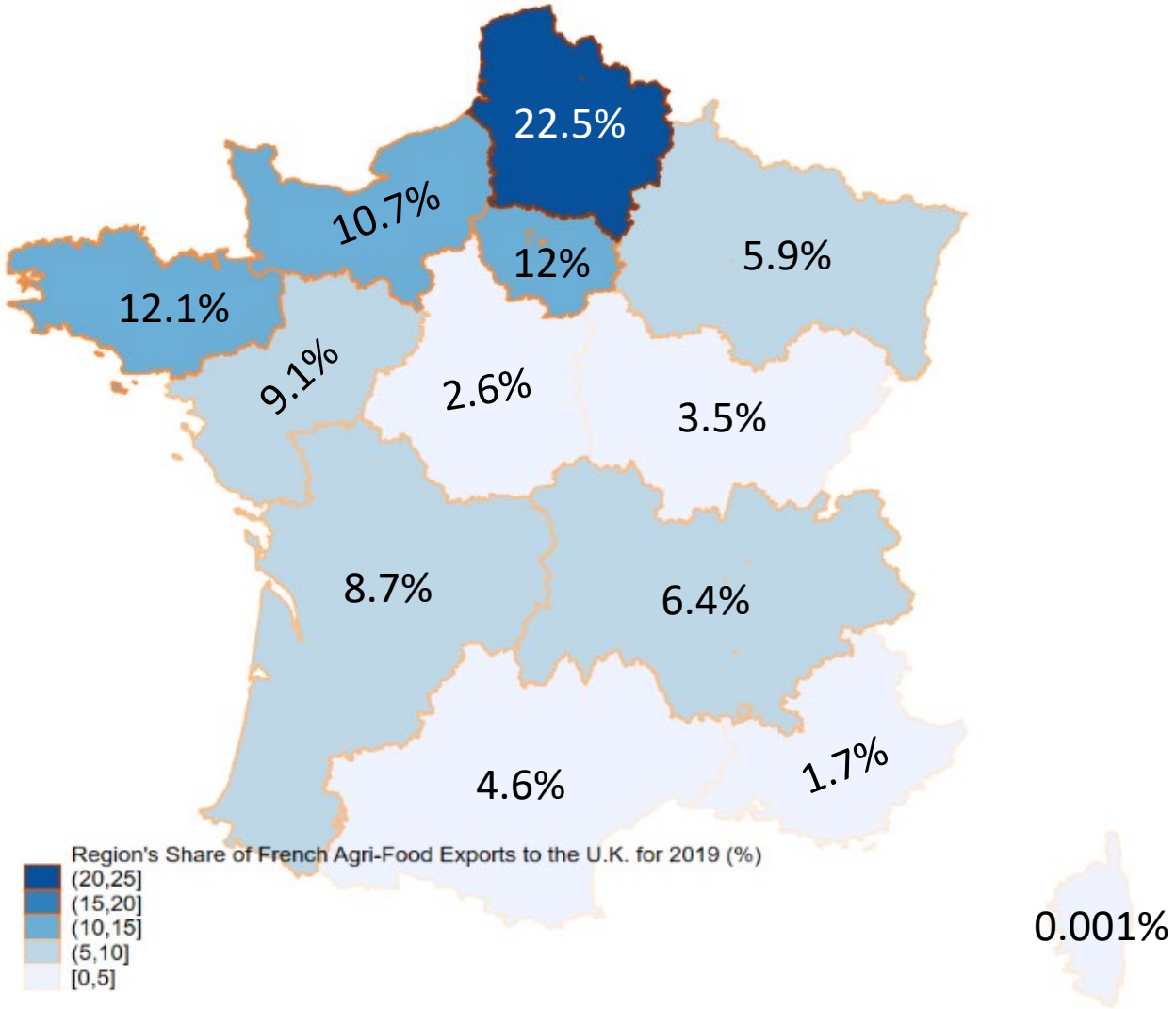
Brexit – A brief timeline

France: An important trade partner of the UK

Product	SITC Rev. 1 Code	FR Ranking	Share in Imports of UK
Milk and cream in solid blocks, blocks or powder	0222	2	27.5%
Butter	0230	3	10.1%
Cheese	0240	2	15.3%
Wheat and meslin, unmilled	0410	3	14.8%
Other fresh vegetables	0545	5	2.9%
Apples, fresh	0514	1	30.3%
Wine of fresh grapes, grape must	1121	1	49.9%

Notes: SITC = Standard International Trade Classification. Source: own computations using data from the AgriFood Trade Dataset (COMTRADE; Syrengelas et al. 2022).

French Regions participation to FR agri-food exports to the UK



Brexit in the literature

- **Brexit** is expected to reduce EU-UK **agri-food trade** (Cheptea et al., 2021)
- **Brexit** is expected to reduce EU-UK **trade in general** (Dhingra et al., 2017; Hosoe, 2018; Steinberg, 2019)

- Negative impact on the UK welfare (Dhingra et al., 2017; Mayer et al., 2019; Steinberg, 2019) and output (Born et al., 2019)
  - Agricultural and Food & Beverage value added is expected to increase both for the EU and the UK (Hosoe, 2018)

- The Brexit **referendum** is found to have some negative impact on traded quantities and prices of Portugal-UK pair (Fernandes and Winters, 2021)

- Also the increase in the probability of Brexit decreases EU-UK bilateral trade between 11 and 20% (Gratziano et al., 2020)

- **Little focus on region-level effects**
  - Smaller impact is expected on the income and trade of Scotland than of the rest of the UK (Figus et al., 2018)
  - Chen et al. (2018): creation of risk exposure index by region. Largest exposure to Brexit risk for UK and Ireland. For the EU the exposure to risk is smaller and heterogeneously distributed across the EU regions.

Contributions

- Investigation of Brexit Referendum's impact at detailed region-product level
  - Using Structural Gravity
- Construction of a **region-level** agri-food trade dataset of **six agri-food product groups**
- Main take-away: **heterogeneous** results, most of the impact concentrated on **England and Wales**, and for France at the **French Regions' exports**
- Part of a two-step analysis:
  - 1: ex-post evaluation of Brexit referendum's impact on agri-food trade
  - 2: ex-ante evaluation of Brexit's impact on agri-food trade

Administrative Division of France and the UK

Source: https://mobile.interieur.gouv.fr/Archives/Archives-des-actualites/2016-Actualites/Les-noms-des-nouvelles-regions-sont-actes

Source : https://fr.ukmap360.com/royaume-uni-%28uk%29-carte-des-r%C3%A9gions

Trade data requirements

International and **intranational** flows (Yotov 2012; Bergstrand et al. 2015)

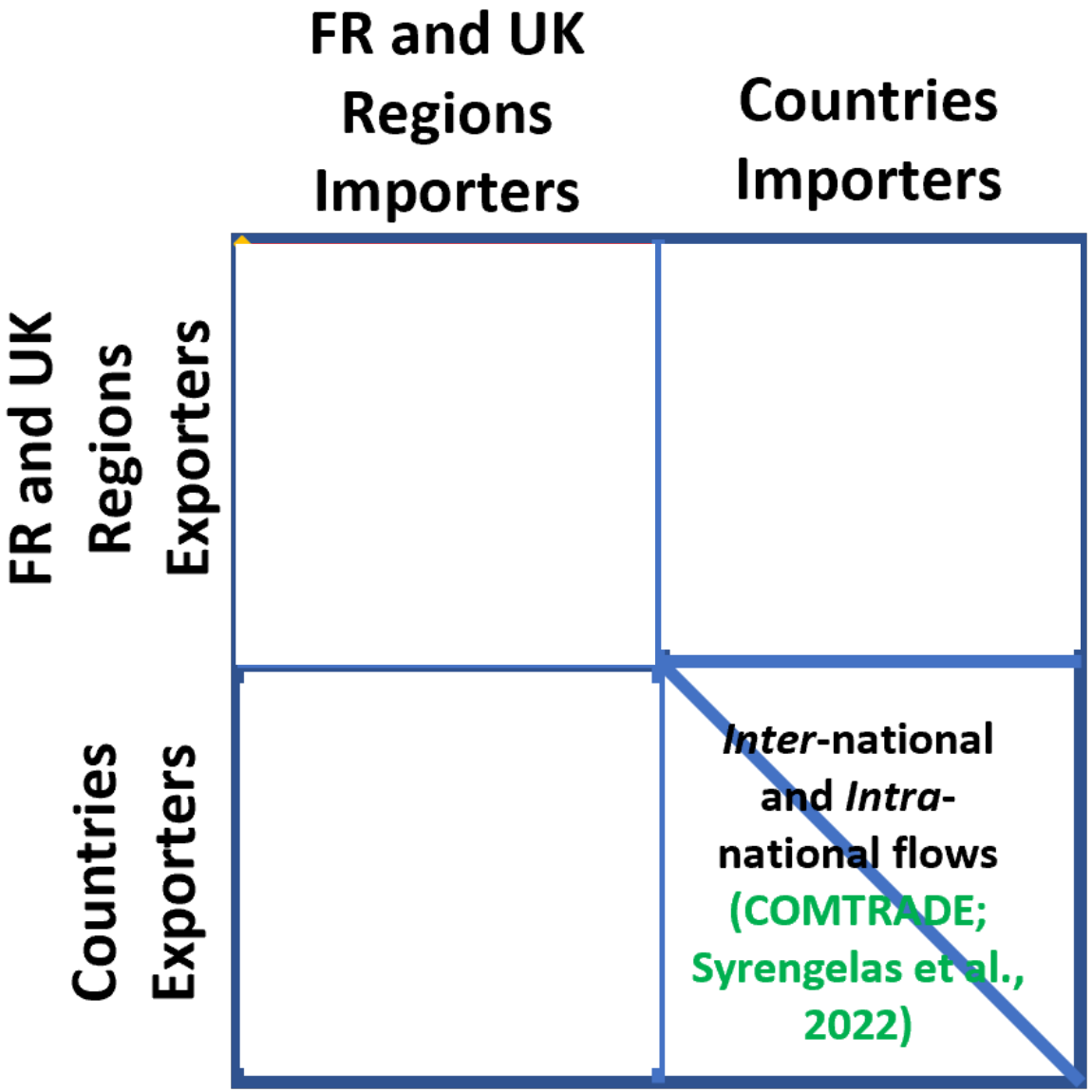
- Agri-Food Trade Dataset (COMTRADE; Syrengelas et al. 2022)

Inter-regional and **intra-regional** flows (own computations)

- Exports of Bretagne to Normandie
- Exports of Bretagne to itself, similar to intra-national flows but at the region level

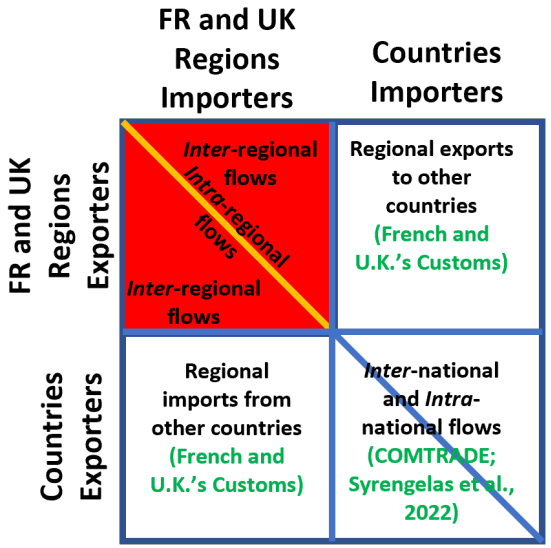
International trade of regions (French Customs, His Majesty's Revenues and Customs - HMRC, own computations from customs' data)

- E.g. exports of Bretagne to Germany, or imports of Scotland from U.S.



Computation of Inter-regional flows

$$x_{ijkt} = \min\{x^*_{iikt}, x^*_{jjkt}\} pr_{ikt} pr_{jkt}$$



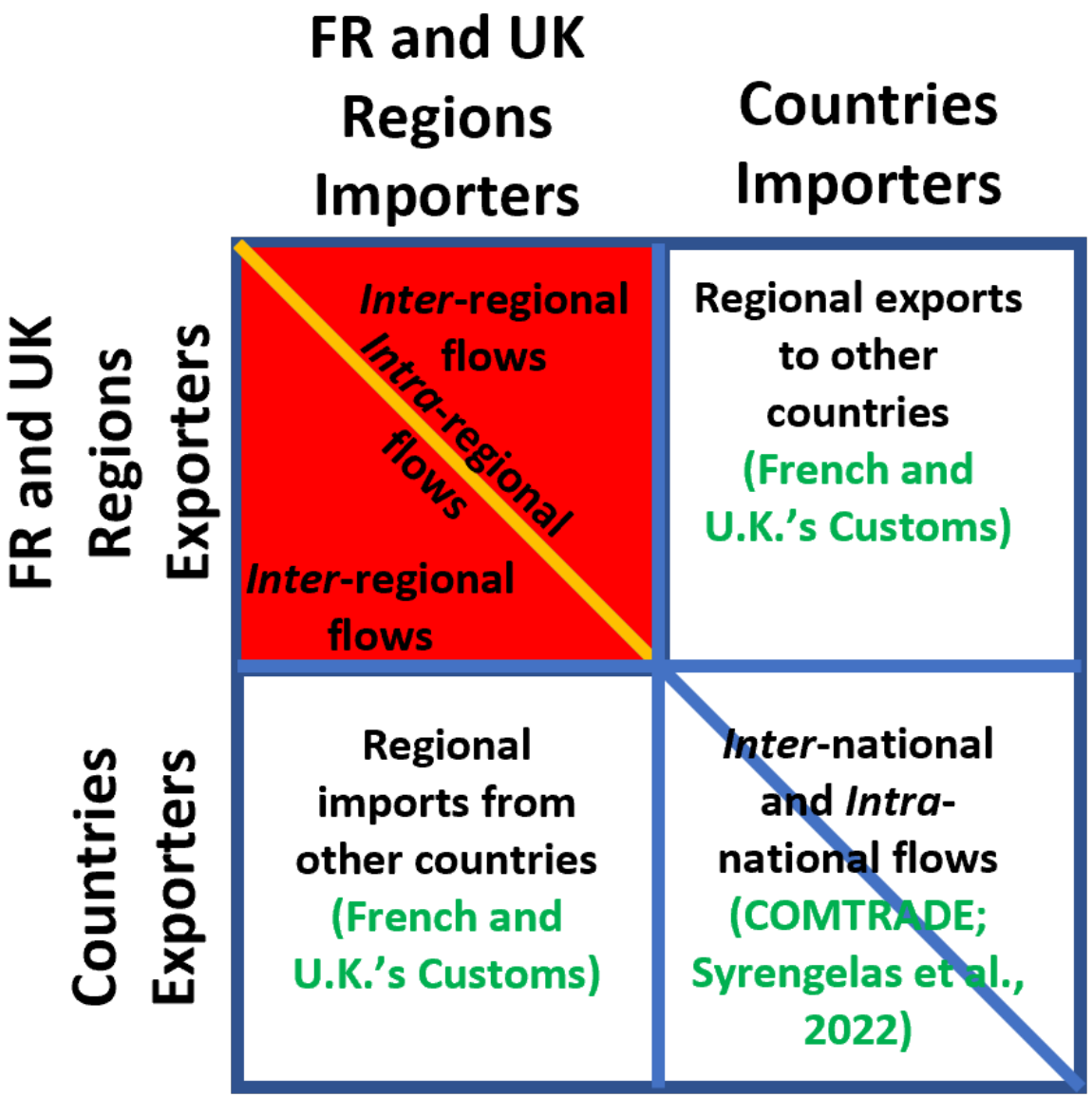
- Where:
  - $x^*_{iikt} = V_{ikt} - X_{ikt}$ (x^*_{jjkt} is the same computation for the importer j)
    - $V_{ikt} = p_{ikt} Q_{ikt}$: total value of i's production of k
    - $X_{ikt} = \sum_{j \neq i} x_{ijkt}$
  - $pr_{ikt} = X_{ikt} / V_{ikt}$: propensity of i to export
  - $pr_{jkt} = M_{jkt} / (x^*_{jjkt} + M_{jkt})$: propensity of region j to import
    - M_{jkt} total imports of j from all foreign suppliers, of product k in t

- The minimum function assures that the flows do not exceed export and import capacities

Computation of Intra-regional flows

Estimation of intra-regional trade:

$$x_{iikt} = (1 - pr_{ikt})x^*_{iikt}$$



Adjustment Coefficient

- Assures that the **computed** inter-regional and intra-regional trade flows **sum-up** to the **inter-national (COMTRADE)** and **intra-national (Syrengelas et al. 2022)** trade flows:

$$AdjCoef_{ijkt} = \frac{x_{ijkt}^{recorded}}{x_{ijkt}^{computed}}$$

Where:

- "computed" and "recorded": source of the data, our computations the former, COMTRADE, Syrengelas et al. (2022), UK and French customs the latter
- $i, j \in \{England\ \&\ Wales, Scotland, Northern\ Ireland, France\}$
- k: product
- t: year

Data: General features

- Six product groups:
  - **Poultry meat, other meat, dairy, cereals, vegetables, fruit**
- **2013-2019**
- 13 Regions of Metropolitan France
- 3 UK Areas:
  - England and Wales, Scotland, Northern Ireland
- 116 additional exporters and importers

- RTA variable: CEPII's Gravity Database (Conte, Cotterlaz, Mayer 2022)

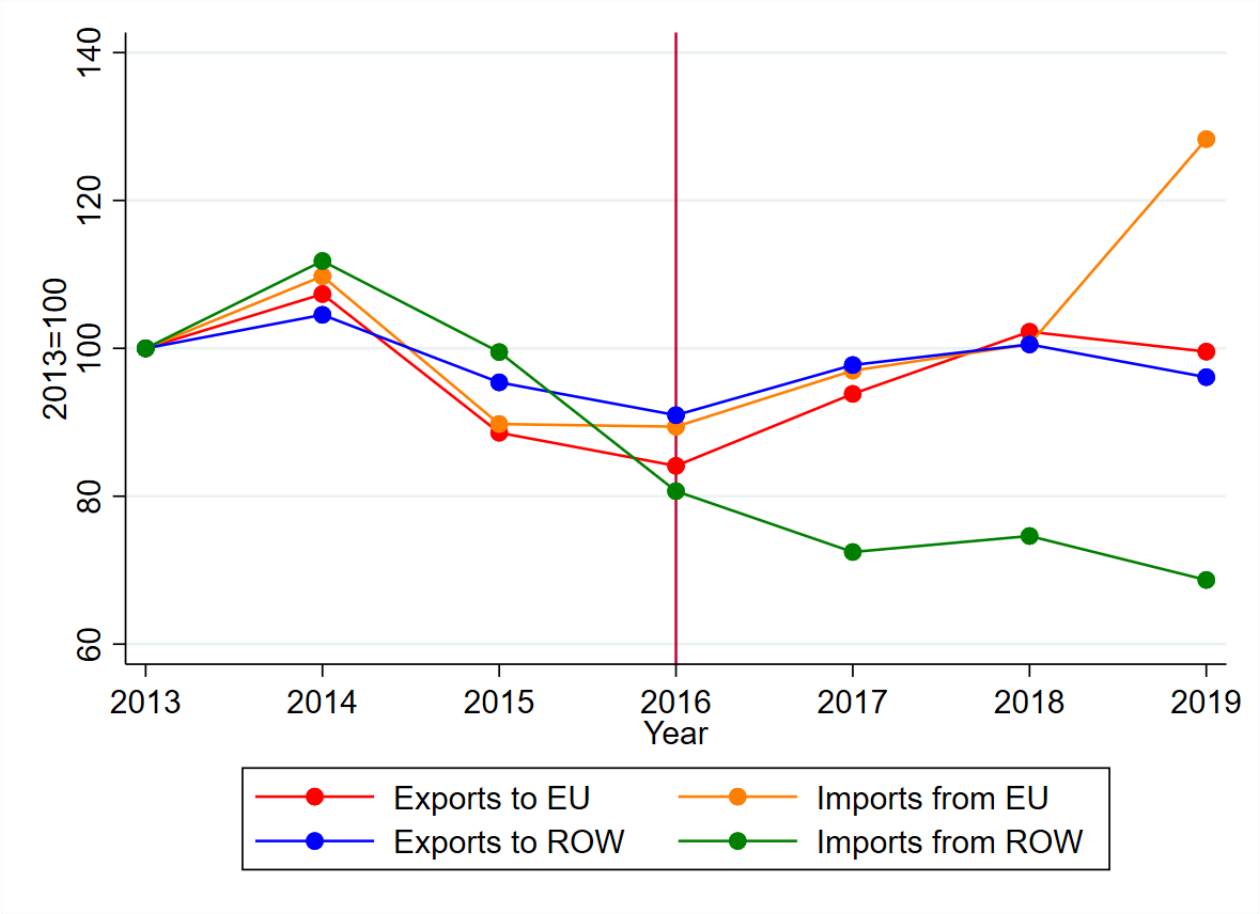
What is included in the product groups (examples)

Poultry Meat	Other Meat	Dairy	Cereals	Vegetables	Fruit
Chicken	Bovine meat, fresh or chilled	Milk & cream	Wheat	Tomatoes	Apples
Ducks	Bovine meat, frozen	Butter	Barley	Lettuce	Oranges
Geese	Porcine meat	Cheese	Oats	Potatoes	Bananas
Guinea fowl	Goats	Yogurt	Rice	Leguminous	Figs
	Sheep	Whey	Maize/corn	Onions, garlic	Nuts

- What is **not** included: preparations such as flours, cookies, breads, canned meat, ice creams, milk chocolates, packaged cereals for breakfast, juice

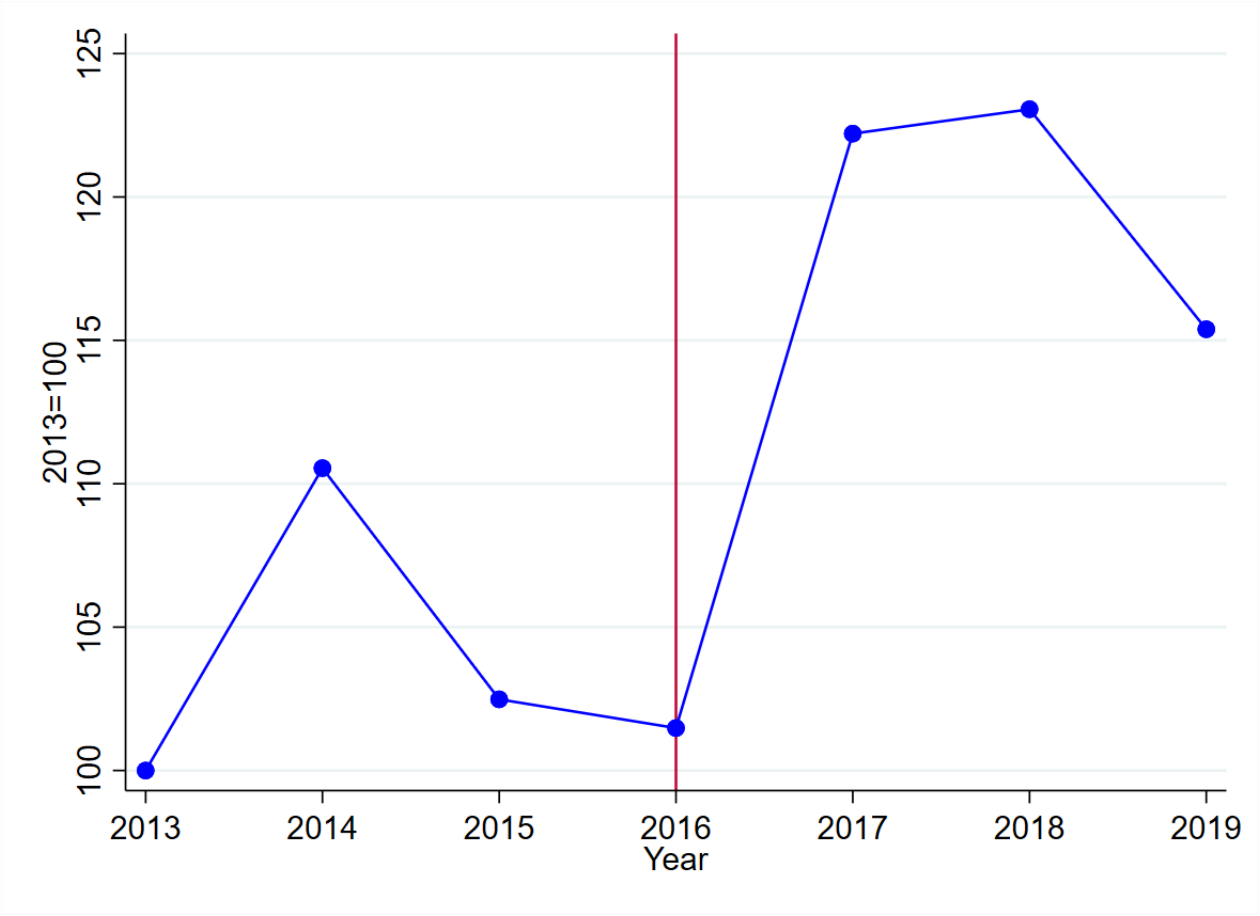
UK “other meat” trade

Other Meat
Bovine meat, fresh or chilled
Bovine meat, frozen
Porcine meat
Goats
Sheep
Meat n.e.s.



Bretagne's "other meat" exports to the UK

Other Meat
Bovine meat, fresh or chilled
Bovine meat, frozen
Porcine meat
Goats
Sheep
Meat n.e.s.



Structural Gravity

- Anderson and van Wincoop (2003, 2004), Baldwin and Taglioni (2006), Yotov (2012), Bergstrand et al. (2015), Anderson et al. (2018)

$$x_{ijkt} = \exp\left(\alpha_{ijk} + \alpha_{ikt} + \alpha_{jkt} + \beta_1 RTA_{ijt} + \beta_2 Referendum_{ijt} + \sum_{t=2014}^{2019} \gamma_t inter_{ijt}\right) + \varepsilon_{ijkt}$$

- Where:
  - x_{ijkt}: the exports of country/region i to destination j, for product k, in year t
  - $\{\alpha_{ijk}, \alpha_{ikt}, \alpha_{jkt}\}$: a set of fixed effects
  - RTA_{ijt}: the Regional Trade Agreements dummy
  - $inter_{ijt}$: a set of yearly international trade dummies
  - $Referendum_{ijt} = 1$ if $t \geq 2017, i, j \in \{England\ and\ Wales, Scotland, N.Ireland\}, i \neq j, i\ and\ j \notin UK$

- PPML (Santos Silva and Tenreyro, 2006, 2011; Fally, 2015)

The average impact of the decision to leave

Variable	ATE	
	Estimates	% Impact
$Referendum_{ijt}$	0.088***	9.2%
	(0.033)	
Log-likelihood	-2.45e+08	
N	304049	

Notes: ***, **, and * represent statistical significance at the 1%, 5% and 10% significance level. Clustered standard errors by exporter-importer-product group in parentheses. % Impact =$[\exp(beta) - 1] \times 100\%$.

Referendum's impacts across UK regions

$$x_{ijkt} = \exp\left(\alpha_{ijk} + \alpha_{ikt} + \alpha_{jkt} + \beta_1 RTA_{ijt} + \beta_k^{ENW,X\ to\ EU} Referendum_{ijt}^{ENW,X\ to\ EU} + \cdots + \sum_{t=2014}^{2019} \gamma_t inter_{ijt}\right) + \varepsilon_{ijkt}$$

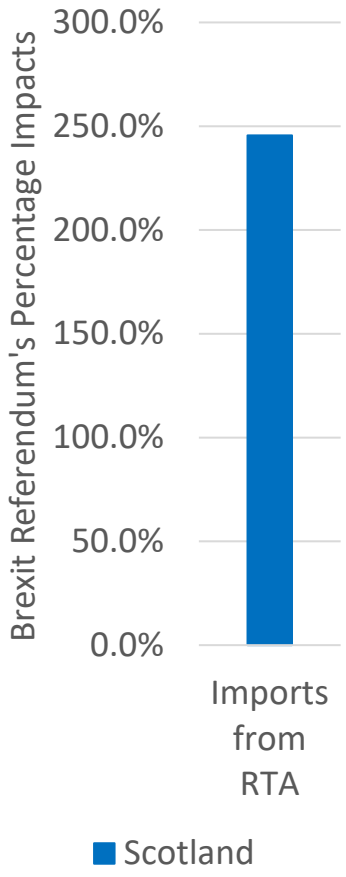
- Where:
  - $Referendum_{ijkt}^{ENW,X\ to\ EU} = 1$ if
    - $t \geq 2017$
    - $i \in \{England\ and\ Wales\}$
    - $j \in EU$
    - $i \neq j$
    - $k \in \{poultry, other\ meat, dairy, cereals, vegetables, fruit\}$
  - The other UK regions' dummies are defined accordingly

Referendum's impacts across UK regions

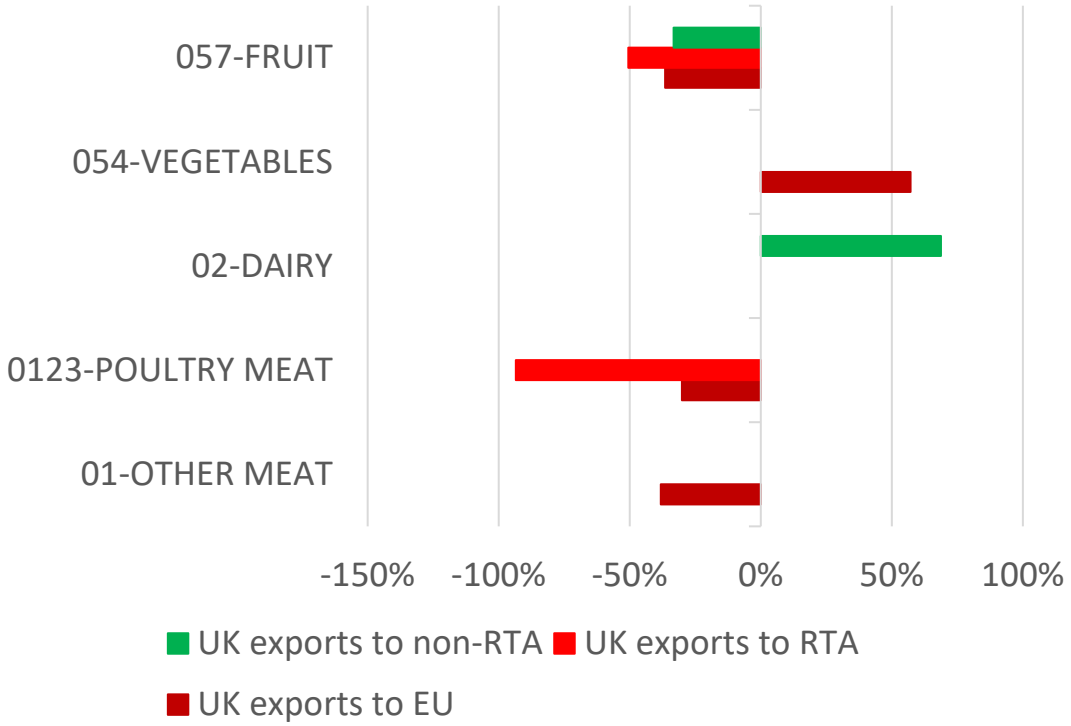
Variable	Trade Relationship with England & Wales		Trade Relationship with Scotland		Trade Relationship with Northern Ireland	
	Estimates	% Impact	Estimates	% Impact	Estimates	% Impact
$Referendum_{ijt}^{X\ to\ EU}$	-0.047	-4.6%	-0.264**	-23.2%	-0.036	-3.5%
	(0.096)		(0.135)		(0.186)	
$Referendum_{ijt}^{M\ from\ EU}$	0.274***	31.5%	0.054	31.5%	0.293*	34.0%
	(0.071)		(0.127)		(0.158)	
$Referendum_{ijt}^{X\ to\ RTA}$	-0.337*	-28.6%	-0.351*	-29.6%	-1.125***	-67.5%
	(0.177)		(0.198)		(0.319)	
$Referendum_{ijt}^{M\ from\ RTA}$	0.206***	22.9%	1.240***	245.6%	-0.091	-8.7%
	(0.073)		(0.436)		(0.357)	
Log-likelihood					-2.45e+08	N=304,049
$Referendum_{ijt}^{X\ to\ Non-RTA}$	0.274***	31.5%	0.041	4.2%	-0.009	-0.9%
	(0.099)		(0.222)		(0.351)	
$Referendum_{ijt}^{M\ from\ Non-RTA}$	-0.228***	-20.4%	0.687	98.8%	0.319	37.6%
	(0.084)		(0.508)		(0.268)	
Log-likelihood					-2.45e+08	N=304049

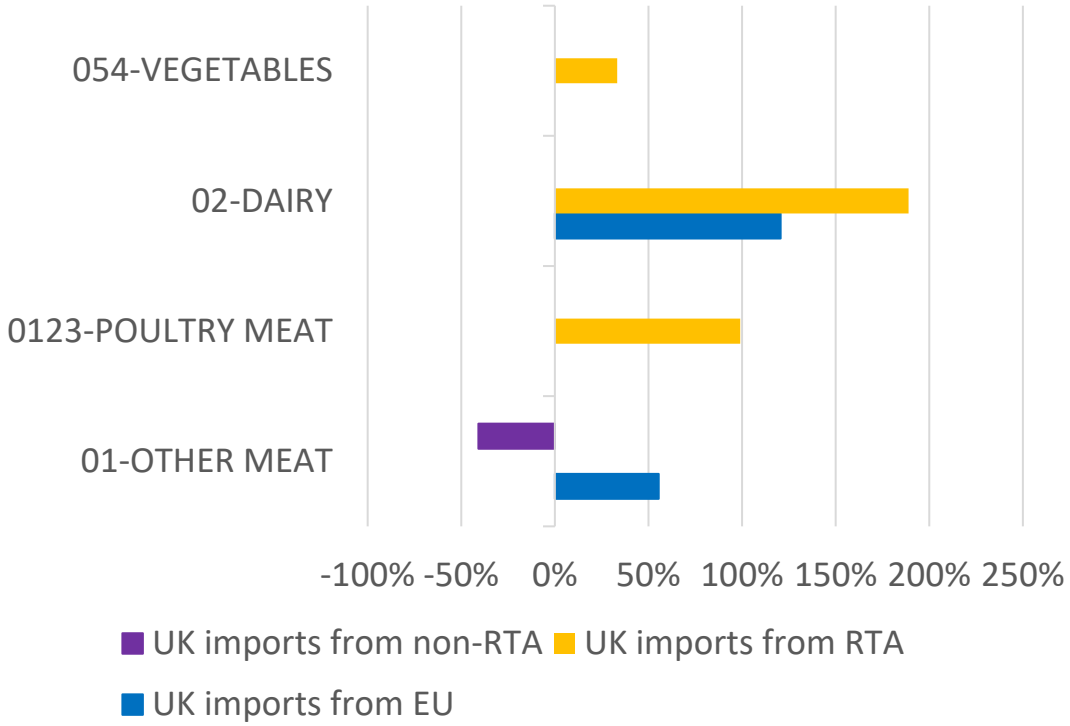
Notes: ***, **, and * represent statistical significance at the 1%, 5% and 10% significance level. Clustered standard errors by exporter-importer-product group in parentheses. % Impact =$[\exp(beta) - 1] \times 100\%$.

Referendum's impacts across UK regions



Referendum's impacts across product-groups





Referendum's impacts across product-groups and UK's regions

- **England & Wales: largely similar impacts to UK-level impacts**
  - There are some differences though, e.g. poultry meat exports to and imports from the EU
  - Both trade with the EU and RTA partners is affected, **imports generally increase, exports affected for fewer products and mostly negative**
  - Exports and imports with the Non-RTA partners are affected in few cases

- **Northern Ireland:**
  - **Minimal impact on NIR-EU trade**
  - Exports to and imports from RTA partners generally decrease
  - Mixed results for exports to non-RTA partners

- **Scotland:**
  - **Exports to EU fall and imports increase when significant**
  - Exports and Imports relating to RTA partners generally drop
  - Non-RTA partners' exports and imports mixed results, mostly increase.

French Regions exports to and imports from UK by product

$$x_{ijkt} = \exp\left(\alpha_{ijk} + \alpha_{ikt} + \alpha_{jkt} + \beta_1 RTA_{ijt} + \sum_{t=2014}^{2019} \gamma_t inter_{ijt} + \delta Referendum_{ijt}^{NoFR}\right) \times$$
$$\exp\left(\sum_{FR}\sum_{k} \beta_k^{FRX} Referendum_{FR,jkt}^{X} + \sum_{FR}\sum_{k} \beta_k^{FRM} Referendum_{i.FR,kt}^{M}\right) + \varepsilon_{ijkt}$$

- Where:
  - $Referendum_{FR,jkt}^{X} = 1$ if
    - $t \geq 2017,$
    - $FR \in \{Bretagne, Normandie, \ldots\}$
    - $j \in \{England\ and\ Wales, Scotland, N.Ireland\}$
    - $k \in \{poultry, other\ meat, dairy, cereals, vegetables, fruit\}$
  - The FR import side dummies are defined accordingly, with i being the UK areas and j the French Regions
  - $Referendum_{ijt}^{NoFR}$: similar to the baseline brexit dummy, but with zeros for observations of French Regions

French Regions' Exports to UK areas

$ = [$2019 exports]*[% impact]

Region	Poultry	Other Meat	Dairy	Cereals	Vegetables	Fruit
Bretagne		**17.2*** **				-0.02***
Normandie	**1.6***	0.5***			-0.4*	-0.003***
Hauts de France	-0.3***	0.8***			**-1.7****	-0.3***
Ile de France				-1.3**	**-1.9****	
Grand Est	0.2***	0.04**				
Bourgogne-Franche Comte					0.01***	-0.04***
Auvergne-Rhone-Alpes	-0.04***					0.7***
Provence-Alpes-Cote d'Azure	0.1***			0.3***	**-6.5*****	
Occitanie	**2.6****			**-4.3***	**-15.5*****	**10.2*****
Nouvelle Aquitaine		0.4*		**-16.8****	**-2.1****	**5.8*****
Pays de la Loire				**-24.7*****	**-2.7*****	**81.6*****
Centre-Val de Loire	-0.2***					**1.8*****
Corsica		0.3***				

Notes: ***, **, and * represent statistical significance at the 10%, 5% and 1% significance level. Monetary values calculated by multiplying the % impact with the 2019 value of trade of these product-groups for the three areas. Red: from computed flows, not from official customs' records.

French Regions' Imports to UK areas

$ = [$2019 exports]*[% impact]

Region	Poultry	Other Meat	Dairy	Cereals	Vegetables	Fruit
Bretagne	-0.6**	**-9.4***			0.05**	0.01**
Normandie	**1.3****	**-3.4***				
Hauts de France		**-8.4****		0.3***		
Ile de France	**-4.1***				0.7*	
Grand Est		-0.5*		-0.001***	0.07***	0.06***
Bourgogne-Franche Comte		-0.2**				
Auvergne-Rhone-Alpes		**-2.3***		0.02*	0.09***	0.2***
Provence-Alpes-Cote d'Azure				0.02***		0.5**
Occitanie		**-2.8****				0.2***
Nouvelle Aquitaine		**-1.1***		-0.3***	0.1**	0.08***
Pays de la Loire		-0.6***		-0.1*		0.08***
Centre-Val de Loire		-0.6*		-0.2**	**2.1***	0.02*
Corsica						

Notes: ***, **, and * represent statistical significance at the 10%, 5% and 1% significance level. Monetary values calculated by multiplying the % impact with the 2019 value of trade of these product-groups for the three areas. Red: from computed flows, not from official customs' records.

Conclusions

- Post-referendum, UK trade increased by 9.2% but this result masks substantial heterogeneity
  - Across direction of the flows (exports or imports), regions, trade relationship with the UK, and products
- Uncertainty regarding custom's procedures and their duration could have impact
  - Case of UK's fruit exports
- Heterogeneous impact across region-product combinations
  - French **meat** and **fruit** producers benefit while **FR cereal** and **vegetables** producers are adversely affected
- Way forward:
  - Specialization and distance as determinants of impact differences
  - General Equilibrium analysis for the impact of Brexit

Thank you for your attention!

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Computation of UK Areas' trade with other countries

- **Regional Trade Statistics (RTS):** detail up to division (2-digit) level of the Standard International Trade Classification (SITC) revision 4 (SITCr4)
- **Overseas Trade Statistics (OTS):** Port-level data, basic heading (5-digit) level of SITCr4
  - We attribute each port to its home region, thus obtaining region-level flows
- A number of OTS flows has **incomplete** information (e.g. exporter is missing):
  - Not Collected trade partner if it is an EU country, PoC Unknown, Inland Clearance, All Other Airports:
    - Solution: compute region-partner-product (division level)-year weights from the RTS records and multiply the OTS flows with these weights
  - Below Threshold Flows:
    - Solution: use flows of OTS with full information (exporter, importer, product, year) to attribute flows to the correct exporter, importer and product

“Translating” parameter estimates to $

- **From the coefficients to % impact of Brexit:**

$$\%\ impact = \left[\exp\left(\hat{\beta}_2\right) - 1\right] \times 100\%$$

- **From the % impact to $ amount** (for the k exports of region i):

$$\$\ impact = \%impact \times \sum_j x_{ijk,2019}$$

Parameter estimates of control variables

Variable	Model			
	ATE	EU or RTA relationship w/ UK	No RTA with UK	French Regions
RTA	0.095**	0.095**	0.091**	0.094**
	(0.042)	(0.042)	(0.042)	(0.042)
Referendum: all except FR				0.102***
				(0.035)
Internat. Border: 2014	-0.033*	-0.033*	-0.033*	-0.033*
	(0.017)	(0.017)	(0.017)	(0.017)
Internat. Border: 2015	0.046**	0.046***	0.046***	0.046**
	(0.018)	(0.018)	(0.018)	(0.018)
Internat. Border: 2016	0.010	0.010	0.011	0.010
	(0.021)	(0.021)	(0.020)	(0.021)
Internat. Border: 2017	0.043*	0.043*	0.052**	0.043*
	(0.025)	(0.025)	(0.024)	(0.025)
Internat. Border: 2018	0.023	0.023	0.031	0.022
	(0.025)	(0.025)	(0.024)	(0.025)
Internat. Border: 2019	0.075***	0.075***	0.084***	0.074***
	(0.027)	(0.027)	(0.026)	(0.027)

Impact on UK areas' trade by product

Product	Area											
	England & Wales				Scotland				Northern Ireland			
	Exports		Imports		Exports		Imports		Exports		Imports	
	% Impact	$ Million	% Impact	$ Million	% Impact	$ Million	% Impact	$ Million	% Impact	$ Million	% Impact	$ Million
Poultry Meat					22.9	3.3**			-36.6	-19.0***		
Other Meat			**-13.3**	**-806.0****					21.3	94.4*		
Dairy	**171.8**	**2690.8*****			-59.7	-29.7***	25.2	35.3**			**58.1**	**148.5*****
Cereals	**-20.4**	**-558.8*****	**13.5**	**641.0*****								
Vegetables			**-22.0**	**-866.4*****	-35.1	-24.3***	-29.8	-43.0***	14.1	5.9***	-20.9	-22.6***
Fruit	-25.8	-68.0***	**-7.4**	**-438.8****					-24.4	-6.1***		

Notes: ***, **, and * represent statistical significance at the 10%, 5% and 1% significance level. Clustered standard errors in parentheses. Monetary values calculated by multiplying the % impact with the 2019 value of trade of these product-groups for the three areas.

Referendum's impacts across product-groups

	Product Group											
Variable	Poultry Meat		Other Meat		Dairy		Cereals		Vegetables		Fruit	
$Referendum_{ijt}^{X\ to\ EU}$	-0.358*	-30.1%	-0.481***	-38.2%	0.036	3.7%	-0.091	-8.7%	0.452***	57.1%	-0.455***	-36.6%
	-0.215		-0.139		-0.162		-0.163		-0.136		-0.108	
$Referendum_{ijt}^{M\ from\ EU}$	0.338	40.2%	0.441***	55.4%	0.791***	120.6%	0.097	10.2%	-0.038	-3.7%	0.071	7.4%
	-0.205		-0.133		-0.154		-0.163		-0.129		-0.079	
$Referendum_{ijt}^{X\ to\ RTA}$	-2.731***	-93.5%	-0.336	-28.5%	-0.409	-33.6%	-0.36	-30.2%	0.113	12.0%	-0.704***	-50.5%
	-0.908		-0.323		-0.342		-0.238		-0.193		-0.191	
$Referendum_{ijt}^{M\ from\ RTA}$	0.688***	99.0%	0.057	5.9%	1.061***	188.9%	0.061	6.3%	0.287*	33.2%	0.048	4.9%
	-0.233		-0.338		-0.294		-0.208		-0.168		-0.065	
N	32408		44658		52486		51305		59045		64147	
$Referendum_{ijt}^{X\ to\ Non-RTA}$	0.319	37.6%	0.15	16.2%	0.523***	68.7%	0.184	20.2%	0.16	17.4%	-0.405**	-33.3%
	-0.214		-0.131		-0.168		-0.144		-0.197		-0.205	
$Referendum_{ijt}^{M\ from\ Non-RTA}$	-0.587	-44.4%	-0.525***	-40.8%	-0.245	-21.7%	-0.037	-3.6%	0.03	3.0%	-0.079	-7.6%
	-0.375		-0.151		-0.911		-0.239		-0.127		-0.064	
N	32408		44658		52486		51305		59045		64147	

French Regions' Exports to UK areas

$ = [$2019 exports]*[% impact]

Region	Poultry		Other Meat		Dairy		Cereals		Vegetables		Fruit	
	% Impact	$ Million	% Impact	$ Million	% Impact	$ Million	% Impact	$ Million	% Impact	$ Million	% Impact	$ Million
Bretagne			**32.2**	**17.2*** **							-39.3	-0.02***
Normandie	**27.5**	**1.6***	19.1	0.5***					-18.0	-0.4*	-66.4	-0.003***
Hauts de France	-37.7	-0.3***	25.6	0.8***					**-25.2**	**-1.7****	-77.4	-0.3***
Ile de France							-28.3	-1.3**	**-22.9**	**-1.9****		
Grand Est	48.3	0.2***	22.1	0.04**								
Bourgogne-Franche Comte									70.2	0.01***	-65.4	-0.04***
Auvergne-Rhone-Alpes	-29.2	-0.04***									40.8	0.7***
Provence-Alpes-Cote d'Azure	46.7	0.1***					41.3	0.3***	**-42.3**	**-6.5*****		
Occitanie	**43.0**	**2.6****					**-23.8**	**-4.3***	**-25.0**	**-15.5*****	**26.0**	**10.2*****
Nouvelle Aquitaine			12.9	0.4*			**-22.8**	**-16.8****	**-24.9**	**-2.1****	**31.1**	**5.8*****
Pays de la Loire							**-44.6**	**-24.7*****	**-24.9**	**-2.7*****	**197.1**	**81.6*****
Centre-Val de Loire	-54.4	-0.2***									**83.1**	**1.8*****
Corsica			255.7	0.3***								

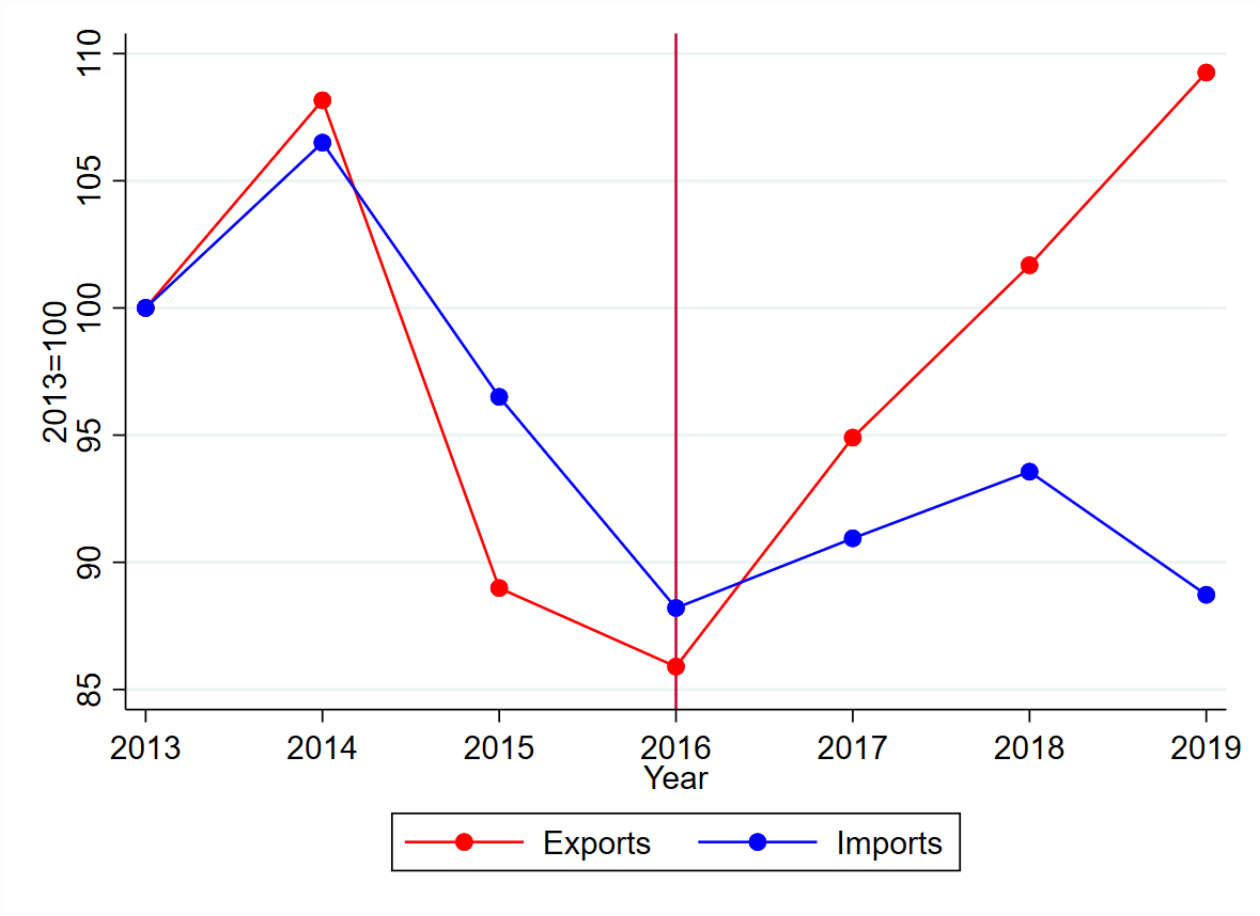
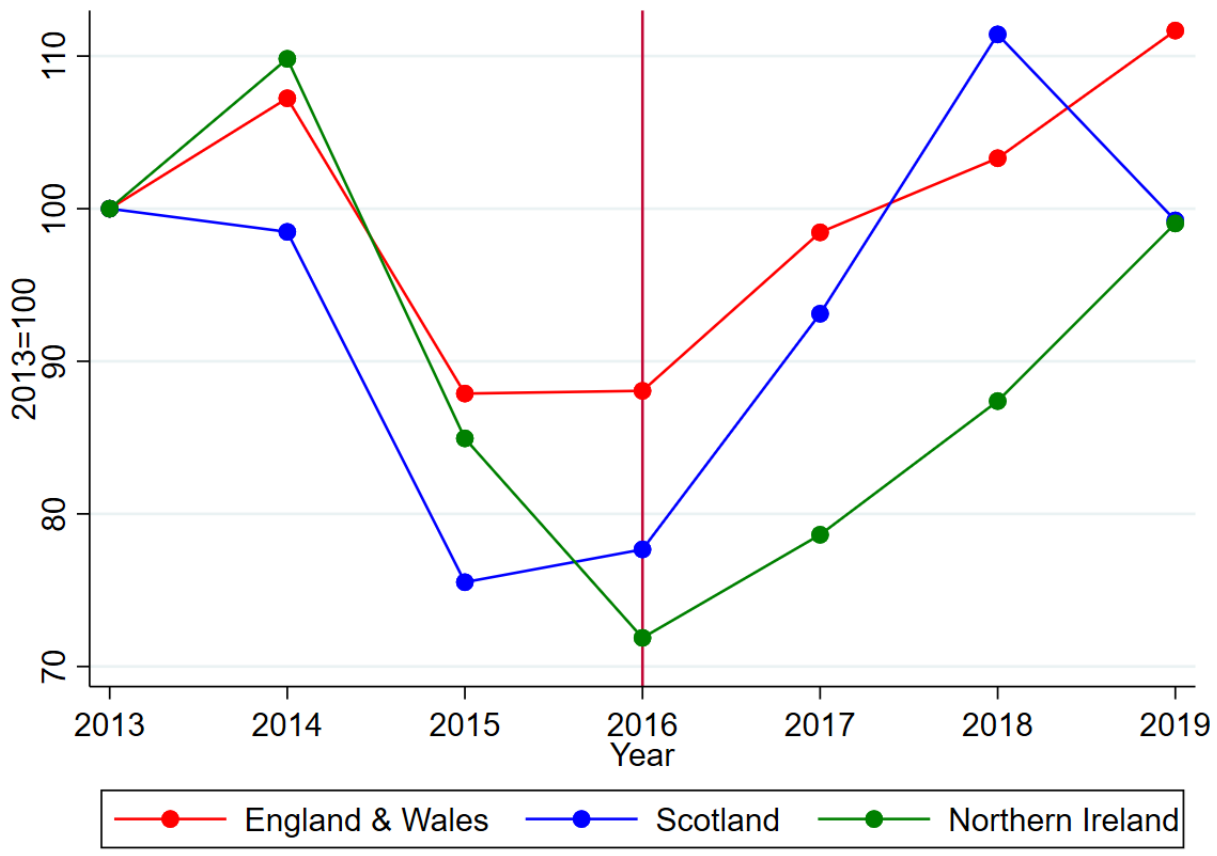
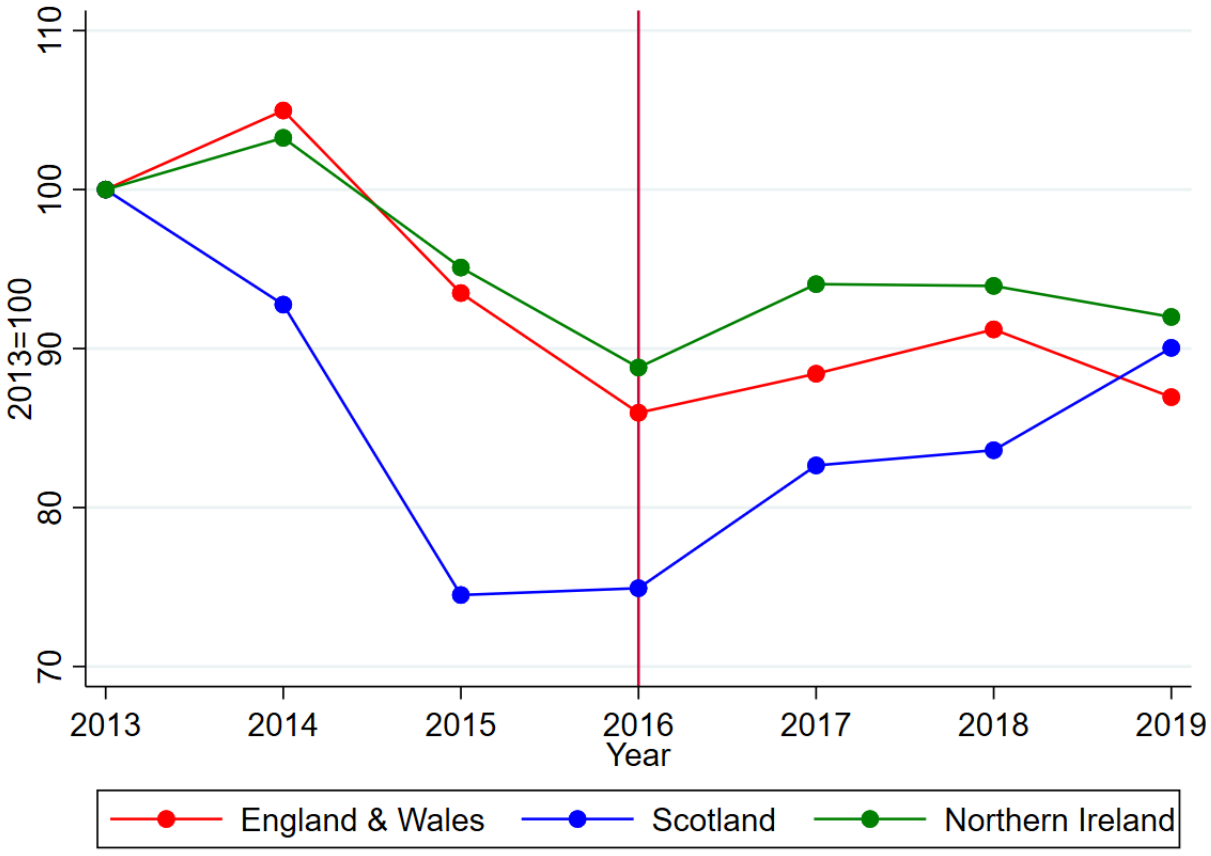
Red: from computed flows, not from official customs' records

French Regions' Imports to UK areas

$ = [$2019 exports]*[% impact]

Region	Poultry		Other Meat		Dairy		Cereals		Vegetables		Fruit	
	% Impact	$ Million	% Impact	$ Million	% Impact	$ Million	% Impact	$ Million	% Impact	$ Million	% Impact	$ Million
Bretagne	-26.8	-0.6**	-41.1	**-9.4*** **					33.0	0.05**	39.7	0.01**
Normandie	37.3	**1.3** **	-18.7	**-3.4*** **								
Hauts de France			-15.0	**-8.4** **			35.8	0.3***				
Ile de France	-30.1	**-4.1*** **							21.4	0.7*		
Grand Est			-13.1	-0.5*			-19.5	-0.001***	38.3	0.07***	67.5	0.06***
Bourgogne-Franche Comte			-20.6	-0.2**								
Auvergne-Rhone-Alpes			-22.7	**-2.3*** **			18.8	0.02*	32.2	0.09***	76.1	0.2***
Provence-Alpes-Cote d'Azure							64.9	0.02***			48.6	0.5**
Occitanie			-15.0	**-2.8** **							48.0	0.2***
Nouvelle Aquitaine			-29.0	**-1.1*** **			-26.4	-0.3***	32.0	0.1**	56.5	0.08***
Pays de la Loire			-27.2	-0.6***			-29.4	-0.1*			280.4	0.08***
Centre-Val de Loire			-16.6	-0.6*			-28.5	-0.2**	84.2	**2.1*** **	36.8	0.02*
Corsica												

UK trends of “other meat” trade



UK regions' trends of "other meat" exports (left) and imports (right)