Discussion Paper – An assessment of analytical options for estimating regional impacts of UK trade agreements on agriculture

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Abstract

The UK is in the process of signing a raft of Free Trade Agreements (FTAs), with potentially large ramifications for domestic agricultural sectors. In Defra, we use a variety of trade models to establish the costs and benefits of such policies on UK consumers and agri-food producers. However, all our trade models aggregate impacts to the UK level. Given we expect production impacts in particular to be regionally concentrated, this is a significant limitation to understanding the overall impact of these FTAs. A variety of approaches could be adopted to estimate these impacts, from the more rudimentary to the more resource intensive. The costs and benefits of these approaches will be discussed. A recommended approach is set out. We examine the appropriateness of this at both a country level – England, Wales, Scotland, Northern Ireland – and at a more detailed regional level. This approach is then tested on an example Free Trade Agreement, the UK's recent FTA with Australia.

Keywords Trade, regional impacts, modelling, welfare

JEL code Agriculture Q1, Welfare Economics D6, Trade F1, General Regional Economics R1, Regional Government Analysis R5 - see: www.aeaweb.org/jel/guide/jel.php?class=Q)

Introduction

The government of the United Kingdom is pursuing an ambitious agenda of signing new Free Trade Agreements (FTAs) with a raft of countries. A manifesto commitment states the government will secure FTAs with countries covering 80% of UK trade in this parliament. There is also a keen and growing interest in the impacts of government policy on the regions of the UK. This paper seeks to combine these two priorities to improve the analysis of regional impacts of FTAs on agri-food sectors.

Currently, government trade models operate at a national level, generating UK-level outputs for changes in imports, exports, welfare, prices and production. However, impacts of trade agreements on producers tend to exhibit strong regional concentration. This paper explores options for improving trade analysis of agri-food goods to estimate the regional impacts of FTAs on agri-food sectors. Using a partial equilibrium model of trade, this paper explores how these national-level impacts can be attributed to the regions of the UK. The analysis incorporates regional estimates of production and consumption, combined with UK-level modelling results, to generate estimates of producer and consumer impacts from liberalisation of agri-food sectors. This paper explores several options for apportioning these regional impacts, highlighting the advantages and disadvantages of multiple approaches, and recommends an initial approach.

This paper starts with a review of existing approaches to regional trade analysis. It then discusses the modelling approach used to generate UK-level trade impacts of agri-food liberalisation. Discussion then turns to options for apportioning regional impacts on consumers and producers. Data sources and limitations are then discussed. The results of our recommended approach are presented with an example trade agreement – the UK's recent FTA with Australia. Finally, the focus then turns to implications for future work.

Methodology

Literature review

Estimating the regional impacts of changes in agricultural policy is an area with significant economic research and working analysis.

Work in progress: To be completed.

Partial equilibrium model

Petra is a partial equilibrium model of trade, one of several trade models used by analysts across the UK government. Petra has been used in this paper as the model to simulate the impacts of a trade policy scenario. Outputs from Petra include changes in imports and exports, domestic consumption and production, consumer and producer prices, tariff revenue and changes in consumer and producer surplus.

Petra is essentially a set of equations based on economic theory, which incorporates and range of factors that influence the price and sales of products, whether importer or produced domestically. Typically, Petra is used to estimate the economic impact of changes in barriers to trade, such as tariff rates and non-tariff measures.

As with all partial equilibrium models, Petra focuses on the direct impact of a policy change on a particular sector. It does not incorporate general equilibrium effects that might result from policy changes, for example from a reallocation of resources or changes in capital allocation, relative wages, or employment. This has the advantage of making it easier to see the potential 'first order' causes and effects from the policy changes being modelled.

The model simulates possible impacts resulting from a policy change; it is not a forecast, but rather is intended to guide its users to the potential direction of movement and order of magnitude of possible changes as well as how sensitive these might be to variations in the policy changes.

Petra is 'static', which means it simulates the change from an initial equilibrium period, based on historical data, to a new equilibrium once all the impacts of the policy change that are being modelled have worked their way through the sectors in the model. It does not predict the path of how the economy will move to its new equilibrium. Nor does it consider how other factors such as demographics or productivity may change over time.

There are different versions of Petra. The version used for this analysis is the Armington version. This is based around the concept that each country supplies a different variety of a product. Goods are differentiated by the country in which they are produced. Markets in each country are competitive, with the number of varieties of each product equal to the number of countries included in the simulation. Firms are price takers, and price equals marginal cost.

Trade Scenarios

The trade scenario used as the basis for this work is the UK-Australia Free Trade Agreement (FTA). This FTA was signed in December 2021 and involves full liberalisation of tariffs on many goods. Several key agri-food commodities are liberalised as part of the deal, and while most sectors are likely broadly unaffected by the FTA, this paper focuses on two UK sectors that are potentially sensitive to this trade policy change: beef and sheepmeat. For both beef and sheepmeat, restrictions on trade will be in force between Entry into Force (EIF) and Year 15, before full liberalisation comes into effect.

Given Petra is a static model producing medium-term outputs, we have simulated new trade based on this final state of full liberalisation. We have therefore assumed a reduction in tariffs between the UK and Australia to 0%, and a reduction in non-tariff measures.

Assessing options for estimating regional impacts of trade policy on agri-food sectors: modelling outputs

Firstly, a key question is which outputs to use from our trade modelling, in order to examine the regional costs and benefits of an FTA.

One option is apportioning changes to gross output by region. A trade model might predict that a sub-sector – say, poultry – contracts by 10%. While we might expect the poultry sector to contract by this same amount across regions, the relative importance of poultry to each region's total agricultural income might vary significantly. As such, we can use these gross output changes and regional farming accounts to examine how a region's total farming gross output should fare. This has several upsides as a metric. Firstly, national-level impacts are often represented by gross outputs – therefore estimating regional impacts with gross output should allow for easy comparison and understanding. Secondly, it provides a simple metric for understanding how local regional economies should be affected. However, it is limited in only demonstrating the

producer impacts; gross output changes are not informative about consumer impacts. As such, we recommend this as part of a range of evidence on regional impacts.

A second option involves using economic welfare measures. Our partial equilibrium modelling in Petra generates changes in Consumer Surplus and Producer Surplus. These give a clear indication of how consumers will fare relative to producers at a national level. By separating these national welfare measures by region, we gain an insight into how regions fare *relative* to one another. These allow us to see whether producer costs and consumer benefits are evenly geographically distributed, or whether the 'costs' are concentrated in certain areas and the 'benefits' concentrated in others. While these measures may not be as broadly understood as gross output changes, the simple comparisons between regions should make them a powerful comparator. Given this strength, this paper recommends welfare metrics as a key tool in examining the regional impacts of trade agreements.

A final option would be to assess trade changes for each region, using a country-level trade model. We could examine import and export changes for England compared to Wales, for example. However, our Petra model is aggregated at a national level, and the data is not available to construct a robust trade model at a country-level. In particular, we do not have data detailing trade between the different countries of the of the United Kingdom. As such, while this might be an ideal solution, data constraints make it near-impossible to pursue with any degree of robustness.

Work in progress: To be completed.

Assessing options for estimating regional impacts of trade policy on agri-food sectors: apportioning results

Work in progress: To be completed.

Data

As above, this paper recommends using a combination of gross output and economic welfare measures to illustrate the regional impacts of FTAs on agri-food. The key question then turns to which measures of regional income, consumption, production and income we use for apportioning these national impacts onto a regional level. In this section, we review the data available for two possible production metrics: income from farming and livestock numbers. We then assess the data for two further metrics for consumption metrics: population and GDP.

Producer Impacts: Income from farming

An approach for apportioning UK-level impacts on producers could involve examining regional splits in UK production of agri-food commodities. One way of looking at this is by examining 'gross output' per sector by region. This data is available at a country and regional level, produced by Defra (for England), and each Devolved Administration for their respective sectors. These data sources are detailed in Table 1 below.

There is a trade-off for gross output data between geographic granularity and product aggregation. At both a country and NUTS1 level[1], gross output is separated out by such

[1] Nomenclature of Territorial Units for Statistics (NUTS), geographic borders set by Eurostat and used by the ONS. NUTS 1 features Scotland, Wales, Northern Ireland and regions of England (e.g. North West, South East).

categories as 'cattle output', 'sheep output' and so on. Within England, data is also available at a more geographically granular level (both NUTS2 and NUTS3), but at the expense of higher aggregation for products. These regional options are not available for gross output data in Wales, Scotland and Northern Ireland. For England, gross output data at NUTS2 level is available for 'livestock output' and 'livestock products output', while NUTS3 is even further aggregated at a product level with a simple 'total livestock output'.

Table 1: Datasets used in this paper for assessing farming incomes by region.

Region	Dataset
England	'Total income from farming in England'[2]
Scotland	'Total Income from Farming Estimates: 2018-20'[3]
Wales	'Aggregate agricultural output and income: 2020'[4]
Northern Ireland	'Aggregate Agricultural Account 1981 onwards'[5]
Regions of England	'Total income from farming for the regions of England'[6]

Work in progress: To be completed.

Producer Impacts: Livestock numbers data

A second option for assessing regional production splits is by looking at the distribution of livestock animals across the UK. The key data source for this is Defra's 'June Survey'[7]. This provides a useful alternative perspective given that animals can be transported to different regions for slaughtering, so one single metric of production locations may be skewed. This provides a useful comparison for country-level impacts, but unfortunately is not available at a level with NUTS 1 regions.

Consumer Impacts: Population data

For apportioning consumer impacts, a simple proxy for consumption is population. While consumption of individual products will vary across regions, broadly consumption and population should be highly correlated for widely-consumed products. This population data is provided by the Office for National Statistics[8] and is available at a very granular level – as localised as NUTS 3.

Consumer Impacts: Gross Domestic Product (GDP)

We can instead proxy for consumption through an estimate of economic activity. One such measure is Gross Domestic Product, or GDP. Indeed, consumption is a component part of the

NUTS 2 constitutes counties, unitary authorities, etc. NUTS 3 is further localised still. Definitions can be found here: https://www.ons.gov.uk/methodology/geography/ukgeographies/eurostat

[2] https://www.gov.uk/government/statistics/total-income-from-farming-in-england

[3] https://www.gov.scot/publications/total-income-farming-estimates-2018-2020/documents/

[4] https://gov.wales/aggregate-agricultural-output-and-income-2020

[5] https://www.daera-ni.gov.uk/publications/aggregate-agricultural-account-1981-2013

[6] https://www.gov.uk/government/statistics/total-income-from-farming-for-the-regions-of-england

[7] https://www.gov.uk/government/statistical-data-sets/structure-of-the-agricultural-industry-in-england-and-the-uk-at-june

[8] https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/datasets/populationestimatesforukenglandandwalesscotlandandnorthernireland

calculation for GDP. This data is again produced by the Office for National Statistics[9] (ONS), and is available at a highly-granular level, from country level down to NUTS 3.

Table 2: Options for assessing consumption splits by country.

Region	**Population** *2020*	**GDP** *2017-19 average, £m*	**Share of UK population** *2020*	**Share of UK GDP** *2017-19 average*
England	56,550,138	1,643,643	84%	87%
Scotland	5,466,000	142,845	8%	8%
Wales	3,169,586	65,169	5%	3%
Northern Ireland	1,895,510	41,131	3%	2%

Table 3: Options for assessing consumption splits by NUTS 1 region.

Region	**Population** *2020*	**GDP** *2017-19 average, £m*	**Share of UK population** *2020*	**Share of UK GDP** *2017-19 average*
East Midlands	4,865,583	109,568	7%	6%
East of England	6,269,161	163,427	9%	9%
London	9,002,488	448,932	13%	24%
North East	2,680,763	53,890	4%	3%
North West	7,367,456	182,403	11%	10%
South East	9,217,265	281,120	14%	15%
South West	5,659,143	139,944	8%	7%
West Midlands	5,961,929	140,519	9%	7%
Yorkshire and the Humber	5,526,350	123,839	8%	7%
Wales	3,169,586	65,169	5%	3%
Scotland	5,466,000	142,845	8%	8%
Northern Ireland	1,895,510	41,131	3%	2%
South East & London	18,219,753	730,052	27%	39%

Work in progress: To be completed.

9 https://www.ons.gov.uk/economy/grossdomesticproductgdp/datasets/regionalgrossdomesticproductallnutslevelregions

Results

We will now apply the metrics established above to an example scenario. The example selected is the recent UK-Australia Free Trade Agreement. Firstly, high-level impacts taken from our partial equilibrium modelling will be presented at a national level. Then we will estimate regional impacts in terms of total farming 'gross output', before moving onto welfare measures of consumer and producer surplus by region.

UK-level modelling results for UK-Australia FTA

The UK-level impacts of the UK-Australia FTA are detailed in Table 4. These are results from Petra, simulating a reduction in NTMs and full liberalisation of bilateral tariffs. The impacts reflect a significant increase in UK imports of Australian beef and lamb, with negligible change in other agri-food sectors. These impacts reduce UK gross output by 3% for beef and 5% for lamb, as reported in the published Impact Assessment[10]. For consumers, these generate lower prices, resulting in gains to UK consumer surplus. For producers, both prices and quantity produced are estimated to fall, generating losses in producer surplus.

Table 4: UK sector impacts from the UK-Australia FTA. Modelling results from Defra's partial equilibrium trade model, Petra.

Sector	Gross output	Consumer Surplus	Producer Surplus
Beef	-3%	£67m	-£30m
Pigmeat	0%	£0m	£0m
Poultry	0%	£0m	£0m
Sheepmeat	-5%	£39m	-£13m
Dairy	0%	£0m	£0m

Estimating gross output changes by region

These gross output changes can be used to generate changes in regional gross output. We assume that the beef sector in each region contracts by the same percentage, each region's agriculture will have a different share of its income that comes from beef. As such, we can simply take the share of total farming gross output that comes from beef and sheepmeat and multiply these by the reductions above. The results of these are shown in Table 5 and 6 below.

Table 5: Country-level impacts of UK-Australia FTA on total farming gross output.

Region	Reduction in total farming gross output
England	-0.5%
Scotland	-1.2%
Wales	-1.6%
Northern Ireland	-0.8%

10 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1041629/impact-assessment-of-the-free-trade-agreement-between-the-united-kingdom-of-great-britain-and-northern-ireland-and-australia.pdf

Table 6: Regional level impacts of UK-Australia FTA on total farming gross output.

Region	Reduction in total farming gross output
East Midlands	-0.3%
East of England	-0.1%
London	n/a
North East	-1.5%
North West	-0.9%
South East	n/a
South West	-0.7%
West Midlands	-0.6%
Yorkshire and the Humber	-0.5%
Scotland	-1.2%
Wales	-1.6%
Northern Ireland	-0.8%
London & South East	-0.4%

Estimating consumer benefits by region

Consumers are expected to benefit from lower beef and lamb prices following the UK-Australia FTA. At a UK-level, these lower prices are estimated to result in a Consumer Surplus gain of £67m for beef and £39m for lamb respectively.

However, consumption is not equally distributed across the UK. As shown in Table 2, 84% of the UK population resides in England. If we instead measure this by GDP, to proxy for consumption, we find England constitutes a similar share of the UK total – around 87% of UK GDP comes from England. As such, the vast majority of these consumer benefits are likely to be felt in England. As Table 7 shows, over £50m of consumer surplus benefits are estimated to arise in England, compared to just £5m in Scotland, £2m in Wales and £1m in Northern Ireland.

Table 7: Consumer impacts by country of UK-Australia FTA on beef and sheepmeat.

This apportions Consumer Surplus changes by regional estimates of i) GDP and ii) population.

Product	Region	Consumer Surplus *i) GDP measure*	Consumer Surplus *ii) Population measure*
Beef	England	£58m	£56m
	Wales	£2m	£3m
	Scotland	£5m	£5m
	Northern Ireland	£1m	£2m
Sheep	England	£34m	£33m
	Wales	£1m	£2m
	Scotland	£3m	£3m
	Northern Ireland	£1m	£1m

We can instead distribute these national impacts at a more localised level, by applying these shares to NUTS 1 regions – as shown in Table 8. Again, we see a similar message of geographically concentrated benefits. For beef, London and the South East alone accounts for £18-26m of the consumer surplus benefit, depending on the allocation metric used. Meanwhile, the North East of England accounts for just £2-3m of benefits.

Table 8: Consumer impacts by NUTS 1 region of UK-Australia FTA on beef and sheepmeat.

This apportions Consumer Surplus changes by regional estimates of i) GDP and ii) population.

Product	**Region**	**Consumer Surplus** *i) GDP measure*	**Consumer Surplus** *ii) Population measure*
Beef	East Midlands	£4m	£5m
	East of England	£6m	£6m
	London	£16m	£9m
	North East	£2m	£3m
	North West	£6m	£7m
	South East	£10m	£9m
	South West	£5m	£6m
	West Midlands	£5m	£6m
	Yorkshire and the Humber	£4m	£6m
	Scotland	£5m	£5m
	Wales	£2m	£3m
	Northern Ireland	£1m	£2m
	London & South East	£26m	£18m
Sheep	East Midlands	£2m	£3m
	East of England	£3m	£4m
	London	£9m	£5m
	North East	£1m	£2m
	North West	£4m	£4m
	South East	£6m	£5m
	South West	£3m	£3m
	West Midlands	£3m	£3m
	Yorkshire and the Humber	£3m	£3m
	Scotland	£3m	£3m
	Wales	£1m	£2m
	Northern Ireland	£1m	£1m
	London & South East	£15m	£11m

Here, we have not accounted for differences in consumption across countries; for example, lamb consumption may be higher per capita in Wales than in England. As such, Wales may experience a higher share of consumer benefits than these metrics indicate. This is an area for potential improvement. However, the broad messages should hold true: the vast majority of consumption benefits will be experienced in England.

Estimating producer losses by region

UK producers are estimated to experience reductions in both prices and quantities produced as a result of the UK-Australia FTA. Gross output is estimated to fall by 2.9% for beef and 5.4% for lamb.

These impacts are more geographically dispersed across the UK than the consumer benefits. UK-level producer surplus is estimated to fall by £13m for lamb. Allocating these impacts by either sheepmeat income by region, or number of sheep per region, gives a qualitatively similar message. Around half of the impact is expected to occur in England, with impacts then felt by Wales, Scotland and Northern Ireland in decreasing orders of magnitude.

Table 9: Producer impacts by country of UK-Australia FTA on beef and sheepmeat.

This apportions Producer Surplus changes by regional estimates of i) output by sector and ii) number of livestock.

Product	**Region**	**Producer Surplus** *i) Output measure*	**Producer Surplus** *ii) Livestock measure*
Beef	England	-£16m	-£16m
	Wales	-£3m	-£3m
	Scotland	-£7m	-£5m
	Northern Ireland	-£4m	-£5m
Sheep	England	-£8m	-£6m
	Wales	-£3m	-£4m
	Scotland	-£2m	-£3m
	Northern Ireland	-£1m	-£1m

If we instead look at these at a NUTS 1 regional level, a similar picture emerges. Negative impacts on beef producers are spread across all regions of the UK, with the greatest negative impacts found in Scotland, Northern Ireland, Wales and the South West of England. These impacts are highlighted in Table 10 below.

Table 10: Producer impacts by NUTS 1 region of UK-Australia FTA on beef and sheepmeat.

This apportions Producer Surplus changes by regional estimates of output. Attributing Producer Surplus by livestock numbers is not possible at this regional split, as livestock numbers are not available at this aggregation.

Product	**Region**	**Producer Surplus** *i) Output measure*
Beef	East Midlands	-£2m
	East of England	-£1m
	London	n/a
	North East	-£1m
	North West	-£2m
	South East	n/a
	South West	-£5m
	West Midlands	-£2m
	Yorkshire and the Humber	-£2m
	Scotland	-£7m
	Wales	-£3m

	Northern Ireland	-£4m
	London & South East	-£1m
Sheep	East Midlands	-£1m
	East of England	-£0m
	London	n/a
	North East	-£1m
	North West	-£1m
	South East	n/a
	South West	-£2m
	West Midlands	-£1m
	Yorkshire and the Humber	-£1m
	Scotland	-£2m
	Wales	-£3m
	Northern Ireland	-£1m
	London & South East	-£1m

Assessing the net welfare impacts of the UK-Australia FTAs on regions

As demonstrated, for UK beef and sheepmeat sectors, the consumer benefits of lower prices are highly geographically concentrated. Most benefits are likely to be overwhelmingly accrued in England, with a substantial proportion of these arising in London & the South East. However, producer losses are more spread across the regions, with noticeable impacts in all of Wales, Scotland and Northern Ireland, as well as regions of England such as the South West.

Taken together, this generates a striking message. For London & the South East, and to a lesser extent the East of England, the consumer benefits from lower beef and sheepmeat prices are found to substantially outweigh any producer losses incurred in that region. However, for Wales, Scotland, Northern Ireland and regions of England in the North and South West, the picture is much more mixed. In these regions, consumer benefits and producer losses are comparable in size, with producer losses even outweighing consumer benefits in certain regions.

It is worth noting that, from a whole-economy perspective, all regions are expected to experience output gains as a result of the UK-Australia FTA. The analysis presented here only focuses on agri-food products, which is only a small section of the UK economy. The published Impact Assessment[11] examines the whole economy and demonstrates that all areas see positive output growth, due to gains in other sectors including manufacturing. However, when local multipliers are accounted for, these impacts can change slightly – including Northern Ireland seeing a small negative output change. Local multipliers have not been accounted for in the agri-food analysis presented in this paper.

Work in progress: To be completed.

11 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1041629/impact-assessment-of-the-free-trade-agreement-between-the-united-kingdom-of-great-britain-and-northern-ireland-and-australia.pdf

Conclusion

This paper has set out several approaches for estimating the regional impacts of FTAs on agri-food products. It recommends a two-fold approach: first, highlighting overall changes in total farming output and secondly, examining welfare measures of producer and consumer surplus. The gross output approach should allow a high-level assessment of the relative magnitude of a shock to a given region, while the welfare approach should allow for the direct comparison of benefits and costs between regions. This approach marks an improvement on existing analysis of trade impacts on agri-food at a regional level, moving beyond qualitative analysis towards a defensible quantitative approach. Further work should focus on developing a more sophisticated approach, exploring the latest developments in spatial economics analysis, including examining the potential for incorporating local multiplier effects.

A key trade-off discussed is that between geographic specificity and product aggregation. While consumer impacts can be attributed reasonably allocated at a highly localised level (NUTS 3), producer impacts suffer from aggregation constraints at such a localised level. The current data availability leads the author to recommend estimating product-level impacts at both a country level and a NUTS 1 level.

Finally, this recommended approach highlights exciting future areas for analysis. This apportionment of modelled welfare impacts could be applied not just to regional splits of consumption and production, but other metrics including income deciles, deprivation, gender and others. These are all areas worthy of further exploration.

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