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Brexit and labour market inequalities: potential spatial and occupational impacts

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Abstract: In this paper we examine the possible distributional impacts of new trade barriers associated with the new Trade and Cooperation Agreement governing relations between the UK and EU after Brexit. We use a model of labour demand that incorporates input–output links across industries, and that allows for demand substitution by firms and consumers and worker reallocation across industries. We find that workers' exposure is moderately increasing across the earnings distribution. Exposure is greater for men than for women as they are more likely to work in manufacturing industries that are relatively harder hit by new trade barriers. Looking across areas, we find that exposure to new Brexit trade barriers is uncorrelated with measures of local deprivation and the impacts of the recent Covid-19 pandemic.

Keywords: trade, income distribution, inequality

JEL classification: D33, D57, F61, F66, J20

I. Introduction

After a year of intense and often fraught negotiations, the UK and EU signed a Trade and Cooperation Agreement (TCA) on 30 December 2020, which came into provisional effect on 1 January 2021. The agreement meant that trade between the EU and UK would remain tariff free, but substantial non-tariff barriers were introduced, affecting the costs to UK firms exporting to and importing from the EU.

The EU is the UK's largest trading partner: prior to the deal, exports to the EU were equivalent in value to around 14 per cent of UK GDP; and imports were equivalent in value to around 17 per cent of UK GDP. As a result, any increased trade costs have the potential to have a significant impact on the UK economy. In one recent analysis, the Office for Budget Responsibility predicted that the long-run effects of a Brexit deal

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would be to reduce real GDP by around 4 percentage points relative to what would have been the case had Brexit not occurred (Office for Budget Responsibility, 2020).

These impacts are likely to be highly unequal across workers and regions; the majority of British workers are not involved in direct trade with the EU, while a minority are highly exposed. For instance, the majority of exports to the EU—around 60 per cent—are goods rather than services, yet only 12 per cent of UK workers are currently employed in the manufacturing and other production industries that produce these goods. This fact alone suggests that the effects of post-Brexit trade barriers are likely to be concentrated among certain workers. Moreover, the manufacturing industries that tend to export relatively more of their output to the EU are concentrated in particular locations, suggesting that leaving the EU could also affect regional inequalities within the UK.

This paper examines the possible impact of increases in trade costs on different groups in the labour market and how it might affect inequality across areas. Our analysis updates results from Griffith *et al.* (2020) who examined possible impacts following a 'no-deal' scenario. We draw on two measures of workers' possible exposure to new trade barriers. The first calculates the importance of new barriers to UK and EU trade for each industry, taking account of costs incurred directly (i.e. on their own exports and imports to and from the EU) and indirectly (faced by industries at higher or lower rungs of the supply chain). While indicative of relative impacts across the workers in different industries, this measure does not have a straightforward interpretation in terms of impacts on worker's welfare, as not all of these new trade costs are likely to be incident on UK workers, and consumers and firms may adjust their purchases in response to relative price changes. To address these shortcomings, our second exposure measure draws on a model of industries' labour demand, tracing through the impacts of changing trade barriers on the costs of importing and exporting on demand for firms' output, to the demand for the services of workers in different occupations, and hence to the wages these workers receive in different local labour markets. This measure—taken literally—gives a prediction of real wage changes for workers in different occupations and areas as a result of new trade barriers following the Brexit deal. Following Griffith *et al.* (2020), we refer to the first of these measures as workers' *ex-ante* exposure and the second as workers' *response-inclusive* exposure.

Our approach only captures the impacts of Brexit due to new trade barriers. It does not include dynamic impacts of Brexit on, for example, investment, competition, immigration, or productivity growth. Each of these factors could affect Brexit's distributional impacts across both worker types and areas, although it is difficult to predict exactly how. For example, whole firms may choose to relocate car production outside of the UK to avoid paying greater costs for inputs rather than making marginal changes to production and hiring. Given the concentration of car production in the UK, this would significantly affect our assessment of how Brexit affects inequality across areas. Head and Mayer (2019) use a structural model to assess how new trade barriers affect location and production choices of car firms and find that a shallow tariff-free, regional trade agreement, similar to the deal the UK eventually struck with the EU, would lead to only minor production and employment losses for the UK. Dhingra *et al.* (2017*b*) combine estimates of predicted impact of Brexit on trade with reduced form estimates of the effect of trade on incomes per capita to evaluate the full dynamic effects of Brexit

on incomes. They find that this triples the scale of the impact of Brexit relative to results from a static trade model. However, it is not clear how these losses ought to be apportioned among income groups or areas.

We also assume that workers are temporally immobile across industries (for our ex-ante exposure measure) or across occupations and areas (for our response-inclusive measure). Capital is also assumed to be specific to industries in different areas. Allowing for capital mobility would, other things equal, tend to exacerbate differences in the earnings impacts across workers as we would expect capital to move from relatively hard-hit sectors to sectors where demand was increasing. These capital movements would tend to reduce labour demand further in shrinking sectors.

One interpretation of these assumptions is that our results capture the short to medium impacts of new Brexit trade barriers. Consistent with this, the estimates of the non-tariff barriers we use do not include future reductions in intra-EU trade costs that the UK would not be party to. As a result, our estimates of the impacts of Brexit are smaller than other studies that incorporate its longer-run impacts. Our estimates of the average real wage impacts of Brexit are a little over half of those of estimates of the effects of the new TCA on long-run income *per capita* estimated from a static trade model, and around a quarter of estimates of the long-run hit to income *per capita* from reduced form estimates of the dynamic losses from reduced openness (UK in a Changing Europe, 2019).

As ever, our estimates also depend on the scale of non-tariff barriers affecting different industries. There is naturally significant uncertainty about these—particularly for service industries. We include sensitivity analysis of our main results to the scale of these costs in the Appendix. However, our results will also depend on how these costs vary across industries and this is difficult to predict *ex ante*.

As Griffith *et al.* (2020) found for the case of a no-deal Brexit scenario, we find that 'blue-collar' workers in machine operative occupations are most exposed to new trade barriers, since they are most likely to work in export-orientated manufacturing industries. However, the impacts on these workers are significantly less than they would be in a no-deal outcome, which involves greater tariff and non-tariff costs to exporting. Since workers in the occupations are predominantly male, men tend to be more significantly impacted by Brexit than women. We also find that exposure to new trade barriers is moderately increasing in earnings.

We also assess Brexit's relative impacts across different areas. We find greater impacts of post-Brexit trade barriers in the North-east and Midlands of England, parts of Eastern Scotland and South Wales. We find no systematic relationship between exposure to new trade barriers and how 'left behind' an area is (based on an index incorporating employment, education, pay, and incapacity benefit receipt), though some deprived areas are also relatively more exposed to new trade barriers. We also assess whether Brexit is likely to compound the effects of the Covid-19 pandemic which led to shutdowns in hospitality and leisure industries. Comparing the spatial impacts of Brexit to those associated with the Covid-19 pandemic we find that there is again no systematic relationship, although some larger cities, such as Birmingham and Manchester, may be badly hit by both shocks.

A number of studies have examined the impacts of Brexit on different local areas. Fetzer and Wang (2020) construct synthetic controls for local areas in the UK and find that between 2016 and 2019, many local areas in the UK have seen lower output

growth relative to a no-Brexit counterfactual. The costs of the Brexit vote tended to be higher for regions that voted to leave in the 2016 Brexit referendum, had larger manufacturing sectors, and a larger share of low-skilled workers. This analysis of course predates the signing of the TCA and the introduction of new trade barriers in 2021. Dhingra *et al.* (2017*a*) examined hard and soft Brexit scenarios using a multi-sector structural trade model, finding that long-run impacts of Brexit were greater in more prosperous regions (with greater concentrations of service exporters). Fusacchia *et al.* (2022, this issue) model the impacts of the TCA on the UK's trade with the EU and other countries, predicting significant declines in both overall exports and imports, and particularly large declines in value added for the textiles, motor vehicles, and services industries. However, they do not discuss its impacts on different workers or areas.

The remainder of this paper is structured as follows. Section II discusses how changes in trade barriers following Brexit might affect different industries and outlines our two measures of workers' exposure. Section III discusses the exposure of different workers to these impacts across occupation groups and the earnings distribution. Section IV discusses possible local area impacts and how these relate to the impacts associated with the Covid-19 pandemic and existing measures of deprivation. Section V concludes.

II. Changes in trade barriers

The TCA means there will be no new tariff barriers applying to UK–EU trade. However, there will be new non-tariff barriers to trade (NTBs), and these costs are likely to be substantial, though difficult to quantify exactly in monetary terms. These costs include the costs of additional customs requirements for both importers and exporters, border delays, and the costs of complying (and verifying compliance) with new regulatory differences.

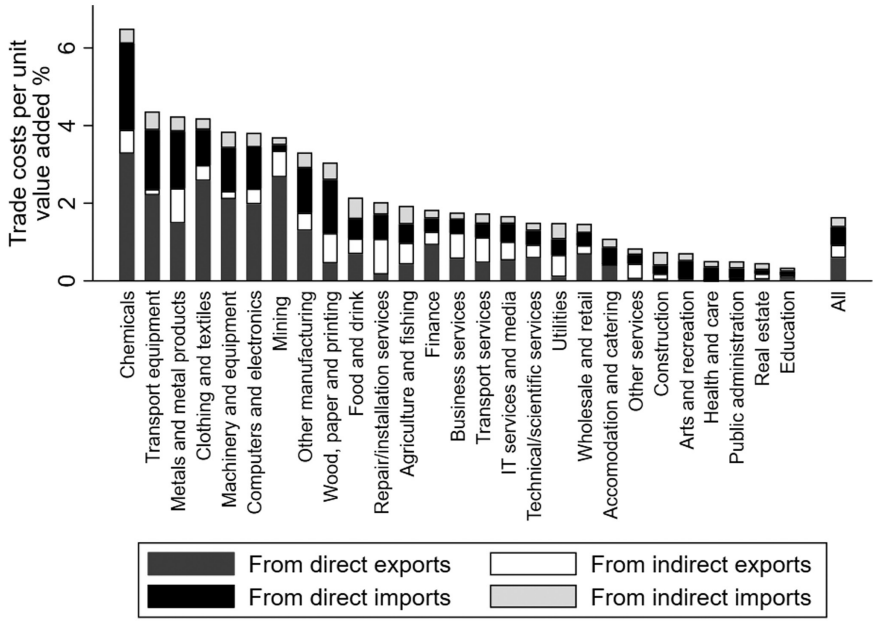
There is considerable uncertainty about the scale of these costs and how they might affect different industries—particularly services such as finance.[1] In what follows we follow UK in a Changing Europe (2019) which assumed that under a free-trade deal in which the UK left the EU Customs Union, UK–EU goods trade would be subject to half of the reducible NTBs that currently apply to trade between the EU and the US—implying an NTB increase of equivalent to a 5.5 per cent tariff. The increase in NTBs for services was assumed to be 7.3 per cent.[2]

Individual workers could in principle be affected by these new trade barriers in a number of ways. Most obviously, increased trade barriers will increase the costs of importing inputs from the EU and exporting output to the EU in the industries they currently work in. Industries can be affected directly (by trade barriers applying to their own sales and purchases) and indirectly (through trade barriers affect their suppliers

[1] See Fusacchia *et al.* (2022) for a discussion of non-tariff barriers in the TCA and how they might vary across sectors.

[2] They also add an additional cost for not being able to take advantage of further intra-EU integration. We do not include this latter cost as it will only apply in the long run.

Figure 1: Changes in trade costs with the EU per unit of value added by industry following the Brexit deal.



Note: Authors' calculation using the ONS Input Output Tables and World Input Output Database. Trade barriers are assumed to be 5.5 per cent of the costs of goods and 7.3 per cent of the costs of services imported or exported to the EU.

and customers). Our *ex-ante* exposure measure is the value of these new direct and indirect trade barriers as a proportion of each industry's value-added. Figure 1 shows the value of these for different (aggregated) industries, separating out trade barriers into those that directly affect each industry's imports and exports.[3]

The figure shows considerable variation across industries in the magnitude of their exposure to trade cost increases. Increases in trade costs are highest for the chemicals, transport equipment, and metals and metal products industries. Exposure to (direct and indirect) costs of imported inputs are an important part of the increase, representing 26 per cent of the overall change in trade costs. Indirect exports are also an important element, accounting for 33 per cent of the total increase. Indirect costs are relatively more important for service industries. Service industries tend to face lower direct exposure to both changes in export and import costs, but many of these industries have high indirect exposure because they supply output to more highly exposed exporters. Among service industries, indirect export exposure to trade costs is particularly important for repair and installation services, finance and business, and transport services.

Exposure to post-Brexit trade costs with the EU across industries does not account for a number of factors that determine how individual workers will ultimately be

[3] See Griffith *et al.* (2020) for details of how these are calculated. These measures assume that trade costs are fully borne by UK firms (and thus can be thought of as an upper bound on UK industries' exposure to new trade costs).

affected by these increased costs. Workers employed in industries that experience reductions in value-added may be able to find re-employment elsewhere; firms may adjust prices in response to shifting demand patterns; consumers may substitute away from products that have become relatively more expensive (for example, UK consumers may switch away from EU imports and towards UK products). We also need to account for changes in the UK's tariff regime with respect to non-EU countries: the UK's new global tariff liberalizes tariffs slightly relative to those charged by the EU for countries with which the UK has no formal trade agreement.[4]

To understand these additional response margins, we draw on a specific-factor model of firms' labour demand (Jones (1975); Kovak (2013); and Kovak and Dix-Carneiro (2015)). Taken literally, our model predicts real wage changes for workers given marginal tariff changes under the following assumptions:

- Workers are defined by occupation group (in particular the nine 1-digit SOC occupation codes) and local labour markets (defined as the UK's 228 'travel to work areas', TTWAs). Workers switch industries (according to prevailing wages) but are assumed to be immobile across occupations and labour markets.
- Capital is specific to industries in different local labour markets.
- There is perfect competition in markets for output, production inputs, and in the markets for labour and capital. In reality, rising trade barriers may affect firm mark-ups with knock-on effects on the real wages of different workers. If domestic firms' mark-ups increase as a result of higher trade barriers, then our exposure measures will tend to understate the overall impacts of Brexit on real wages. It is difficult to know how relaxing this assumption would affect our assessment of Brexit's distributional effects.
- Industries in different countries (the UK, EU, and non-EU) produce distinct varieties of output. Consumers and firms in different countries decide how much of these to purchase on the basis of their relative prices.
- Firms decide how many workers to hire locally given product prices, the cost of intermediate inputs (which are both determined at the national level), and wages (which vary across local labour markets and skill groups).
- Markets for labour and capital clear within each labour market (there is no unemployment).

We also make assumptions on firms' production technology, and consumer preferences in order to pin down the impact of trade barriers on relative prices (see Griffith *et al.* (2020) for further details). This includes assumptions on the responsiveness of consumer demand for different countries' products to changes in relative prices. For our baseline results, we take these from Caliendo and Parro (2015).

The assumptions on labour and capital mobility are intended to reflect the fact that trade shocks can have significant and persistent impacts on wages and employment in

[4] The changes involved converting specific duties from euros to pounds (and others to percentages), rounding down many tariffs to standardized bands and eliminating 'nuisance tariffs' (those below 2 per cent). In what follows, we assume trade costs with non-EU countries fall by the share of UK imports from countries on which the UK trades on 'most favoured nation' terms multiplied by the proportional difference between the EU's external tariffs and the UK's new global tariff. This assumes no change in the UK's trade barriers with countries with which the UK previously had a free trade agreement through the EU (such as Japan, Canada, and South Korea). The UK has signed continuity deals of some kind with most of these countries.

different local labour markets (Topalova (2007); Autor *et al.* (2013); Hakobyan and McLaren (2016); Dix-Carneiro and Kovak (2017)). These papers suggest that labour and capital are slow to reallocate across labour markets in response to shocks.

To estimate workers' exposure, we require information on the occupations employed by different industries and the industrial composition within different travel-to-work areas. For this we draw on data from the Annual Survey of Hours and Earnings (ASHE) (Office for National Statistics, 2019*a*) and the Business Structure Database (BSD) (Office for National Statistics, 2019*b*). We describe these data sources in the online Appendix. As the BSD does not cover Northern Ireland, and Northern Ireland is likely to be very differently affected by post-Brexit trade barriers (including new trade barriers with Great Britain), we focus on impacts in Great Britain only.

In what follows, we use the results of this model to understand the relative 'exposure' of different sorts of workers to post-Brexit changes in trade barriers. As our results are potentially sensitive to key assumptions (for example the nature of and scale of NTBs), we report alternative results in the online Appendix to this document.

III. Exposure of different workers to new trade barriers

(i) Exposure across occupation groups

We begin by describing how exposure varies across workers in different occupation groups and the characteristics of those workers. For this we draw on the 2019 Quarterly Labour Force Survey (QLFS) (Office for National Statistics, Social Survey Division, 2019)

Table 1 shows that average response-inclusive exposure is greatest for workers in machine operative, technical, and skilled trades roles. Our model predicts median real wages falls of 2.15, 1.65, and 1.56 per cent, respectively, for these groups. Machine operatives and those in skilled trades are disproportionately likely to be male, older, likely to work in manufacturing, and less likely to hold a degree. Despite their lower levels of formal qualifications, their average pay is also relatively high. Workers in technical roles tend to earn more, and also tend to be more educated.

Columns (9) and (10) in Table 1 give information about the distribution of workers' exposure as measured in our model. There is considerable variation in exposure across workers, with overall exposure almost twice as high for workers at the 90th percentile of the exposure distribution relative to the 10th. Exposure also varies within an occupation group according to conditions in workers' local labour markets. For example, the predicted real wage decline among machine operatives ranges from 1.81 per cent at the 10th percentile to 3.05 per cent at the 90th percentile. This dispersion reflects the fact that in some local labour markets, exposed industries employ a much greater fraction of machine operatives than in others. We discuss variation in exposure across local labour markets further in section IV.

(ii) Exposure across the earnings distribution

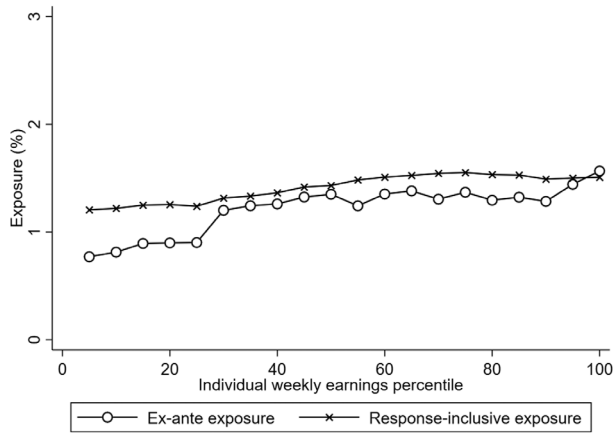
Figure 2 plots average exposure according to our ex-ante and responsive inclusive exposure measures at different points of the earnings distribution.

Table 1: Characteristics and response-inclusive exposure of workers in different occupations

	(1)	(2)	(3)	(4)	(5)	(6)	(8)	(9)	(10)
Occupationgroup	% total	Prop. degree	Prop. male	Prop. manuf.	Age	Weekly earnings (£)	p50 real wage fall	p10 real wage fall	p90 real wage fall
1.Managers	10.3	0.48	0.64	0.11	44.6	923	1.55	1.34	1.83
2.Professional	22.2	0.75	0.48	0.07	41.2	778	1.33	1.22	1.47
3.Technical	14.4	0.48	0.55	0.10	39.5	677	1.65	1.49	1.92
4.Administrative	11.0	0.29	0.24	0.08	42.7	402	1.38	1.15	1.48
5.Skilled trades	7.6	0.10	0.89	0.25	39.6	528	1.56	1.29	2.36
6.Other service	9.5	0.19	0.19	0.01	40.8	294	0.91	0.71	1.09
7.Sales	8.2	0.18	0.38	0.04	36.2	306	1.27	1.09	1.46
8.Machine ops	5.9	0.08	0.87	0.31	43.9	487	2.15	1.81	3.05
9.Elementary	10.9	0.10	0.51	0.08	38.0	269	1.20	0.91	1.39
All	100	0.37	0.50	0.10	40.2	567	1.40	0.96	1.82

Note: Authors' calculations from 2019 Quarterly Labour Force Survey. Responsive-inclusive exposure is the predicted real wage fall from the model outlined in section II. It varies by workers' region and across nine occupation groups.

Figure 2: Measures of individual ex-ante and response-inclusive exposure over the earnings distribution.



Note: Authors' calculations from Annual Survey of Hours and Earnings and Business Structure Database. Ex-ante exposure is defined as the sum of non-tariff barriers newly applying to exposure and imports to the EU (as a percentage of UK value-added) in each worker's main industry of employment. Responsive-inclusive exposure is the predicted real wage fall from the model outlined in section II. It varies by workers' region and across nine occupation groups. We smooth by plotting average exposure within five percentile bands.

Both measures of exposure are mildly increasing across the earnings distribution, indicating that higher-earning workers are worse affected. This is because higher-earning workers are more likely to be employed in the relatively hi-tech manufacturing industries that export relatively more of their output to the EU. The response-inclusive measure is relatively higher for workers at the lower end of the earnings distribution than the ex-ante measure. This reflects the impact of worker mobility across industries, and the fact that workers in lower paid occupations tend to earn more in more highly exposed industries than other workers in the same occupations employed in less exposed industries. When trade costs increase, workers in these occupations leave exposed

industries and drive down the wages of other workers in the same occupation employed elsewhere.

In Appendix B we examine how the distributional impact varies when we make different assumptions about the level of non-tariff barriers (in a pessimistic scenario, where NTBs are 50 per cent greater than in our baseline case, and in an optimistic scenario where NTBs are 50 per cent lower than they are in our baseline case). While these changes shift the level of workers' exposure, they do not change the relationship between exposure and earnings in Figure 2.

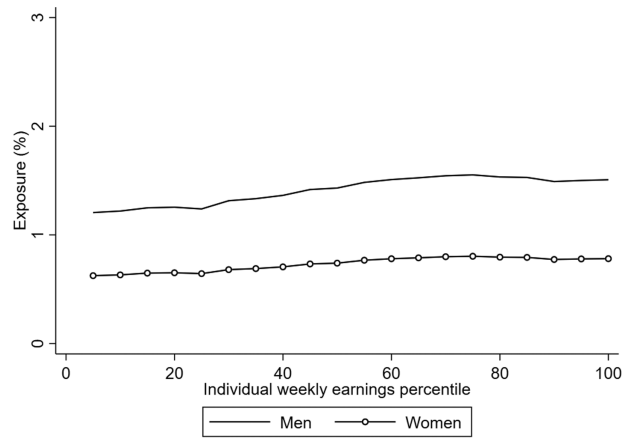
(iii) Exposure by gender

Figure 3 shows how exposure under our two measures varies by gender. Unsurprisingly, given the disproportionate share of men in the most exposed occupations, machine operatives, technical workers, and those in skilled trades exposure tends to be higher for men than for women. In both cases, exposure increases slightly with earnings, although the increase is slightly steeper for men than for women.

(iv) Comparison with a no-deal scenario

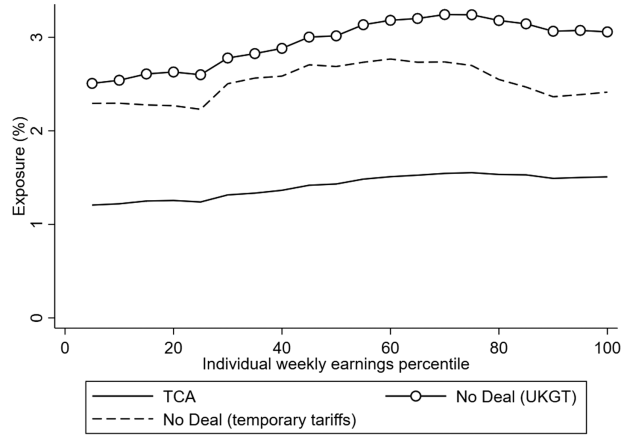
How did the TCA affect exposure relative to a no-deal scenario in which trade with the EU defaulted to World Trade Organization (WTO) rules (a 'no-deal' outcome)? We consider two different no-deal scenarios. In the first we assume (following UK in a Changing Europe (2019)) that the increase in NTBs in a no-deal scenario is three-quarters as large as the estimated reducible non-tariff barriers between the EU and the US, which implies an increase in non-tariff barriers of 8.3 per cent. In addition, the

Figure 3: Measures of individual response-inclusive exposure over the weekly earnings distribution by gender.



Note: Authors' calculations from Annual Survey of Hours and Earnings and Business Structure Database. Responsive-inclusive exposure is the predicted real wage fall from the model outlined in section II. It varies by workers' region and across nine occupation groups. We smooth by plotting average exposure within five percentile bands.

Figure 4: Measures of individual response-inclusive exposure in deal and no-deal scenarios.



Note: Authors' calculations from Annual Survey of Hours and Earnings and Business Structure Database. Response-inclusive exposure is the predicted real wage fall from the model outlined in section II. It varies by workers' region and across nine occupation groups. We smooth by plotting average exposure within five percentile bands.

EU applies its common external tariff to imports from the UK, and the UK applies its 'global tariff' (UKGT) to imports from the EU. In the second, we make the same assumption about non-tariff barriers, but consider a case where the UK applied the 'temporary' no-deal tariffs announced in March 2019 (preceding the UKGT) to imports from the EU and other countries with which it had no formal trade agreement. These are substantially lower for many goods than they are under the UKGT.

Figure 4 shows the results: relative to our TCA outcome, no-deal scenarios imply significantly higher exposure, both because of reduced demand for UK exports in the EU but also due to higher consumer price increases and increases in the costs of production for firms importing intermediate inputs from the EU. Exposure under the UKGT tariffs is also increasing in earnings. Under the UK temporary tariffs, exposure follows an inverse U-shape, with exposure relatively lower for those at the top and bottom of the earnings distribution.[5] The difference between the UKGT and temporary tariff scenarios is that the latter (i) see smaller increases in consumer prices and thus lower exposure for workers overall and (ii) expose workers in some industries to much greater import competition from both the EU and from third counties, while allowing those in other industries to benefit from cheaper production inputs. This latter channel alters the distributional impact in a way that favours higher earners.

IV. Exposure of different local labour markets

In this section we focus on the impacts of Brexit on different areas across the UK. We focus on results from our response-inclusive measure. These results are driven by

[5] This is the closest scenario to that reported in Griffith *et al.* (2020), which also finds an inverted U-shape for exposure. The only difference is that we assume non-tariff barriers to be uniform across industries (to make our assumptions comparable with those made for the TCA agreement).

differences in the industrial composition of different regions and differences in the proportion of workers in different occupation groups. For instance, if a large proportion of the workforce in a given location are machine operatives, and a large fraction of these workers are employed in exposed industries, then area-level impacts will tend to be larger. Of course, individual firms within an industry might vary in their exposure to Brexit in ways that alters its relative impacts across regions, and some firms may respond more strongly to new costs than others (for example, firms may relocate operations entirely rather than make marginal changes to their hiring). These differences across areas may not be captured by our exposure measure. For this reason, we focus on relative impacts across regions, and the correlation of these impacts with other shocks and characteristics rather than making specific predictions about impacts for individual areas.

Panel (a) in Figure 5 shows a map of travel to work areas (TTWAs) in Great Britain by population weighted quintile of our Brexit exposure measure.[6]

The areas that appear most exposed to new trade barriers are the North-east and Midlands of England, as well as Eastern Scotland and South Wales. These are areas with more significant manufacturing industries, which, as Figure 1 shows, are likely to see the greatest increase in trade costs as a result of new trade barriers with the EU. The least-exposed areas are rural regions with little exposure to manufacturing or export-focused service industries in the South-west of England, as well as rural areas in Wales and Scotland.

In the Appendix we examine the sensitivity of these findings to alternative assumptions on non-tariff barriers associated with the TCA. Figure B.2. in the Appendix show the equivalents of Figure 5 under an optimistic (a) and pessimistic (b) scenario for the non-tariff barriers that are introduced. The relative spatial patterns are largely unchanged with only 20 of the 218 TTWAs changing quintile of impact and none by more than 1 quintile.

(i) Potential impacts on 'left-behind' areas

The UK government has committed to reducing spatial inequalities around the country by 'levelling up' left-behind towns, cities, and regions of the UK. How do the potential impacts from Brexit relate to how deprived (left-behind) different areas are?

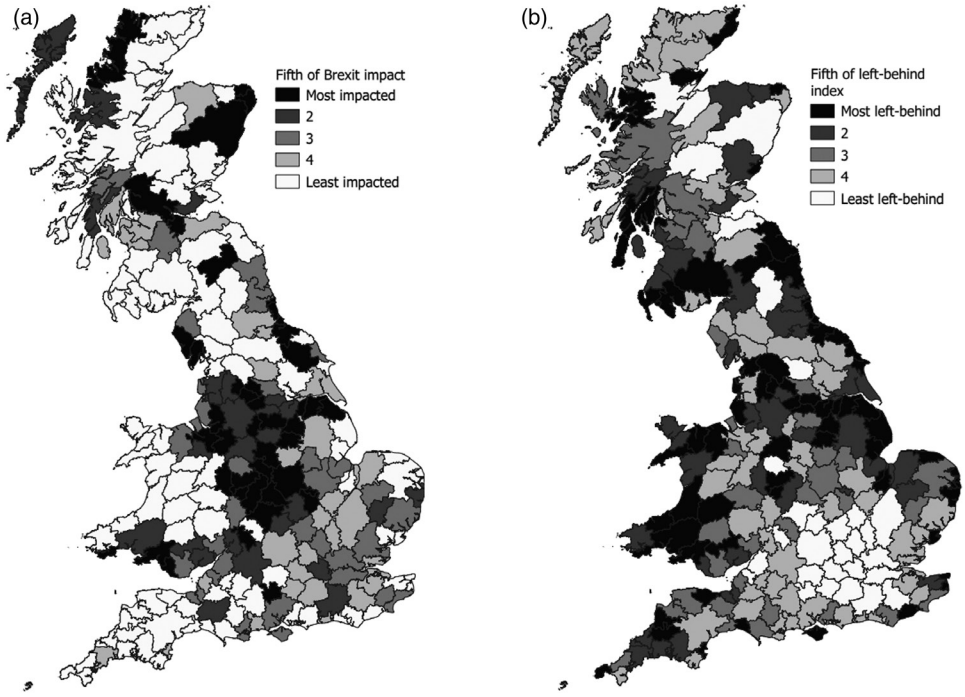
To identify how left-behind an area is, we focus on economic factors and use the same measures as Davenport and Zaranko (2020), namely employment, formal education, pay, and incapacity benefits.[7] These are closely aligned to the components used in the government's own measures to determine which areas should be targeted by levelling-up funds, which are productivity, unemployment, and formal education.[8]

[6] We weight by the population during quintile construction to smooth out the impact of the high variation in TTWA population. However, London is excluded from this weighting and is then placed in the quintile in which its index value would place it to avoid it skewing the quintiles. This means that, London aside, roughly equal populations are placed in each grouping.

[7] For details of the exact measures used, see Appendix A.2.

[8] See HM Treasury *et al.* (2021) for full details.

Figure 5: Response-inclusive exposure to post-Brexit trade barriers across TTWAs.



Note: Authors' calculations from Annual Survey of Hours and Earnings and Business Structure Database and from sources outlined in Appendix A.2. Responsive-inclusive exposure in panel (a) is the predicted real wage fall from the model outlined in section II averaged across workers within in each TTWA. Orkney and Shetland are not shown for scaling purposes.

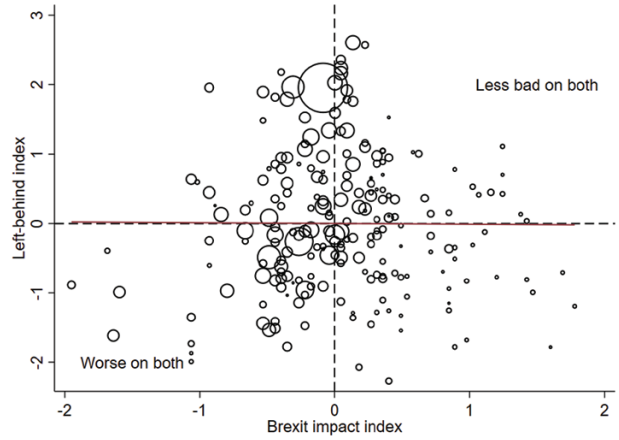
We combine this information into an index using the approach of Anderson (2008).[9] This method of combining different variables into a single measure weights components according to their correlations with each other, giving greater weight to variables which are less correlated with other variables in the index (and which thus can be thought of as embodying additional information).

Panel (b) in Figure 5 shows a map of TTWAs in Great Britain by population weighted quintile, of our left-behind index.[10] Of the 62 TTWAs in the most left-behind group, 44 are coastal, including large coastal communities such as Blackpool, Grimsby, Hartlepool, and Clacton, but also rural areas of Wales and Scotland. Many medium-sized former industrial towns in the North of England are also in the most left-behind fifth. These include former textiles towns such as Burnley and Blackburn, steel towns such as Scunthorpe, and former mining towns such as Merthyr Tydfil and Doncaster.

[9] Using the first principal component of these variables gives very similar results The code to create this index is based on a program written by Cyrus Samii (see https://cyrussamii.com/?p=2656).

[10] Population weighting is done without London, as outlined in footnote 5.

Figure 6: Correlation between Brexit impacts and left-behind index.



Note: Brexit exposure is the output of the model outlined in section II average across workers within each TTWA. Left-behind index includes employment, formal education, pay, and incapacity benefits, as outlined in Appendix A.2. Points are scaled by population size. Red line is a line of best fit (unweighted). Points are scaled by population size. The TTWA of Whitehaven is an outlier in terms of Brexit exposure and has been omitted.

Figure 6 shows the relationship between our left-behind index and our Brexit exposure measure (we omit Whitehaven, an outlier in terms of estimated Brexit exposure). There is no clear relationship between our left-behind index and measure of Brexit exposure and the correlation between them is –0.01. Although, on average, areas that are more exposed to new Brexit trade barriers are not more left-behind, areas in the bottom-left quadrant of Figure 7 may now fall further behind as a result of new trade costs with the EU.

These areas badly impacted by Brexit but already left-behind are overwhelmingly 'post-industrial' areas which have seen significant deindustrialization but have also retained substantial manufacturing employment into the twenty-first century. In fact, the 16 TTWAs (7 per cent of the total) in the highest fifth on both measures include Sunderland, Middlesbrough, and Hartlepool in the North-east, and other traditionally left-behind towns such as Burnley, Grimsby, Mansfield, and Scunthorpe. Among these 16 TTWAs, the average manufacturing share of employment is 15.8 per cent compared to 9.4 per cent in the areas in the top fifth of our left-behind measure but not in the top fifth for Brexit impact, compared to a national average across all TTWAs of 10.1 per cent.[11]

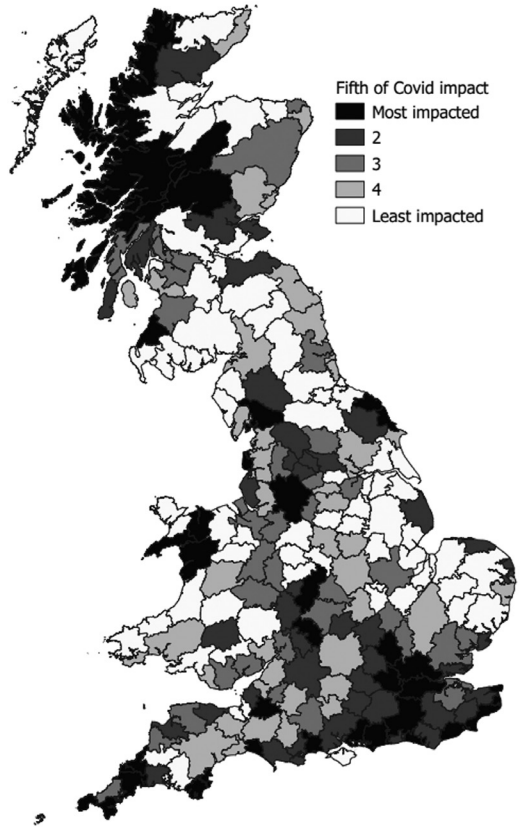
(ii) Relationship with Covid impacts

We now assess whether the impacts of Brexit are likely to compound the impacts of the Covid-19 pandemic, which also had very different impacts across areas.[12] The enforced

[11] Tradeable goods are defined as SIC sector C (Manufacturing).

[12] See Davenport *et al.* (2020*a*) for evidence of different sectoral impacts of Covid-19 and Davenport *et al.* (2020*b*) for an exploration of different geographic aspects of the crisis.

Figure 7: Index of Covid impacts across TTWAs



Note: Authors' calculations from sources outlined in Appendix A.3. Index includes changes in unemployment, job vacancies, furlough rates, and employment in lockdown-shutdown sectors. Orkney and Shetland not shown for scaling purposes.

closure of many businesses due to lockdowns and social-distancing restrictions had huge economic impacts, evidenced by the near 10 per cent fall in GDP estimated to have occurred during 2020.[13]

To identify how impacted by the Covid-19 crisis an area was, we combine measures of furlough rates, changes in unemployment, changes in job vacancy postings, and rates of employment in sectors closed during lockdowns.[14] We again combine these into an index using the approach of Anderson (2008).

Figure 7 shows a map of TTWAs in Great Britain as above but for impact of the Covid-19 crisis.[15] We highlight the following patterns:

[13] See Office for National Statistics (2021) for full details.
[14] Full details of the data sources used can be found in Appendix A.3.
[15] Groupings are again made by non-London population weighted quintiles.

- Coastal areas were badly hit by Covid-19, with 27 of the 38 TTWAs in the most impacted fifth being coastal. These are mostly traditional coastal tourist destinations, including Colwyn Bay, Blackpool, Brighton, and Scarborough.
- Rural tourist destinations, similarly to coastal areas, were badly hit by Covid. Parts of the Lake District, Peak District, and other national parks are among the worst affected two-fifths of areas.
- Larger cities, which are often significant retail and leisure destinations, were also severely impacted, with London, Manchester, and Birmingham in the most impacted fifth, and Liverpool, Leeds, and Edinburgh in the second most impacted fifth.
- The least impacted areas appear to mostly be smaller post-industrial towns in the North of England and rural areas without large tourism sectors. The same is true of some rural areas which don't have significant tourist industries.
- Regionally, the areas most impacted by Covid-19 are more dispersed than left-behind areas, although the most Covid-impacted areas are concentrated in the South-east, South-west, and Scotland, which together account for 27 of the 38 most Covid-impacted group. Wales and the East Midlands both have over half of TTWAs in the least Covid-impacted group.

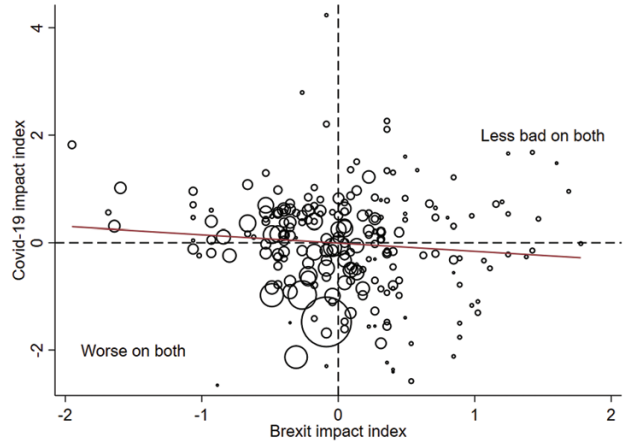
There is no systematic relationship between the impacts of Covid-19 and how left-behind an area is. The correlation between the two indices is –0.12. This does mean that there are some areas badly affected on both fronts, and some on neither, so this is still important. The areas in the most badly impacted group on both fronts are almost exclusively coastal, and include Blackpool, Margate, and Colwyn Bay.

Figure 8 also shows that there is little systematic relationship between Covid-19 impacts and Brexit, with a weakly negative correlation between the two of –0.10. Again. this means there are some areas that will be badly hit by both shocks, but also some hit by neither, with the majority hit relatively harder by one but not the other.

Only two out of the 218 TTWAs are in the top fifth on both measures. One of these is Birmingham, which is rare in retaining significant manufacturing employment, and so being vulnerable to new trade barriers, while also containing a large student population and leisure sector, meaning it suffers from the economic impacts of the pandemic. Manchester also fits this description and is in the top two-fifths on both measures, and the same is true of the areas around Heathrow and Gatwick airports, which were hit by a lack of air travel during the pandemic and also appear relatively more exposed to Brexit.

Finally, the map in Figure 9 shows areas featuring in the top two-fifths on more than one of these measures. Seven TTWAs out of 218 are in the top two-fifths on all three measures. These include Manchester and Birmingham, which contain significant deprivation but also retain some manufacturing employment, and have thriving city centres with large leisure and tourism sectors. These places are likely to face significant challenges over the coming years, as the sources of recovery from their relative

Figure 8: Index of Covid impacts across TTWAs.



Note: Brexit exposure is the output of the model outlined in section II averaged across workers within each TTWA. Covid-19 impact index includes changes in unemployment, job vacancies, rates of furlough, and employment in lockdown-shutdown sectors, as outlined in Appendix A.3. Points are scaled by population size. The red (solid) line is a line of best fit (unweighted). The TTWA of Whitehaven is an outlier in terms of Brexit exposure and has been omitted.

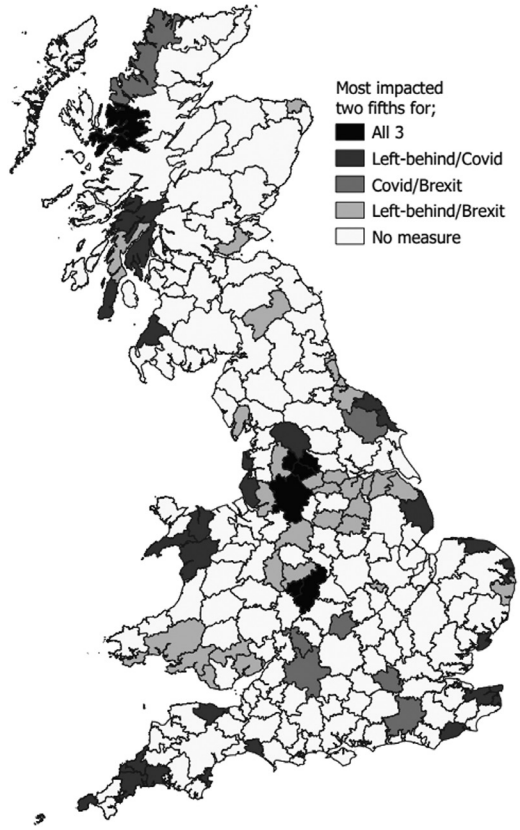
problems in recent years are affected by the challenges of Covid and Brexit. Aside from parts of rural Scotland, the other places doing badly on all three measures are clustered around these two cities.

V. Conclusion

This paper has examined the distributional consequences of the TCA agreement between the UK and EU and the associated increase in trade costs. Exposure to new trade barriers is greatest among machine operatives, as well as those in skilled trades and technical occupations who are more likely to be employed in the hi-tech manufacturing industries that export relatively more of their output to the EU. Similarly, areas with greater concentrations of manufacturing industries—notably in the Midlands and North-east of England, South Wales, and Eastern Scotland—are relatively more exposed to new trade barriers.

The pattern of impacts is relatively flat across the earnings distribution and uncorrelated with how 'left behind' an area is. Thus, while Brexit's impacts are likely to be highly unequal, they do not appear to be systematically related to existing inequalities across workers or areas. However, there are areas which may be badly impacted by Brexit and were already struggling, typically areas retaining significant manufacturing employment, and this could make the task of 'levelling up' left-behind areas more difficult. Some larger cities which were hit quite hard by the Covid-19 pandemic may also be further hit by Brexit, particularly when a significant fraction of their workers is still employed in export-intensive manufacturing industries.

Figure 9: Areas in the worst two-fifths of multiple measures.



Note: Authors' calculations from comparing the three measures outlined earlier: Brexit impact, Covid-19 vulnerability, and our left-behind index. Fifths of impact are as defined in Figures 5, 6, and 8. Details of all three measures can be found in the Appendix, sections A.1., A.2., and A.3.

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