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**SECTORAL AND REGIONAL DISTRIBUTION OF EXPORT SHOCKS:
WHAT DO TWO HUNDRED THOUSAND UK FIRM OBSERVATIONS SAY?**

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By Rafał Kierzenkowski, Peter Gal, Gabor Fulop, Dorothee Flaig and Frank van Tongeren

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Abstract/résumé**Sectoral and regional distribution of export shocks:
What do two hundred thousand UK firm observations say?**

This study explores the impact of export shocks on firms and re-aggregates results to derive distributional effects on sectors and regions. In a first step, firm level data are used to assess the empirical relationship between exports and three outcome variables – labour productivity, employment and wages. In a second step, an illustrative set of changes in trading relationships generate sectoral export shocks, which are simulated with the OECD METRO model of trade and subsequently fed into micro-level estimates. The method developed in this study can be applied to other countries, conditional on the availability of data. As an initial case study, the analysis is for the United Kingdom which has weak regional productivity outside London, partly related to sectoral and trade specialisation. In particular, the most productive regions are specialised in knowledge-intensive services and are more intensive in tradable services. The results suggest limited impacts of export shocks on sectoral employment, except for car and truck manufacturing, consistent with a high integration of the sector with European value chains. Labour productivity and wages are negatively affected across most sectors, but the effects are smaller on the services sector relative to the goods sector. Given that services activities are concentrated in more productive regions, these regions are more resilient to shocks. The United Kingdom has a strong comparative advantage in services sectors and promoting the opening of global services markets would be an important way to offset potential negative impacts of export shocks on the other sectors of the economy.

JEL classification: D24, F14, F16, J3, J21, R12

Keywords: exports, sectors, regions, firms, productivity, employment, wages, United Kingdom, European Union

**Distribution sectorielle et régionale des chocs à l'exportation :
Que disent deux cent mille observations d'entreprises au Royaume-Uni?**

Cette étude explore l'impact des chocs à l'exportation sur les entreprises et regroupe les résultats pour en déduire les effets distributifs sur les secteurs et les régions. Dans une première étape, des données d'entreprises sont utilisées pour évaluer la relation empirique entre les exportations et trois variables de résultat - la productivité du travail, l'emploi et les salaires. Dans un second temps, un ensemble de changements illustratifs des relations commerciales est à l'origine de chocs sectoriels à l'exportation, qui sont simulés avec le modèle de commerce METRO de l'OCDE et introduites ensuite dans des estimations au niveau microéconomique. La méthode développée dans cette étude peut être appliquée à d'autres pays, conditionnellement à la disponibilité des données. En tant qu'étude de cas initiale, l'analyse porte sur le Royaume-Uni dont la productivité régionale est faible en dehors de Londres, en partie liée à la spécialisation sectorielle et commerciale. En particulier, les régions les plus productives sont spécialisées dans les services à forte intensité en connaissances et sont plus intensives dans les services échangeables. Les résultats suggèrent des impacts limités des chocs d'exportation sur l'emploi sectoriel, à l'exception de la production de voitures et de camions, en accord avec une forte intégration du secteur dans les chaînes de valeur européennes. La productivité du travail et les salaires sont affectés négativement dans la plupart des secteurs, mais les effets sont plus faibles sur le secteur des services par rapport au secteur des biens. Étant donné que les activités de services sont concentrées dans des régions plus productives, ces régions sont plus résistantes aux chocs. Le Royaume-Uni dispose d'un fort avantage comparatif dans les secteurs des services et la promotion de l'ouverture des marchés mondiaux des services serait un moyen important de compenser les effets négatifs potentiels des chocs d'exportation sur d'autres secteurs de l'économie.

Classification JEL : D24, F14, F16, J3, J21, R12

Mots clés : exportations, secteurs, régions, entreprises, productivité, emploi, salaires, Royaume-Uni, Union européenne

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SECTORAL AND REGIONAL DISTRIBUTION OF EXPORT SHOCKS: WHAT DO TWO HUNDRED THOUSAND UK FIRM OBSERVATIONS SAY?

Rafał Kierzenkowski, Peter Gal, Gabor Fulop, Dorothee Flaig and Frank van Tongeren¹

Introduction

Background

1. **This paper investigates the distributional effects of export shocks across sectors and regions with disaggregated data.** The analysis develops a methodology combining bottom-up and top-down approaches. It uses sectoral export shocks derived from a computable general equilibrium (CGE) model. These shocks are then applied to firm-level estimates of the relationship between several outcome variables and exports. These estimates are identified for an average firm in each sector, and then re-aggregated into sectors and regions using firm-level data combined with detailed regional-sector data on employment.

2. **Theoretical models predict that trade exposure affects firm performance, but the co-movement between labour productivity and wages is not always ensured.** Following an increase in trade exposure (e.g. a trade liberalisation), more productive firms start to export or expand their exports, less productive firms either produce for the domestic market or are forced to exit, and there is more intra-industry re-allocation towards more productive firms (Melitz, 2003). Moreover, entering export markets provides opportunities to learn new technologies and business practices, and to reap benefits from larger economies of scale (Alvarez et al., 2013). However, export-induced productivity gains are not necessarily conducive to higher wages. Three effects can be distinguished in a model with oligopolistic market structure and union wage setting (Egger and Etzel, 2012). Exports raise labour demand and wages, but labour demand is more elastic in an open economy, and greater competition on the product market lowers profits and union wage claims (rent-sharing mechanism). The latter two effects are dominant for trade between two symmetric countries with a large number of competing firms. The wage fall is smaller in industries with low productivity, as unemployment compensation leads to wage compression and has an equalising effect. Yet, wages could rise if the market power of incumbents is large. When trade occurs between two asymmetric countries, wages are expected to rise in industries that have a higher labour productivity than in the foreign economy, and vice versa.

3. **Empirically, exporting firms have higher productivity and wages, but more export-intensive firms and sectors face greater competition, reducing rent sharing.** Exporting firms are more productive than non-exporting firms mainly because more productive firms self-select into export markets. In addition, the Melitz-type effect of improvements to allocative efficiency as well as increases in firm-level productivity following trade liberalisation have been found for several countries and sectors (De Loecker, 2007; Li and Harris, 2008; Fabling and Sanderson, 2010; Tanaka, 2013; Atkin et al., 2017). As they are more productive, exporting firms pay higher wages relative to domestic firms (export wage premium). Yet, evidence for Germany shows that an increase in exports is negatively associated with wages, in particular for low-skilled workers, within firms covered by collective bargaining (Felbermayr and Hauptmann, 2014). Also, the probability of signing wage agreements in large French firms rises with their exports (Carluccio et al., 2016). A study of Italian firms shows that changes in skill composition and export-related experience are additional channels affecting the export wage premium (Macis and Schivardi, 2016). Given the lack of a strong consensus on the relationship between exports and wages, the paper contributes to the literature by providing a novel set of detailed, sector-specific estimates on this link.

1. The authors are part of the OECD secretariat and are grateful to Catherine L. Mann and Dorothee Rouzet for useful comments and suggestions on earlier drafts of this paper.

4. **The analysis is applied to the United Kingdom, for which several rich datasets are available and can be combined.** Previous OECD research focused on the macroeconomic effects of trade and other shocks (Kierzenkowski et al., 2016). Trade shocks were calibrated with the OECD CGE model of trade (METRO) and simulated with the National Institute Global Econometric Model (NiGEM). This study goes beyond macroeconomic effects by assessing the distributional impacts of trade shocks on sectors and regions. Several refinements are introduced by deepening the analysis with firm-level data based on export shocks calibrated with the METRO model, modelling in detail UK exports of services (which account for about 45% of total exports), considering a larger number of illustrative shocks, and gauging the impacts on labour productivity, wages and employment. The main advantage of this approach is the richness it can provide in terms of sectoral and regional implications by combining the strengths of two methods. The METRO model has detailed tariffs and trade flows but it has no endogenous productivity effects through capital expansion or technological change – it is static in this sense. To complement it with dynamic effects, the empirical approach estimates the link between trade intensity and productivity over a three-year horizon by relying on firm-level data. The downside of this approach is that the results may not capture the full long-term general equilibrium effects on productivity, wages and employment resulting from cross-sectoral and regional spillovers. Hence, the results should be interpreted as short- to medium-term effects of up to three years (assuming full resource reallocation), and their key value added is to highlight the likely differential impacts across regions.

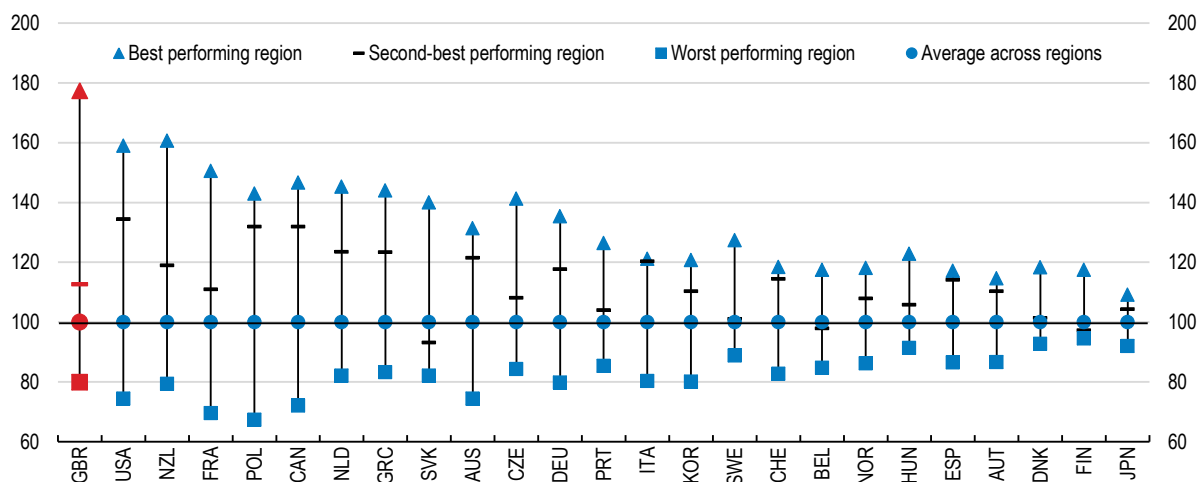
5. **The United Kingdom will leave the European Union, which will modify the UK's trading relationships.** In 2016, the EU market accounted for about 12% of the UK's GDP and nearly 45% of its total exports, and the United Kingdom had with the European Union a trade surplus in services of close to 1% of GDP and a trade deficit in goods of almost 5% of GDP. Currently, the United Kingdom is member of the EU Single Market and has a preferential access to 53 non-EU markets covered by approximately 40 FTAs as part of the EU Customs Union, but these trade linkages will be redefined outside the European Union. With this as a background, the paper considers three sets of hypothetical sector-specific export shocks to illustrate their distributional impacts on UK sectors and regions.

Regional economic performance in international perspective

6. **Trade shocks may have important distributional effects given large disparities in cross-regional performance in the OECD.** The average regional productivity gap across OECD regions has widened over the past two decades (OECD, 2016). Disparities in productivity are particularly high in the United Kingdom, which has the largest gap among OECD countries between the most and the least productive regions (Figure 1). However, these regional differences in productivity are essentially driven by London, with the second-best performing region being above but close to the UK average. Most UK regions have below-average productivity performance. Many OECD countries show marked differences for participation and unemployment rates across regions, but the United Kingdom performs better on both accounts than the OECD average (Figure 2). Differences in household disposable incomes per capita across UK regions are relatively high (Figure 3), yet they are smaller than the regional disparities in productivity, which suggests that taxes and transfers help in mitigating regional inequalities in household earnings. There is a positive relationship between the dispersions in labour productivity and incomes in the OECD, with the United Kingdom being close to trend (Figure 4).

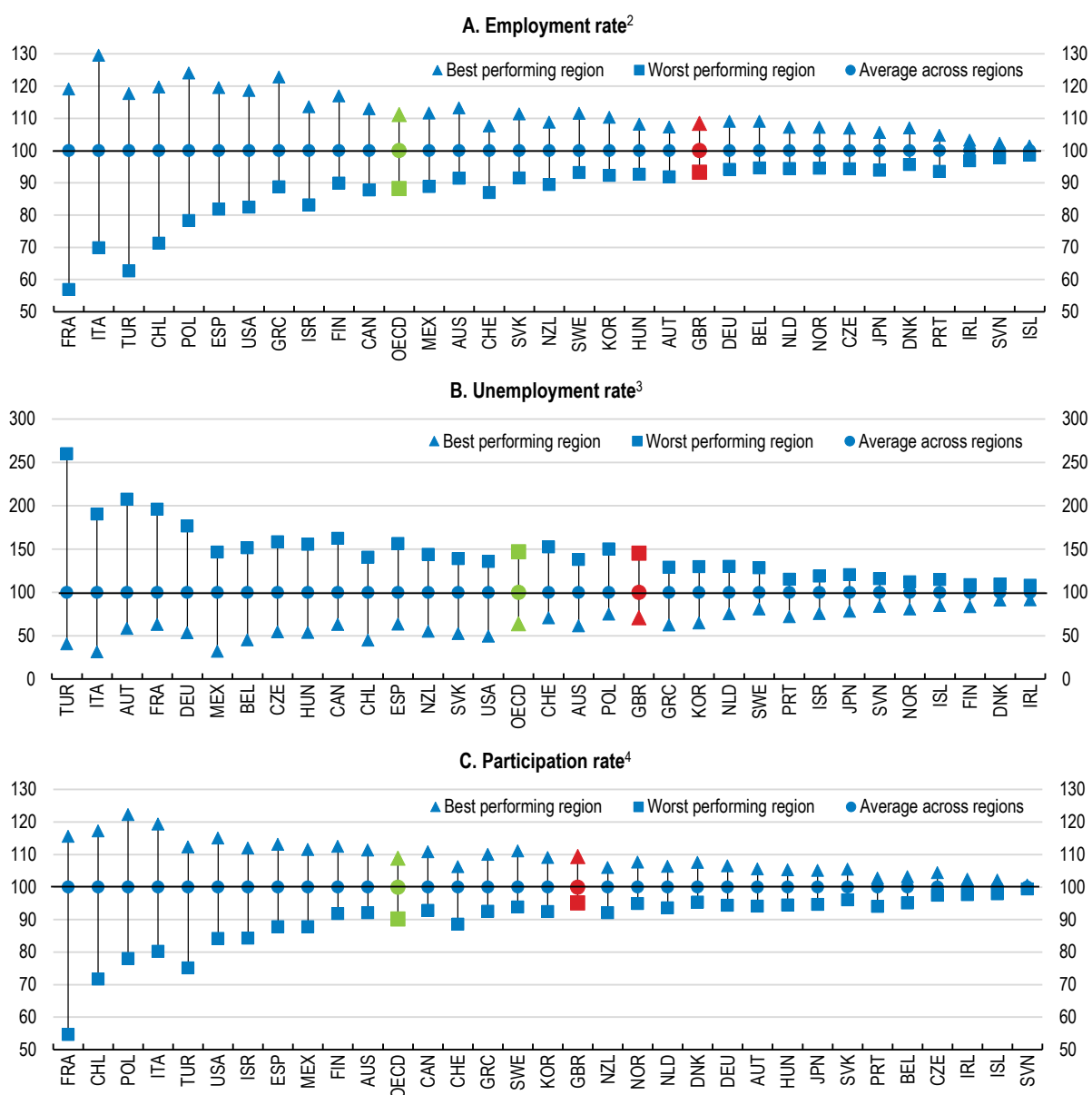
Figure 1. Disparities in regional labour productivity are important in the United Kingdom

Gross value added (GVA) per worker by region (at TL2 level), index average level across regions = 100, 2014¹



1. Data refer to 2013 for Finland and Hungary. Data refer to 2012 for Japan, New Zealand and Switzerland. In the case of the United Kingdom, there are 12 regions (i.e. North East England, North West England, Yorkshire and The Humber, East Midlands, West Midlands, East of England, Greater London, South East England, South West England, Wales, Scotland and Northern Ireland) at TL2 level. Countries are ranked in descending order of the difference in the level of productivity between the best and the worst performing region. Chile and Mexico, where regional disparities in labour productivity are very high, are excluded from the chart.

Source: OECD (2017), "Regional Economy", OECD Regional Statistics (database).

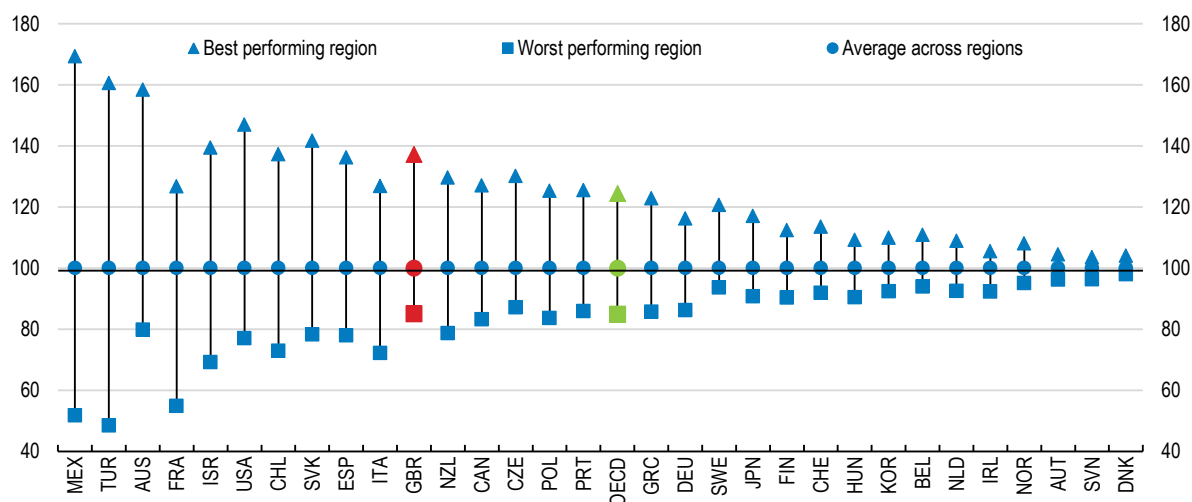
Figure 2. Regional differences in UK labour market outcomes are smaller than the OECD averageBy region (at TL2 level), index average level across regions = 100, 2015¹

- 2014 for Chile, Iceland, Israel, Japan, Korea, Mexico, New Zealand and the United States. Data refer to the population aged over 15. Territorial level 2 (TL2) refers to large regions within a country. In the case of the United Kingdom, there are 12 regions (i.e. North East England, North West England, Yorkshire and The Humber, East Midlands, West Midlands, East of England, Greater London, South East England, South West England, Wales, Scotland and Northern Ireland) at TL2 level. The OECD aggregate is calculated as an unweighted average of the data shown.
- Countries are ranked in descending order of the difference in the level of employment rate between the best and the worst performing region.
- Countries are ranked in descending order of the difference in the level of unemployment rate between the worst and the best performing region.
- Countries are ranked in descending order of the difference in the level of participation rate between the best and the worst performing region.

Source: OECD (2017), "Regional Labour", *OECD Regional Statistics* (database).

Figure 3. Household incomes are dispersed significantly across UK regions

Disposable household income per capita by region (at TL2 level), index average level across regions = 100, 2014¹

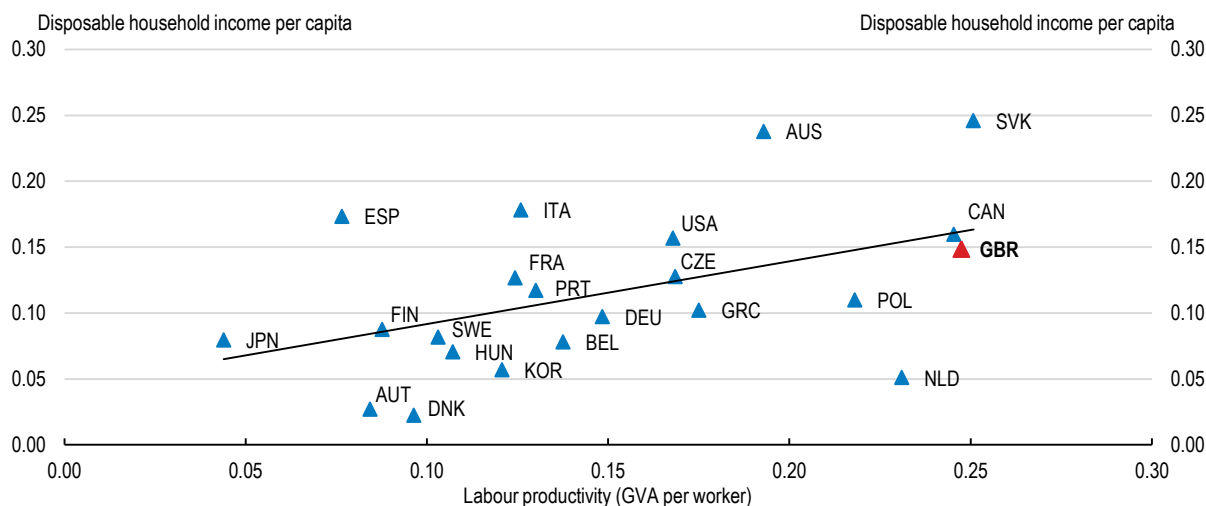


1. 2013 for Belgium, Finland, France, Greece, Hungary, Ireland, Japan, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden and Switzerland. 2012 for Chile. Territorial level 2 (TL2) refers to large regions within a country. In the case of the United Kingdom, there are 12 regions (i.e. North East England, North West England, Yorkshire and The Humber, East Midlands, West Midlands, East of England, Greater London, South East England, South West England, Wales, Scotland and Northern Ireland) at TL2 level. Countries are ranked in descending order of the difference in the level of household disposable income per capita between the best and the worst performing region. The OECD aggregate is calculated as an unweighted average of the data shown.

Source: OECD (2017), "Regional Economy", *OECD Regional Statistics* (database).

Figure 4. Dispersions in labour productivity and disposable household income are positively correlated

Coefficient of variation (standard deviation / mean) across regions at TL2 level, 2014¹



1. 2013 for Belgium, Finland, France, Greece, Hungary, the Netherlands, Poland, Portugal, the Slovak Republic, Spain and Sweden. 2012 for Japan. Mexico, where regional disparities in labour productivity are very high, is excluded from the chart. Territorial level 2 (TL2) refers to large regions within a country. In the case of the United Kingdom, there are 12 regions (i.e. North East England, North West England, Yorkshire and The Humber, East Midlands, West Midlands, East of England, Greater London, South East England, South West England, Wales, Scotland and Northern Ireland) at TL2 level.

Source: OECD (2017), "Regional Economy", *OECD Regional Statistics* (database).

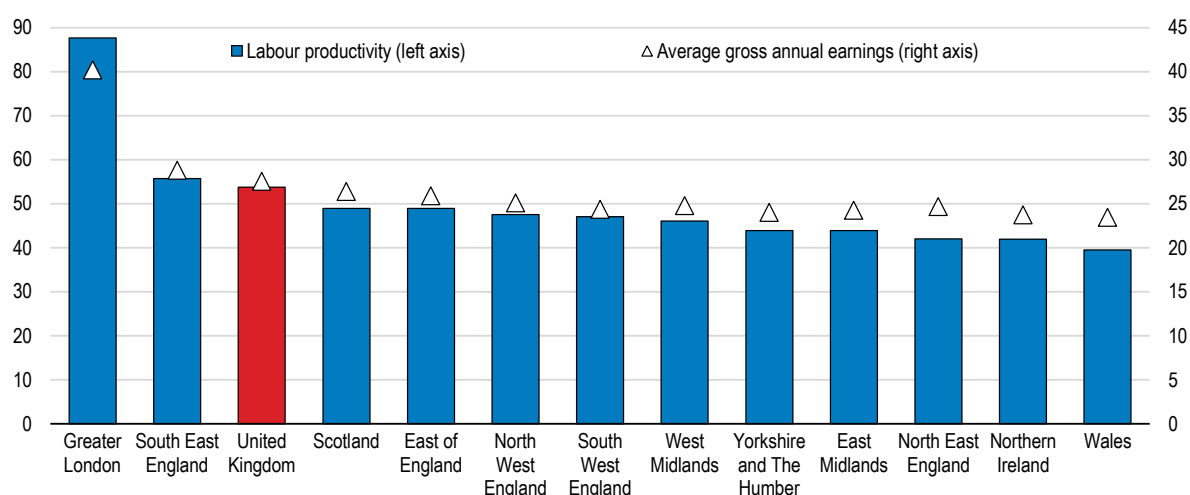
Labour productivity and exports across UK regions

Determinants of regional productivity differences

7. **Differences in labour productivity and wages are significant across the United Kingdom.** Greater London is the UK's productivity powerhouse, followed by the South East, while other regions are below the UK average (Figure 5). In turn, disparities in wage levels broadly reflect those in productivity. Productivity compression below the UK average suggests that a number of common factors could hold back most regions. There are several reasons why lower productivity regions fail to catch up (CBI, 2016). *First*, educational attainment of young people at 16 is low, skills are weak and explain one-fifth to one-quarter of all vacancies across regions, and graduates from the best universities often migrate to London. *Second*, regional and urban transport links are poor and firms face challenges to absorb digital technology, reducing their ability to share best practice and access labour, markets and suppliers. *Third*, employee-related incentive programmes do not sufficiently promote better management practices, which can be a stronger bottleneck for lagging regions where management needs to improve. *Fourth*, innovation and export capacity are weak and this can disproportionately affect the less productive regions which rely more on manufacturing goods exports.

Figure 5. Greater London and South East England have above-average productivity and wages

In GBP thousand, current prices, 2014¹



1. Labour productivity refers to gross value added per worker. Data for average gross annual earnings refer to all employee jobs including part-time employee jobs.

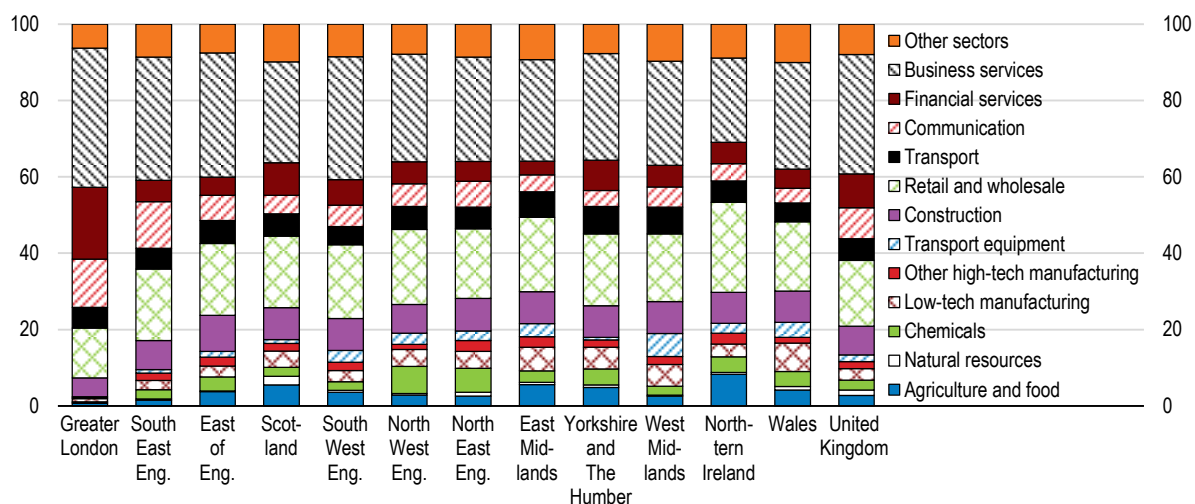
Source: OECD (2017), "Regional Economy", *OECD Regional Statistics* (database); and ONS (2016), "Annual Survey of Hours and Earnings: 2016 provisional results", Office for National Statistics, October.

8. **Sectoral specialisation is also an important factor behind regional differences in productivity.** At first sight, most regions seem to have a similar sector composition (Figure 6). However, a more detailed analysis shows that the most productive UK regions are intensive in knowledge-based services, including financial and insurance activities, information and communication, and professional and scientific activities (Figure 7). In parallel, the least productive regions have a lower specialisation in knowledge-intensive services sectors and are relatively more specialised in manufacturing, in particular its low-tech segment. Several factors may explain a weakening contribution of the manufacturing sector to overall productivity gains. Recessions undermined this sector, which tended to recover less than the rest of the economy, and there was a cross-sector shift from above-average-productivity jobs to below-average-productivity jobs between 1991 and 2015 (IPPR, 2016). Other factors include greater demand for services compared to manufactured goods, reductions in the number of workers needed to produce manufactured

goods, and greater competition from emerging and other advanced economies (OECD, 2017a). Weak domestic supply chains (concomitant with strong integration in global value chains) are also holding back the manufacturing base, especially in car manufacturing (Figure 8). Finally, the pricing in foreign currency and weak ability to compete with imports limit the potential positive impacts of exchange rate depreciation on exports and production (JPMorgan, 2016).

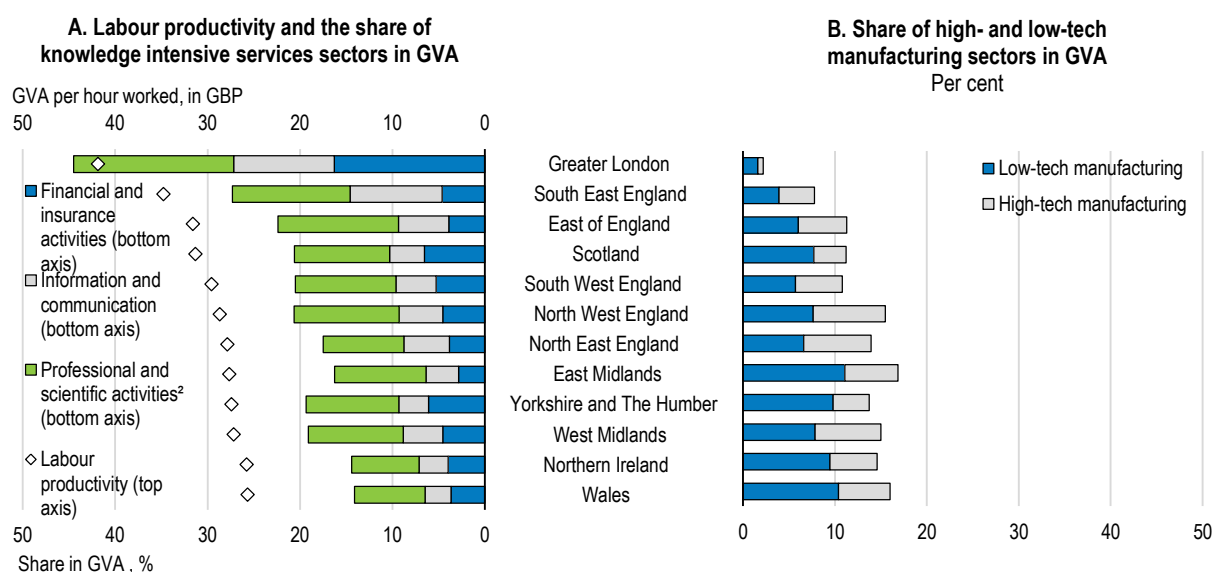
Figure 6. Sector specialisation seems uniformly distributed across UK regions

Sector shares in gross value added by region, per cent, 2015¹



1. Regions are ranked in descending order of the level of labour productivity. Low tech manufacturing includes textiles, wearing apparel and leather products (CB), basic metals and metal products (CH) and other manufacturing and repair (CM). Transport equipment includes car and truck manufacturing and other transport equipment (incl. aerospace). Other high tech manufacturing includes computer, electronic and optical products (CI), electrical equipment (CJ) and machinery and equipment not elsewhere classified (CK). Wood and paper products and printing (CC) and public services (O-Q) are excluded from the calculations.

Source: ONS (2016), "Regional gross value added (income approach), UK: 1997 to 2015", Office for National Statistics, December.

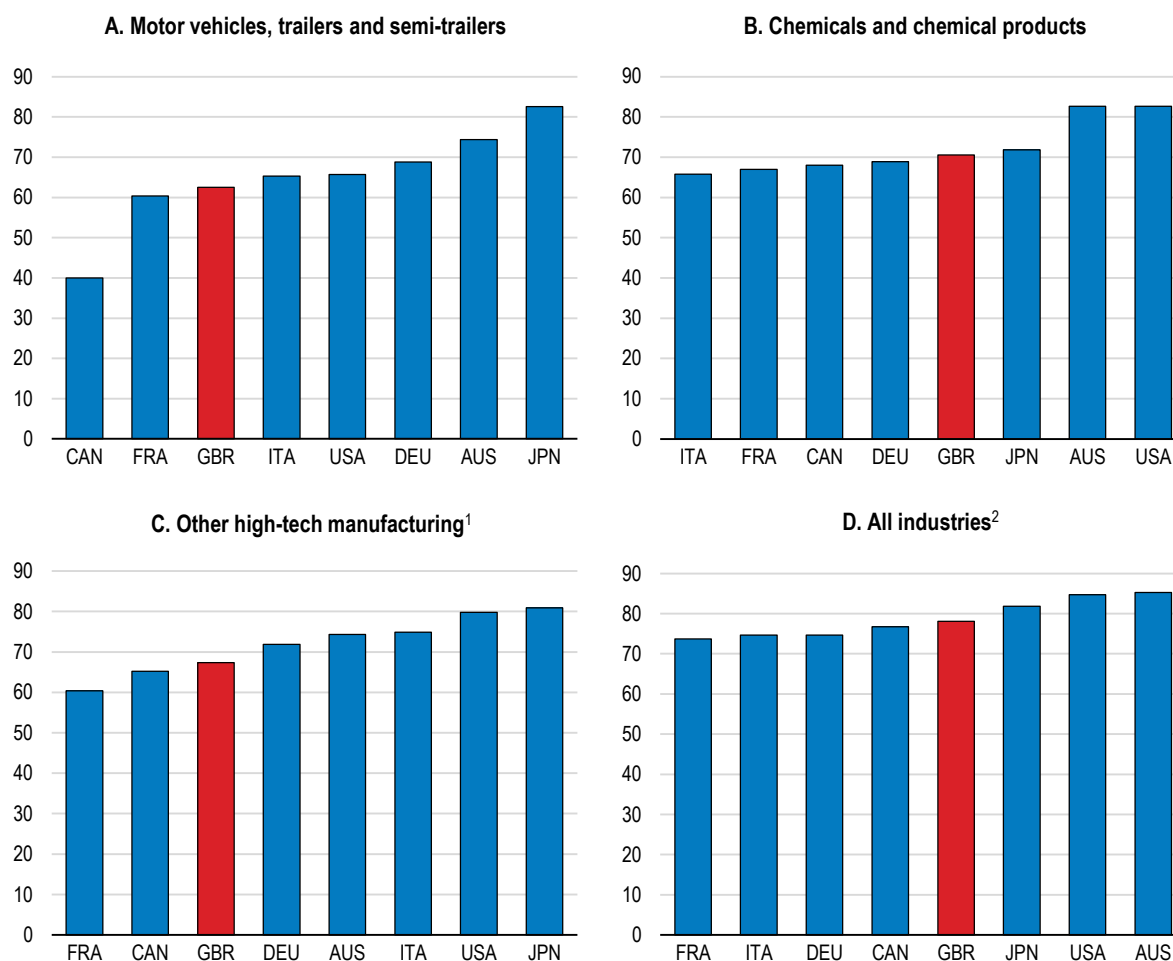
Figure 7. Most productive UK regions are heavily specialised in knowledge intensive servicesBy regions at TL2 level, 2015¹

- Regions are ranked in descending order of their level of labour productivity (i.e. gross value added (GVA) per hour worked). High-tech manufacturing refers to chemicals and chemical products (CE), basic pharmaceutical products and preparations (CF), computer, electronic and optical products (CI), electrical equipment (CJ), machinery and equipment not elsewhere classified (CK), transport equipment (CL) based on SIC07 industry classification. Low-tech manufacturing refers to food products, beverages and tobacco (CA), textiles, wearing apparel and leather products (CB), wood and paper products and printing (CC), coke and refined petroleum products (CD), rubber and plastic products (CG), basic metals and metal products (CH), other manufacturing and repair (CM) based on SIC07 industry classification.
- Professional, scientific and technical activities and administrative and support service activities

Source: ONS (2016), "Regional gross value added (income approach), UK: 1997 to 2015", Office for National Statistics, December; and ONS (2017), "Regional and sub-regional productivity in the UK: Jan 2017", Office for National Statistics, January.

Figure 8. Domestic content in key export sectors is comparatively low

Domestic value added share of gross exports by selected industries, percentage, 2014



1. Other high-tech manufacturing includes machinery and equipment, nec; electrical and optical equipment; and other transport equipment.

2. All industries refer to all sectors including services.

Source: OECD (2018), "Trade in value added, nowcast estimates", *OECD-WTO: Statistics on Trade in Value Added* (database), January.

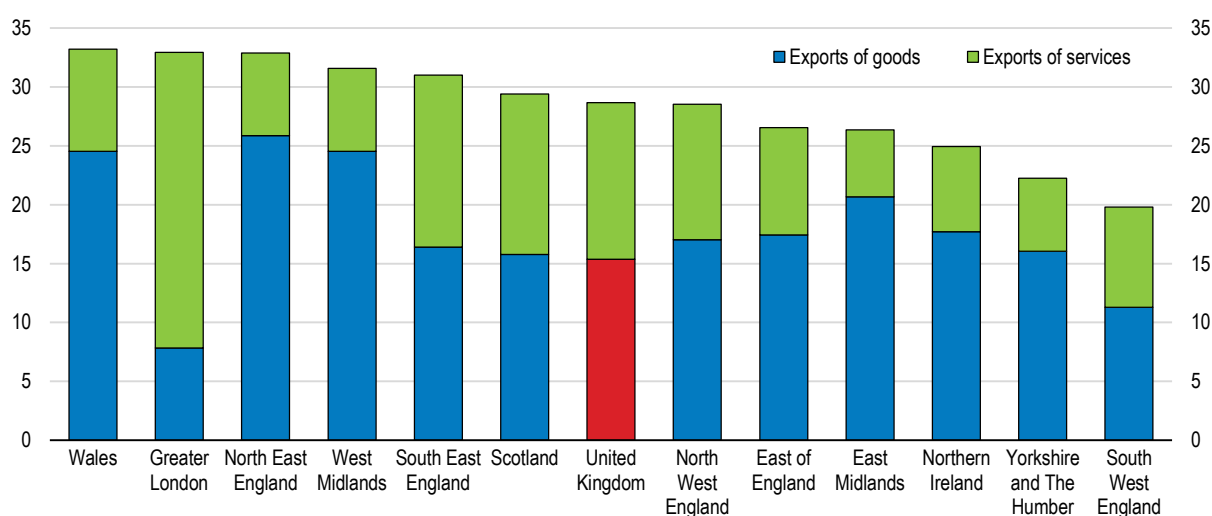
9. Differences in labour productivity within sectors and regions are larger than across them.

Every region and sector has a great variety of firms with different levels of productivity, and some regions (such as Greater London) have a greater number of high-productivity firms (frontier firms). Greater urbanisation, proximity of rural regions to cities, and the development of tradable sectors (especially among tradable services, manufacturing or resource extraction) have been identified as factors promoting the catch-up of the least productive regions in the OECD (OECD, 2016). However, evidence for the United Kingdom shows that within-region and within-sector differences in productivity are larger than across-region and across-sector differences (Haldane, 2016), which suggests the existence of barriers to the diffusion of innovation, knowledge and technology (Andrews et al., 2015, 2016). For instance, even if the supply of digital infrastructure is appropriate, take-up by UK smaller firms could be low owing to high costs, limited awareness and low digital skills (CBI, 2016).

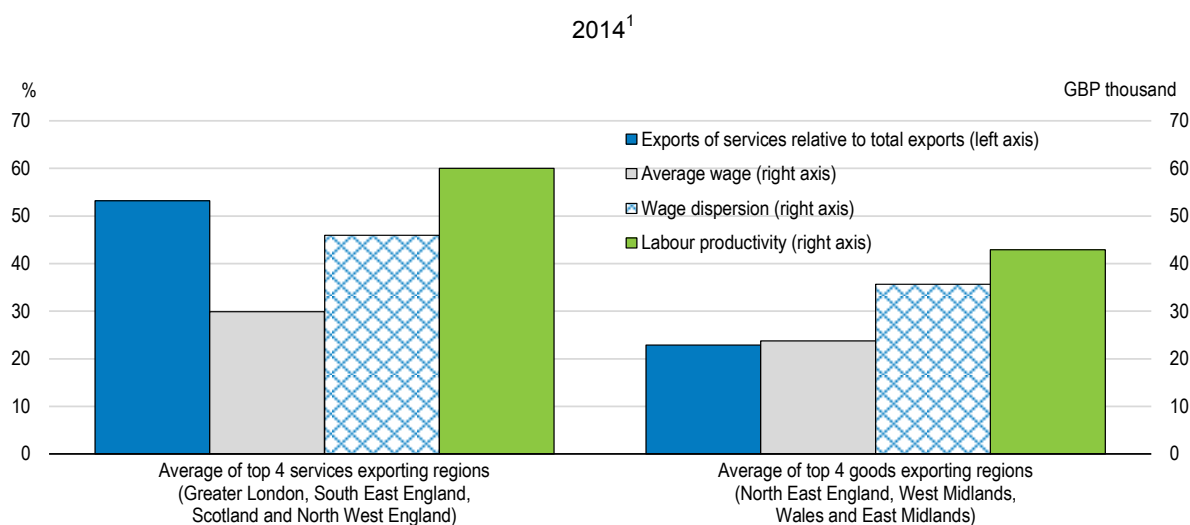
Role of export structure in explaining regional productivity

10. **The composition of tradable sectors goes hand in hand with regional differences in productivity and wages.** Total UK exports of goods account for 16% of gross value added (GVA), against 12% of GVA for services, but these aggregates mask sizeable regional heterogeneities (Figure 9). Export intensity varies and exceeds 30% of GVA in five regions and is at or below 25% of GVA in three others. Exporting firms pay higher wages, but this link does not hold for regions, as for instance Wales and North East England are among the biggest exporters but lag behind peers in terms of GVA per employee and earnings (Figure 5). The regional structure of exports appears more important, in particular the difference between tradable goods and tradable services. Greater London, South East England and Scotland have large tradable services sectors and the highest productivity levels in the United Kingdom. More generally, regions with the highest services exports in total exports combine better productivity performance and higher wage levels, but incidentally their within-region dispersion in wages is also higher (Figure 10). This contrasts with regions where goods exports are dominant and which lag behind in terms of productivity and wages, but also have smaller differences in wage distribution. Regional specialisation could potentially explain these patterns, with low value added stages of production (such as assembly lines) located in goods-oriented regions and high-value added stages of production (such as firms' management, marketing or design) located in services-oriented regions.

Figure 9. Composition differences exist between tradable services and tradable goods across regions
As a percentage of regional GVA, 2014



Source: HM Revenue & Customs (2016), "Regional Trade Statistics", December; ONS (2016), "Estimating the value of service exports abroad from different parts of the UK: 2011 to 2014", Office for National Statistics, July; OECD (2017), "Regional Economy", *OECD Regional Statistics* (database).

Figure 10. Regions specialised in tradable services have higher productivity, wages and inequality

1. The top 4 services/goods exporting regions are identified by exports as a share of regional gross value added (GVA). Data for average gross annual earnings refer to all employee jobs including part-time employee jobs. Wage dispersion refers to the difference between top and bottom deciles. Labour productivity refers to GVA per worker.

Source: HM Revenue & Customs (2016), "Regional Trade Statistics", December; ONS (2016), "Estimating the value of service exports abroad from different parts of the UK: 2011 to 2014", Office for National Statistics, July; OECD (2017), "Regional Economy", *OECD Regional Statistics* (database); and ONS (2016), "Annual Survey of Hours and Earnings: 2016 provisional results", Office for National Statistics, October.

11. **When coping with globalisation, UK regions specialised in tradable goods face challenges and regions specialised in tradable services face opportunities.** Estimates of revealed comparative advantage (Brakman and Van Marrewijk, 2016) find some sectors to be highly competitive in terms of gross exports but not in terms of value added exports (transport equipment), and vice versa (mining). More importantly, both indicators concur that the United Kingdom has a comparative advantage in a number of services sectors (air travel, financial services, other business and services), but has a comparative disadvantage in many goods sectors (textiles, other manufacturing and recycling, leather, plastics, basic metals, electricity, food, agriculture). Recent OECD estimates suggest that the range of products in which the United Kingdom has a comparative advantage has narrowed over time, although the importance of automobiles in the UK's export basket has increased (Araujo et al., 2017).

Modelling export shocks

Assumptions

12. **Three stylised sets of sector-specific export shocks are considered.** Previous OECD analysis considered two types of trade shocks in the near term (Kierzenkowski et al., 2016). UK trade was assumed to be governed by the most favoured nation (MFN) status from 2019, before the negotiation of a comprehensive FTA between the United Kingdom and the EU27 bloc, similar to the one between the European Union and Canada, by 2023. Building on this analysis, this study extends it to non-tariff measures (NTMs) on goods and trade restricting measures on services, and considers three types of trade shocks simulated using the OECD METRO model of trade (Box 1):

- The "Tariffs and non-tariffs" export shock assumes that total UK trade is governed by tariffs set under the MFN regime of the WTO, augmented with the effect of higher than currently trade costs related to NTMs *vis-à-vis* the European Union on goods (manufacturing, agriculture and food)

(OECD, 2011), and higher restrictions on trade in services (insurance, financial services, business services, communication, trade, transport, construction and government services). NTMs capture a whole range of non-tariff costs to trade, including the potential role of different future regulatory frameworks in the European Union and the United Kingdom (regulatory divergence);

- The “FTA” export shock assumes that tariffs on goods are unchanged in trade with the European Union, but they are increased in trade with non-EU countries, NTMs on goods and services trade restrictions are set at half their values in the “Tariffs and non-tariffs” shock (except for communication and other government services sectors, see below) (Figure 11), and there is an extra trade cost for compliance with rules of origin (equivalent to 10% of the tariff and modelled as an additional cost on exports).
- The “FTA and global services liberalisation” export shock illustrates what it would take for services exports to offset the negative impacts of the “FTA” export shock, for instance as a result of a multilateral effort to reduce services trade barriers. Specifically, this shock assumes that services exports uniformly increase across all services sectors by such an amount that the overall change in GDP is zero. Recent empirical evidence suggests that reducing restrictive regulations would lower firms’ mark-ups in a majority of services sectors and foster pro-competitive gains from trade liberalisation, potentially leading to increases in productivity (Rouzet and Spinelli, 2016).

Table A3 in the Annex presents in detail the initial and the final tariffs, and assumed changes in NTMs on goods and trade costs on services, under the three shocks. These shocks differ from a recent study by Dhingra et al. (2017), which always assumes increases in services barriers, and differentiates across its two scenarios by the degree of these changes and those of tariffs on goods.

Box 1. The METRO model

The analysis uses the METRO model, which is a computable general equilibrium model (CGE) described in detail in OECD (2015). CGE models rely on a complete specification of all economic activity within and between countries (and therefore the different inter-linkages that tie these together) and are suitable for examining whole-of-the-economy impacts. The METRO model builds on the GLOBE model developed by Scott McDonald and Karen Thierfelder (2013). The novelty and strength of the METRO model lies in the detailed trade structure and the differentiation of commodities by use – commodities and thus trade flows are distinguished by use category, i.e. whether these are designed for intermediate use, used by households, for government consumption or as investment commodities. On the supply side, the efficiency (or productivity) of production factors – capital, labour, land and intermediates – is assumed to be unaffected by trade intensity. The model is comparative static, and assumes that factor endowments (labour, capital, land and natural resources) are fixed, but production factors are domestically mobile across alternative uses.

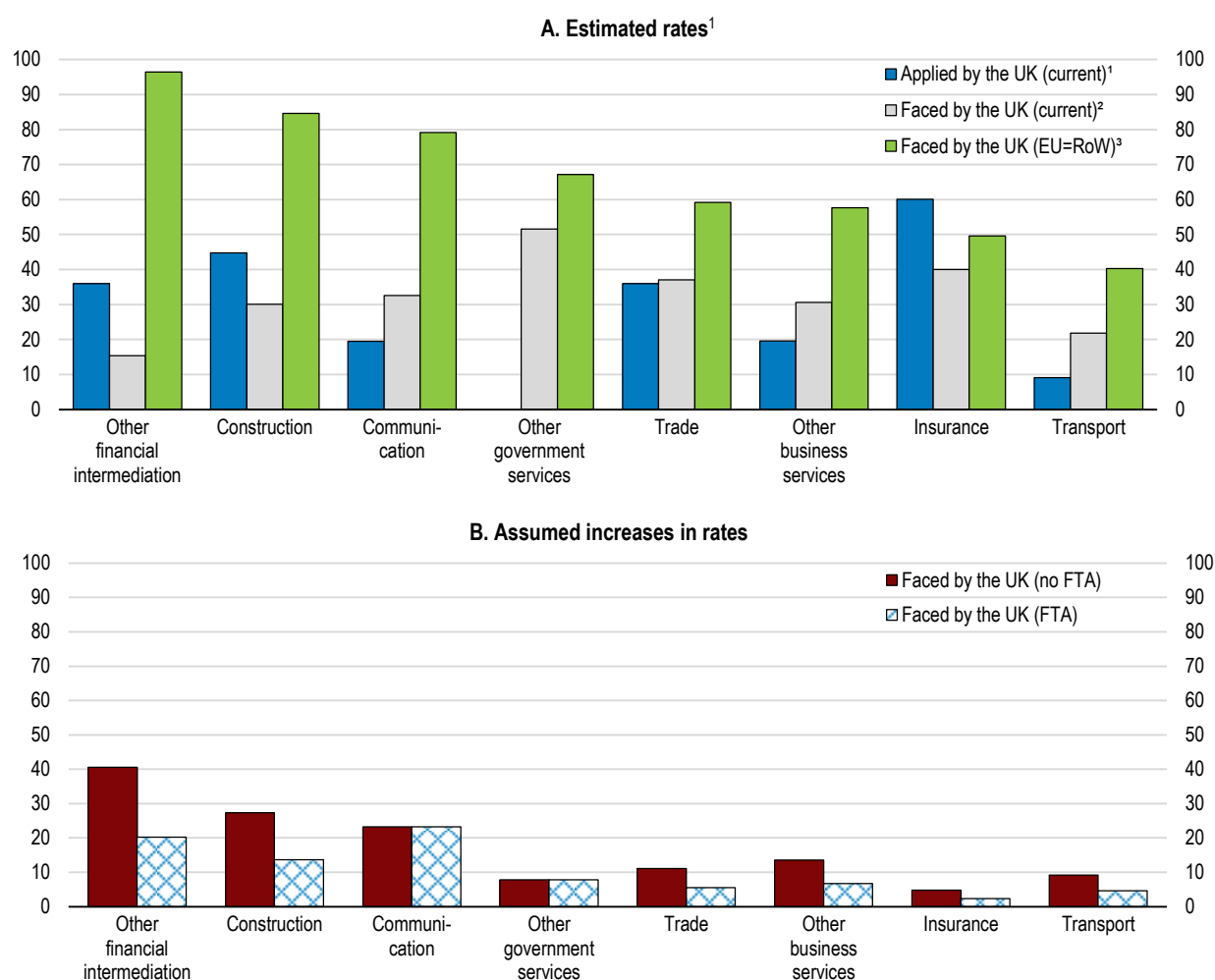
The database of the model relies on the GTAP v9 database (Aguiar et al., 2016) in combination with the OECD Trade in Value Added data (OECD, 2013). Policy information combines tariff and tax information from GTAP with OECD estimates of non-tariff measures on goods, trade facilitation and export restricting measures.

The underlying approach is the construction of a series of single-country CGE models that are linked through trade relationships. The model distinguishes activities which produce commodities. Activities maximise profits and form output from primary inputs (i.e. land, natural resources, labour and capital), combined using Constant Elasticity of Substitution (CES) technology, and intermediate inputs in fixed shares (Leontief technology). Households are assumed to maximise utility subject to a Stone-Geary utility function. Most of the policy instruments are formulated as *ad valorem* rates on commodities and activities. *Ad valorem* estimates of NTMs on goods and services barriers are implemented as ‘iceberg’ trade costs: reducing these trade costs leads to an efficiency gain (less of the good or service is needed to satisfy demand, or put differently, less of it ‘melts away’ in transit). Taxes are the only income source to the government (income tax is defined by fixed tax rates) and closure rules for the government account allow for various fiscal specifications (the default assumption is a fixed internal balance and flexible government expenditures).

Source: OECD (2015), METRO v1 Model Documentation. McDonald, S. and K.E. Thierfelder (2013), Globe v2: A SAM Based Global CGE Model using GTAP Data, Model documentation. Available at: <http://www.cgemod.org.uk/>

Figure 11. Estimated and assumed tariff equivalents of barriers on services trade

Ad valorem equivalents of restrictions on trade in services, percentage, 2011



1. It refers to the CEPII import restrictiveness index of the United Kingdom.
2. It is calculated as a weighted average of 42 countries' CEPII import restrictiveness index, where the weights are calculated as exports from sector *s* of the United Kingdom to sector *s* of country *i* as a share in the total exports from sector *s* of the United Kingdom to sector *s* of all countries.
3. It is calculated as a weighted average of 42 countries' CEPII import restrictiveness index with the EU countries import restrictiveness index considered equal to the average of non-EU countries' import restrictiveness index. The weights are calculated as exports from sector *s* of the United Kingdom to sector *s* of country *i* as a share in the total exports from sector *s* of the United Kingdom to sector *s* of all countries. RoW: rest of the world.

Source: Calculations based on Fontagné, L., C. Mitaritonna and J. Signoret (2016), "Estimated Tariff Equivalents of Services NTMs", *CEPII Working Paper*, No. 2016-20, August; and Timmer, M. P., Dietzenbacher, E., Los, B., Stehrer, R. and de Vries, G. J. (2015), "An Illustrated User Guide to the World Input–Output Database: the Case of Global Automotive Production", *Review of International Economics*, 23: 575–605.

13. **Trade in services is subject to important barriers.** Services restrictions include border measures (local presence requirements, etc.) and behind-the-border measures stemming from domestic laws, regulations and practices. The OECD has recently published an in-depth analysis of services trade policies, including a discussion of barriers to services trade using the OECD Services Trade Restrictiveness Index (STRI) OECD (2017b), and cross-country calculations of *ad valorem* tariff equivalents of the STRI

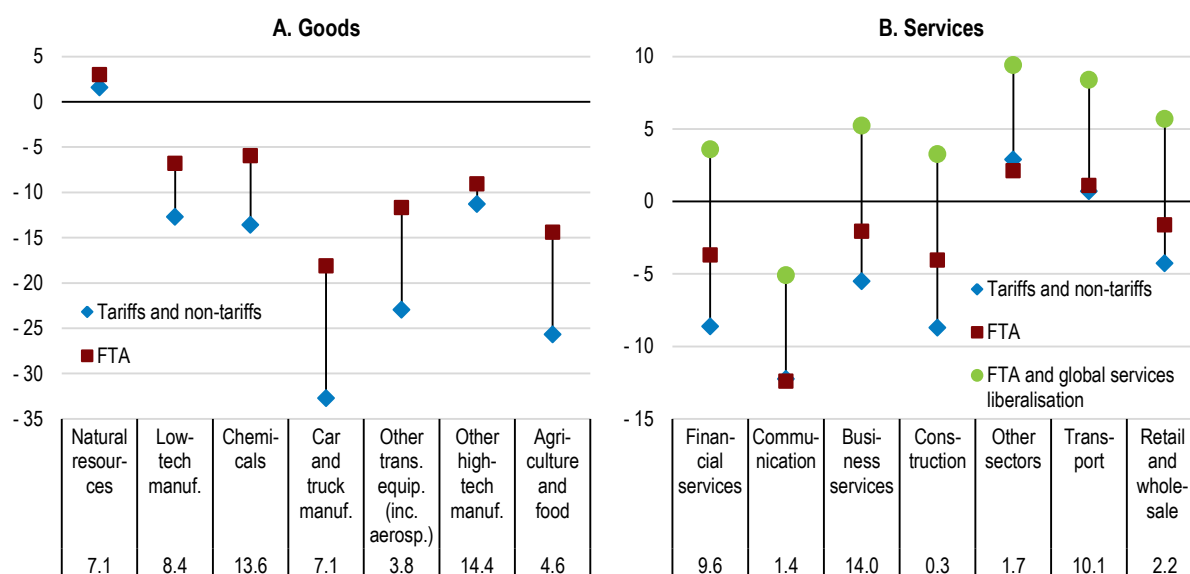
(Benz, 2017). This study uses estimates of tariff equivalents of trade barriers on services sectors, estimated by comparing actual trade against a benchmark from Fontagné et al. (2011, 2016), which can readily be incorporated in the METRO model. Transport, communications and other business services appear the most liberalised in the United Kingdom (Figure 11, Panel A). However, the insurance sector is estimated to be the most protected, followed by construction, and other financial intermediation. For these sectors, tariff equivalents of services barriers are higher in the United Kingdom than the weighted average rates applied by countries importing from the United Kingdom. Should the United Kingdom face the same level of barriers on the EU market as it faces on non-EU markets, the estimated rates would increase significantly, in particular for financial services, construction and communication sectors (Figure 11, Panel B). For the export shock with the offsetting positive increase in services exports, the associated changes in services barriers are not calculated.

14. **Only a fraction of estimated non-tariff measures is amenable to policy changes.** The term “non-tariff measures” (NTMs) covers a diverse set of measures in terms of purpose, legal form and economic effect. NTMs comprise all policy measures other than tariffs and tariff-rate quotas that have a more or less direct incidence on international trade as they affect the price of traded products, the quantity traded, or both. More importantly, domestic regulations may prescribe specific requirements for products to be sold on a given market. Generally, such measures aim to overcome or reduce the impacts of perceived market imperfections, such as those related to negative externalities, risks for human, animal or plant health, or information asymmetries. However, they also tend to increase production and trade costs and may affect, positively or negatively, the development of new technologies or production methods.

15. **NTMs can become non-tariff barriers if they are explicitly introduced as a masked way to reduce or stop imports from certain exporting countries, or if they impose unnecessary costs and compliance burdens.** Regulations may have adverse effects on imports particularly if they differ from those applied in the exporting country, as foreign suppliers wishing to export to regulated markets generally face additional trade costs. The diversity of NTMs makes their quantitative analysis difficult, and they have been the subject of substantial academic and policy attention. Unlike tariffs, trade costs related to NTMs cannot be reduced to zero: exporters will always incur some cost related to compliance with foreign (and domestic) regulations.

16. **The challenge is to assess which part of the trade costs related to NTMs is potentially reducible, or ‘actionable’.** Berden et al. (2009) find that intra-EU trade costs related to NTMs are not zero, but significantly lower than extra-EU trade. In the context of transatlantic trade and investment flows, they argue that 50% of trade costs could be eliminated in an optimistic scenario, but a reduction by 25% would be more realistic. This finding is guiding the assumption made for NTMs facing UK goods and costs on services exports outside the European Union. It is assumed that the tariff equivalents of NTMs on UK-EU trade would rise to 50% of the observed difference of intra- and extra-EU trade in the case when UK trade is governed by the MFN status, and by 25% of this difference if UK-EU trade is covered by an FTA (Figure 11, Panel B). As the FTA is modelled on the EU-Canada CETA agreement, no liberalisation is assumed for communication and other government services (Webb, 2017).

17. **Despite large increases in the various non-tariff trade costs, the METRO model simulations show larger impacts of different shocks on goods than on services (Figure 12).** This is due to a stronger responsiveness of goods producing sectors to tariff changes, partly explained by the limited scope of the services trade that is actually covered in the trade data and the trade cost estimates. Those do not include foreign commercial presence and cross-border movement of people, which are larger than cross-border exports of services (OECD, 2017). The “FTA and global services liberalisation” export shock implies a 7.2% increase in services exports, on top of the change in exports implied by the “FTA” shock, to offset the negative impact on GDP. Except for communication, this would translate into an expansion of services exports across all sectors.

Figure 12. Simulation results: export shocks by sectorPercentage change in exports compared to current level¹

1. Current levels (as a percentage of total exports, 2015) of export shares are shown on the second line of the x-axis' label. Sectors are ranked in descending order of the level of labour productivity. The agriculture sector in the firm level data covers only the corporate segment.

Source: Own calculations; and OECD (2015), *METRO model database*.

Estimation and simulation

18. **The empirical analysis quantifies the impact of sector-level export shocks on firm-level outcomes to derive the effects on sectors and regions.** The analysis is three-pronged (Box 2). The *first* step is to estimate the historical relationships at the firm level between the outcome variables (productivity, employment and wages) and sector-aggregate exports. Although the effects of entry and exit of firms are disregarded, estimating the responsiveness (or elasticities) to sector aggregate exports rather than identifying the effects based on firm-level export changes carries two advantages. *First*, it takes into account potential spillovers on non-exporting firms rather than focusing only on those firms that export. *Second*, it mitigates the risk of endogeneity stemming from potential reverse causality between the outcome variables and exports, assuming export concentration within sectors is not too high. The sample contains about 210,000 firm-year observations over the period 1995-2014. As shown in the Annex, thirteen key sector-groups are considered (Table A1), for which regression results are obtained with each sector-group treated separately (Table A2). Financial services are not covered by the firm-level dataset, hence the elasticities for the financial sector are assumed to be the same as for business services. The *second* step combines the sector-level export shocks as provided by the METRO model (OECD, 2015), with the estimated elasticities in the first step to simulate all three outcomes for an average firm in each sector. The *third* step aggregates these simulations to sectors and regions, the results of which are presented below.

19. **The approach considers the average firm in each sector.** Put differently, this framework does not differentiate the impacts across firms by their export intensity, implying that the impact on the outcome variables is the same for all firms in a sector. Moreover, the export shocks from the METRO model incorporate general equilibrium effects, but the simulation phase using firm-level data does not take into account cross-sector spillover effects on the outcome variables (productivity, wages and employment).

Box 2. Estimation, simulation and aggregation of results

The estimation step uses firm-level data to assess the empirical relationship between outcome variables and exports. Firm-level data stem from Orbis, a large-scale longitudinal company-level database from Bureau van Dijk, with data spanning 20 years (1995-2014). The database covers the business sector, except financial services, at 2-digit industry codes in the NACE Rev 2 classification system (codes from 1 to 82, except 64-66). The sample contains 30,000 to 40,000 company accounts each year and the analysis retains firms that report for at least three consecutive years and for all the outcome variables considered (to obtain a common sample), yielding about 210,000 firm-year observations for the whole period.

The firm-level regressions take the following form:

$$\Delta Y_{it} = \beta_Y^{(s)} \Delta X_{st} + D_{size,t-3} + D_{age,t} + D_i + D_t + \varepsilon_{it}, \quad \text{for } Y = LP, WP \text{ or } L \quad (1)$$

where Y_{it} represents for firm i either its labour productivity (LP_{it}) measured by the log of real value added over employment or its wage (W_{it}) measured by the log of real labour costs per employment or its employment (L_{it}) measured by the number of employees on payroll, ΔX_{st} denotes changes in the log of weighted-average exports of firms at the sector level, D_{size} and D_{age} stand for firm-size (seven categories) and age (five categories) categories, D_i and D_t indicate firm and year fixed effects respectively, and ε_{it} is the error term.

The coefficient of export changes, $\beta_Y^{(s)}$, is allowed to vary by sectors s to capture the potentially different reaction of the outcome variable depending on the economic activity of the firm. Real value added, exports and wages are calculated with 2-digit industry-level value added deflators. Three-year changes are used instead of one-year changes, which helps to identify more distant near-term effects and mitigates problems of high variability of year-to-year changes at the firm level. Moreover, outlier individual data with growth rates above top 1% or below bottom 1% of the total sample are removed. Standard errors are clustered at the sector level, to allow for potential correlation in the error term both across firms and over time (Moulton, 1986).

The simulation step uses the effects of shocks on exports, as derived from the OECD METRO model, to predict impacts on firm-level output variables. Based on the mapping of the Global Trade Analysis Project (GTAP) between activity (ISIC) and product (CPC) data, the METRO model provides export simulations for sectors, ΔX_s^{METRO} , in response to the tariff and tariff-equivalent changes under different shocks. Since these simulations are the same for each firm i in a given sector s , they can be referred to as follows (time subscript t is omitted for simplicity):

$$\widehat{\Delta Y}_s = \beta_Y^{(s)} \Delta X_s^{METRO}, \quad \text{for each outcome variable } Y = LP, WP \text{ or } L \quad (2)$$

The aggregation step uses the economic activity (sectors) and the location (regions) of the companies as recorded in their financial accounts. The aggregation is performed for the three outcome variables: employment, productivity and wages.

The *employment impact* at the sector level is given by equation (2) and the regional impact, $\widehat{\Delta L}_r$, is the weighted sum of these sector-level impacts:

$$\widehat{\Delta L}_r = \sum_s w_{sr} \widehat{\Delta L}_s, \quad \text{for each sector } s \text{ in region } r, \quad (3)$$

where the weight of sector s in region r is defined as $w_{sr} = \frac{L_{sr}}{\sum_s L_{sr}}$. The weights w_{sr} are obtained by using sector-region total employment figures for the year 2015 as provided by the UK Office for National Statistics (ONS), adjusted by relying on industry classification indicators at the firm level (NACE Rev 1 and NACE Rev 2) to ensure comparability with the industry structure of the METRO model (ISIC Rev 3, which is equivalent to NACE Rev 1 for our purposes).

The *productivity impact* at the sector level, $\widehat{\Delta LP}_s$, is the estimated within-firm effect, assumed to be uniform across firms in a given sector (disregarding reallocation effects from the entry and exit of firms):

$$\widehat{\Delta LP}_s = \widehat{\Delta LP}_i \quad \text{for each firm } i \text{ in sector } s. \quad (4)$$

The productivity impact at the regional level, $\widehat{\Delta LP}_r$, is the weighted average of within-sector effects:

$$\widehat{\Delta LP}_r = \sum_s w_{sr} \widehat{\Delta LP}_s \frac{LP_{sr}}{LP_r}, \quad (5)$$

The OECD regional productivity database is used to calculate the sector-region aggregate productivity, LP_{sr} , using an adjustment similar to the calculation of employment shares, so as to map the sector structure of the METRO model.

The *wage impact* at the sector level is derived similarly to the productivity effect. Also, the regional average wage is obtained as a sum of the within-sector effects.

Illustrating the distributional effects of export shocks

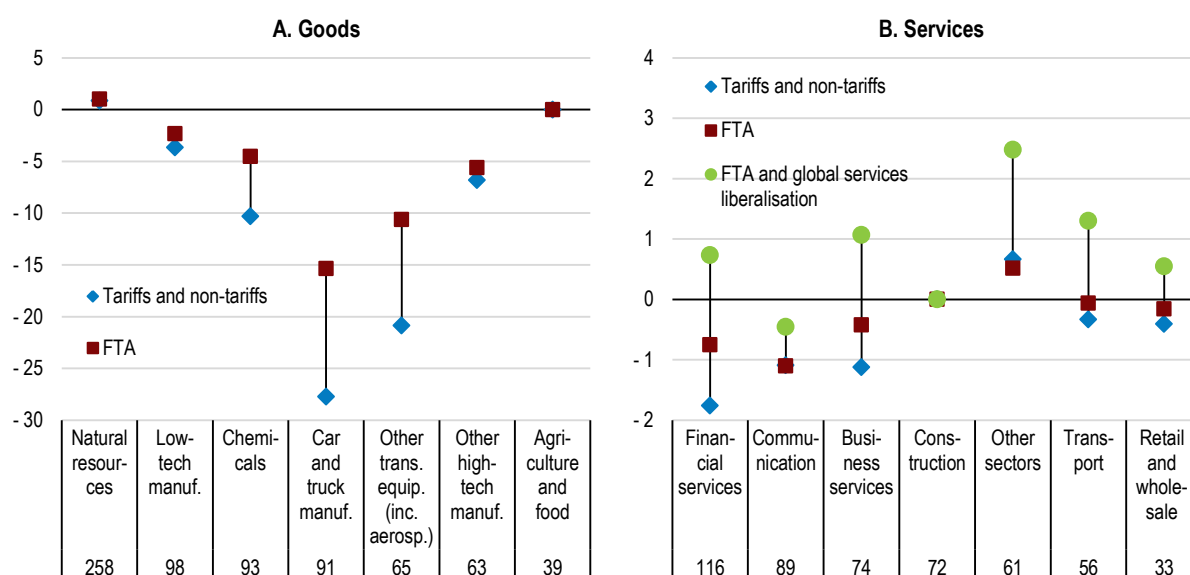
Transmission of shocks to sectors

20. **Labour productivity and wages are estimated to fall across most sectors following a negative export shock, with larger impacts on the goods sector and smaller impacts on the services sector.** Labour productivity drops in all goods sectors outside natural resources and agriculture (mainly the agro-food sector), by less than 5% in low-tech manufacturing, 5-10% in high-tech manufacturing and chemicals, and between 10-25% in car and truck manufacturing and other transport equipment (including aerospace) (Figure 13, Panel A). This contrasts with much more limited impacts on services sectors, where labour productivity falls at most by 2% across all types of shocks (Figure 13, Panel B). The impact of shocks on sectoral wages largely mimics the impacts on labour productivity (Figure 14). These differences between goods and services result from the smaller size of export shocks provided by the METRO model (Figure 12), combined with the lower estimated responsiveness of services to historical trade shocks than that of goods-producing sectors (Figure 15 and Table A2). As the estimates only include cross-border exports of services, they do not include potential effects on commercial presence in foreign markets and the associated wage and productivity effects. Relative to the “Tariffs and non-tariffs” export shock, the “FTA” export shock significantly mitigates the sectoral impacts for goods, in particular for transport equipment and chemicals.

21. **Employment effects are small overall, with one exception.** Car and truck manufacturing is the most affected, with a decline in employment in the range of 3-6% (Figure 16), due to the combined effects of the large size of the export shock (Figure 12) and the estimated statistically-significant relationship between exports and employment (Figure 15 and Table A2). The magnitude of these effects is likely to be driven by the high reliance of the sector on international value chains (Figure 8) and important economies of scale of production. In other sectors, job losses do not exceed 1% in the goods sector and are even more limited in the services sector, as a result of very low or statistically insignificant export elasticities in the sector-specific estimations for employment (Figure 15 and Table A2). A relatively contained response of employment to trade shocks and a more pronounced reaction of wages are consistent with the adjustment patterns observed on the UK labour market.

Figure 13. Export shocks have larger productivity impacts on goods than on services

Percentage change in gross value added (GVA) per total employment compared to current level¹

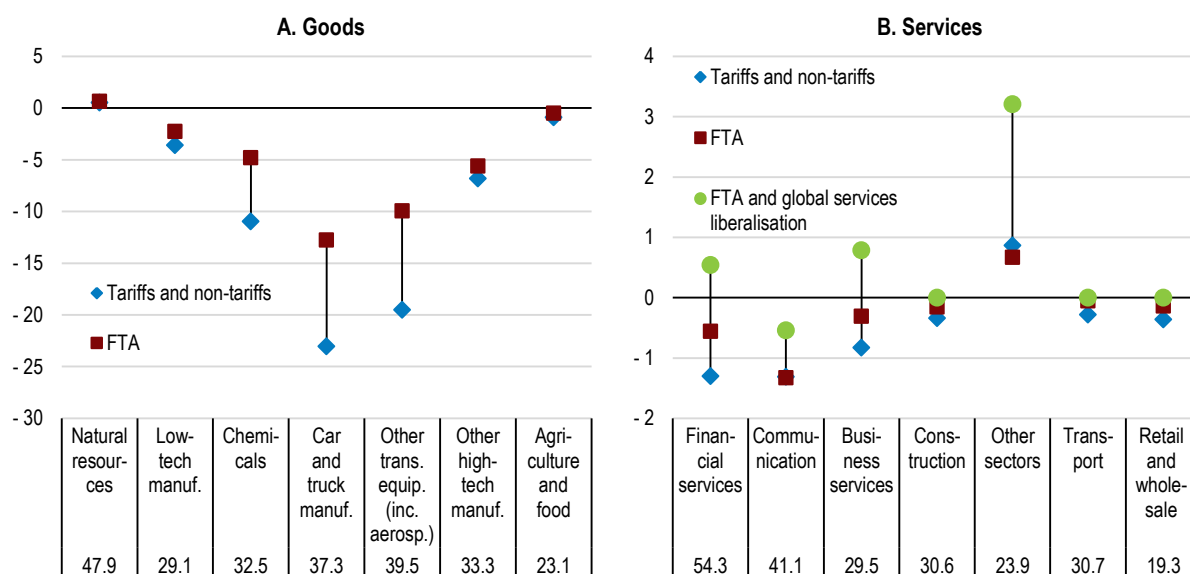


1. Current levels (in GBP thousand, current prices, 2015) of labour productivity are shown on the second line of the x-axis' label. Sectors are ranked in descending order of the level of labour productivity.

Source: Own calculations; ONS (2016), "UK GDP(O) low level aggregates", in Quarterly National Accounts: Quarter 3 (July to Sept) 2016, Office for National Statistics, December; and ONS (2016), "UK business register and employment survey (BRES): 2014 revised and 2015 provisional", Office for National Statistics, September.

Figure 14. Effects on wages mirror the effects on labour productivity across sectors

Percentage change in average gross annual earnings compared to current level¹

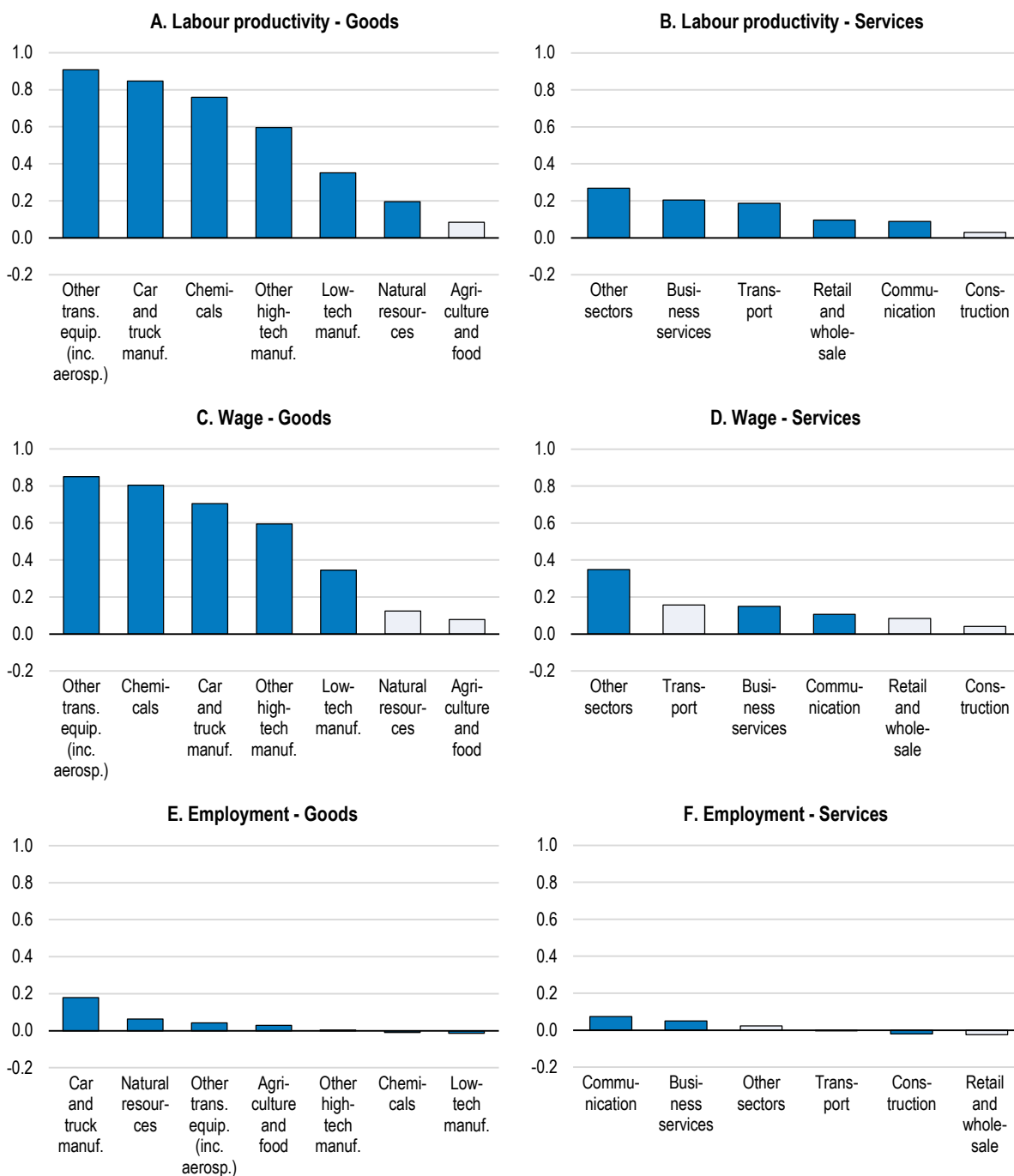


1. Current levels (in GBP thousand, current prices, 2015) of average gross annual earnings are shown on the second line of the x-axis' label. Sectors are ranked in descending order of the level of labour productivity. Data for average gross annual earnings refer to all employee jobs including part-time employee jobs.

Source: Own calculations; ONS (2016), "Annual Survey of Hours and Earnings: 2016 provisional results", Office for National Statistics, October; ONS (2016), "UK GDP(O) low level aggregates", in Quarterly National Accounts: Quarter 3 (July to Sept) 2016.

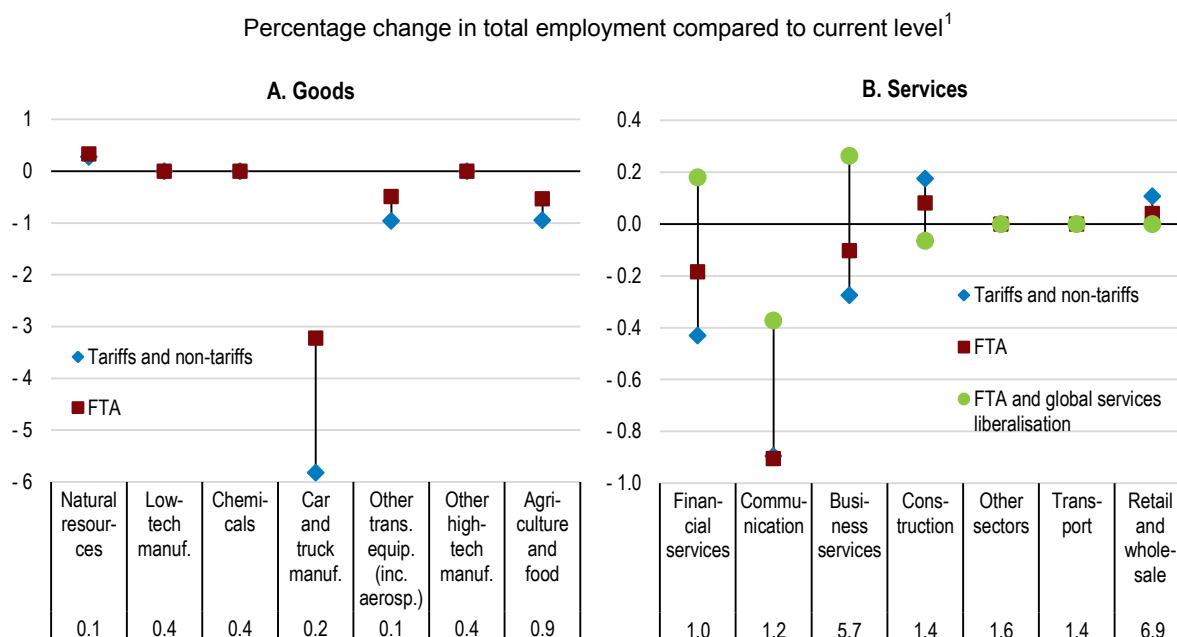
Figure 15. Goods sectors were more responsive than services sectors to past export shocks

Sector-specific effects, coefficient estimates¹



1. Coefficient estimates highlighted with dark blue are statistically significant at least at the 10% level.

Source: Own calculations.

Figure 16. Sectoral employment exposure to shocks is low, except for car manufacturing

1. Current levels (in million persons, 2015) of total employment are shown on the second line of the x-axis' label. Sectors are ranked in descending order of the level of labour productivity.

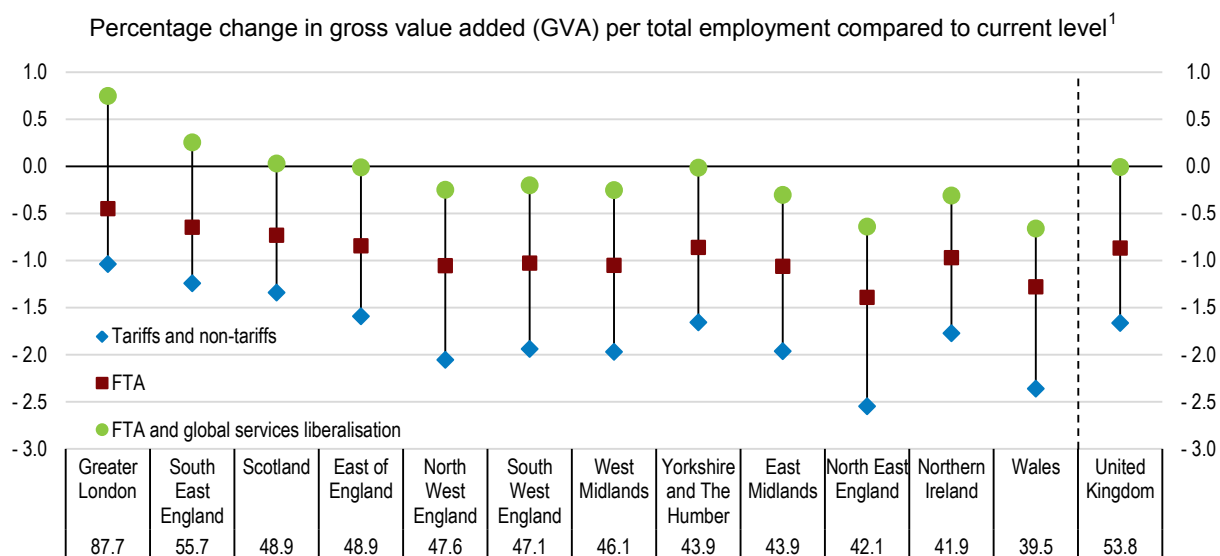
Source: Own calculations; ONS (2016), "UK GDP(O) low level aggregates", in Quarterly National Accounts: Quarter 3 (July to Sept) 2016, Office for National Statistics, December; and ONS (2016), "UK business register and employment survey (BRES): 2014 revised and 2015 provisional", Office for National Statistics, September.

Transmission of shocks to regions

22. **Regional disparities in productivity increase following shocks, as resilience is positively correlated with regional productivity levels.** Export shocks reduce labour productivity in all regions, but there is an important heterogeneity across them (Figure 17). Greater London is the least affected, and Wales and North East England are the most vulnerable. More generally, falls in labour productivity tend to be the smallest in the regions with the highest productivity levels and the greatest in the regions with the weakest productivity performance. This finding is driven by the generally stronger impacts of shocks on the goods producing sectors (Figure 12) and a more service-oriented sector-composition of the most productive regions (Figure 7). The different types of export shocks also generate changes in regional productivity of different magnitudes, with the "Tariffs and non-tariffs" export shock implying the largest widening of the productivity distribution across regions. Moreover, all regions are less affected by the "FTA" export shock than by the "Tariffs and non-tariffs" export shock. When introducing an offsetting positive shock on services exports, regions with large services sectors would benefit the most (Greater London and South East England), but the negative impact of the "FTA" export shock would also be fully offset or mitigated in other regions.

23. **Real wages are subject to relatively smaller downward pressures in more productive regions.** The reaction of wages to export shocks closely reflects changes in labour productivity (Figure 18). Wage falls are smaller in the most productive regions, but appear comparatively greater in the least productive regions. An "FTA" export shock is conducive to the smallest reduction in wages and has a low standard deviation in wage changes across regions, implying a modest impact on wage distribution. By contrast, an offsetting positive export shock would lead to an increase in wages in Greater London, and a smaller reduction in most other regions.

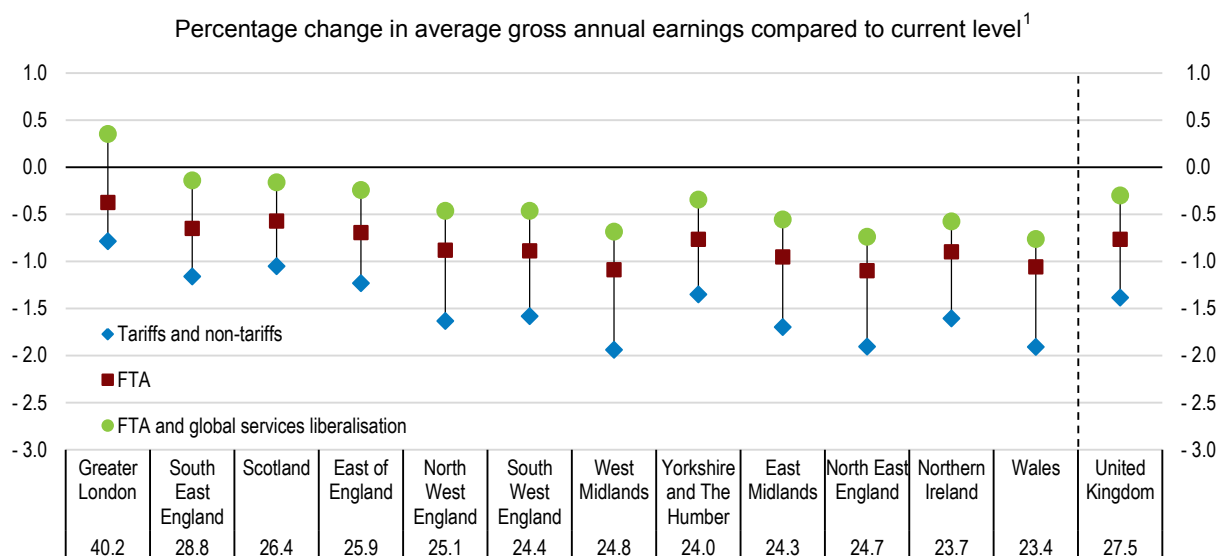
Figure 17. More productive regions show less negative responses in productivity



1. Current levels (in GBP thousand, current prices, 2014) of labour productivity are shown on the second line of the x-axis' label. Regions are ranked in descending order of the level of labour productivity. Figures for the United Kingdom refer to the employment weighted average of regional results.

Source: own calculations; and OECD (2017), "Regional Economy", *OECD Regional Statistics* (database).

Figure 18. Wage impacts across regions largely reflect those on labour productivity



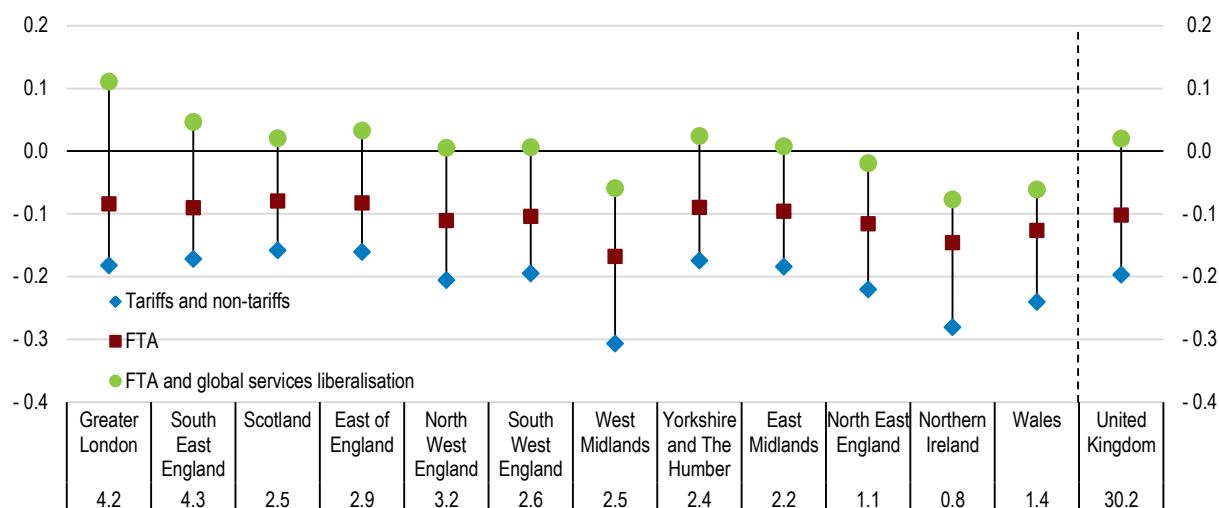
1. Current levels (in GBP thousand, current prices, 2015) of average gross annual earnings are shown on the second line of the x-axis' label. Regions are ranked in descending order of the level of labour productivity. Data for average gross annual earnings refer to all employee jobs including part-time employee jobs. Figures for the United Kingdom refer to the employment weighted average of regional results.

Source: Own calculations; and ONS (2016), "Annual Survey of Hours and Earnings: 2016 provisional results", Office for National Statistics, October.

24. **There is no clear relationship between regional productivity levels and exposure of regional employment to shocks for most regions.** As for labour productivity and wages, employment in all regions is negatively affected, but the overall impacts are small (Figure 19). Employment in the least productive Northern Ireland, Wales and the West Midlands is affected the most, but for other regions the correlation

between employment changes and productivity levels is weak. Among different shocks, the “Tariffs and non-tariffs” shock appears to have the strongest impact on employment and the “FTA and global services liberalisation” shock would generate a modest increase in overall employment.

Figure 19. Employment effects of export shocks are limited
Percentage change in total employment compared to current level¹



1. Current levels (in million persons, 2014) of total employment are shown on the second line of the x-axis' label. Regional employment is measured at place of work. Regions are ranked in descending order of the level of labour productivity. Figures for the United Kingdom refer to the employment weighted average of regional results.

Source: own calculations; and OECD (2017), "Regional Economy", *OECD Regional Statistics* (database).

Conclusion

25. **This paper assesses the distributional effects of export shocks on several outcome variables across sectors and regions.** It considers some illustrative changes in trading relationships, whose aim is not to reflect government plans. The analysis is applied to the United Kingdom and, conditional on the availability of data, could be extended to other countries. The United Kingdom has a significant heterogeneity in regional labour productivity and wages levels, with less performing regions being more specialised in goods than in services and having a relatively low domestic content of exports. This makes sectors highly integrated with international value chains vulnerable to potential increases in tariff and non-tariff barriers. High labour market flexibility ensures a high resilience of employment to shocks. Moreover, there is scope to offset negative export shocks on goods sectors by working towards greater global liberalisation of services trade, which would benefit the UK's services-oriented economy to a large extent.

26. **The paper could be extended in several ways.** Potential discontinuation and creation of firms (entry and exit) are not taken into account in the simulations, which could introduce more complex impacts. Future work could test for differential impacts across firms within sectors to assess whether more productive firms are affected differently than less productive ones. This would help to assess changes in allocative efficiency following export shocks, in the spirit of Melitz (2003), providing a more comprehensive analysis of sectoral and regional productivity impacts.

Annex 1

Table A1. Sector group correspondence table

Sector groups	Office for National Statistics (ONS)	
	SIC 2007 code	Section/Division name
Goods		
Agriculture and food	A	Agriculture, forestry and fishing
	CA	Food products, beverages and tobacco
Chemicals	CE	Chemicals and chemical products
	CF	Basic pharmaceutical products and preparations
	CG	Rubber and plastic products
Low-tech manufacturing	CB	Textiles, wearing apparel and leather products
	CC	Wood and paper products and printing
	CH	Basic metals and metal products
	CM	Other manufacturing and repair
Natural resources	B	Mining and quarrying
	CD	Coke and refined petroleum products
Other high-tech manufacturing	CI	Computer, electronic and optical products
	CJ	Electrical equipment
	CK	Machinery and equipment not elsewhere classified
Car and truck manuf. Other transport equipment (incl. aerospace)		Manufacture of motor vehicles, trailers and semi-trailers (29)
	CL	Manufacture of other transport equipment (30)
Services		
Business services	L	Real estate activities
	M	Professional, scientific and technical activities
	N	Administrative and support service activities
Communication	J	Information and communication
Construction	F	Construction
Financial services	K	Financial and insurance activities
Other sectors	O	Public administration and defence; compulsory social security
	P	Education
	Q	Human health and social work activities
	R	Arts, entertainment and recreation
	S	Other service activities
	D	Electricity, gas, steam and air-conditioning supply
	E	Water supply; sewerage and waste management
Retail and wholesale	G	Wholesale and retail trade; repair of motor vehicles
	I	Accommodation and food service activities
Transport	H	Transportation and storage

Note: The United Kingdom Standard Industrial Classification of Economic Activities (SIC) 2007 is based exactly on the European Union's industrial classification system (NACE Rev. 2).

Source: Office for National Statistics.

Table A2. Estimation results from the baseline regressions

	Average effects			Allowing for sector-specific effects		
	(1) Labour Productivity	(2) Wages	(3) Employment	(4) Labour Productivity	(5) Wages	(6) Employment
Explanatory variables						
Sectoral exports	0.1557***	0.1400***	0.0105			
<i>Average effect</i>	(0.0383)	(0.0377)	(0.0143)			
<i>Sector-specific effects</i>						
Goods						
Agriculture and food				0.0839 (0.0556)	0.0785 (0.0641)	0.0298*** (0.0095)
Natural resources				0.1955*** (0.0437)	0.1234 (0.1135)	0.0636** (0.0313)
Low-tech manufacturing				0.3510*** (0.0735)	0.3446*** (0.0740)	-0.0146 (0.0213)
Chemicals				0.7589*** (0.1846)	0.8044*** (0.1858)	-0.0092 (0.0217)
Car and truck manuf.				0.8470*** (0.0351)	0.7041*** (0.0304)	0.1786*** (0.0102)
Other transport equipment (incl. aerospace)				0.9077*** (0.1763)	0.8500*** (0.1561)	0.0423*** (0.0110)
Other hi-tech manufacturing ⁽¹⁾				0.5968*** (0.1207)	0.5945*** (0.0557)	0.0042 (0.0209)
Services						
Business services				0.2043*** (0.0495)	0.1502*** (0.0403)	0.0503* (0.0258)
Communication				0.0893*** (0.0300)	0.1066*** (0.0269)	0.0735*** (0.0042)
Construction				0.0289 (0.0299)	0.0406 (0.0260)	-0.0200* (0.0101)
Retail and wholesale				0.0957* (0.0537)	0.0848 (0.0519)	-0.0245 (0.0152)
Transport				0.1869* (0.0966)	0.1568 (0.1058)	-0.0040 (0.0079)
Other sectors				0.2687*** (0.0301)	0.3485*** (0.0373)	0.0239 (0.0298)
Size and age controls (categories)	Yes	Yes	Yes	Yes	Yes	Yes
Firm and year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	211,649	211,649	211,649	211,649	211,649	211,649
R-squared	0.359	0.494	0.582	0.363	0.501	0.582

Note: (1) Other than chemicals, transport equipment and motor vehicles. Cluster robust standard errors (at the sector level) in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Financial services are not covered in the firm level data hence for the simulations the elasticities for the financial sector are assumed to be the same as for business services.

Source: OECD

Table A3. Tariff and non-tariff measures underpinning trade shocks in the METRO model

A. Tariffs in % of the value of goods

Sector	Tariffs imposed by UK on imports from other countries				Tariffs imposed by other countries on UK exports			
	Initial		Shock		Initial		Shock	
	EU	ROW	EU	ROW	EU	ROW	EU	ROW
Agriculture	0.0	1.3	5.1	3.5	0.0	5.5	5.1	14.7
Food	0.0	4.1	5.1	10.9	0.0	10.0	5.1	35.4
Natural resources	0.0	0.0	2.1	0.0	0.0	2.4	2.1	17.6
Textiles	0.0	5.7	8.0	14.4	0.0	5.6	8.0	19.4
Wearing apparel	0.0	7.5	8.0	16.8	0.0	6.7	8.0	26.7
Leather products	0.0	8.0	8.0	16.1	0.0	8.1	8.0	27.0
Wood products	0.0	0.8	5.1	1.2	0.0	3.0	5.1	13.3
Paper products, publishing	0.0	0.0	0.1	0.0	0.0	2.4	0.1	11.7
Petroleum, coal products	0.0	0.4	2.1	0.7	0.0	2.5	2.1	11.7
Chemical, rubber, plastic	0.0	1.7	3.2	2.2	0.0	3.0	3.2	10.7
Mineral products nec.	0.0	3.4	2.1	5.5	0.0	5.6	2.1	25.3
Ferrous metals	0.0	0.2	1.4	0.3	0.0	2.4	1.4	6.5
Metals nec.	0.0	0.9	1.4	1.1	0.0	3.4	1.4	16.7
Metal products	0.0	1.7	1.4	2.4	0.0	5.1	1.4	9.9
Motor vehicles and parts	0.0	4.4	4.4	6.7	0.0	9.8	4.4	21.5
Transport equipment nec.	0.0	1.2	4.4	3.0	0.0	1.9	4.4	6.0
Electronic equipment	0.0	1.1	0.9	1.6	0.0	1.1	0.9	4.7
Machinery and equipment nec.	0.0	1.3	1.6	1.7	0.0	3.0	1.6	11.7
Manufactures nec.	0.0	0.9	1.6	1.1	0.0	4.0	1.6	17.8

B. Estimated services trade costs in % of the value of services

	Services trade costs imposed by UK on imports from other countries	Services trade costs imposed by other countries on UK exports		
	Initial = with shock	Initial	With "Tariffs and non-tariffs" shock	With "FTA" shock
Insurance	60.0	40.0	44.8	42.4
Other financial intermediation	36.0	15.4	55.9	35.6
Construction	44.8	30.0	57.3	43.7
Communication	19.5	32.6	55.9	55.9
Trade	36.0	37.0	48.1	42.6
Transport	9.1	21.8	31.0	26.4
Other business services	19.5	30.6	44.1	37.4
Other government services	0.0	51.5	59.4	59.4

C. Estimated non-tariff measures in % of the value of goods

	Measures imposed by the EU on UK exports	
	"Tariffs and non-tariffs" shock	"FTA" shock
Agriculture	15.1	7.5
Food	15.1	7.5
Natural resources	0.0	0.0
Textiles	0.8	0.4
Wearing apparel	0.8	0.4
Leather products	0.8	0.4
Wood products	15.1	7.5
Paper products, publishing	8.5	4.3
Petroleum, coal products	0.0	0.0
Chemical, rubber, plastic	4.3	2.1
Mineral products nec.	0.0	0.0
Ferrous metals	1.9	0.9
Metals nec.	1.9	0.9
Metal products	1.9	0.9
Motor vehicles and parts	8.5	4.3
Transport equipment nec.	8.5	4.3
Electronic equipment	4.4	2.2
Machinery and equipment nec.	0.8	0.4
Manufactures nec.	0.8	0.4

Note: Tariffs are trade-weighted averages across partner countries and subcategories of goods within sectors. ROW denotes "Rest of the World". NTBs are ad valorem equivalents of restrictions on trade in services, based on Fontagné, L., C. Mitaritonna and J. Signoret (2016), "Estimated Tariff Equivalents of Services NTMs", CEPII Working Paper, No. 2016-20, August; and Timmer, M. P., Dietzenbacher, E., Los, B., Stehrer, R. and de Vries, G. J. (2015), "An Illustrated User Guide to the World Input–Output Database: the Case of Global Automotive Production", Review of International Economics, Vol. 23, No. 3, August.

Source: OECD calculations.

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