



Department for
International Trade

Technical annexes accompanying the Scoping Assessment of a Free Trade Agreement (FTA) between the United Kingdom of Great Britain and Northern Ireland and the Gulf Cooperation Council





Introduction

These technical annexes describe the methods used to undertake the analysis presented in the Scoping Assessment of a UK-GCC FTA, and their limitations.



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Annex 1: description of Computable General Equilibrium modelling

The macroeconomic analysis in this assessment uses a Computable General Equilibrium (CGE) model, that the UK government has recently procured from Purdue University (a GTAP model).¹ The model uses a different specification to the GETRADE model which has been used in some previous scoping assessments. The following section highlights key features and assumptions underpinning the model. For a full technical description of the model and dataset please see the original model documentation.²

Dataset

The modelling uses the GTAP 10.1 dataset, the latest available GTAP dataset at the time, and draws on trade data from 2014. Where appropriate, the baseline data are updated to reflect changes to tariffs and significant developments in trade policy since 2014. However, changes in the pattern of trade between 2014 and today are not fully reflected in the updated estimates.

Model structure and assumptions

The model is based upon a set of structural assumptions describing the interactions between agents in the domestic economy, and the trade linkages between different countries.

The specification of the CGE model used in this assessment is based on the standard GTAP model (version 7), which relies on an Armington trade theory specification. This specification captures the impacts arising from increased specialisation across and within countries (according to Ricardian comparative advantage) but does not capture the full range of channels through which a trade agreement may generate economic gains.

Key modelling assumptions include:

- full employment of labour: the model assumes that in the long run the economy fully adjusts to new trade policy and displaced workers would be reallocated to jobs in other sectors.³ The model assumes a fixed labour supply which means that the wage rate is flexible and adjusts to restore the equilibrium following the changes in trade barriers triggered by the FTA. This full employment closure rule is a common assumption employed in CGE modelling. It implies that the overall level of equilibrium employment in the long run is not affected by the Free Trade Agreement (FTA) but workers gain from increased wages due to higher productivity and a more efficient allocation of labour

¹ For this analysis DIT used RunGTAP user interface, which itself relies on GEMPACK software.

² Erwin L. Corong, Thomas W. Hertel, Robert McDougall, Marinos E. Tsigas, Dominique van der Mensbrugge, 2017. "The Standard GTAP Model, Version 7" Journal of Global Economic Analysis. Vol 2 No 1

³ As argued by Petri and Plummer (2017:10), the assumption is used in most applied models of trade agreements.



- the capital supply in the model is not fixed, allowing for capital stock accumulation to occur by assuming a fixed rate of return to capital (i.e. capital supply can adjust); the rate of return to capital is parametrised using the GTAP database
- perfect labour mobility between sectors in the same country, but not across skill types or between different countries
- countries are linked only via trade in goods and services, there are no migration or international capital flows (capital is not allowed to move across countries). The primary trade policy levers impacting these links are tariffs, non-tariff measures and regulatory restrictions on services

Developments in model specification compared to previous DIT analysis

DIT's modelling, like any modelling, is subject to ongoing developments, such as when new data becomes available or new evidence supports recalibration of the model. To inform the longer-term development of DIT's modelling approach and toolkit, DIT established an independent expert Modelling Review Panel to explore ways to improve the department's modelling toolkit and approach to modelling trade.

The approach used to model an FTA with GCC is consistent with the approach used in the India scoping assessment, published in January 2022. However, this approach is different to that used in previous assessments published by the department. Changes in approach have been informed by the discussions of the Modelling Review Panel.⁴ Specifically, DIT has procured the static GTAP model from Purdue University on which to run the modelling for this FTA. In light of the panels' discussions, DIT has additionally implemented these complementary steps:

- update to selected underlying tariff data in the modelling to the latest data available in the GTAP 10.1 database to better reflect the pattern of global trade
- undertaking the modelling at a more disaggregated sector level (the 63 out of 65 sectors allowed by the GTAP 10.1 database) to reduce the potential for aggregation bias and to better and more accurately reflect the changes in trade policy accounted for in the baseline
- update to the inputs to better approximate the potential impact of an FTA between the UK and GCC (section 3)

The specification of the CGE model used in this assessment is based on the standard GTAP model (the Armington specification).⁵ The Armington specification is used as a base for most CGE models used around the world. Some examples of FTA publications which are modelled using an Armington trade specification include the USITC's TPP CGE assessment (2016), the EU Commission's Impact Assessments for Australia and New Zealand (2017) and the Canadian Government's CPTPP CGE assessment (2018). The Armington specification is also

⁴ The full report from Trade Modelling Review Panel with its recommendations will be published in due course.

⁵ See detailed explanation of Armington elasticities in: Erwin L. Corong, Thomas W. Hertel, Robert McDougall, Marinos E. Tsigas, Dominique van der Mensbrugge, 2017. "The Standard GTAP Model, Version 7" Journal of Global Economic Analysis. Vol 2 No 1.



used in the external model used in the department's scoping and impact assessments for the UK-Japan agreement, as well as the scoping assessment for the UK's accession to CPTPP and an FTA with India. It does, however, differ from the department's previously published scoping assessments for the US, Australia, and New Zealand, which use a 'new trade theory' specification resembling a Melitz-style model.⁶ For a detailed discussion of the key differences between the two models see 'Technical annexes for the scoping assessment for UK accession to the Comprehensive and Progressive Agreement for Trans-Pacific Partnership'.⁷

Sensitivity analysis

Modelling exercises are inherently uncertain and present a stylised representation of the trading relationship in order to gauge the broad range of possible results from a trade agreement. In addition to the two modelled scenarios, sensitivity analysis was conducted by varying: the core parameters within the model, the expected non-tariff measures (NTM) reduction estimates and some of the model's structural assumptions.

Specifically, the sensitivity of the central GDP point estimate was analysed in response to the changes in:

- i) the elasticity of substitution between imports from different countries (so-called Armington trade elasticity)
- ii) the assumption on the technical and rent generating NTMs ratio
- iii) the estimates of UK-FTA partner NTMs

This sensitivity analysis is similar to that used in the previously published Scoping Assessments. However, it does not account for the uncertainty arising from the baseline.

Sensitivity check: trade elasticities

The values of the trade elasticities may be important determinants of the outcomes for any CGE modelling. High values of the elasticities lead to a relatively greater response of model outcomes to a given reduction in trade barriers, and vice versa. The modelling relies on the set of elasticities estimates incorporated into the most recent version of the GTAP database (v.10.1).

To test the robustness of the core scenarios a Monte Carlo simulation was run, varying the values of trade elasticities and utility function parameters by 25%, following Hertel (2003). Using RunGTAP's built-in sensitivity tool, the above shocks were applied through a

⁶ See HMG (2018) 'EU Exit: Long-term Economic Analysis Technical Reference' paper or for detailed description of previously used models.

⁷ The technical annexes for the scoping assessment for UK accession to the CPTPP can be accessed [here](#).



percentage variation under a triangle distribution.⁸ For modelling convenience, the shocks were applied to sectors that contribute most to the modelled absolute change in trade flows.⁹

The sensitivity results are summarised in Table 1 below. There are three main conclusions to draw from this sensitivity exercise. First and foremost, the results are strongly robust to the applied changes to trade elasticity across both core scenarios both for the UK and GCC (all other things equal): the sensitivity results are identical to the central estimates when rounded to 2 d.p. Secondly, for both economies, the estimated GDP gains minimally differ when the size of trade liberalisation is greater (i.e. narrow confidence interval in both scenarios). Third, the modelling results for GCC are relatively more uncertain than for the UK (i.e. wider confidence intervals across both scenarios).

Table 1: Sensitivity results: Armington elasticities

	Central estimate (real GDP)	Lower bound (90% CI)	Upper bound (90% CI)
UK: Scenario 1	0.057%	0.056%	0.058%
GCC: Scenario 1	0.069%	0.067%	0.070%
UK: Scenario 2	0.110%	0.108%	0.111%
GCC: Scenario 2	0.162%	0.159%	0.165%

Source: DIT modelling.

Sensitivity check: technical and rent generating ratio

Typically, NTMs in CGE models are modelled as a pure loss of efficiency (so-called deadweight rent assumption, DWR). The implementation of this approach is referred to as iceberg costs, which models the NTMs in terms of lost imports: the idea is that some of the product is lost between the buyer and the seller (akin to an iceberg melting on its journey). However, there is an alternative approach to modelling the nature of NTMs: one could argue that (a fraction of) NTMs are rent generating, i.e. similar in nature to tariffs, enabling a redistribution of income back into a CGE model and, thus, increasing the welfare losses from NTMs removal.

In line with the analysis in previous scoping assessments (on the potential impacts of a UK FTA with India, Australia, New Zealand and accession to CPTPP) and impact assessments (UK FTAs with Australia and New Zealand), the core scenarios assume a 70:30 ratio (iceberg: rent-generating) when implementing NTM shocks within CGE models. This means that 70% of the NTMs liberalisation is expected to materialise as pure productivity growth and 30% is expected to resemble tariffs liberalisation.

In CGE modelling applications the share of rent-generating NTMs varies from 0% to 40%, i.e. the ratio assumptions vary from 100:0 to 60:40. Most studies assume 0%, meaning 100% of

⁸ That is, in a Monte Carlo simulation the parameter of interest which would otherwise have a value of 1, will be sampled from a range 0.75 – 1.25.

⁹ Sensitivity results are not expected to alter if the robustness shocks were applied to all sectors, given the subsequently marginal contribution of the omitted sectors to the overall trade impacts.



the NTM liberalisation is expected to materialise as productivity growth with no impact on revenue.

Sensitivity analysis assesses the impact of changing the core iceberg-rent generating ratio of 70:30, to 100:0, where it is assumed that NTM liberalisation will fully materialise as productivity gains only.¹⁰

The sensitivity results show that, under the alternative assumption in scenario 2, real GDP gains marginally increase from 0.1096% to 0.1101% for the UK, and from 0.1623% to 0.1796% for GCC, all else equal. For scenario 1, the respective values increase from 0.0570% to 0.0572% for the UK and from 0.0686% to 0.0740% for GCC. Evidently, in both scenarios, the increase in GDP growth is greater for the GCC than it is for the UK (in absolute and relative terms). The sensitivity results are identical to the central estimates when rounded to 2 d.p.

Sensitivity check: NTM estimates

As is the case for any Scoping Assessment, there remains a great deal of uncertainty surrounding the depth of NTM liberalisation in a prospective GCC-UK FTA. Unlike for tariffs, where one can compare possible outcomes based on historical precedence, NTM inputs are derived from an econometric estimation and are subject to additional modelling uncertainty.

To test the robustness of the core results to the applied NTM estimates, a Monte Carlo simulation was run, varying the values of the NTM shocks and allowing them to deviate 25% below and above their input estimates in both core scenarios. As in the case of Armington elasticity robustness check, RunGTAP's built-in sensitivity tool was used and the above shocks were applied through a percentage variation under a triangle distribution. Again, for modelling convenience, the shocks were applied to sectors that contribute most to the modelled absolute change in trade flows.¹¹

The results are reported in Table 2 below. This sensitivity test suggests that estimates are strongly robust to the assumed changes in NTM values. As in the case of the two previous sensitivity checks, the sensitivity results are identical to the central estimates when rounded to 2 d.p.

Table 2: Sensitivity check: NTM estimates

	Central estimate (real GDP)	Lower bound (90% CI)	Upper bound (90% CI)
UK: Scenario 1	0.057%	0.057%	0.057%

¹⁰ A sensitivity test on the other extreme, i.e. 60:40 ratio, was not conducted as it is not expected to materially change the results. Moreover, this assumption is rarely used in the literature.

¹¹ Sensitivity results are not expected to alter if the robustness shocks were applied to all sectors, given the subsequently marginal contribution of the omitted sectors to the overall trade impacts.



GCC: Scenario 1	0.069%	0.067%	0.070%
UK: Scenario 2	0.110%	0.109%	0.111%
GCC: Scenario 2	0.162%	0.158%	0.166%

Source: DIT modelling.

Method for calculating pound figures

The results presented throughout the scoping assessment have been expressed in pound sterling values (£). These are derived from the modelling outputs which are expressed in percentage change terms. The conversion to pound sterling values allows the contextualisation of results in terms relatable to today's economy.

For GDP, £ values (expressed in 2019 prices) are calculated by applying the percentage change from the modelling to projections of the level of GDP in 2035 estimated using the OBR's long term economic determinants. This provides the best summary estimate of the value of the long-run increase in GDP in £ values, expressed in today's prices. This is because the 'long-run' in this context is typically assumed to be around 15 years following the implementation of the agreement. For further context, and in light of the considerable uncertainty surrounding projections of future growth, £ values compared to 2019 levels of GDP are also presented.

For trade and impacts on GCC's GDP, £ values (also expressed in 2019 prices) are calculated by applying the percentage changes to the DIT's projections set out in DIT's Global Trade Outlook.¹² The GTO projections are supplemented by additional assumptions regarding the evolution of the UK and the GCC's market shares where necessary.

Sectoral £ impacts are calculated by converting the \$ GVA impacts from the CGE model into £s at the 2014 USD-GBP exchange rate,¹³ which are then inflated to 2019 levels, in line with the GDP deflator of UK GDP between 2014 and 2019.¹⁴ Regional % and £ impacts are calculated by combining the CGE % sector impacts with 2019 ONS sectoral GVA data. The data used to convert the percentage figures to pound sterling values are detailed in Table 3.

Table 3: Data sources used to convert CGE modelling impacts into pound sterling values

Key Metric	Data Used
GDP	CGE model % impacts

¹² DIT, Global trade outlook – September 2021 report.

¹³ Bank of England Data, average annual spot exchange rates

¹⁴ ONS, GDP – data tables (August 2021).



	<p>ONS GDP estimate¹⁵</p> <p>Bank of England Exchange rate¹⁶</p> <p>OBR long term economic determinants (for 2035/36 estimates)¹⁷</p> <p>Global Trade Outlook projections of GCC GDP (for 2035 estimates)</p> <p>IMF GCC GDP estimate¹⁸</p>
Total Trade and trade with the GCC (Exports and Imports)	<p>CGE model % impacts</p> <p>ONS UK total trade: all countries, non-seasonally adjusted, 2019</p> <p>Global Trade Outlook projections of UK total exports and imports (for 2035 estimates)¹⁹</p> <p>For bilateral trade between the UK and GCC in 2035, projections are combined with a market share assumption that the UK maintains its 2019 market share in the GCC.</p>
Wages	<p>CGE model % impacts</p> <p>ONS, UK sector (S.1): Wages and salaries (D.11): Resources: Current price: £ million: Not seasonally adjusted</p>
GVA by sector	<p>CGE model \$ impacts</p> <p>Bank of England exchange rate</p> <p>OECD, GDP in current prices \$ (to inflate to 2019)²⁰</p>
GVA by region	See annex with regional methodology
Household spending and business investment	<p>CGE model \$ impacts</p> <p>Bank of England Exchange rate²¹</p> <p>Global Trade Outlook data²²</p>

¹⁵ ONS, GDP – data tables (May 2022).

¹⁶ Bank of England Data, average annual spot exchange rates.

¹⁷ OBR, Economic and fiscal outlook – March 2022 long term economic determinants.

¹⁸ International Monetary Fund, World Economic Outlook Database, October 2021

¹⁹ DIT, Global trade outlook – September 2021 report.

²⁰ OECD Data, Gross domestic product (May 2021).

²¹ Bank of England Data, average annual spot exchange rates.

²² DIT internal calculations



Annex 2: modelling inputs

This section outlines the method and assumptions used to derive the non-tariff measure (NTMs) estimates, to be used as inputs for the Computable General Equilibrium (CGE) modelling.

Non-tariff Measures (NTMs) inputs for Goods and Services

NTMs, including regulatory restrictions for services, are any policy measures outside of tariffs, that can influence trade by changing what can be traded at what cost. Not all NTMs are aimed at restricting trade and can serve legitimate policy objectives. However, they can have an impact on trade flows.

NTMs, including regulatory restrictions for services, can be hard to observe directly. Therefore, for this assessment we estimate them using an econometric gravity model. Building upon best practice in the literature, a gravity model is used to provide estimates of the levels of non-tariff measures in goods and services in various countries. Gravity modelling is an econometric framework for estimating the determinants of international trade patterns. It is referred to as the “workhorse model of international trade”, due to its ability to consistently explain patterns of international trade. The estimates are expressed in ad valorem equivalent terms, that is, in terms of the tariff that would create a similar cost and therefore, have the same impact on trade flows as the NTM.

The gravity models use data from the GTAP database on the trade flows between 121 countries for 30 sectors for the years 2004, 2007, 2011, and 2014.²³

NTM reduction assumptions for goods and services sectors

To determine the NTM reduction inputs for goods and services sectors, a gravity model is used to estimate the level of NTMs across 30 sectors in all GCC countries and the UK. An actionability assumption of 50% and 33% (goods and services sectors respectively) is used to acknowledge the fact that an FTA cannot remove NTMs in their entirety. A percentage reduction assumption of 10% and 30% is then applied to calculate the reduction in the actionable NTM we can expect as the result of the FTA.²⁴

Further to this, we assume 0% reduction in oil, gas, coal and other transport equipment sectors. This is because NTMs in these sectors are unlikely to be reduced through an FTA (see box 1 for detail on reasoning). The econometric specification for estimating NTM levels is set out in box 2.

²³ GTAP Database, <https://www.gtap.agecon.purdue.edu/databases/default.asp>

²⁴ Empirical evidence on precise NTM reductions following an FTA is limited. Existing assessments, such as the European Commission ex-post analysis of the EU-Korea FTA, however largely estimate it to be in the region of 10% to 25%.



Box 1: Impact of FTAs on non-tariff measures (NTMs) in energy and other transport equipment sectors

NTM reductions enter the CGE model as a fall in trade costs, which in turn lead to an increase in international trade. Because of the nature of the energy and other transport equipment markets and the GCC FTA, the CGE modelling assumes 0% reductions in these sectors.

Energy

i) Nature of the energy market

Energy commodities trade at international benchmark prices and trade flows of these global commodities are unlikely to be impacted by an individual FTA. Import prices are driven by volatility in the international price, exchange rates and trade costs.

Trade costs in energy are dominated by transport and storage costs (for example construction of pipelines and liquification terminals). Most existing regulatory NTMs in energy concern safety and environmental standards. Therefore, the NTMs that are actionable in an FTA are likely to be small in comparison to other import price drivers.

ii) Lack of energy-specific provisions in GCC FTA

There is little evidence to suggest that the provisions in this FTA would have any direct and significant impact on energy sectors. Therefore, the reduction in NTMs in energy sectors from a UK-GCC FTA is likely to be 0 or very small.

Other Transport Equipment

The vast majority (90%) of trade in this sector between the UK and GCC is in aerospace equipment, which largely consists of turbojet engines (73%). This sector includes other products (such as rail and other motor vehicles), however their size is negligible in the modelling context.

There is little evidence that commercial UK exports of turbojets, engines or fuselages will expand in response to an FTA with the GCC. Further to this, some of the UK's existing aerospace exports to the GCC are exported under military contracts. An FTA is likely to have limited impact on such contracts and trade flows.



Box 2: Gravity model specification for goods sectors

The level of the NTMs is estimated using a gravity model for goods and services sectors.

MFN NTM estimates are obtained using the methodology of Fontagne et al (2011), which estimates NTMs from importer-time fixed effects that capture the relative restrictiveness of importing countries that cannot be attributed to other barriers.²⁵ This method aims to estimate AVE NTMs that would create observed trade distortions, controlling for standard gravity variables and using a ranking of estimated fixed effects. For more details on the methodology please see the original paper.

To obtain NTM estimates for goods, we use the following specification:

$$(1) y_{ijt} = \exp(\beta_1 EU_{ijt} + \beta_2 EEA_{ijt} + \beta_3 FTA_{ijt} + \beta_4 \ln(Tariff_{ijt})) + GDP_{jt} + \delta_{ijt} + \pi_{it} + \omega_{jt} + \varepsilon_{ijt}$$

The following is used for services:

$$(2) y_{ijt} = \exp(\beta_1 EU_{ijt} + \beta_2 EEA_{ijt} + \beta_3 FTA + GDP_{jt} + \delta_{ijt} + \pi_{it} + \omega_{jt} + \varepsilon_{ijt})$$

In the specification for the model above y_{ijt} denotes bilateral trade, π_{it} and ω_{jt} are sets of exporter-time and importer-time fixed effects respectively, and δ_{ijt} is a vector of standard gravity resistance variables. GDP_{jt} is importer GDP which is included with a coefficient constrained to unity. Also included are dummy variables for EU and EEA membership and a measure of tariffs (in goods sectors), to avoid tariff reductions being captured in β_3 . A dummy variable indicating the presence of an FTA between trading partners is included also.

The percentage reduction approach used in this scoping assessment represents a departure from the methodology used in some previous assessments. This includes CPTPP and India scoping assessments which used the DESTA and STRI database to estimate the reduction in NTMs. This scoping assessment uses a broad-brush percentage reduction approach as GCC countries are not included in the STRI database, which pose a challenge to identifying appropriate STRI scores.

NTM input assumptions

The section below summarises the NTM reduction assumptions in scenarios 1 and 2. Scenario 1 represents an agreement with moderate tariff liberalisation and moderate reduction in NTMs to trade. Scenario 2 represents full tariff liberalisation and a higher degree of reduction in NTMs.

²⁵ Where Fontagne et al (2011) use a constraint of 0.8 to reflect a perspective that the income elasticity of imports is less than unity, we change this to unity to reflect the perspective of the wider gravity modelling literature



Table 4: Applied percentage point reduction in tariffs and NTMs

Sectors	Scenario 1				Scenario 2			
	UK imports from GCC		UK exports to GCC		UK imports from GCC		UK exports to GCC	
	Reductions in tariffs	Reductions in NTMs						
Agri-food	2.9%	3.1%	3.7%	1.9%	3.6%	9.4%	4.6%	5.6%
Industrial goods	1.8%	1.6%	3.2%	1.2%	2.0%	4.9%	3.5%	3.5%
Services		2.0%		2.1%		6.1%		6.2%

Source: DIT CGE Modelling (2022).



Annex 3: supplementary results

This Annex provides additional detail to the analysis set out in the main Scoping Assessment.

3.1 Baseline assumptions

In the scoping assessment two modelled scenarios are presented against a status-quo baseline (Baseline 1). This baseline accounts for the following:

- UK's MFN Tariff (UKGT) for the US, China, India and GCC
- FTA between the UK and the EU27 (based on an 'average' FTA), the UK-Japan FTA and UK-Singapore FTA

3.2 Further supplementary results for scenarios

Table 15: Results by component of UK GDP

Component of UK GDP	% change estimates	
	Scenario 1	Scenario 2
	% Change	% Change
Consumption	0.09%	0.17%
Investment	0.09%	0.17%
Government	0.06%	0.10%
Net exports	0.51%	0.91%

Source: DIT CGE Modelling (2022).

Table 6: UK nations and regions results

Region	Scenario 1		Scenario 2	
	% Change in GVA	Change in GVA £ million, 2019	% Change in GVA	Change in GVA £ million, 2019
East of England	0.19%	320	0.35%	590
East Midlands	0.21%	230	0.37%	420
London	0.16%	750	0.30%	1400
North East	0.21%	120	0.38%	210
North West	0.19%	350	0.34%	650



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South East	0.18%	540	0.34%	990
South West	0.19%	270	0.35%	500
West Midlands	0.22%	320	0.39%	560
Yorkshire and the Humber	0.21%	260	0.37%	480
Northern Ireland	0.20%	90	0.37%	160
Scotland	0.19%	270	0.34%	500
Wales	0.19%	130	0.36%	240

Source: DIT CGE Modelling (2022). Note: Based on 2019 data.



Table 7: Distribution of SMEs in each sector and % point change in GVA shares in each sector

Sector name	Distribution of SMEs	Scenario 1		Scenario 2	
		% point Change in GVA Share	GVA (£m) change	% point Change in GVA Share	GVA (£m) change
Agriculture, Forestry and Fisheries	2.73%	0.00%	-5	0.00%	-6
Beverages and tobacco products	0.24%	0.00%	9	0.00%	18
Processed food	0.72%	0.00%	-4	0.00%	-5
Food products n.e.c.	0.36%	0.00%	20	0.00%	40
Chemical, rubber, part plastic products	0.36%	0.00%	45	0.00%	93
Energy	0.43%	0.00%	-13	0.00%	-22
Manufacture of electrical equipment	0.12%	0.00%	-13	0.00%	9
Machinery and equipment n.e.c.	0.84%	0.02%	307	0.02%	447
Motor vehicles and parts	0.12%	0.00%	56	0.00%	80
Transport equipment n.e.c.	0.60%	0.00%	-65	-0.01%	-113
Manufactures n.e.c.	0.24%	0.00%	45	0.00%	68
Minerals, ferrous metals and wood products	0.48%	0.00%	74	0.00%	114
Paper products, publishing	1.29%	0.00%	-3	0.00%	0
Textiles and apparel	0.36%	0.00%	34	0.00%	70
Other business services	22.86%	-0.01%	-94	-0.02%	-124
Communications	1.05%	0.00%	-3	-0.01%	10
Construction	16.36%	0.00%	86	0.00%	171
Other financial services	1.17%	-0.01%	-44	-0.01%	-69
Insurance	0.58%	0.00%	-2	0.00%	2
Services	8.59%	0.00%	149	0.00%	294
Recreational and other consumer services	9.12%	0.00%	14	0.00%	41
Public services	15.77%	0.00%	117	0.00%	230
Trade and distribution services	15.58%	0.00%	178	0.01%	334

Source: BEIS BPE and DIT CGE Modelling (2022).



Table 8: Change in shares of employment and GVA by sector for scenario 1

Sector name	Scenario 1		
	Change in share of employment	Change in sector share of total UK GVA (percentage point)	Change in UK GVA (£m)
Agriculture, Forestry and Fisheries	0.00%	0.00%	-5
Beverages and tobacco products	0.00%	0.00%	9
Processed food	0.00%	0.00%	-4
Food products n.e.c.	0.00%	0.00%	20
Chemical, rubber, part plastic products	0.00%	0.00%	45
Energy	0.00%	0.00%	-13
Manufacture of electrical equipment	0.00%	0.00%	-13
Machinery and equipment n.e.c.	0.02%	0.02%	307
Motor vehicles and parts	0.00%	0.00%	56
Transport equipment n.e.c.	-0.01%	0.00%	-65
Manufactures n.e.c.	0.00%	0.00%	45
Minerals, ferrous metals and wood products	0.01%	0.00%	74
Paper products, publishing	0.00%	0.00%	-3
Textiles and apparel	0.00%	0.00%	34
Other business services	-0.02%	-0.01%	-94
Communications	-0.01%	0.00%	-3
Construction	0.00%	0.00%	86
Other financial services	0.00%	-0.01%	-44
Insurance	0.00%	0.00%	-2
Services	-0.01%	0.00%	149
Recreational and other consumer services	0.00%	0.00%	14
Public services	0.00%	0.00%	117
Trade and distribution services	0.00%	0.00%	178

Source: DIT CGE modelling 2022.



Table 9: Change in shares of employment and GVA by sector for scenario 2

Sector name	Scenario 2		
	Change in share of employment	Change in sector share of total UK GVA (percentage point)	Change in UK GVA (£m)
Agriculture, Forestry and Fisheries	0.00%	0.00%	-6
Beverages and tobacco products	0.00%	0.00%	18
Processed food	0.00%	0.00%	-5
Food products n.e.c.	0.00%	0.00%	40
Chemical, rubber, part plastic products	0.00%	0.00%	93
Energy	0.00%	0.00%	-22
Manufacture of electrical equipment	0.00%	0.00%	9
Machinery and equipment n.e.c.	0.03%	0.02%	447
Motor vehicles and parts	0.01%	0.00%	80
Transport equipment n.e.c.	-0.01%	-0.01%	-113
Manufactures n.e.c.	0.00%	0.00%	68
Minerals, ferrous metals and wood products	0.01%	0.00%	114
Paper products, publishing	0.00%	0.00%	0
Textiles and apparel	0.00%	0.00%	70
Other business services	-0.03%	-0.02%	-124
Communications	-0.01%	-0.01%	10
Construction	0.00%	0.00%	171
Other financial services	0.00%	-0.01%	-69
Insurance	0.00%	0.00%	2
Services	-0.01%	0.00%	294
Recreational and other consumer services	0.00%	0.00%	41
Public services	0.00%	0.00%	230
Trade and distribution services	0.00%	0.01%	334

Source: DIT CGE modelling 2022.



Annex 4: method for assessment of impacts on regions and nations

This annex describes the data and method used to assess the implications of the agreement for the regions and nations of the UK.

Trade agreements affect places differently depending on a host of factors including the composition of economic activity in areas, the relative competitiveness of those activities compared to the rest of the country, and the degree to which those regions and nations are integrated into international trade.

This method uses the differing composition of economic activity across UK regions and nations to consider how regions could be positively or negatively impacted based on the modelled sectoral changes in GVA.

Data and method

Central methodology

The impact on nations and regions of the UK are estimated by apportioning the estimated sectoral impacts from the CGE model to the nations and regions of the UK. These are apportioned using current output (GVA) for each sector within each nation and region (NUTS-1) of the UK.²⁶

The regional impact is calculated by weighting the UK wide change to each sector's output from the CGE modelling (denoted as *UK Impact_s* below) by the share of the sector's GVA that is produced in each region. This is then summed across all sectors to calculate the overall impact for each region (where *r* stands for NUTS 1 region and *s* stands for sector):

$$\text{Regional Impact}_r = \sum_s \text{Share of GVA}_{rs} \times \text{UK Impact}_s$$

The apportionment approach means that the uncertainties affecting the sectoral impacts also affect the sub-national impacts. In addition, due to data availability, the sub-national impacts may be subject to additional uncertainty.

Location Quotient Weighted Approach

²⁶ NUTS-1 regions of the UK are used. These include Northern Ireland, Scotland, Wales and nine English regions. Further information on the NUTS-1 classification can be found at "The establishment of a common classification of territorial units for statistics (NUTS), Eurostat 2018.



There is some evidence to support the presence of regional multipliers resulting from changes in trade. These occur where tradable sectors and exporters pay higher wages and the expansion of exports leads to the creation of jobs in other non-tradeable sectors, through a ‘local employment multiplier effect’.²⁷

However, the estimates based upon this approach are now presented as a sensitivity analysis. They are presented as a sensitivity analysis, rather than central estimate, because the scale and persistence of these multiplier effects is highly uncertain.²⁸ On a conceptual level, they are particularly uncertain over the long-term horizon where the CGE modelling approach assumes that markets fully adjust and that labour is mobile across regions: in this long-run framework any local multiplier effects would be expected to dissipate. On a practical level, there are limited examples in literature where the local multiplier effects of trade policies have been estimated. As such, attempting to adjust the estimates for these potential impacts introduces additional uncertainty to the estimates. There is limited evidence to guide the scale of adjustment which should be applied to capture these potential effects.

The sensitivity approach multiplies the regional impact by each sector’s location quotient in each region to account for the rank and direction of potential second order effects in each region. The sectoral changes are then constrained to ensure the overall change in a sector matches the sectoral change from the CGE results (where r stands for NUTS 1 region and s stands for sector):

$$Regional\ Impact_r = \sum_s^S Share\ of\ GVA_{rs} \times UK\ Impact_s \times Location\ Quotient_{rs} \times Constraint_s$$

The average is then taken between this, and the simple apportionment methodology, to provide for a sensitivity analysis. However, there is limited evidence to guide this choice. Therefore, the sensitivity analysis should be interpreted as providing a broad indication of the direction of impacts.

Location Quotient

The location quotient is calculated by dividing a sector’s employment share in a region by the employment share in the UK. A value of one indicates that an industry’s share of employee jobs in the region is the same as its share of employee jobs nationally. A value greater than one means that the industry makes up a larger share of employee jobs in the region than the national levels, indicating that the nation or region is particularly specialised in a sector).

Location quotients are calculated using data from the ONS’ Business Register and Employment Survey, the official source of employee and employment estimates by geography and industry.

²⁷ For example, Moretti (2010) “Local Multipliers” in American Economic Review: Papers & Proceedings 100 (May 2010): 1–7



Limitations

The aim of the regional analysis is to provide a high-level overview of potential UK regional impacts, using an intuitive analytical approach rather than precise estimates or forecasts. The analysis is subject to the same limitations as CGE modelling in general, as set out in the main report and the CGE modelling annex. In addition, the sub-national analysis requires several additional simplifying assumptions and is subject to limitations, for example:

- it is based on sector results and location quotients at a highly aggregate level. It therefore does not fully reflect differences in patterns of production across nations and regions of the UK
- it does not explicitly consider the varying trade patterns of individual sectors across each part of the UK
- it assumes the long-term structures of regional economies are consistent with GVA and employment data from 2019
- it assumes that the sector GVA shock is the same for all nations and regions of the UK i.e., the CGE model provides only a UK-wide sectoral shock
- it does not give any insight into how nations and regions adjust to a new long-term equilibrium
- it does not explicitly take account of any impacts arising from the Protocol on Ireland/Northern Ireland (to the Withdrawal Agreement)



Annex 5: method for estimating the value of duties

This annex sets out the method for estimating the value of duties UK businesses and consumers currently face on UK-GCC trade, and for calculating the ad valorem equivalents (AVEs) for tariff lines under the UK's Global Tariff (UKGT) schedule, that have been used in this scoping assessment.

Duties on UK-GCC trade methodology

UK exports to the GCC

The total value of duties on UK trade is calculated using trade flow data from ITC Trade Map and official country statistics at the 8-digit product classification (HS2017), with current estimates a range of 2017-19, different averages throughout that period and single years.

To calculate annual duties on UK exports, the GCC countries' current MFN tariff rates are multiplied by the average of GCC countries' imports from the UK (2017 to 2019) at the 8-digit product classification level.²⁹

The data is grouped into intermediate or final consumption goods using the UN's 'Broad Economic Categories' (BEC).³⁰

UK imports from the GCC

The total value of duties on GCC trade is calculated using average trade flow data (2017 to 2019) from Eurostat at the 8-digit product classification (HS2017).

To calculate duties on UK imports from GCC countries, the current MFN tariff rates are multiplied by the average UK imports from GCC countries (2017 to 2019) at the 8-digit product classification level.³¹ Import data is from Eurostat which provides a more detailed breakdown of the tariff regime by which a product enters the UK. For these calculations, imports entering the UK as non-MFN 0 are used.

The data is grouped into intermediate or final consumption goods using the UN's 'Broad Economic Categories' (BEC).

²⁹ GCC country tariffs are DIT best estimates as of November 2021 using WTO TAO, WITS 2020, Zakat, Tax and Customs Authority & Market Access Map, International Trade Centre, www.macmap.org

³⁰ See accompanying manual of the 5th revision of BEC <https://unstats.un.org/unsd/trade/classifications/bec.asp>. For the purposes of this analysis, goods that are allocated as "Capital Goods" are treated as "Intermediate", as they are likely to be purchased by businesses.

³¹ UK tariff rates are based off UKGT, 2021.



Limitations

Following a similar approach widely applied in the literature, the calculations aim to provide an indication of the potential magnitude of tariff liberalisation.³² They are subject to a number of limitations:

- they are based upon current trade patterns and do not take into account the likely changes in trade patterns resulting from changes to barriers to trade
- the proportion of any tariff reductions passed through to consumers is not known, some businesses may consume final goods or not fully adjust the prices of their products/services to UK consumers
- the analysis is based on the UK's and GCC countries' current tariff levels and does not take into account any future changes to tariff levels

Methodology for calculating Ad Valorem Equivalent (AVE) tariff rates

AVEs are estimated when the tariff is not an ad valorem tariff (for example 5% or 10% of the value of the import), but instead a specific amount per unit (such as 30 GBP / 100kg). There are a number of different types of non-ad valorem tariffs, such as a fixed charge per unit of the good imported (specific tariff) or a combination of the two (compound tariff or mixed tariff).

The methodology uses trade data to estimate the unit price of a tariff line by dividing the reported trade value by the reported trade volume. The tariff is then divided by the calculated unit price to estimate an ad valorem equivalent. Where the tariffs are more complex, for example dependent on the content of ingredients such as alcohol, lactose, or sucrose, we use alternative data sources and assumptions.

AVE estimates are based on UK-EU trade flows across 2017-2019 as reported in HMRC Overseas Trade Data at CN8 level. For agri-food products, estimates are calculated both with and without below threshold trade allocation (BTTA), and the final AVEs are based on an average of the two.

Detailed methodology

- i) Obtain a list of UKGT tariff lines and rates at the CN8 level

The UKGT tariff schedule is predominantly defined at the CN8 level. However, there are cases where tariffs are defined at the CN10 level. In such cases, the AVE calculations are based on the maximum rate across the 10-digit products underneath a given CN8 commodity code.

- ii) Estimate unit price of tariff lines

³² For example, see, "Consumer benefits from EU trade liberalisation: How much did we save since the Uruguay Round?" Lucian Cernat, Daphne Gerard, Oscar Guinea and Lorenzo Isella - Chief Economist Note, DG Trade, Issue 1, February 2018.



Calculations are based on HMRC overseas trade data statistics on UK-EU trade for all relevant tariff lines. For robustness, given fluctuations in trade across specific years, we use average trade flows over 2017-2019 (inclusive). We extract value (£s), volume (kg), as well as supplementary unit data on UK imports from the EU in order to estimate import AVEs.

The AVE estimates are based on UK-EU trade, rather than UK-World trade, because historical UK-EU trade has been less affected by tariff and non-tariff barriers, and therefore represents the best indication of demand for certain imports in the absence of trade barriers. Imports from non-EU partners, however, do face instances of high tariff and non-tariff barriers which could discourage imports. This in turn could result in lower volumes of trade, and an underestimate of both the value of customs duties paid and the true extent of tariff protection. Whilst using EU trade flows does mitigate this endogeneity problems, it may also underestimate AVEs in instances where EU prices are high relative to the rest of the world. Recalling that the AVE represents the value of duties paid relative to the value of a good, the higher the price of a good (which can either reflect higher quality or lower price competitiveness), the smaller the overall AVE.

For tariffs per kg (such as 34 GBP/kg), volume unit prices are calculated by dividing the reported trade value by the reported trade volume. However, this simple unit price approach is not possible for all tariff lines. For example, some tariff lines have a tariff expressed in other units (such as a rate of 43 GBP/1,000 items or 12 GBP/hl). Where the tariffs are applied based on units, we cannot use an estimated price based on the HMRC trade volume, which is measured in kg. Instead, we gather trade data in 'supplementary unit' terms. We then divide the trade value by the number of units to estimate the price per unit of product.

Where there is no trade under a tariff code, we cannot calculate an AVE.

iii) Estimate the tariff and AVE

To estimate the AVE, we divide the tariff by the unit price. The calculations to do this are differentiated by tariff type, to account for differences in how the tariffs are defined and to capture any necessary content assumptions. Where the AVE depends on the content of the product, e.g. lactose, sucrose, and alcohol, desk research is used to develop the content assumptions which are applied in the calculations.

Caveats and limitations:

- AVEs are only indicative measures and are not precise estimates of the level of protection on goods. There are limitations surrounding the methodology used to calculate the AVEs that undermine any level of certainty at which we could claim they are accurate representations of equivalent tariff rates.
- When using AVE estimates, it is important to choose the appropriate estimate and level of detail. There can be large variation in the tariff lines for a particular product, thus the chosen level of detail, e.g. a particular CN8/HS6/HS4/ or range of codes, will largely influence the AVE estimate. The basis on which this decision is made is also important, for example if you were to choose the AVE of the code with the most trade, this code may differ depending on whether it is assessed by trade value or trade volume.
- The context of AVEs is very important as AVE estimates are only applicable for the specific year and schedule from which they were derived. They are not transferrable across years and especially not across countries or trade partners. There may also be



differences in the methodologies for estimating AVEs so direct comparisons between different external AVE sources should be avoided.

- The AVE estimates do not take any account of other preferential trade policy instruments. For example, the estimates do not consider the impacts of trade flows in goods which enter under WTO/FTA TRQs. These goods will enter under an In-Quota Rate which, for the most part, will be significantly lower than the MFN rate. Therefore, for commodities that have allocated WTO/FTA TRQs, the UKGT AVE rates are not always a realistic indication of the tariff rates at which a proportion of these commodities enter the UK; in fact for some particular cases the Out-of-Quota MFN tariff rates are largely prohibitive, so little enters at the AVE rate.
- The AVE estimates are based on UK-EU trade, rather than UK-World, which for some products may result in lower AVEs where EU prices are high.
- AVEs change significantly over time. There is high volatility in AVE estimates for yearly comparisons of some specific tariff lines due to differences in both annual values and volumes of trade. Therefore, we have used averages across multiple years.
- AVE estimates rely heavily on Unit Price estimates from customs data on reported annual values and volumes of trade which are liable to issues such as misreporting and suppression of data. This exacerbates the intrinsic volatility of trade data and the combined impacts create significant changes in AVE estimates over time that are not necessarily representative of commodity price changes alone.
- AVEs with certain weighting denominators such as net drained volume or net carcass weight have been estimated using volume data. Converting volume data to these weighting denominators has not been possible.



Annex 6: method for assessment of the impacts on small and medium-sized enterprises (SMEs)

This annex describes the data and method used to assess the implications of the agreement for SMEs.

Small and medium-sized enterprises can be defined as:

- firms employing fewer than 50, and fewer than 250 employees respectively
- firms not exceeding either (a) £44 million in annual turnover or (b) an annual balance-sheet total of £38 million

Analysis shows the variation of SMEs across different sectors and compares them with the estimated pattern of impacts across sectors set out in the scoping assessment.

SMEs represent a key component of the UK economy: in 2021 these made up over 99% of the total number of private sector businesses, representing 61% of private sector employment and 52% of private sector turnover.³³

Data and method

Information on the characteristics of UK businesses come from the BEIS Business Population Estimates (BPE) dataset. The BPE combines a number of data sources on the business population (UK Business: Activity, Size and Location (ONS), Business Demography (ONS) and Small and Medium Enterprise Statistics (BEIS)) to generate estimates of number, employment, turnover and other characteristics for all active private sector businesses, including sole-traders and unregistered businesses. Business characteristics by sector are then mapped from the Standard Industrial Classification (SIC) 2007 used by the BPE to the GTAP 10A sector definitions used in the CGE modelling.

Table 10: SMEs in the profile of UK businesses

Business size (number of employees)	Number of Businesses	% of Total Businesses	Number of employees	% of Employee Proportion	Turnover (£m)	% Turnover Proportion
None	4,174,920	74.7	4,539,000	16.8	302,520	6.8
1-49	1,372,705	24.6	8,320,000	30.8	1,286,776	28.9
50-249	35,620	0.6	3,474,000	12.9	720,540	16.2

³³ BEIS, Business Population Estimates 2021, (October 2021).



>249	7,655	0.1	10,639,000	39.4	2,139,335	48.1
All Businesses	5,590,900	100.0	26,972,000	100.0	4,449,171	100.0

Source: BEIS Business Population Estimates (2021).

The BPE shows that the concentration of SMEs varies markedly across sectors of the economy. The table below gives the distribution of SMEs across the economy using the sector definitions used by GTAP dataset. SMEs are present in all sectors of the economy, but four sectors, as defined by GTAP, – construction, business services, public services, and retail and wholesale trades – are estimated to make up over two-thirds of the total number of UK SMEs.

Table 11: SMEs across sectors by number and turnover

GTAP Sector	Sectoral Distribution of SMEs	SMEs Turnover by Sector, £ million	Estimated Contribution to Turnover		
			Micro/Small	Medium	Large
Agriculture, forestry, and fisheries	2.73%	41299	80.04%	9.67%	10.28%
Energy	0.43%	36599	14.98%	9.28%	75.74%
Food products n.e.c.	0.36%	16163	15.69%	18.20%	66.11%
Processed foods	0.72%	32327	15.69%	18.20%	66.11%
Beverages and tobacco products	0.24%	10776	15.69%	18.20%	66.11%
Textiles and apparel	0.36%	16163	15.69%	18.20%	66.11%
Minerals, ferrous metals and wood products	0.48%	21551	15.69%	18.20%	66.11%
Paper products, publishing	1.29%	34041	24.24%	17.28%	58.48%
Chemical, rubber, part plastic products	0.36%	16163	15.69%	18.20%	66.11%
Manufacture of electrical equipment	0.12%	5388	15.69%	18.20%	66.11%
Machinery and equipment n.e.c.	0.84%	37715	15.69%	18.20%	66.11%
Motor vehicles and parts	0.12%	5388	15.69%	18.20%	66.11%
Transport equipment n.e.c.	0.60%	26939	15.69%	18.20%	66.11%



Manufactures n.e.c.	0.24%	10776	15.69%	18.20%	66.11%
Services	8.59%	165335	35.68%	14.21%	50.11%
Public services	15.77%	143680	42.70%	14.87%	42.43%
Construction	16.36%	260019	59.59%	12.90%	27.52%
Trade and distribution services	15.58%	882915	35.09%	17.58%	47.34%
Recreational and other consumer services	9.12%	91047	30.42%	12.49%	57.09%
Communications	1.05%	23266	29.65%	16.69%	53.65%
Other business services	22.86%	432292	44.27%	17.18%	38.55%
Other financial services	1.17%	-	-	-	-
Insurance	0.58%	-	-	-	-

Source: DIT Internal Analysis of BEIS Business Population Estimates (2021). Note: No turnover data available for Financial or Insurance sectors.

The data on which sectors SMEs belong to (as above), are paired with the sectors where output is expected to increase or decrease relative to the baseline as a result of an FTA. This provides a preliminary assessment of whether SMEs are concentrated in industries where GVA decreases relative to the baseline. For the purpose of identifying which sectors have a higher concentration of SMEs, the analysis focuses on sectors in which employment changes by more than +/- 0.05% relative to the baseline.

Limitations

The preliminary analysis is in line with best practice in this area but requires several simplifying assumptions and is subject to several limitations:

- this approach does not take into account whether SMEs may be more or less affected by changes in trade barriers than other businesses
- mapping the Standard Industrial Classifications to the sector aggregations used in the GTAP modelling requires several simplifying assumptions which could result in biases in the estimated distribution of SMEs across GTAP sectors
- BEIS BPE data captures data on unregistered and sole traders, however it does not allow for disaggregation between small and micro businesses and there is no available turnover data for the finance or insurance sectors



Annex 7: method for assessment of impacts on groups in the labour market

This annex describes the data and method used to assess the implications of the agreement for various groups in the labour market including sex, ethnicity, disability and age.³⁴

The international evidence suggest that trade agreements and trade liberalisation have the potential to affect various sectors of the economy and groups differently.³⁵ This is because consumption patterns and employment patterns can differ systematically across groups.

The method analyses the characteristics of the workforce within sectors where employment is predicted to decline relative to the baseline over the long run due to the FTA.

Data and Method

Sectors in the CGE model are defined by the GTAP 10A dataset used. These sectors are mapped from GTAP to the Standard Industrial Classification (SIC) 2007 sectoral definitions used by the Annual Population Survey (APS). The APS is a combined survey of households in Great Britain that draws on data from the Labour Force Survey.

The table below presents data from an average of the years 2016-2018 of the APS, showing estimates of the proportions of those employed in each of the 23 GTAP sectors with various characteristics.

³⁴ Sex, disability and age are a subset of those characteristics protected under the Equality Act 2010. For the purposes of this analysis, we utilise data regarding ethnicity to consider the protected characteristic of race. Other characteristics are not analysed due to a lack of data covering their demographics across sectors of the economy.

³⁵ The characteristic that has been studied in the greatest depth is sex. (UNCTAD, 2017) uses a method similar to the one used in this annex and (OECD, 2018) extends this approach to look at how women are affected as a result of impacts to global value chains.



Table 12: Proportion of employment by sector and protected characteristics³⁶

GTAP Sector (23 Disaggregation)	Females	Males	Disabled	Ethnic Minorities	Age (16-24)	Age (65+)
Agriculture, forestry, and fisheries	27.4%	72.6%	14.5%	1.4%	10.0%	18.3%
Food products n.e.c.	31.3%	68.7%	7.9%	12.1%	10.2%	2.6%
Processed foods	37.9%	62.1%	11.4%	15.0%	9.0%	2.1%
Beverages and tobacco products	26.5%	73.5%	6.8%	5.8%	9.0%	1.2%
Energy	21.2%	78.8%	10.1%	6.7%	8.5%	2.0%
Textiles apparel	49.6%	50.4%	11.6%	16.6%	9.7%	4.8%
Minerals, ferrous metals and wood products	16.4%	83.6%	10.5%	5.0%	10.8%	4.0%
Paper products, publishing	36.9%	63.1%	12.1%	8.8%	7.1%	4.6%
Chemical, rubber, part plastic products	32.4%	67.6%	9.5%	8.0%	8.7%	2.4%
Motor vehicles and parts	13.0%	87.0%	10.4%	9.1%	9.1%	2.4%
Transport equipment n.e.c.	13.2%	86.8%	10.4%	4.7%	9.6%	2.6%
Manufacture of electrical equipment	30.4%	69.6%	8.2%	10.9%	7.6%	2.8%
Machinery and equipment n.e.c.	18.7%	81.3%	11.3%	6.1%	8.3%	3.3%
Manufacturing n.e.c	31.3%	68.7%	12.1%	8.5%	8.0%	3.9%
Services	25.6%	74.4%	12.2%	16.6%	7.7%	4.5%
Construction	12.4%	87.6%	11.0%	5.5%	9.8%	3.7%
Trade and distribution services	48.4%	51.6%	13.6%	14.2%	24.6%	3.5%
Communications	26.4%	73.6%	11.4%	14.0%	9.5%	0.9%

³⁶ Employment is defined as set out in ILODEFR. For further information see Labour Force Survey User Guide: Details of LFS variables 2019.



Other financial services	42.5%	57.5%	9.3%	16.1%	8.3%	1.6%
Insurance	46.7%	53.3%	10.2%	9.1%	11.8%	1.6%
Other business services	40.2%	59.8%	11.4%	13.6%	8.7%	4.5%
Recreational and other consumer activities	54.8%	45.2%	13.3%	9.1%	18.4%	5.1%
Public services	68.6%	31.4%	13.8%	12.2%	7.6%	3.4%
Total	46.9%	53.1%	12.6%	11.9%	11.9%	3.8%

Source: ONS Annual Population Survey

The CGE modelling provides estimates of the changes in share of overall employment accounted for by each sector of the UK economy resulting from a free trade agreement. For the purposes of estimating potential impacts on different groups in the labour market, the analysis focuses on sectors in which employment changes by more than +/- 0.05 relative to the baseline.

Limitations

The aim of the analysis is to estimate the long run changes in employment in sectors according to population group. This provides a proxy for whether the labour market impacts of the agreement may result in a disproportionate impact on specific groups.

The analysis requires several simplifying assumptions and is subject to following limitations:

- the data from the Annual Population Survey only allows descriptive analysis of the composition of sectors where individuals with various characteristics are employed, not inferential analysis of how these individuals or employers will respond to sectoral shocks. The analysis therefore cannot make inference about how groups will be impacted
- the analysis uses the available data sources to describe the characteristics of workers in sectors which may increase or decrease their employment relative to the baseline under an agreement. It does not assess the welfare impacts of any agreement on various groups
- mapping the employment data, which is recorded in the Annual Population Survey by Standard Industrial Classification to the sector aggregations used in the GTAP modelling could result in biases in the estimated distribution of employment across the GTAP sectors
- the proportions estimated above are based on a snapshot of the demographics. By only using the years available the analysis does not take into account trends that may be present in the proportions
- the analysis is based on the structure of the UK workforce from 2016-2018. Whereas the CGE modelling results reflect the UK economy in the long run when the composition of the workforce may have changed



Annex 8: method for assessment of environmental impacts

This annex sets out the methodology for estimating the impact of the FTA on Green House Gas (GHG) and transport emissions. It also provides the environmental performance indicators (EPI) for GCC member states.

Greenhouse gas emissions

To estimate the impacts from the FTA on UK and GCC greenhouse gas emissions, an extension to the core CGE model is used, known as GTAP-E. This model has been used as part of DIT's development work to incorporate recommendations from the Modelling Review.³⁷ GTAP-E differs from DIT's previous assessment of environmental impacts, as it allows for the estimation of partner and global impacts, as well as accounting for emissions from household consumption of energy. GTAP-E also uses additional assumptions, such as inter-fuel and fuel-factor substitution, which are not present in DIT's previous approach. These assumptions are outlined further below.

GTAP-E background

GTAP-E incorporates carbon emissions from the combustion of fossil fuels, as well as a mechanism to trade these emissions internationally. The database provides carbon dioxide (CO₂) emissions data distinguished by fuel and by user for each of the 141 countries/regions in the Global Trade Analysis Project (GTAP) database³⁸.

It uses GTAP 10 and data on different energy sources compiled by the International Energy Agency (IEA). Emissions are also reported for three types of non-CO₂ GHGs – CH₄ (methane), N₂O (nitrous oxide) and the group of fluorinated gases (F-gases). Each emission flow is associated with one of the four sets of emission drivers: output by industries, endowment by industries, input use by industries and consumption by households.

GTAP-E is widely used in other countries, by international institutions and by academics (World Bank, United Nations, IMF). Further information on the mechanics behind GTAP-E can be found in Burniaux and Truong.³⁹ Using the GTAP-E model, the following impacts have been captured as a result of a UK-GCC FTA:

UK emissions

³⁷ <https://www.gov.uk/government/publications/trade-modelling-review-expert-panel-report-and-recommendations>

³⁸ <https://www.gtap.agecon.purdue.edu/default.asp>

³⁹ "GTAP-E: An Energy-Environmental Version of the GTAP Model", https://www.gtap.agecon.purdue.edu/resources/res_display.asp?RecordID=923



GTAP-E assumes energy substitution is an important factor in assessing energy-environment-economy linkages. Energy is modelled as a primary input, instead of being an intermediate input. The production structure therefore captures energy as an additional factor of production (in GTAP, energy is an intermediate input). This impact is captured on two levels: first, allowing for the possibility of substitution between alternative fuels and secondly, allowing for the substitution between energy and capital as factors of production (jointly creating the energy-capital composite). The energy-capital composite is then substitutable with other factors of production (i.e. labour, land and natural resources). If the demand for the energy-capital composite increases, there might still be an increased overall demand for energy inputs. This reflects short-term complementarity between energy and capital.

This is supported by the economic literature, which suggests that physical capital and energy could be substitutes or complements in production, often depending on the time horizon.⁴⁰ They are more likely to be complements in the short or medium term, and substitutes in the long term as firms have more time to adjust their technologies. The GTAP-E model also assumes the energy market is perfectly competitive in the long-run.

Being a fully specified general equilibrium model, GTAP-E accounts for the impacts originating in both supply side (production) and demand side (consumption) of the economy (it is a top-down approach).⁴¹ It therefore estimates the emissions changes related to household consumption of energy (gas, petrol etc.) Further information on the mechanics behind GTAP-E can be found in Burniaux and Truong.⁴²

Partner country emissions

GTAP-E provides a single consistent framework to estimate the impact of an FTA not just on UK emissions but also partner country and global emissions. Therefore, the modelling results are used to produce an estimate for the impact on the GCC as an aggregate, as well as for the UK.

Limitations of the greenhouse gas emissions

Quantitative assessment of the environmental impact is based on the estimated economic impact of the FTA. Consequently, the environmental assessment conducted in this analysis inherits the limitations of the economic modelling.

With respect to the environmental modelling, there are caveats concerning the interpretation of the results:

⁴⁰ See Burniaux & Truong, 2002. Rutherford & al, 1997.

⁴¹ The top-down approach to energy modelling starts with a detailed description of the macro economy and then derives from there the demand for energy inputs in terms of the demand for various sectors' outputs through highly aggregate production or cost functions.

⁴² "GTAP-E: An Energy-Environmental Version of the GTAP Model", https://www.gtap.agecon.purdue.edu/resources/res_display.asp?RecordID=923



- Results do not take into account the projected decline in greenhouse gas emissions in various sectors or declines in emissions intensity that might be expected to follow from government policies. For example, the decarbonisation or policy measures to deliver the UK's net zero commitment, and firm and consumer behaviour.
- It is a top-down approach to energy modelling and therefore does not include a detailed specification of energy technologies.
- The current reference year for GTAP-E is 2014. UK GHG emissions have declined significantly since 2014. According to ONS⁴³ data, total UK GHG emissions have fallen by around 21% between 2014 and 2020 (from 608 MtCO₂e in 2014 to 481 MtCO₂e in 2020).
- The current static version of GTAP-E does not account for the technique effect – where trade opening can lead to the adoption of more environmentally friendly production techniques, either through technology transfer or investment which can lead to a decline in GHG emissions and emission intensity over the long-term.

Transport emissions

Method

The impact of a new trade agreement on aviation and maritime emissions is estimated using the CGE-based economic analysis and HMRC trade data as inputs.

HMRC trade data gives the tonnage of goods transported via each mode of transport. Published forecasts in aviation and maritime traffic are used to estimate projected traffic by mode. The estimated output changes from the CGE-based economic analysis are linked to HMRC Overseas Trade Statistics to convert the impact of the deal to tonnage and added to traffic projections to estimate the effects of the bilateral agreement on aviation and maritime traffic. Using the distance between trading partners and emissions factors for specific ship types and freighter aircraft, this traffic impact is converted into an emissions impact.

Updates to the methodology for the GCC transport emissions

The methodology used to estimate the impact of transport emissions has been updated since previous publications to improve the robustness of the estimates.

- The distance that goods are estimated to travel between the UK and GCC members is approximated using a weighted average of the distance between the UK and each GCC member. Distances are weighted using the proportions of trade between the UK and each GCC member.
- The emissions factors used to estimate baseline maritime emissions have been updated. On average, sea tankers are estimated to have lower emissions factors than those associated with more traditional cargo/container ships. The emissions

⁴³ ONS, Greenhouse gas emissions in the United Kingdom, 1990 to 2019 and (provisional) 2020.



factors now exclude sea tankers, typically used to transport energy products. This is because the CGE modelling estimates that the majority of the increase in goods traded will be in non-energy products. Therefore, the updated emissions factors reflect more closely the increase in the types of shipping (and associated emissions) expected as a result of the agreement.

- The emissions estimates are highly uncertain. For the estimates of maritime emissions, the sensitivity analysis applies a 25% increase in the assumed distance that goods travel. This provides an indicative sense of the additional impact from ships should the deviate from taking the shortest route.

Limitations of the transport emissions method

As with production emissions, the impact of the FTA on transport emissions is based on the CGE results and therefore inherits the same limitations of economic modelling.

The methodology uses several assumptions:

- services are negligible (that is, ignores the FTA's impact on the movement of people and examines goods only)
- significant technological change has a negligible impact in the medium-term (that is, no consideration is made for long-haul electric aircraft and hydrogen-powered cargo ships becoming available), and emissions intensity does not change over time. Emissions intensity (CO₂e emissions per tonne per km) is expected to improve over time under business-as-usual conditions reflecting technological change and global climate ambitions, with emissions savings coming from more modest improvements from cleaner fuels, energy efficiency savings, and engine upgrades. However, estimates of future changes in emissions factors for maritime and aviation are not available. Using the current emissions factors is a conservative approach that will likely overestimate the change in emissions.

The analysis also does not include the impact on transport emissions from changes in trade with third countries.



Environmental Performance Index (EPI)⁴⁴

Air quality indicators

Table 13 - Air Quality⁴⁵

	UK	Bahrain	Kuwait	Oman	Qatar	Saudi Arabia	UAE
Rank	14	81	45	96	63	93	63
EPI	84.7	41.2	55.0	36.4	48.6	37.4	48.6
10-year change	5.5	8.3	6.4	10.3	4.3	10.1	4.7

Table 14 - PM2.5 Exposure

	UK	Bahrain	Kuwait	Oman	Qatar	Saudi Arabia	UAE
Rank	18	162	144	171	169	176	168
EPI	75.4	16.5	24.2	11.7	13.0	10.0	13.9
10-year change	9.7	6.4	4.4	7.1	7.8	6.0	8.1

Table 15 - Ozone Exposure⁴⁶

	UK	Bahrain	Kuwait	Oman	Qatar	Saudi Arabia	UAE
Rank	29	165	82	135	150	148	172
EPI	64.5	23.1	44.1	32.7	28.5	29.0	18.8
10-year change	3.7	3.0	-1.5	4.4	-0.3	0.7	5.3

Table 16 - Household Solid Fuels Exposure

	UK	Bahrain	Kuwait	Oman	Qatar	Saudi Arabia	UAE
Rank	1	41	23	50	1	42	1
EPI	100	77.4	98.7	70.8	100	76.2	100
10-year change	-	11.5	10.1	15.3	-	16.9	-

Water quality indicators

Table 17 - Sanitation and Drinking Water⁴⁷

	UK	Bahrain	Kuwait	Oman	Qatar	Saudi Arabia	UAE
Rank	1	61	39	57	41	55	40
EPI	100	56.6	67.4	58.3	66.5	59.3	67.2
10-year change	0.8	2.3	2.2	3.2	2.9	5.9	1.7

⁴⁴ [Environmental Performance Index \(EPI\)](#), 2020

⁴⁵ Air quality is a composed indicator made of household solid fuel use; PM2.5 average exposure, and PM2.5 exceedance of WHO thresholds.

⁴⁶ To ground-level ozone pollution.

⁴⁷ This indicator measures how well countries protect human health from environmental risks on two indicators: unsafe drinking water and unsafe sanitation.



Table 18 - Water Resources⁴⁸

	UK	Bahrain	Kuwait	Oman	Qatar	Saudi Arabia	UAE
Rank	6	17	43	62	25	64	21
EPI	98.5	86.9	43.1	13.4	70	11.8	76.8
10-year change	-	-	-	-	-	-	-

Forestry indicators

Table 19 - Ecosystem Services

	UK	Bahrain	Kuwait	Oman	Qatar	Saudi Arabia	UAE
Rank	115	1	45	30	176	11	1
EPI	28.3	100	48.4	67		96.9	100
10-year change	-0.6	98	23.8	40.1	-100	5.4	43.6

Tree cover loss

The UK ranks 117th on the Environmental Ranking Performance index for tree cover loss with an EPI of 24 and a 10-year change value of -3.8.

Saudi Arabia ranks 1st with an EPI score of 100 indicating virtually no tree cover loss. Data for the other GCC countries regarding tree cover loss is not provided on the EPI.

Waste management

Table 20 – Municipal solid waste generated (kg per day per capita)⁴⁹

	UK	Bahrain	Kuwait	Oman	Qatar	Saudi Arabia	UAE
	1.3 (2019)	1.8 (2019)	1.6 (2010)	1.2 (2010)	1.3 (2015)	1.4 (2015)	1.6 (2013)

Table 21 - Controlled Solid Waste

	UK	Bahrain	Kuwait	Oman	Qatar	Saudi Arabia	UAE
Rank	17	59	133	133	60	56	93
EPI	92.9	60.4	-	-	60.2	61.4	26.8
10-year change	-	-	-	-	-	-	-

⁴⁸ A score of 100 indicates that a country has 100% of its population connected to a sewer system and 100% of household wastewater is treated, mitigating threats to aquatic ecosystems.

⁴⁹ World Bank, ["What a Waste 2.0" database](#)



Biodiversity and Ecosystems

Table 22 - Biodiversity and Habitat

	UK	Bahrain	Kuwait	Oman	Qatar	Saudi Arabia	UAE
Rank	6	173	71	159	129	136	34
EPI	88	18.9	66	28.2	41.3	38.8	80.9
10-year change	19.3	0.2	33.6	1.1	-2.1	0.1	39.4

Table 23 - Ecosystem & Services

	UK	Bahrain	Kuwait	Oman	Qatar	Saudi Arabia	UAE
Rank	115	1	45	30	176	11	1
EPI	28.3	100	48.4	67	-	96.9	100
10-year change	-0.6	98	23.8	40.1	-100	5.4	43.6



Annex 9: method for assessment of impact on developing countries

This annex describes the data and method used to assess the effect of the agreement on developing countries. For this analysis, we define developing countries as those in the African, Caribbean and Pacific (ACP) group, including those trading under Economic Partnership Agreements (EPAs) with the UK, or those trading under the UK's Generalised Scheme of Preferences (GSP).

On average from 2017-19, the UK imported goods worth £28 billion⁵⁰ from developing countries, including £5 billion from Least Developed Countries (LDCs). Developing countries exports to the UK are equivalent to 3.4% of their global annual exports. However, for some individual countries or products, the importance of the UK as a market is considerably higher. For instance, the UK imported 22.0% of Belize's exports, 12.3% of the Seychelles' exports, 10.3% of St. Lucia's exports, 8.9% of Kenya's and 8.6% of Bangladesh's exports⁵¹.

These countries may therefore experience preference erosion when the UK signs a Free Trade Agreement (FTA). This is because the FTA would reduce their relative competitiveness due to the greater market access agreed between the UK and FTA partners. This can lead to UK demand shifting away from the developing countries' products and towards the FTA partners' products. Reduced demand for developing country exports could negatively impact their economy's trade balance, foreign reserves and GDP. It may also reduce demand for goods and industries that can drive future development and growth.

Table 24 shows the sectors in which there are products exported from developing countries to the UK at risk of trade diversion, including total UK imports from developing countries and trade from individual developing countries in those products. Overall, in the context of total trade flows, these risks from preference erosion are not expected to be substantial.

Table 24: Developing country exports identified as being at potential risk of trade diversion from a UK-GCC FTA (2017 to 2019 average)

HS6 code and product description	UK imports from developing countries	GCC Partner exports to World	Developing countries' reliance on the UK market (UK exports as % of total exports)
030614: Frozen crabs, cooked by steaming or by boiling in water	£2m	£26m (Bahrain)	Bangladesh \$1m (22%)

⁵⁰ HMRC trade data (accessed February 2022).

⁵¹ WITS trade data using average values for 2017-2019 (accessed Jan 2021).



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030617: Frozen shrimps and prawns, cooked by steaming or by boiling in water (excl. cold-water shrimps and prawns)	£56m	£153m (Saudi Arabia) £12m (Bahrain)	Bangladesh \$61m (15%)
070999: Fresh or chilled vegetables n.e.s	£38m	£7m (Oman)	Bangladesh \$2m (19%) Dominican Republic \$1m (12%) Ghana \$2m (96%) India \$20m (26%) Kenya \$14m (54%) Morocco \$7m (21%) Mozambique \$3m (64%) Senegal \$19m (86%)
080410: Fresh or dried dates	£8m	£157m (Saudi Arabia) £153m (Oman) £150m (UAE)	Namibia \$2m (35%) Occ. Pal. Terr. \$3m (15%)
151190: Palm oil and its fractions	£75m	£50m (Oman)	Papua New Guinea \$63m (81%) Solomon Islands \$9m (100%)
151590: Fixed vegetable fats and oils and their fractions	£2m	£15m (Oman)	Kenya \$2m (15%)
160529: Shrimps and prawns, prepared or preserved, in airtight containers (excl. smoked)	£6m	£36m (UAE)	Indonesia \$8m (11%) India \$10m (19%)
190219: Uncooked pasta, not stuffed or otherwise prepared, not containing eggs	£2m	£57m (Saudi Arabia) £25m (Oman)	Ghana \$2m (83%)
392062: Plates, sheets, film, foil and strip, of non-cellular poly"ethylene terephthalate"	£3m	£11m (Oman)	Egypt \$4m (11%) Pakistan \$4m (22%)
630140: Blankets and travelling rugs of synthetic fibres	£3m	£37m (UAE)	Cambodia \$3m (26%)
690490: Ceramic flooring blocks, support or filler tiles and the like	£1m	£12m (UAE)	Pakistan \$1m (97%)

Source: FCDO analysis using HMRC trade data.



Data and method

This analysis provides an indication of whether the market access agreed as part of the FTA is likely to negatively impact on the trade flows of developing countries receiving preferential market access to the UK. It does this by identifying products at the HS6 code level that are particularly vulnerable to preference erosion.

To determine whether trade diversion may occur because of tariff reductions between the UK and the FTA partner, we first analyse trade data from the FTA partner to determine the competitiveness of their exports. Then we analyse and contrast developing countries' trade flows to determine their value of exports and the relative importance of the UK market for those goods. Products which are competitive for the partner country, have a positive UKGT rate and are at risk of preference erosion for developing countries are identified.

Criteria to identify competitive goods of the FTA partner

FTA partner exports of a good at HS6⁵² are defined as competitive if *any* of the following indicators are met:

- Partner's global exports exceed UK total imports
- More than 1% of UK imports of the good are imported from the partner
- Global exports from the partner are greater than 1% of total global imports
- Revealed comparative advantage⁵³ is greater than 1, indicating that the partner exports a higher proportion of the good than the global average.

Criteria for goods at risk of preference erosion for developing countries

Developing countries' exports⁵⁴ of a good at HS6 are defined as "at risk of preference erosion" if:

- Exports to the UK account for more than 10% of global exports of that product, indicating reliance on the UK market.

And either of the following two criteria are also met:

- Exports exceed 1% of the country's total exports
- Annual average exports are greater than US\$1m

⁵² FTA partner's trade data sourced from TradeMap, averaged from 2017-2019.

⁵³ Calculated as the product share of the FTA partner's global exports divided by the product share of global imports, using TradeMap data, averaged from 2017-2019.

⁵⁴ Developing country global exports sourced from UN Comtrade, averaged from 2017-19, using mirror data (world imports from developing countries).



Products which meet both sets of the above criteria are highlighted as potentially at risk of trade diversion from an agreement that proposes to liberalise these product lines. The list of sensitive products is then analysed to identify any missing goods, for which trade diversion risks were expected but the trade data had not flagged. A reduced list of prioritised products has been presented in Table 24 based on a combination of factors that deem them *more* sensitive than others, such as more of the criteria being true, higher values of both partner exports to the world and developing country imports to the UK as well as factors such as partner's existing presence in the UK market. Source data is scrutinised to interrogate partner country competitiveness and developing country trade flows, and other information sources are consulted to assess the full risk of preference erosion.

Limitations

There are however limitations with this analysis. We consider only static competitiveness threats rather than dynamic considerations of emerging industry and trade expansion across developing country partners. Therefore these results cannot comprehensively predict the extent to which a change in relative tariffs faced by the developing country and by the FTA partner would lead importing firms in the UK to switch from suppliers in one country to another.

The presence of globally competitive producers in the FTA partner country is one factor, however using Revealed Comparative Advantage may be an imperfect measure of the FTA partner's competitiveness in a given sector. Developing countries may already be more competitive than other producers where preferential access is not being used.

Other factors that shape how the market will respond include price elasticity, the availability of substitutes, the transaction costs involved in changing suppliers. These are not considered in this static analysis.

Furthermore, the analysis takes 3-year averages across the time period 2017-19 in nominal terms. Therefore, the results do not consider inflation and exchange rate differentials which would both impact the value of imports and exports at product level.

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- using trade and investment to underpin the government's agenda for a Global Britain and its ambitions for prosperity, stability and security worldwide.

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