Unravelling Trade Integration: Local Labour Market Effects of the Brexit Vote *

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December 23, 2019

Abstract

This paper uses high frequency data on the near universe of online job adverts in the UK to study the impact of the trade policy uncertainty caused by the Brexit referendum on labour demand between January 2015 and September 2019. It develops measures of regional exposure to the threat of potential most-favoured-nation (MFN) tariffs if the UK were to leave the EU without a trade deal. It shows that regions relatively more exposed to the tariff threat differentially reduced online hiring in the period after the referendum and this effect was distinct from the impact of the exchange rate depreciation, uncertainty surrounding future immigration policy and the financial services sector. Both skilled and unskilled job adverts were affected, with unskilled job adverts experiencing a slightly greater relative decline. Based on newspaper coverage and Google searches, the paper develops two novel time-varying measures of Brexit-specific trade policy uncertainty and shows that the relative decline in job adverts was concentrated in months with greater uncertainty about future trade arrangements with the EU. The study concludes that the threat of unravelling global integration has an important impact on labour markets.

Keywords: trade uncertainty, trade policy, labour demand, online job adverts, Brexit, hiring

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1. Introduction

The consequences of trade barriers for economic outcomes is a long studied area of research, yet the impact of uncertainty about possible future barriers, as opposed to barriers themselves, is less well understood. With some of the world's major economies entering a period of heightened uncertainty in their trade relations, this area of trade research is becoming increasingly important. The Brexit vote and its aftermath provide a unique opportunity to study trade uncertainty given the extended period of negotiations, the continued ambiguity about the outcome, and the real risk of the reintroduction of significant trade barriers between the EU and the UK.

The past decade has witnessed renewed interest in the impact of trade integration on labour markets (e.g. Autor et al. (2014), Pierce and Schott (2016) & Hummels et al. (2014)). This research has documented some substantial negative labour market consequences of import competition and offshoring and some positive effects of exporting. While we have a good understanding the effects of liberalization and integration, we know little about the labour market costs of reversing existing trade agreements and unravelling global integration.

In this paper, we provide new evidence on the labour market impact of the potential reversal of trade agreements. We exploit the product-level variation in EU most-favoured-nation (MFN) tariffs, that would be placed upon UK exports to the EU if the UK were to leave without a trade deal, to explore how trade uncertainty affects online hiring in local labour markets.[1] We study how the referendum result itself, and changing uncertainty about the future imposition of MFN tariffs during the three-year period after the referendum, affected the posting of job adverts online. We use a high frequency dataset consisting of the near universe of online job adverts posted in the UK between January 2015 and September 2019, which allows us to track the real-time response of UK firms to tariff uncertainty as the political process evolved.

Our results show that regions that were *ex ante* more exposed to the possible introduc-

[1] Most-favoured-nation (MFN): "Under the WTO agreements, countries cannot normally discriminate between their trading partners. Grant someone a special favour (such as a lower customs duty rate for one of their products) and you have to do the same for all other WTO members." More information can be found here: https://www.wto.org/english/thewto$_e$/$whatis_e$/tif_e/$fact2_e$.htm

tion of MFN tariffs in the future differentialy reduced online hiring after the referendum relative to less exposed regions. A one standard deviation increase in potential future tariff exposure led to a 1.9% decrease in job postings in our baseline specification, controlling for relevant confounding factors. We also construct two time-varying proxies for Brexit-specific tariff uncertainty. The first uses the intensity with which the UK's top ten newspapers were publishing articles discussing both Brexit and trade policy uncertainty. The second uses the Google search intensity in the UK for terms relating to both Brexit and trade policy. Using these measures, we show that the relative decline in online hiring for more exposed regions was larger in periods of heightened uncertainty about future tariff arrangements with the EU.

We find that the impact of tariff uncertainty was distinct from the impact of the exchange rate depreciation that immediately followed the referendum, uncertainty about future immigration policy, and exposure to the financial services sector. The depreciation of the pound immediately after the referendum led to increased job postings in regions whose exports became more competitive, and decreased job postings in regions that disproportionately rely on intermediate imports, which became more expensive. Regions with a higher *ex ante* employment share of EU, and specifically EU8,[2] nationals differentially increased hiring after the vote, so tariff uncertainty was operating in the opposite direction to this immigration effect. Local labour markets with greater *ex ante* employment shares in financial services, by contrast, reduced hiring after the vote relative to those with lower shares.

Tariff exposure had a remarkably similar impact on the posting of both skilled and unskilled job adverts after the referendum, although the relative decline was very slightly greater for unskilled job adverts. The impact of exposure to the financial services sector and exposure to more expensive imported inputs had a greater negative effect on the posting of skilled job adverts after the vote, while exposure to immigration from Eastern EU nationals was associated with a greater increase in the posting of unskilled job adverts after the vote and mattered less for the posting of skilled job adverts. Both skilled and un-

[2]The EU8 countries are a group of eight of the 10 countries that joined the European Union during its 2004 enlargement. They are commonly grouped together separately from the other two states that joined in 2004, Cyprus and Malta, because of their relatively lower per capita income levels in comparison to the EU average. They are the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia. We henceforth refer to this group as Eastern EU or 'EEU' countries as all are in Eastern Europe.

skilled job adverts were affected by exposure to EU immigration and the positive effect of UK exports becoming more competitive in foreign markets.

Overall, our results suggest that the threat of future trade barriers has an important negative impact on local labour markets through the reduced advertising of job openings. Our contribution to the literature consists of several elements. First, we contribute to the emerging literature looking at the immediate impacts of trade barriers and loss of market access. Amiti et al. (2019), Cavallo et al. (2019) and Fajgelbaum et al. (2019) all study the consequences of the 2018 US trade war for prices, trade flows and welfare. In the context of Europe, Mayer et al. (2018) has attempted to quantify the trade-related welfare gains each country member has reaped from the European Union and what the cost of reverting to a shallow regional agreement or WTO terms would be.

In the context of the Brexit referendum, we are not studying the effects of actual tariffs but the threat of future ones and so we also contribute to the literature on economic policy uncertainty. There is a substantial literature showing that uncertainty affects investment, growth and employment. Rooted in the earlier work of Bernanke (1983) and Hassler (1996) who highlighted the importance of variations in uncertainty, Bloom (2009) develops a theoretical model whereby macro uncertainty shocks produce a rapid drop and rebound in aggregate output and employment as higher uncertainty causes firms to temporarily pause their investment and hiring.[3] We contribute both by zooming in on trade-specific uncertainty and by investigating how the time-varying nature of uncertainty affects a near real-time measure of labour demand.

We additionally contribute to the expanding literature looking specifically at trade policy uncertainty (Pierce and Schott (2016); Crowley et al. (2018a); and Handley and Limão (2017)). While these papers typically study the effect of trade policy uncertainty on trade, investment, and firm entry/exit, we consider how this feeds through to labour markets. Two recent papers that have studied the economic consequences of the uncertainty surrounding Brexit are Crowley et al. (2018b) and Graziano et al. (2018). The former paper studies firm entry and exit from foreign markets, using a difference-in-difference approach that compares firms that are differentially exposed to potentially high "threat-point" tar-

[3]For a review of the theoretical literature, see Dixit and Pindyck (1994). For a review of some of the empirical literature, see Baker et al. (2016).

iffs, before and after the referendum. The latter paper concentrates on uncertainty pre-referendum and its impact on the value of bilateral trade. Our approach adds to this work by exploiting a higher frequency outcome variable, which stretches almost to the present day (end of Q3 2019), and includes the whole of the renegotiation period.

Third, our paper contributes to a broader literature on the economic impacts of the Brexit referendum, providing new evidence on another first-order consequence of the Brexit vote for hiring and labour markets. Costa et al. (2019) also study the Brexit referendum and show that that the devaluation of the pound on the night of the referendum resulted in a negative effect on worker salaries and training post-referendum. We follow their method to control for the impact of exchange rate changes and confirm that the exchange rate depreciation had an impact on online hiring that is distinct from that of tariff uncertainty. Our findings also support the work of Bloom et al. (2019), who show that more productive, internationally exposed, firms have been more negatively impacted by the uncertainty caused by the anticipation of Brexit than less productive domestic firms. Breinlich et al. (2019) show that the Brexit vote increased outward foreign direct investment from the UK into the other EU member states, which points to the possibility that our results could be operating through firms relocating away from the UK or hiring in other parts of Europe.

Finally, we add to a relatively new literature using real-time labour market data, such as online job adverts, to study labour markets (Hershbein and Kahn (2018); Deming and Noray (2018); Deming and Kahn (2017)).

This paper proceeds as follows: Section 2 provides background information on the referendum, Section 3 summarises the data sources used, Section 4 outlines the empirical strategy, Section 5 presents the results, Section 6 provides robustness checks and Section 7 concludes.

2. Background on the Brexit Referendum

On the 23rd January 2013, UK Prime Minister David Cameron committed to hold a referendum on the UK's membership of the European Union if his party won the next gen-

eral election.[4] This promise introduced a period of increased uncertainty about the future trade policy between the UK and the EU; Table 1 outlines some of the key dates in the Brexit process. The referendum date was eventually announced in February 2016 and the UK electorate voted to leave the European Union on the 23rd June 2016. While the uncertainty began in 2013, the result of the referendum came as a big surprise to many observers. Evidence of this includes betting markets that had placed the likelihood of a 'leave' outcome at around 30% for most of the preceding year, and the fact that the pound-dollar exchange rate fell by 8 percent in the 24 hours following the referendum. This was the sterling's biggest one-day loss since the introduction of free-floating exchange rates in the 1970s, reflecting the adjustment of market expectations to the outcome of the referendum.

In the event of Britain leaving the EU, UK firms trading with the EU faced two main potential future trade arrangements with different tariff schedules. One scenario was that the UK would retain tariff free access to the EU (by remaining in the Customs Union or negotiating a Free Trade Agreement), while the other scenario was that the UK would export to the EU under the EU's WTO tariff schedule and pay MFN tariffs. Prior to the referendum, and indeed throughout the negotiation period, it was unclear which of these outcomes would be realised, and hence firms had to infer the probability of an MFN outcome from political signals. The EU is the UK's largest trade partner which means that future MFN tariffs would have a non-trivial impact on UK firms: in 2014, the 27 other EU members accounted for 45 percent of UK exports and 53 percent of imports (Dhingra et al., 2017).

In the initial period after the referendum, it was proposed, although still with a substantial degree of ambiguity, that the UK would leave the single market and then trade on the basis of a new free trade agreement without regulatory alignment but with the majority of goods being traded without being subject to tariffs. The challenges of the Irish border subsequently came to the fore, specifically the management of different regulatory regimes without having a physical (or "hard") border and the potential to undermine key elements of the Good Friday Agreement. The EU insisted on introducing a "backstop" into the transition agreement, negotiated by Theresa May, to ensure that, in the absence of a mutually agreed solution to managing the border, at least Northern Ireland would remain in the customs union of the EU. However, this transition agreement failed three times to

[4] https://www.bbc.co.uk/news/uk-politics-21013771

Table 1: Brexit Timeline

Date	Event
23rd January 2013	David Cameron declares he is in favour of an EU referendum
14th April 2015	Launch of the Conservative Party Manifesto for the 2015 General Election, committing to "hold an in-out referendum on our membership of the EU before the end of 2017"
7th May 2015	Election of Cameron on Manifesto containing referendum promise
7th September 2015	European Union Referendum Act passed in parliament
20th Feb 2016	Date of referendum confirmed
23rd June 2016	EU Referendum
13th July 2016	Cameron steps down, Theresa May becomes Prime Minister
29th March 2017	Invocation of Article 50
8th June 2017	Snap General Election
15th November 2018	The Withdrawal Agreement is agreed and published
25th November 2018	EU27 leaders endorse the withdrawal agreement and approve political declaration on future EU-UK relations
15th January 2019	First failed vote on withdrawal deal
16th January 2019	Government wins vote of no confidence
12th March 2019	Second failed vote on withdrawal deal
14th March 2019	Vote to request extension of Article 50 (to 12th April if no deal agreed or 22nd May if deal agreed)
29th March 2019	Third failed vote on withdrawal deal and originally planned leaving date
10th April 2019	The UK and EU27 agree to extend Article 50 until 31st October 2019
24th May 2019	Theresa May gave official notice of her resignation
24th June 2019	Boris Johnson elected Prime Minister by conservative party members

Notes: This table shows the timeline of the events leading to the UK's exit from the European Union. *Sources*: Commons Briefing papers CBP-7960, Nigel Walker, https:https://researchbriefings.parliament.uk/ResearchBriefing/Summary/CBP-7960.

pass through parliament, leading Theresa May to give official notice of her resignation on the 24th May 2019.

Boris Johnson was subsequently elected as the new leader of the Conservative Party, showing strong support for a 'no deal' Brexit. On June 25th 2019 he stated "We are getting ready to come out on 31 October, do or die",[5] once again raising the perceived probability of an MFN outcome.

3. Data

3.1 Online job adverts

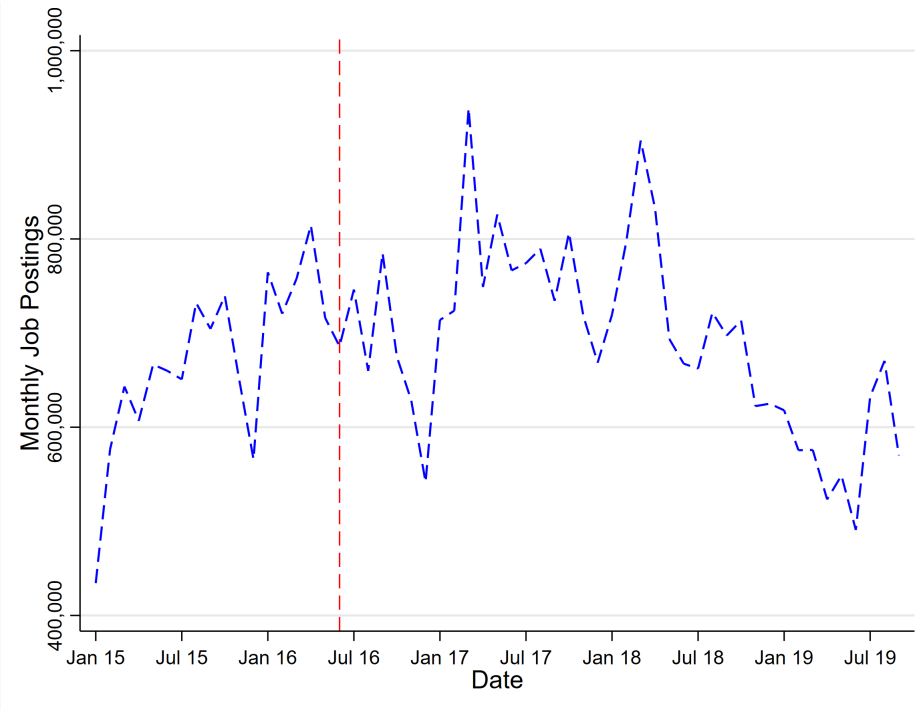
We use data collected by Burning Glass Technologies (BGT), a company that scrapes what they identify to be the quasi-universe of UK online job postings on a daily basis.[6] These postings are sourced from more than 40,000 online job boards and company websites, with a total of over 60 million UK job adverts over the period 2012-2019. BGT classify the job adverts by Travel to Work Areas (TTWA), Local Authority District, and region. They also use machine learning techniques to classify the adverts by SIC (Standard Industrial Classification) codes, SOC (Standard Occupational Classification) codes and skill clusters, as well as clean the data and remove duplicate postings.

Over the period of January 2015 to September 2019, a total of 29,575,440 postings are present in our dataset, which translates into an average of 6,226.408 per year. Figure 1 displays the time series of monthly job postings over the period of our analysis. The postings cover 641 different SIC codes at the 4-digit level, and 225 TTWAs across the UK. Of the total sample of job postings 76% are classified with a TTWA. Table 2 displays summary statistics for monthly job postings and all other variables used in the paper.

[5] https://www.theguardian.com/politics/2019/jun/25/brexit-boris-johnson-britain-will-leave-eu-31-october-do-or-die

[6] Carnevale et al. (2013) have shown that online job vacancy data is strongly correlated with data on total vacancies. Hershbein and Kahn (2018) estimate, for the United States, that approx. 85% of all jobs are posted online and those posted online are biased to higher skilled and white collar jobs. Online job adverts therefore do not provide a complete picture of the entire labour market, but can provide a useful barometer on labour market demand.

Figure 1: Monthly online job postings



Notes: The vertical red dotted line identifies June 2016, the month of the Brexit referendum.

3.2 Sectoral Exposure to MFN Tariffs

We begin by constructing the exposure to MFN tariffs at the sectoral level. The tariffs used in the analysis are taken from World Integrated Trade Solution (WITS), and we select the applied most-favoured-nation (MFN) tariffs that the EU applies to imports coming from the rest of the world (excluding countries with which the EU has preferential trading arrangements). The data are aggregated at the 6-digit level of the Harmonised System (HS6) and contain the simple average of tariffs across higher levels of disaggregation. We match these tariffs to the EU-27 imports from the UK[7] at the HS6 level and then match the combined dataset with 4-digit SIC codes using a crosswalk provided by WITS.[8]

From there we can aggregate the tariffs to the sectoral level using both a simple average across tariff lines, and a trade weighted average. The simple average tariff threat is:

[7]That is, we excluding the UK from the EU imports. We focus on imports because they are likely to be more reliably recorded than exports.

[8]The H2007 to SIC crosswalk can be found here: http://wits.worldbank.org/WITS/WITS/Support%20Materials/CMTNomenclatureandConcordancesList.aspx?Page=ProductNomenclatureandConcordances. This must be connected to the H2012 nomenclature in order to match the trade and tariff data. We therefore use a H2007 to H2012 crosswalk available here: https://unstats.un.org/unsd/trade/classifications/correspondence-tables.asp. We use pre-determined data from 2014 to avoid endogeneity concerns.

Table 2: Summary statistics

	Mean	Median	Minimum	Maximum	Standard deviation
Monthly postings	2,436	661	1	206,743	10,229
TTWA tariff exposure	0.06362	0.04771	0.002717	0.6847	0.0639
Finance employment share	0.01923	0.01249	0.002956	0.09151	0.01666
Xrate impact via imports	-0.0652	-0.06521	-0.06646	-0.06441	0.0003273
Xrate impact via exports	0.06219	0.06271	0.05052	0.07054	0.003467
EU national worker share	0.04318	0.04217	0.01822	0.1441	0.01468
Eastern EU national worker share	0.02785	0.02683	0.01212	0.05814	0.008542
US postings proxy	9,138	8,733	2176	31,260	3,253
Specific tariff exposure	0.0007102	0.0003343	0	0.007683	0.001093
Quota exposure	0.0002691	0.0001662	0	0.003092	0.0003513
Newspaper-based uncertainty index	5.344	5.44	0.24	18.2	3.613
Google-search-based uncertainty index	1.912	1.805	0.5175	5.09	1.023

Notes: This table displays summary statistics for all of the key variables used in the analysis. The newspaper uncertainty index has been scaled by 100 so the mean of 5.344 represents 534 articles per month.

$$tariff_threat^{(s)}_{j,2014} = \frac{1}{n_j} \sum_{p \in j} \tau_{p,2014} \tag{1}$$

The trade weighted average tariff threat is:

$$tariff_threat^{(w)}_{j,2014} = \sum_{p \in j} \frac{X_{p,2014} \tau_{p,2014}}{\sum_{p \in j} X_{p,2014}} \tag{2}$$

where j indexes 4-digit SIC sectors, p products at the HS6 level, n_j the number of HS6 level products associated to production in sector j, $\tau_{p,2014}$ represents the simple average 2014 tariff rate at the HS6 level (as a percentage), and $X_{p,2014}$ exports from the UK to the EU-27 of a particular HS6 product in 2014. We focus on the 2014 tariffs for two reasons. First, we want to avoid the unlikely possibility that the EU might be strategically adjusting its MFN tariffs in anticipation of the possibility of Brexit. Second, as our analysis uses a trade-weighted tariff measure and we want to avoid the possibility of trade flows being affected by the referendum results.

The tariff data are aggregated up to 442 sectors, of which all except one actually export to the EU. Taking the simple average, 19% of sectors have an average tariff of zero, 56% have tariffs greater than zero and smaller than or equal to 5, 18% have tariffs between 5 and 10, and 8% of sector have rates greater than 10. The mean tariff rate across all sectors is 3.7, with a maximum of 56.6 and a standard deviation of 4.8. These descriptive statistics are broadly similar for the trade weighted average. We primarily focus on the trade-weighted

average tariffs in our analysis, providing a robustness check using the simple average.

We are focusing primarily on the effect of future MFN tariffs on UK exports, rather than UK import tariffs, for a few reasons. Firstly, while the UK would not be able to control the tariffs placed upon its exports if it left the EU without a trade deal, it would be able to directly control its import tariffs. In addition, it was often suggested during the negotiation period that the UK would unilaterally place low, or zero, tariffs on imports if it were to leave without a deal.[9] We would therefore expect that the perceived risk of harm from future import tariffs would be substantially lower than the risk of harm from tariffs on UK exports, which were widely known to default to WTO terms if the UK left without a deal.

3.3 Regional Exposure to MFN Tariffs

We construct measures of exposure to tariffs at the local labour market level by weighting the sectoral measures using baseline employment shares within a local labour market for each industry. Our analysis uses UK TTWAs[10] as our statistical unit, which aim to reflect the geographic region where the population would generally commute to a larger town, city or conurbation for the purposes of employment. The current criteria for defining TTWAs are that at least 75% of the area's resident workforce work in the area and at least 75% of the people who work in the area also live in the area. The area must also have an economically active population of at least 3,500. TTWAs range in population size from 6,800 to 8.4 million. Our approach hence builds on the literature on local labour markets (e.g. Autor et al. (2014)).

The regional tariff exposure measure is defined as:

$$tariff_threat_r = \sum_{j \in r} \frac{employment_{j,2015} \times tariff_threat^{(w)}_{j,2014}}{\sum_{j \in r} employment_{j,2015}} \tag{3}$$

where $employment_{rj,2015}$ is aggregate employment in TTWA r in industry j in 2015, and $tariff_threat^{(w)}_{j,2014}$ is the trade-weighted measure of industry j's exposure to future EU MFN

[9] For example, see https://www.ft.com/content/d97854c2-2941-11e9-a5ab-ff8ef2b976c7

[10] Travel to Work Areas are defined by the Office for National Statistics using census data for commuting between wards, based on the different locations of individuals' home and work addresses. See here: https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/articles/traveltoworkareaanalysisingreatbritain/2016

tariffs based upon the level of these tariffs in 2014, as defined above.[11] The total employment within each TTWA (the denominator) includes service sectors where each service sector is allocated a value of zero for the tariff threat.[12]

The UK has 228 TTWAs and we consider the 218 for the UK excluding Northern Ireland. We use employment data from the UK Business Register and Employment Survey (BRES) for 2015 that contains a breakdown of employment by SIC4 industry within each TTWA in the UK. BRES collects employment information from businesses across the whole of the Great Britain economy for each site that they operate, while the same information is collected separately for Northern Ireland. BRES surveys approximately 85,000 businesses. For 2015 the BRES data includes 28.5 million employees, 91% of the total UK labour force as estimated by the ONS.[13] As it is a business survey, the quality of the industry classifications is preferable to industry data from household surveys such as the Annual Population Survey, which we use for the immigration controls.

We ideally would like to use the employment composition before there was any possibility of Brexit. However, the sampling of BRES changed in 2015, substantially improving its coverage by including business units with a single Pay As You Earn (PAYE) code for which no Value Added Tax (VAT) data are available. Prior to 2015, such units were excluded from the sampling frame and thus we choose to use 2015 data for the employment weights. We consider all employed individuals in a TTWA: an employee is defined as anyone aged 16 years or over that is paid directly from the payroll, in return for carrying out a full-time or part-time job or being on a training scheme. Employment includes employees plus the number of working owners who receive drawings or a share of the profits.

Figure 3 displays the distribution of the exposure measures at the TTWA level and figure 4 provides a map of the exposure measures. Examples of TTWAs in the top 5% in terms of exposure are Carlisle, Stoke on Trent and Plymouth. Examples of those in the bottom 5% in terms of exposure are Bath, London and Worthing. The median is 0.047 and the standard deviation is 0.064.

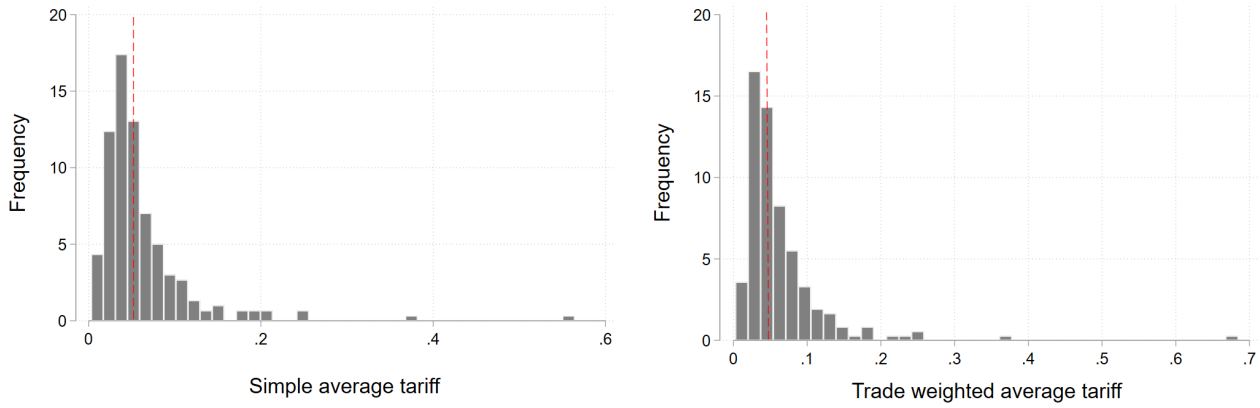
Finally, we map the job postings to our tariff exposure measure using the TTWA names

[11] We also repeat this analysis using the simple average across tariff lines for robustness.

[12] Although Brexit created uncertainty about future treatment of UK services providers by the EU, we are unable to quantify the magnitude of this threat and therefore it does not enter our analysis.

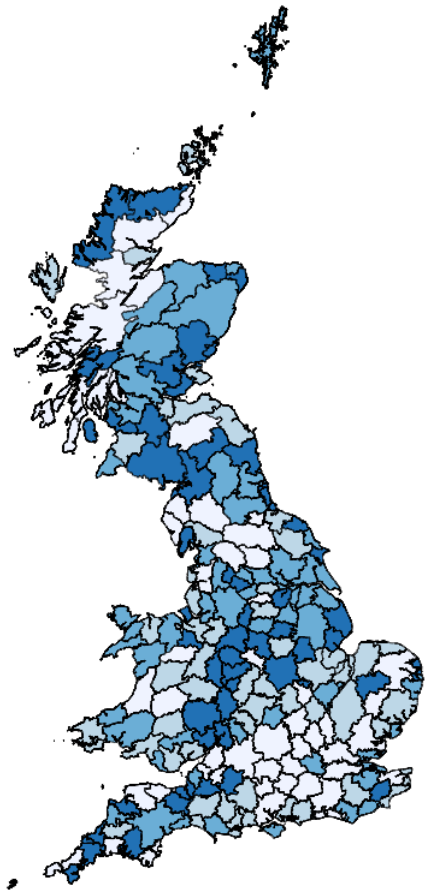
[13] https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/bulletins/uklabourmarket/2015-07-15

Figure 3: Distribution across TTWAs



Notes: This graph displays the MFN tariff threat for the 213 TTWAs. Median denoted by vertical red dotted line. *Sources*: Tariff data: World Integrated Trade Solution (WITS). Trade data: UN Comtrade. HS6-SIC crosswalk from WITS and UN.

Figure 4: Tariff exposure by TTWA



Notes: This map displays the baseline employment-weighted tariff exposure for each TTWA. Darker colours represent more exposed areas. The darkest blue colour represents exposure measures in the range of 0.075 to 0.68. The lightest colour represents exposure measures ranging from 0.0027 to 0.033.

in the BRES data. When mapping to TTWAs, there are 5 TTWAs in the BRES data that have no job postings in the BGT data and so we exclude these from the analysis. In addition, our analysis excludes job postings that have not been possible to classify by TTWA. This leaves us with a final dataset with 213 TTWAs for 57 months, resulting in 12,141 observations.

3.4 Classifying job adverts by skill type

Our job postings data provides information on the occupational classification of each of the postings at the 4 digit Standard Occupational Classification (SOC) level. Examples include 'Managers and proprietors in agriculture and horticulture' or 'Metal plate workers, and riveters'. The Office for National Statistics classifies the 2-digit sub-major groups of the SOC 2010 into four skill levels.[14] We define the top two levels as 'high skill' and the bottom two as 'low skill'. Examples of high skill sub-major groups include 'Science, research, engineering and technology professionals' (level 4) and 'Business and public service associate professionals' (level 3). Examples of low skill sub-major groups include 'Administrative occupations' and 'Elementary trades, plant and storage related occupations'. For evolution of skilled and unskilled job postings over time see Figure 5.

3.5 Measures of Trade Policy Uncertainty

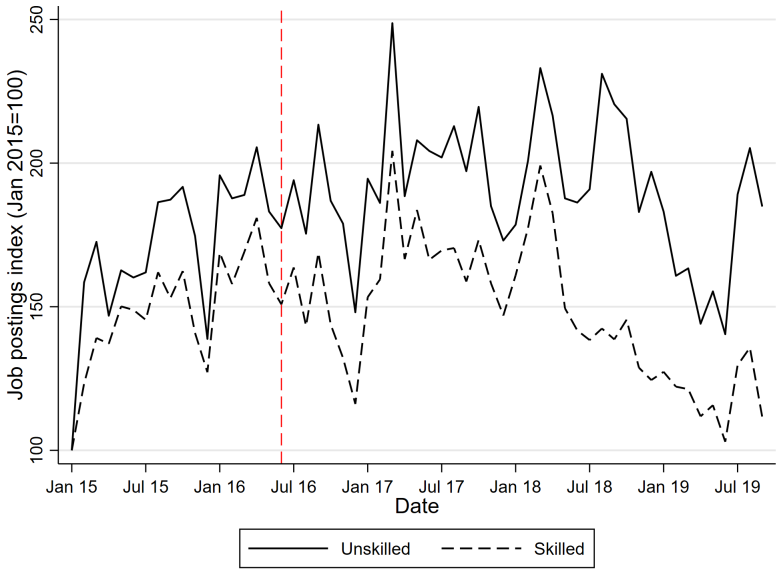
3.5.1 Newspaper coverage measures

Our objective is to estimate the response to changes in beliefs about the likelihood that UK firms will be subject to MFN tariffs when trading with the EU after Brexit. Since we do not directly observe firm-level beliefs about tariffs, we develop proxies that reflect uncertainty about the future tariff arrangements with the EU.

Our first approach uses UK newspaper coverage frequency and builds closely upon the methodology in Baker et al. (2016)'s Economic Policy Uncertainty (EPU) Index and Ahir et al. (2018)'s World Trade Uncertainty (WTU) Index, but focuses specifically on the trade uncertainty caused by the Brexit referendum. We begin by combining the list of trade pol-

[14] https://www.ons.gov.uk/file?uri=/methodology/classificationsandstandards/standardoccupationalclassificationsoc/soc2010/soc2010volume1structureanddescriptionsofunitgroups/soc2010volume1webtcm77181317.pdf

Figure 5: Skilled and unskilled job postings over time



Notes: This graph compares job postings of high skill and low skill workers over time using a 3-month moving average. Both are normalised to 100 in January 2014. The vertical line represents June 2016, the month of the Brexit referendum.

icy uncertainty related terms from the EPU and the WTU, which include words such as "trade policy" or "world trade organization". We then remove all terms that would not be related to the trade uncertainty caused specifically by the Brexit referendum (for example, "NAFTA" or "Doha round"). This leaves us with a condensed list of 7 trade related terms: 'trade', 'tariffs', 'duties', 'WTO', 'World Trade Organisation', 'trade policy', 'trade agreement'. We then follow the WTU Index and search for articles that mention any of these terms with the words 'uncertain', 'uncertainty' or 'uncertainties'. While the EPU and WTU indices are interested in general trade policy uncertainty, in this paper we aim to isolate the trade policy uncertainty caused by the Brexit referendum. We therefore add an additional requirement for these terms to appear with the words 'Brexit', 'no deal', 'leave EU' or 'EU'.

Table 3 summarises these terms. We took a monthly count of any article including a term from Category A, a term from Category B, and a term from Category C. We search among the top 10 most popular UK newspapers by circulation: The Daily Mail, The Sun, The Mirror, The Express, The Times, The Telegraph, The Guardian, The Independent, The Daily Express and The Metro. Our data comes from Factiva, a news aggregator, and covers the period of 2015-2019. This index is displayed in the left panel of Figure 6. Newspaper coverage peaked on the referendum date of June 23rd 2016. It subsequently declined,

Table 3: Uncertainty measure included terms

Category 1	Category 2	Category 3
brexit	uncertainty	trade
no deal	uncertain	tariffs
leave EU	uncertainties	duties
EU		wto
		world trade organisation
		trade policy
		trade agreement

Notes: This table displays the terms used in the uncertainty measures. We counted any article including a term from Category A, a term from Category B and a term from Category C.

then reaching its second highest point in November 2018, the month when the UK and EU agreed on the text of the draft withdrawal agreement and a summit was held where all EU27 nations endorsed the Brexit deal. Newspaper covereage remained high until March 2019, when the government put in a request to extend Article 50.

3.5.2 Google search measures

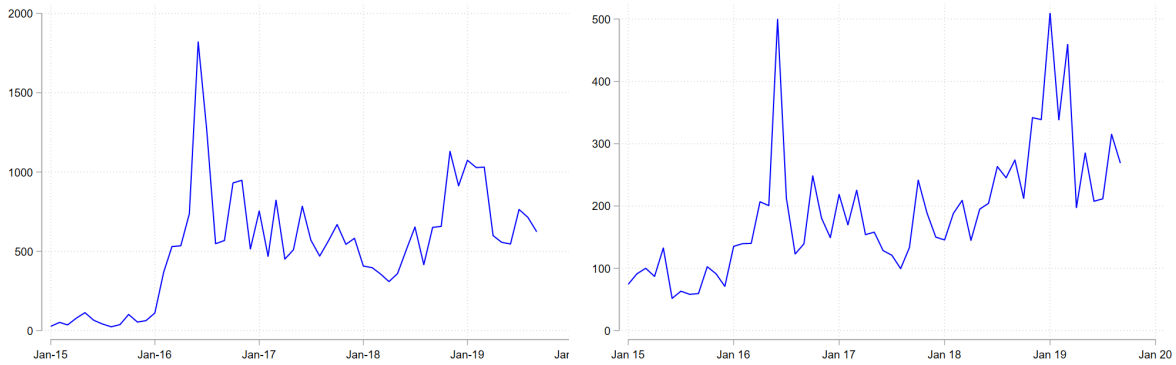
Our second approach is to use Google searches.[15] Google searches offer an alternative way to gauge the degree of public concern surrounding Brexit and future trade policy, through directly observing what people are searching for. Google Trends[16] provides public information on the Google searches conducted within a given region over time. We use searches for the same terms as for the newspaper measure, but exclude the uncertainty-related terms. We assume that when individuals are uncertain about future trade arrangements they will not search for the word 'uncertain', whereas newspapers would report on uncertainty using these words.

Figure 6 shows the google trends measure on the right panel. Similarly to the newspa-

[15] An alternative was to follow the approach in papers such as that by Graziano et al. (2018) and use prediction markets to gauge uncertainty. These authors use the average daily price of a contract traded in PredictIt.org paying $1 if a majority voted for Brexit in the referendum as a measure of pre-referendum trade policy uncertainty. However, betting markets tend to release contracts on narrowly defined questions over a limited period of time. Since we aim to measure the perceived probability of firms facing MFN tariffs over the entire pre-and post-Brexit period, this type of measure was not feasible. Public polling was an additional option, but few polls asked the same question over time.

[16] https://trends.google.com/trends

Figure 6: Brexit trade policy uncertainty measures



(a) Newspaper coverage

(b) Google searches

Notes: The graph on the left shows the uncertainty measure constructed using newspaper articles including key terms relating to Brexit, uncertainty and trade policy. These measures reflect the total number of articles in the UK's top 10 newspapers including the relevant searches terms in each month. The graph on the right shows the uncertainty measure constructed using google searches for key terms relating to Brexit and trade policy. These measures reflect search intensity for the relevant search terms in each month.

per measure, this measure has a peak on the referendum month, but unlike the newspaper measure its second peak in late 2018 is of the same order of magnitude as the first peak, suggesting that search intensity for Brexit-related trade policy was equally high in late 2018 and early 2019 as it was just after the referendum. Newspaper coverage, on the other hand, never came close to the same intensity as just after the referendum during the three year period after the vote.

3.6 Control variables

The Brexit referendum also introduced other factors which may have affected the posting of online job adverts during this period. We focus on three key control variables: changes to the expected supply of EU or EEU nationals working in the UK, the sharp depreciation of the pound sterling after the referendum, and the increased uncertainty felt by the financial sector. Below we discuss the construction of the immigration controls, leaving defining the exchange rate and financial services sector control variables to Section 4.

3.6.1 Immigration data

To measure the employment share of EU and EEU nationals in a TTWA before the vote we use data from the Annual Population Survey (APS) in 2015. The APS is a continuous household survey covering the UK, with the aim of providing between-census estimates of key social and labour market variables at a local area level. The APS is not a stand-alone survey, but combines data from two waves of the main Labour Force Survey (LFS) with data collected on a local sample boost. The datasets comprise 12 months of survey data and are disseminated quarterly, with an achieved sample size of approximately 320,000 respondents. The APS is the most comprehensive source of data on employment by nationality of workers and is typically used for research on immigration in the UK.

The data provide a breakdown of the share of employment of EU and EEU nationals in each UK region and SIC2 industry, where there are 11 regions (for example North West, South West, Scotland), excluding Northern Ireland. We use data on the SIC2 employment composition of each TTWA in a given region to construct the employment share measures. A map of these measures is displayed in Figure 8 in the Appendix.

3.7 US job adverts

We also conduct an additional robustness check using US job postings data from BGT. Our aim is to control for global sectoral trends in online hiring that could be driving our results. The key idea is to create a placebo postings variable based on US postings data but which varies at the UK TTWA level. In other words, if the UK was facing the same sectoral trends in hiring as the US, but still had the same TTWA employment composition, this is what we would expect to see in terms of the evolution of online job adverts at the TTWA level.

We therefore create a control which varies at the UK TTWA level and by month. To do this, we first map the 6-digit North American Industry Classification System (NAICS) code, the US sector classification, to the 4 digit SIC codes, the UK equivalent.[17] We then use the same TTWA pre-sample sectoral employment shares that we used to construct the tariff threat measure as weights for the US national sectoral job postings, creating an extrapo-

[17] We use a crosswalk from the US Census Bureau (https://www.census.gov/eos/www/naics/concordances/concordances.html)

lated measure of the evolution of postings that would have occurred for each TTWA, had it followed the sectoral trends occurring in the US. Although there is a chance that US postings were also affected by the Brexit vote, we assume that this impact in the US would be far more muted than in the UK.

4. Empirical Strategy

4.1 Baseline specification

Our baseline specification estimates the impact of the post-referendum period on monthly online job postings in UK local labour markets as a function of a labour market's exposure to future potential MFN tariffs over the period of January 2015-September 2019. We estimate the following model:

$$\log(postings_{rt}) = \beta_0 + \beta_1 tariff_threat_r \times post_vote_t + \gamma_t + \gamma_r + \epsilon_{rt} \tag{4}$$

where $postings_{rt}$ are the total number of online job adverts posted in month-year t and TTWA r, $post_vote_t$ is a dummy variable for the time period after the referendum, and $tariff_threat_r$ is a measure of the exposure of TTWA r to future MFN tariffs with the EU. The latter, discussed more fully in the data section, is defined as:

$$tariff_threat_r = \sum_{j \in r} \frac{employment_{j,2015} \times tariff_threat_{j,2014}}{\sum_{j \in r} employment_{j,2015}} \tag{5}$$

where $employment_{rj,2015}$ is aggregate employment in TTWA r in industry j in 2015, and $tariff_threat_{j,2014}$ is the trade-weighted measure of industry j's exposure to future EU MFN tariffs based upon the level of these tariffs in 2014.

Because our specification includes month-year dummy variables we do not include the post-vote variable on its own. We are also interested in the impact of trade policy uncertainty for different skill groups and so we run the specification in (4) separately for skilled and unskilled job postings, with these categories defined in the Data section.

4.2 Time-varying trade policy uncertainty

The outcome of the referendum introduced a large overnight increase in uncertainty about future trade policy between the UK and EU. We proxy for this step change in uncertainty initially through our $post_vote_t$ dummy. However, the degree of uncertainty continued to vary substantially in the period after the referendum as political events unfolded. We therefore also explore how time-varying measures of uncertainty surrounding future tariff arrangements with the EU affected online hiring in regions relatively more exposed to the future MFN tariffs. We consider the following specification:

$$\log(postings_{rt}) = \beta_0 + \beta_1 tariff_threat_r \times tariff_uncertainty_t + \gamma_t + \gamma_r + \epsilon_{rt} \quad (6)$$

where $tariff_uncertainty_t$ is a measure of the degree of MFN tariff uncertainty in month-year t. We construct two different types of uncertainty measures: the first using newspaper articles and the second using Google searches. These measures are described in the Data section above.

4.3 Other channels

4.3.1 Accounting for immigration policy uncertainty

Immigration was a central theme of the Leave campaign and was one of the policy areas given priority during the negotiation period. The referendum result introduced substantial uncertainty surrounding freedom of movement of people between the UK and EU and the future ability of UK firms to employ EU nationals. We therefore introduce an additional control for a TTWA's share of employment of EU nationals and Eastern EU nationals in the pre-referendum period, interacted with the post-referendum dummy. We hypothesise that firms relying on EU workers may react to increased uncertainty about the ability to employ workers in the future by hiring more aggressively in advance of leaving the EU.

4.3.2 Accounting for the exchange rate depreciation

One of the most notable immediate impacts of the EU referendum was the large overnight depreciation of the pound with respect to the dollar and euro, the magnitude of which

speaks to the unexpected nature of the referendum results. UK firms are likely to have been affected by this depreciation, both through increased cost of imported inputs, and through increased competitiveness of export products. The depreciation was also not equal with respect to different currencies: for example, the pound-dollar exchange rate fell by 8 percent overnight on June 23/24 while the pound-euro exchange rate fell by 6 percent. Since imports and exports differ in their source and destination countries, industries trading in different world markets faced a different effective sterling depreciation. The differential cost and revenue shocks from these country specific variations in the unexpected sterling depreciation therefore affected industries differently (Costa et al., 2019). If these sector-specific changes across time are correlated with the threat of MFN tariffs then we may be concerned that our key estimated impact is biased.

Following Costa et al. (2019), we include controls for the sector-specific (2-digit SIC) exposure to the exchange rate depreciation both in terms of exports and imported inputs, interacted with a post_vote dummy.[18] These controls are constructed as follows. The intermediate import weighted exchange rate change (where the depreciation corresponds to a *negative* value) is:

$$\hat{E}_o^M \equiv \sum_i \sum_{s \neq uk} S_{sio} \hat{E}_s$$

The export weighted exchange rate change (where the depreciation corresponds to a *positive* value because of the minus sign in front of the formula) is:

$$\hat{E}_o^X \equiv - \sum_{d \neq uk} S_{dxo} \hat{E}_d$$

where s indexes the source country for imported inputs, d the destination country for exports, o the sector, i imports, and x exports. $\hat{E}_s$ is the change in the exchange rate between the pound sterling and source country currencies, and $\hat{E}_d$ is similarly defined but for destination country currencies. S_{sio} and S_{dxo} are the sector-specific shares of imports and exports respectively coming from specific sources/destinations. A depreciation of the pound with respect to any currency would lead to a negative value for $\hat{E}_s$ or $\hat{E}_d$ and, as long trade is concentrated among partner countries for which there was indeed a depreciation,

[18] We are very grateful to Swati Dhingra for sharing the data with us.

this should lead to a negative value for $\hat{E}_s^M$ (more expensive imported inputs) and a positive value for $\hat{E}_d^X$ (more competitive exports).[19] Figure 8 in the Appendix provides maps of these measures by TTWA.

4.3.3 Financial Services

We want to ensure our results are not picking up hiring patterns caused by the uncertainty surrounding future service sector regulation, so we add a control variable for the proportion of workers in each TTWA employed in the finance sector in 2015, defined as SIC codes 64-66, interacted with the post-vote variable. The financial sector in the UK is reliant on arrangements with the EU, such as 'passporting', and so was also affected by the uncertainty surrounding the Brexit referendum. We hypothesise that areas with more financial services might also be less exposed to tariffs that apply to certain types of industry and agriculture, hence biasing our results towards zero.[20] Figure 9 in the Appendix displays a map of this measure of financial service sector employment share by TTWA.

4.4 Other threats to identification

A primary threat to identification is omitted variable bias, that is to say region-time varying factors that affect job postings and are correlated with both $post_vote_t$ and $tariff_threat_r$.

One such potential concern is the the EU MFN tariffs tend to be high in declining industries because the EU is trying to protect these industries from competition to slow down the process of job losses. If some UK regions in our analysis are dominated by such declining industries, we might mistakenly attribute their worsened job market performance to the Brexit shock. This concern is attenuated by the fact that these tariffs are negotiated at the supranational level and the UK doesn't have direct control over the specific industries that get protected, although it may be able to achieve protection either through effective negotiation, or through shared interests with other EU states.

[19] Interpreting the coefficients can be somewhat counter-intuitive, for a more detailed treatment see (Costa et al., 2019)

[20] A firm authorised in an EEA (European Economic Area) state can carry out activities that it has permission for in its home state and any other EEA state by either establishing a branch or agents in an EEA country or providing cross-border services. https://www.bankofengland.co.uk/prudential-regulation/authorisations/passporting

Table 4: Baseline results

Dep variable: log postings	(1)	(2)	(3)	(4)	(5)
post vote * tariff exposure	-0.273***	-0.343***	-0.303***	-0.309***	-0.328***
	(0.070)	(0.072)	(0.070)	(0.070)	(0.070)
post vote * finance employment share		-2.200***	-1.087***	-1.219***	-1.141***
		(0.243)	(0.255)	(0.252)	(0.252)
post vote * xrate impact via imports			91.260***	98.201***	93.630***
			(17.511)	(17.385)	(17.396)
post vote * xrate impact via exports			-7.556***	-9.579***	-9.839***
			(1.607)	(1.737)	(1.837)
post vote * EU national share				1.396***	
				(0.285)	
post vote * Eastern EU national share					2.206***
					(0.542)
Observations	12,141	12,141	12,141	12,141	12,141
Adjusted R-squared	0.984	0.985	0.985	0.985	0.985
TTWA FE	YES	YES	YES	YES	YES
Month-Year FE	YES	YES	YES	YES	YES

Notes: This table displays the results from the regressions of the log of monthly job postings in each TTWA on the trade-weighted average tariff exposure measure at the TTWA level interacted with the post vote dummy variable, with and without controls. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

More broadly, there may be global sectoral trends which happen to correlate with exposure to EU tariffs. We attempt to address this concern in our robustness exercises by controlling for time-varying US online job postings aggregated to the UK TTWA level using UK pre-sample sectoral employment weightings (see the Data section for more information). Any UK trends that are also seen in the US should therefore be controlled for.

5. Results

5.1 Baseline Results

Table 4 displays the results from specification laid out in equation 4. Column (1) displays the coefficients on the interaction term between the post vote dummy variable and the TTWA trade weighted tariff exposure measure. The coefficient is negative and strongly significant, showing that online hiring decreased in regions relatively more exposed to future MFN tariffs after the referendum. For example, a one standard deviation (6.4 percentage point) increase in a TTWA's tariff exposure measure is associated with a relative

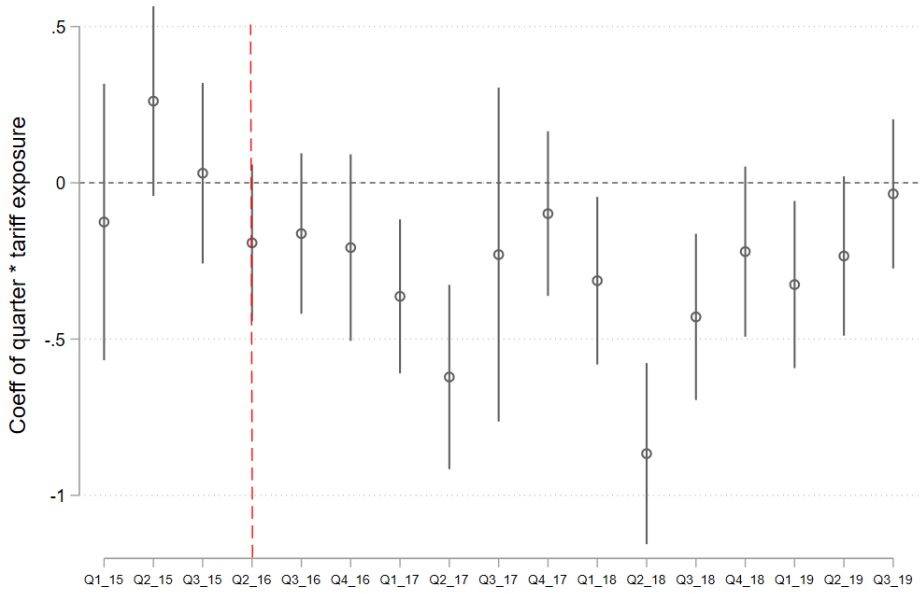
decrease in postings of approximately 1.7% in the post-referendum period relative to the pre-referendum period. Columns (2)-(5) subsequently add the controls described earlier in the paper.

Column (2) controls for the baseline (2015) employment share in each TTWA in the financial sector, as defined above. After adding this control, the coefficient on the tariff exposure variable increases in magnitude. The coefficient on the finance employment share interaction term is also negative and strongly significant, suggesting that areas with a higher share of finance sector employment differentially decreased online job postings after the vote. A one standard deviation (1.7 percentage point) increase in a TTWA's employment share in finance is associated with a decrease of 3.7% in postings in the post-referendum period relative to the pre-referendum period.

Column (3) in Table 4 shows the results when also controlling for the impact of the exchange rate depreciation. The coefficient on the tariff exposure measure remains negative and statistically significant when including these controls. As expected, depreciation is good for exports and hence TTWAs benefiting more from this hire relatively more workers. A one standard deviation decrease (0.003) in the *xrate impact via exports* measure (where lower values reflect higher exposure to the benefits of more competitive exports) increased postings by approximately 2.3%. Similarly, the depreciation is bad for imported inputs so TTWAs that are more exposed to this reduce postings. A one standard deviation decrease (0.0003) in the *xrate impact via imports* measure (where lower values reflect higher exposure to more expensive imports) decreased postings by approximately 2.7%.

We also explore how uncertainty about immigration policy with the EU affected online hiring. Columns (4) and (5) in Table 4 display the results for tariff exposure when also including the interaction term between the post-referendum dummy and a TTWA's pre-vote employment share of EU or EEU nationals in addition to the finance share and exchange rate controls. Adding additional terms does not reduce the significance of the coefficient on tariff uncertainty and this coefficient marginally increases in size after adding it. The coefficients on the immigration interaction terms are positive, suggesting that TTWAs with a higher share of EU or EEU nationals employed in 2015 differentially increased hiring after the referendum relative to TTWA's employing a lower share of EU or EEU nationals. The magnitude of these coefficients is quite substantial: taking column (4) as an example,

Figure 7: Impact of tariff exposure over time



Notes: This graph shows the coefficients from the regressions of the log of monthly job postings on the trade-weighted average tariff exposure measure at the TTWA level interacted with a dummy variable for each quarter from Q1 2015 to Q3 2019. Regressions also controlled for the finance employment share and EU immigrant share interacted with the quarter dummies, the exchange rate measures interacted with the post vote dummy variables, TTWA fixed effects and month-year fixed effects. Coefficients are relative to the base period of the two quarters prior to the referendum: Q1 2016 and Q4 2015. The dots represent the point estimates and the lines the confidence intervals. The red line shows the quarter when the referendum occurred, Q2 2016.

a 1 standard deviation increase in the EU national share (1.5%) is associated with a 2% increase in hiring. The coefficient is even higher and remains strongly significant for column (5) which includes the interaction term for employment of EEU nationals.

After adding all of the control variables in column (4, which we take as our headline specification, the magnitude of the coefficient on our tariff exposure interaction term implies that a one standard deviation (6.4 percentage point) increase in a TTWA's tariff exposure measure is associated with a relative decrease in postings of approximately 1.9% in the post-referendum period relative to the pre-referendum period.

These results are consistent with at least two possible interpretations. Firms could be attempting to employ more immigrant workers before the UK leaves the EU so that these workers will be able to stay longer term under pre-settlement status (designed for EU national working in the UK for less than 5 years at the date the UK leaves the EU).[21] Alternatively, firms could be replacing immigrant workers from the EU who are leaving the UK

[21]The cutoff seems to be the day of leaving so any workers migrating right up until the final day will be afforded these rights. https://www.gov.uk/settled-status-eu-citizens-families

post Brexit vote (perhaps due to uncertainty, or a change in their experience in the UK). On aggregate, net immigration of EU nationals to the UK decreased during the period after the referendum (ONS, 2019) and so we speculate that the latter explanation is most likely to be the cause. Unfortunately we are not able to tell whether immigrant workers or UK nationals are being hired into the jobs being posted online.

The results in this table suggest that tariff uncertainty, financial service sector uncertainty, the exchange rate depreciation, and immigration policy uncertainty (or actual changes in immigration) all had a separate, and meaningful, impact on hiring. The impact of tariff uncertainty remains important even after considering these other effects of the vote. While tariff uncertainty and financial service sector uncertainty both decreased the posting of online job adverts, immigration policy uncertainty had the opposite effect. Meanwhile, the exchange rate depreciation had a different effect depending on whether regions were more exposed to the effect through imports or exports.

Figure 7 displays the coefficients from the regression of log-postings on the tariff exposure measure interacted with quarter dummies. Following recent work on event studies (e.g. Freyaldenhoven et al., 2019) we exclude the two quarters prior to the referendum (Q4 2015 and Q1 2016) so all coefficients are relative to that period. We also control for the finance share and EU immigrant share interacted with the quarter dummies, the post referendum exchange rate controls, month-year and TTWA fixed effects.

This graph shows that there were two key periods when more exposed regions differentially reduced hiring: in the year following the referendum and in the first three quarters of 2018, with a recovery period in between and in early 2019. Here these coefficients compare the differential effect of hiring for more and less tariff-exposed regions in each quarter and hence we would not expect seasonality to be a big issue because all regions should be affected by it in a similar way.

5.2 Skill breakdown

Table 5 displays the same regressions run separately for skilled and unskilled job adverts, the classification of which is described in the Data section. Interestingly, the effect of the referendum for more tariff exposed regions strongly affected the posting of both skilled

Table 5: Impact of tariff exposure for skilled/unskilled job adverts

Dep variable: log postings	(1)	(2)	(3)	(4)	(5)
	Panel (a) Skilled postings				
post vote * tariff exposure	-0.247***	-0.329***	-0.286***	-0.291***	-0.302***
	(0.079)	(0.081)	(0.078)	(0.078)	(0.079)
post vote * finance employment share		-2.600***	-1.315***	-1.425***	-1.352***
		(0.262)	(0.288)	(0.284)	(0.285)
post vote * xrate impact via imports			107.819***	113.596***	109.412***
			(19.804)	(19.847)	(19.767)
post vote * xrate impact via exports			-7.673***	-9.368***	-9.239***
			(1.763)	(1.901)	(2.010)
post vote * EU national share				1.170***	
				(0.313)	
post vote * Eastern EU national share					1.513**
					(0.606)
Observations	12,134	12,134	12,134	12,134	12,134
Adjusted R-squared	0.982	0.982	0.983	0.983	0.983
TTWA FE	YES	YES	YES	YES	YES
Month-Year FE	YES	YES	YES	YES	YES
	Panel (b) Unskilled postings				
post vote * tariff exposure	-0.297***	-0.331***	-0.306***	-0.314***	-0.343***
	(0.087)	(0.089)	(0.087)	(0.087)	(0.088)
post vote * finance employment share		-1.066***	-0.564**	-0.746***	-0.645**
		(0.264)	(0.278)	(0.272)	(0.274)
post vote * xrate impact via imports			34.329*	44.039**	37.988*
			(20.782)	(20.743)	(20.684)
post vote * xrate impact via exports			-6.615***	-9.444***	-10.105***
			(1.895)	(2.060)	(2.190)
post vote * EU national share				1.945***	
				(0.328)	
post vote * Eastern EU national share					3.358***
					(0.645)
Observations	12,128	12,128	12,128	12,128	12,128
Adjusted R-squared	0.977	0.977	0.977	0.977	0.977
TTWA FE	YES	YES	YES	YES	YES
Month-Year FE	YES	YES	YES	YES	YES

Notes: Panel (a) displays coefficients from the regressions of the log of monthly skilled job postings on the trade-weighted average tariff exposure measure at the TTWA level, with and without controls. Panel (b) repeats the same regressions for unskilled job adverts. The difference in the number of total observations in the regressions results from the fact that in some month-years all job adverts are either skilled or unskilled. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

and unskilled job adverts, with the coefficients being remarkably similar. Panel (a) shows the effect for skilled job adverts, while panel (b) shows the effect for unskilled job adverts.

The coefficients on the tariff exposure interaction term remain statistically significant and negative in all of the regressions for both skilled and unskilled adverts. The magnitude of the coefficients is very slightly greater for unskilled postings in all regressions. The coefficients on the financial sector share interactions are larger in magnitude and have a higher degree of statistical significance for skilled postings, suggesting that having a higher share of employment in the financial sector prior to the vote was associated with a greater decline in skilled job postings after the vote.

The import effect of the exchange rate depreciation does not appear to have mattered so much for unskilled postings; the coefficients on the *xrate impact via imports* interaction term are only weakly significant for unskilled postings and of a lower magnitude, while they remain highly significant and larger for skilled postings. By contrast, the export channel of the exchange rate depreciation mattered for both skilled and unskilled postings, with strongly significant coefficients of a similar order of magnitude for both skilled and unskilled postings.

Exposure to immigration from EU nationals is important for both skilled and unskilled postings. The coefficients in column (4) are highly significant and positive for both skilled and unskilled postings. Yet exposure to immigration from EEU nationals appears to have had a greater effect on unskilled postings. For skilled postings the coefficient on the interaction term for the EEU share is only significant at the 5% level and is half the size of the coefficient in the same regression for unskilled postings.

5.3 Trade policy uncertainty measures

Table 6 displays the results using the time-varying Brexit-related trade policy uncertainty proxies. Panel (a) displays the results using the newspaper-based uncertainty measure. The coefficients on the tariff exposure measure interacted with the uncertainty measure are negative and statistically significant to at least the 5% level, suggesting that TTWAs that were more exposed to future MFN tariffs differentially reduced online job adverts at times when there was higher newspaper coverage of Brexit-related trade policy uncer-

Table 6: Response of hiring to time-varying trade policy uncertainty

Dep variable: log postings	(1)	(2)	(3)	(4)	(5)
	Panel (a) Newspaper-based measures				
tariff exposure * newspaper uncertainty index	-0.017**	-0.016**	-0.021***	-0.020**	-0.019**
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
xrate impact via imports * post vote		118.708***	99.139***	97.887***	98.857***
		(16.005)	(16.356)	(16.318)	(16.343)
xrate impact via exports * post vote		-8.066***	-7.815***	-7.312***	-7.236***
		(1.614)	(1.612)	(1.661)	(1.698)
finance emp share * newspaper uncertainty index			-0.146***	-0.136***	-0.141***
			(0.029)	(0.028)	(0.028)
EU national share * newspaper uncertainty index				-0.069**	
				(0.032)	
EEU national share * newspaper uncertainty index					-0.110*
					(0.060)
Observations	12,141	12,141	12,141	12,141	12,141
Adjusted R-squared	0.984	0.985	0.985	0.985	0.985
TTWA FE	YES	YES	YES	YES	YES
Month-Year FE	YES	YES	YES	YES	YES
	Panel (b) Google-trends-based measures				
tariff exposure * google-search uncertainty index	-0.039	-0.038	-0.075***	-0.067**	-0.053*
	(0.028)	(0.028)	(0.028)	(0.028)	(0.028)
xrate impact via imports * post vote		118.495***	81.291***	77.732***	80.518***
		(15.999)	(16.321)	(16.312)	(16.328)
xrate impact via exports * post vote		-8.095***	-7.619***	-6.083***	-5.636***
		(1.615)	(1.612)	(1.647)	(1.673)
finance emp share * google-search uncertainty index			-1.171***	-1.031***	-1.091***
			(0.104)	(0.101)	(0.101)
EU national share * google-search uncertainty index				-0.889***	
				(0.121)	
EEU national share * google-search uncertainty index					-1.596***
					(0.208)
Observations	12,141	12,141	12,141	12,141	12,141
Adjusted R-squared	0.984	0.985	0.985	0.985	0.985
TTWA FE	YES	YES	YES	YES	YES
Month-Year FE	YES	YES	YES	YES	YES

Notes: This table displays coefficients from the regressions of the log of monthly postings on the interaction term between the tariff exposure measure at the TTWA level and the monthly measures of Brexit-related trade policy uncertainty. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

tainty. In terms of magnitude for the specification with all controls in column (5), going from a month with the 75th percentile newspaper uncertainty measure (equivalent to 714 related articles published in the top 10 newspapers) to a month with the 25th percentile newspaper uncertainty measure (equivalent to 359 related articles[22]) is associated an additional 0.5% decline in job postings for a one standard deviation (6.4 percentage points) change in the tariff exposure measure.

Panel (b) shows the results using the google search based uncertainty measure. We constructed this measure using the index provided by google trends, which scales search intensity of the chosen search terms to be relative to each other, with a maximum of 100 for the term with the greatest search intensity. We then divided this index by 100 to obtain our index. The coefficients on the google search interaction terms become statistically significant when controls for the financial services sector and immigration are added, suggesting that these measures do not pick up quite the same type of uncertainty as picked up by the newspaper coverage measures. In terms of magnitude for the composite google search coefficient in column (5), going from the 75 percentile (2.25) to the 25th percentile (1.3) of the google search index was associated with a one standard deviation (6.4 percentage points) change in the tariff exposure measure leading to an additional 0.4% decline in job postings.

Overall these results suggest that TTWAs that were more exposed to tariff uncertainty differentially reduced hiring in the months when there was greater Brexit-related trade policy uncertainty. The significance of the interaction terms for control variables suggests these were also months when areas heavily reliant on immigration from the EU and with high pre-vote employment shares in the financial sector also cut back on hiring.

6. Robustness checks

6.1 Simple average tariffs

One concern with our methodology was that trade patterns may have already adjusted in the years prior to the vote based upon the political signals that an EU referendum could

[22] We then divide the raw count of articles by 100 to obtain the newspaper uncertainty index

Table 7: Baseline regional results using simple average tariffs

Dep variable: log postings	(1)	(2)	(3)	(4)	(5)
post vote * tariff exposure	-0.276***	-0.360***	-0.306***	-0.316***	-0.337***
	(0.079)	(0.081)	(0.078)	(0.078)	(0.079)
post vote * finance employment share		-2.208***	-1.089***	-1.224***	-1.147***
		(0.244)	(0.255)	(0.252)	(0.252)
post vote * xrate impact via imports			91.435***	98.402***	93.783***
			(17.498)	(17.374)	(17.386)
post vote * xrate impact via exports			-7.463***	-9.495***	-9.751***
			(1.605)	(1.735)	(1.835)
post vote * EU national share				1.408***	
				(0.286)	
post vote * Eastern EU national share					2.226***
					(0.544)
Observations	12,141	12,141	12,141	12,141	12,141
Adjusted R-squared	0.984	0.984	0.985	0.985	0.985
TTWA FE	YES	YES	YES	YES	YES
Month-Year FE	YES	YES	YES	YES	YES

Notes: This table displays the results from the regressions of the log of monthly job postings in each TTWA on the simple average tariff exposure measure at the TTWA level interacted with the post vote dummy variable, with and without controls. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

arise. We therefore also repeat our analysis taking the simple average of the tariffs faced by each SIC4 industry, as opposed to the trade weighted average, to check that the trade weights were not biasing our method. Table 7 displays the results: the coefficients on the tariff exposure interaction terms are qualitatively very similar i.e. strongly significant and negative. The only difference is using the simple average tariffs results in slightly larger coefficients in each of the regressions. The coefficients on the other control variables are all very similar.

6.2 US controls

An additional concern with our analysis is that the results could be driven by other sector specific trends after the vote that happen to be correlated with tariff exposure. One way to proxy for this is to also include controls for online job adverts in the U.S., as was discussed in the Data section above. Table 8 shows the baseline results when adding the constructed US control for each TTWA. Including these controls does not change the significance or magnitude of the coefficients by any substantial degree. The US controls are only statistically significant before controlling for the exchange rate and immigration, suggesting that

Table 8: Baseline regional results with US controls

Dep variable: log postings	(1)	(2)	(3)	(4)	(5)
post vote * tariff exposure	-0.268***	-0.337***	-0.302***	-0.308***	-0.326***
	(0.069)	(0.071)	(0.070)	(0.070)	(0.070)
post vote * finance employment share		-2.170***	-1.088***	-1.221***	-1.143***
		(0.243)	(0.254)	(0.252)	(0.252)
post vote * xrate impact via imports			90.775***	97.737***	93.129***
			(17.503)	(17.377)	(17.390)
post vote * xrate impact via exports			-7.109***	-9.115***	-9.378***
			(1.617)	(1.742)	(1.839)
post vote * EU national share				1.408***	
				(0.286)	
post vote * Eastern EU national share					2.237***
					(0.543)
US postings	0.000**	0.000**	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	12,141	12,141	12,141	12,141	12,141
Adjusted R-squared	0.984	0.985	0.985	0.985	0.985
TTWA FE	YES	YES	YES	YES	YES
Month-Year FE	YES	YES	YES	YES	YES

Note: This table displays the results from the regressions of the log of monthly job postings in each TTWA on the trade-weighted average tariff exposure measure at the TTWA level interacted with the post vote dummy variable, with and without controls. It additionally controls for the trends in US postings for each SIC industry, weighted by the industry employment share in each TTWA in 2015. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

sector-time hiring patterns in the US are not a strongly related to hiring patterns in the UK.

6.3 NTBs

Our main tariff exposure measure is calculated using ad valorem tariffs. Although these tariffs are the most common, there are also relevant non-ad valorem tariffs. Two key cases are specific tariffs, computed on the physical quantity of the good being imported, and tariff-rate quotas, made up of a low tariff rate on an initial increment of imports (the within-quota quantity) and a very high tariff rate on imports entering above that initial amount. Following Crowley et al. (2018a) we use data of EU MFN tariffs from the WTO Tariff Analysis Online website[23] to calculate similar tariff threat measures for specific tariffs and quotas. Specifically, we create trade weighted averages of dummies indicating whether or not a particular product has a specific tariff or a quota. Out of 9,455 products at the CN8 level:[24] 2,358 have no form of tariff or quota; 6,011 have a positive ad valorem

[23] https://www.wto.org/english/tratop_e/tariffs_e/tariff_data_e.htm
[24] CN8 is the European equivalent of the HS8 nomenclature

Table 9: Accounting for specific tariffs and quotas

Dep variable: log postings	(1)	(2)	(3)	(4)
post vote * ad val tariff exposure	-0.299***	-0.294***	-0.285***	-0.293***
	(0.071)	(0.072)	(0.071)	(0.072)
post vote * specific tariff exposure		-2.321		5.410
		(3.556)		(4.171)
post vote * quota exposure			-30.805***	-40.629***
			(11.713)	(13.942)
Observations	12,141	12,141	12,141	12,141
Adjusted R-squared	0.984	0.984	0.984	0.984
TTWA FE	YES	YES	YES	YES
Month-Year FE	YES	YES	YES	YES

Note: No extra controls are included so this table should be compared to column (1) of Table 4. Ad val tariff exposure is calculated as a trade weighted average of percentage tariff rates. Specific tariff exposure is similarly defined except averaging over dummies for whether or not a particular tariff line is subject to specific tariffs. Quota exposure averages over dummies for whether or not a particular tariff line is subject to a quota. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

tariff only; 704 have a specific tariff only; 43 have a quota only; 294 have a quota combined with a specific tariff (above the quota limit); 45 have a quota combined with an ad valorem tariff (above the quota limit). We then include these weighted average measures in our baseline regression as a robustness check on our results.

Table 9 present the results. Relative to our baseline result which only considers ad valorem tariffs (see column (1) of Table 4), the effect changes very little and continues to be significant at the 1% level.[25] The threat of specific tariffs does not appear to have an overall impact, perhaps because the measure is somewhat blunt, i.e. we don't have a comparable measure of the size of the tariff given different approaches to measuring quantity. However, quota risk is significant and negatively impacts job postings. Taking the results from column (4), a one standard deviation change in quota exposure (0.00035) leading to a 1.4% reduction in job postings across TTWAs.

[25]The ad valorem measures are provided by Crowley et al. (2018a)who construct their measures from WTO Tariff Analysis Online, meaning they differ slightly from ours as reported in Column (1) of 4 where we use data from the World Integrated Trade Solution

Table 10: Excluding London

Dep variable: log postings	(1)	(2)	(3)	(4)	(5)
post vote * tariff exposure	-0.281***	-0.343***	-0.303***	-0.315***	-0.331***
	(0.070)	(0.072)	(0.070)	(0.070)	(0.070)
post vote * finance employment share		-2.181***	-1.090***	-1.117***	-1.093***
		(0.251)	(0.260)	(0.258)	(0.259)
post vote * xrate impact via imports			91.281***	99.001***	93.357***
			(17.535)	(17.354)	(17.423)
post vote * xrate impact via exports			-7.558***	-10.031***	-9.932***
			(1.608)	(1.765)	(1.846)
post vote * EU national share				1.779***	
				(0.343)	
post vote * Eastern EU national share					2.332***
					(0.571)
Observations	12,084	12,084	12,084	12,084	12,084
Adjusted R-squared	0.984	0.984	0.984	0.984	0.984
TTWA FE	YES	YES	YES	YES	YES
Month FE	YES	YES	YES	YES	YES

Note: This table displays the same regressions as in Table 4 but London is excluded. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

6.4 Excluding London

A further concern could be that our results are driven mainly by trends occurring in London. Table 10 hence repeats the analysis in Tab 4 but excludes the TTWA of London. The results do not qualitatively change and the coefficients on the tariff exposure interaction terms are very similar, but slightly higher when excluding London. The coefficients on the finance employment share interaction terms are slightly lower when excluding London, while the coefficients on the immigration interaction terms are slightly higher when excluding London.

7. Conclusion

In this paper, we exploit the *ex ante* product-level variation in EU MFN tariffs that would be placed upon UK trade with the EU if the UK were to leave without a trade deal, to explore how the potential unravelling of trade integration affects online hiring and local labour markets.

We use a dataset consisting of the near-universe of all online job adverts posted in the

UK between 2015 and September 2019, to track the real-time hiring response of UK firms to tariff uncertainty as the political events unfolded.

We find that areas that were more exposed to the threat of future tariffs on their exports to the EU decreased online hiring, relative to regions that were less exposed, during the period after the referendum result. A one standard deviation increase in potential future tariff exposure led to a 1.9% decrease in job postings in our baseline specification, controlling for other confounding factors. We show that these results are distinct from the impact of the exchange rate depreciation, uncertainty about future immigration policy, and the importance of financial services in the region.

The relative decline in online hiring in tariff exposed regions occurred during periods of increased uncertainty, proxied by increases in UK newspaper coverage of Brexit-induced trade policy uncertainty and more google searches for terms related to Brexit and trade policy.

We conclude that the threat of future trade barriers caused by the Brexit referendum has been an important factor in affecting the hiring decisions of UK firms. Furthermore, the evidence indicates that a retreat from trade integration, as opposed to increased integration, appears to have negative consequences within local labour markets.

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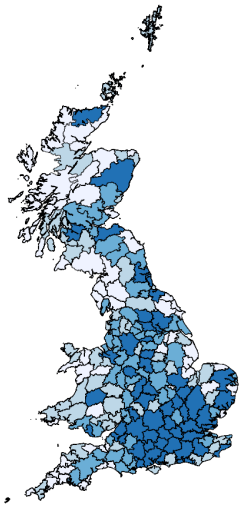
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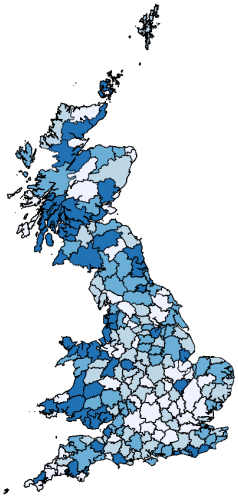
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Appendix: Maps for control variables

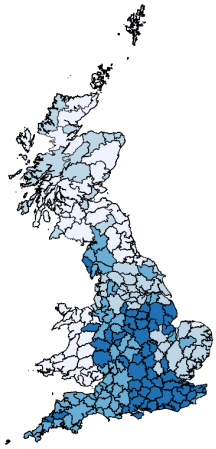
Figure 8: Exposure to the exchange rate depreciation and immigration



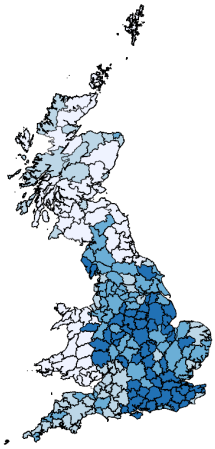
(a) Exposure to more expensive imports



(b) Exposure to cheaper exports



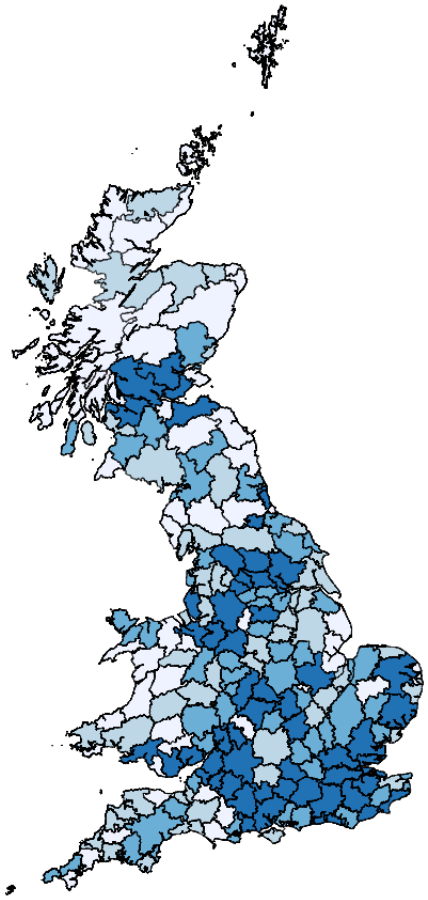
(c) EU national employment share



(d) Eastern EU national employment share

Notes: Panel (a) displays the measure of exposure to the impact of the exchange rate depreciation on the price of intermediate imports. Areas with darker blue had a higher employment share in 2015 in sectors more affected by higher cost imports. Panel (b) displays the measure of exposure to the impact of the exchange rate depreciation on the price of exports. Areas with darker blue had a higher employment share in 2015 in sectors with more competitive export prices after the vote. Panel (c) displays the 2015 employment share of EU nationals and panel (d) displays the share of Eastern EU nationals.

Figure 9: 2015 employment share in the financial sector



Notes: This figure displays the 2015 employment share in the financial sector, as defined in the Data section, for each TTWA.