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

Beata Javorcik
Oxford & CEPR

Ben Kett
Oxford

Katherine Stapleton
Oxford

Layla O'Kane
Burning Glass Technologies

July 10, 2020

Abstract

This paper uses high frequency data on the near universe of job adverts posted online in the UK to study the impact of the Brexit referendum on labour demand between January 2015 and December 2019. We develop measures of local labour market exposure to the threat of trade barriers on both goods and services exports if the UK were to leave the EU without a trade deal. We find that regions that were more exposed to potential barriers on professional services exports saw a differential decline in online job adverts in the period after the referendum, particularly for higher-skilled jobs. This effect was distinct from the impact of the exchange rate depreciation, uncertainty surrounding future immigration policy and the threat of future barriers on trade in goods.

Keywords: **services trade, trade uncertainty, labour demand, online job adverts, Brexit**

*Javorcik e-mail: beata.javorcik@economics.ox.ac.uk. Kett e-mail: ben.kett@economics.ox.ac.uk. Stapleton email: katherine.stapleton@economics.ox.ac.uk. O'Kane email: lokane@burning-glass.com. We thank seminar participants at Oxford, UCL, LSE, FREIT and Villars for their comments, Burning Glass Technologies for providing us with the data, Costa et al. (2019) for sharing their constructed exchange rate variables, and Crowley et al. (2018b) for sharing their NTB variables. The views presented in the paper are solely of the authors and not any institutions they may be affiliated with.

1. Introduction

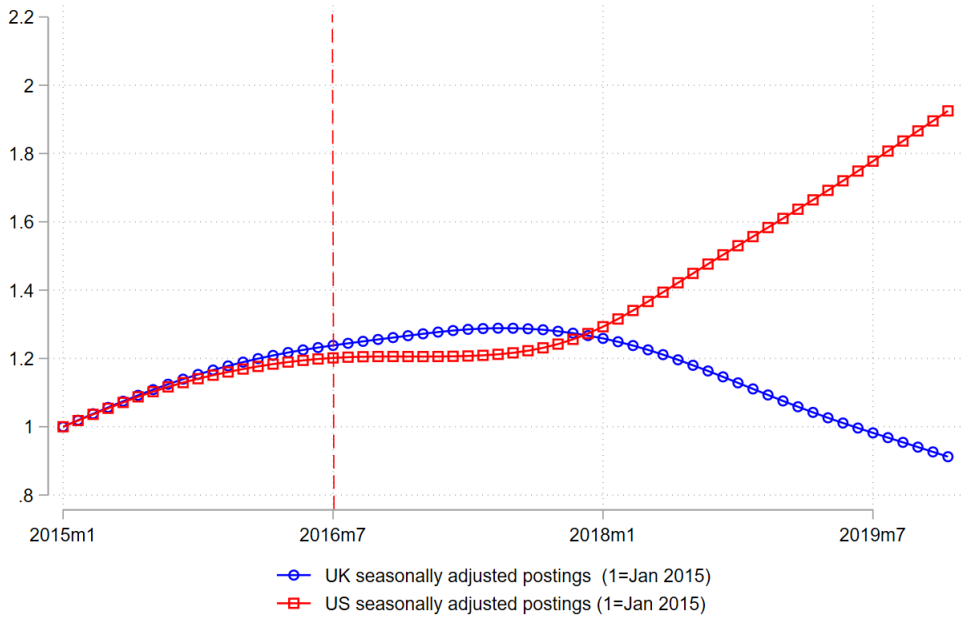
The consequences of trade barriers for economic outcomes have been studied for a long time, yet the impact of uncertainty about possible future barriers, as opposed to barriers themselves, is less well understood. In addition, research that does exist on the impact of uncertainty about possible future barriers has typically focused on goods trade, rather than services trade, despite the growing role of services in global exports. With some of the world's major economies in a period of heightened uncertainty in their trade relations and the growing prevalence of deep trade agreements in 21st century trade policy, this area of research is becoming increasingly important. The Brexit vote and its aftermath provide a unique opportunity to study the impact of trade policy uncertainty, particularly with regard to services trade.

This paper examines how the threat introduced by the Brexit vote of 'unravelling' decades worth of deep integration with the EU, which is the world's most integrated trading bloc, affected labour demand in the UK. We use a high frequency dataset consisting of the near universe of job adverts posted online in the UK between January 2015 and December 2019, which allows us to evaluate the immediate labour demand response to the trade policy uncertainty caused by the referendum result and political events during the negotiation period. Figure 2 displays the normalised seasonally adjusted time series of monthly job postings over the period of our analysis for both the UK and US. Both countries followed a similar trend before the referendum but started to diverge substantially from January 2018 onwards. In 2019 total job postings in the UK were 10% lower than in 2015, whereas in the US they were 64% higher.

We develop measures of local labour market exposure to potential future barriers on exports of goods and services to the EU. We take the 'threat' of no trade deal being reached between the UK and EU and evaluate the barriers that exporters would face under this scenario. For services, if the UK were to leave the EU and Single Market without a deal, it would become a 'third party' to other EU & European Economic Area (EEA) countries and trade in services would revert to the terms set under the General Agreement on Trade in Services (GATS). The UK would then face rules set by individual member states.[1] This

[1]The EU's Single Market is an area that seeks to guarantee the free movement of goods, capital, services, and labour within the EU. It encompasses the EU's 27 member states, and has been extended, with excep-

Figure 1: Monthly online job postings, UK and US



Notes: Both trend lines are smoothed using the Hodrick-Prescott time-series filter, removing cyclical components, and normalised to 1 in January 2015 for comparison. The vertical red dotted line identifies the date of the Brexit referendum.

would represent a major shift in policy for many UK service sectors as the EU Single Market is a highly integrated area for trade in services, and services account for 80% of UK economic output and 46% of exports to the EU.

We exploit the pre-vote variation in the difference between these regulations that individual member states place on services trade with other EEA members and non-EEA members, in different sectors. For each export destination and sector, we construct the regulatory 'gap' between the threat of the stringent restrictions UK exporters could face and the minimal restrictions they currently face using the OECD's Services Trade Restrictiveness Index (STRI) and the Intra-EEA STRI, respectively, focusing primarily on trade barriers to professional services exports. UK industries were differentially exposed to this threat of regulatory barriers depending on the pre-vote composition of their exports by country and, in turn, local labour markets were differentially exposed to this threat based upon their pre-vote employment composition by industry.

For goods, no trade deal with the EU would mean reverting from tariff-free trade to

tions, to Iceland, Liechtenstein and Norway through the Agreement on the EEA and to Switzerland through bilateral treaties.

trade under WTO terms, where the UK would face Most Favoured Nation (MFN) tariffs on its exports to the EU. We exploit the product-level variation in EU MFN tariffs to construct measures of the tariff threat to sectors and local labour market.[2] We relate the monthly job advert data for each of the UK's 213 local labour markets, defined as Travel to Work Areas (TTWAs), to their pre-vote exposure to these potential future barriers to exports of services and goods to the EU, controlling for the impact of the exchange rate depreciation and exposure to immigration policy changes. The result of the Brexit referendum was largely unexpected; betting markets placed the odds of a 'leave' result at around 30% in the months leading up to the referendum (Graziano et al., 2018). We hence follow a difference-in-differences approach comparing job adverts in highly exposed localities to less exposed localities in the post-referendum relative to the pre-referendum period. We demonstrate that this strategy is warranted as the data show no statistically significant differences in pretrends.

We find that regions that were *ex ante* more exposed to the threat of future trade barriers on professional services exports experienced a decline in online job postings after the referendum, relative to less exposed regions. This decline was economically meaningful; a one standard deviation increase in exposure to potential future barriers led to a 3.1% decrease in monthly job postings in our baseline specification, controlling for exposure to tariffs, the impact of the exchange rate depreciation, and immigration policy uncertainty. The effect was mainly felt by higher skilled job adverts, with a particular impact on postings for executives, managers and professional occupations. When broken down by professional service sectors, the effect was concentrated primarily in financial services, information services, engineering and, to some extent, legal services. In contrast to services barriers, we find that the threat of future tariffs on goods does not seem to have impacted the posting of job adverts.

The financial services sector received a lot of attention during the Brexit negotiation period because of its importance to the UK economy. In 2018, for example, financial services alone accounted for 6.9 percent of UK GDP and 11.7 percent of services exports (ONS,

[2]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

2018). The issue of 'passporting' rights, which allow financial businesses authorised in any Member State to operate freely across the EEA, was central to the Brexit discussions because the removal of these rights was perceived as an insurmountable barrier to many of the core business operations of financial firms based in the UK.[3] We therefore also separately explore the impact of this threat to the financial service sector on labour demand. We exploit the fact that the UK publishes data on the regional breakdown of exports of services, which is available for certain industry categories, of which financial services is one. This allows us to exploit additional variation in the EU export intensity of the financial service sector across different UK regions. We find local labour markets that were reliant on EU export intensive financial services experienced a substantial decline in the posting of job adverts after the vote and this affected lower-skilled job adverts in addition to higher skilled ones.

After the Brexit referendum took place in June 2016, three and a half years passed before the UK officially left the European Union on the 31st January 2020. This period was characterised by a long and varying political process, including three general elections, two changes of Prime Minister, dramatically different competing visions for the UK's future relationship with the EU, and multiple failed votes in parliament. Businesses were left to interpret the political signals and adjust to regular changes in the implications of the proposed arrangements. In the second part of the paper, we therefore focus on the evolution of public perceptions and media coverage during this drawn out negotiation period.[4] We construct two measures of time-varying Brexit-induced trade-policy uncertainty. The first uses the intensity with which the UK's top ten newspapers were publishing articles mentioning both Brexit and uncertainty about future trading relationship with the EU. The second uses the Google search intensity in the UK for terms relating to both Brexit and trade policy.

Using these measures, and also the Brexit Uncertainty Index developed by Bloom et al. (2019), we show that the relative decline in online job adverts for regions more exposed to future professional services trade barriers was larger in months with heightened uncertainty over future trading policy arrangements with the EU. This also holds when running

[3]For more information on passporting, see https://www.bankofengland.co.uk/prudential-regulation/authorisations/passporting

[4]In Section 2 we provide a timeline of the key events during this period.

a placebo test using the counterfactual of the postings that would have occurred, had UK sectors followed the same trajectory as in the US, suggesting that the results do not just reflect sectoral trends.

On aggregate, we estimate that approximately one third of the total decline in the posting of job adverts in the UK, relative to the pre-vote trend, can be explained by the reduced hiring caused by exposure to the threat of barriers on professional service exports. This is equivalent to around 1.5 million fewer job adverts being posted cumulatively between June 2016 and December 2019. Taken together, our results suggest that the threat of unravelling trade integration with a country's major trading partners can have substantial negative effects on labour markets through the reduced advertising of job openings. For the UK, it was the threat of barriers on trade in services, and particularly financial services, that mattered the most, rather than the threat of barriers on goods trade, despite the often greater focus on tariffs and goods supply chains during the discourse around the economic impact of Brexit.

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 the potential cost of reverting to a shallow regional agreement or WTO terms. We contribute to this literature by providing evidence on the impact of trade barriers on near real-time labour demand, proxied by online job adverts, and also by evaluating the relative impact of barriers on both services and goods trade.

We also contribute to the literature on economic policy uncertainty. There is a substantial body of research 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.[5] We contribute both by focusing on trade-specific uncertainty and by investigating how the time-varying nature of trade policy 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' tariffs, 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 considering services barriers as well as 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

[5]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).

parts of Europe.

Fourth, we add to a broad literature on understanding trade in services that stretches from examining the benefits of services liberalization (Arnold et al. (2011), Arnold et al. (2016), Barone and Cingano (2011), Beverelli et al. (2017), Breinlich et al. (2018)) to services offshoring (Liu and Trefler (2019), Crinò (2010), Eppinger (2019), Amiti and Wei (2005)) to the tradability of services (Jensen and Kletzer (2005), Gervais and Jensen (2019)). Regarding services trade and Brexit, Ebell (2016) and Mulabdic et al. (2017) highlight the particular importance of deep trade agreements for services trade and indicate that any deal outside the single market is likely to have a major impact on trade flows. We provide new evidence on how the threat of services trade barriers and unravelling deep trade agreements affects labour markets, demonstrating the important and often under-emphasised role that trade in services plays in advanced economies.

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 and construction of our exposure measures, Section 4 outlines the empirical strategy, Section 5 presents the results, Section 6 the robustness checks, Section 7 look at aggregate effects, and Section 8 concludes.

2. Background on the Brexit Referendum

2.1 The referendum

The UK electorate voted to leave the European Union on the 23rd June 2016 with a lead of 3.8%, against the positions held by the major political parties and to the surprise of many observers. The unexpected nature of this vote is evidenced by the 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 (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). Furthermore, the Ipsos Mori 'Issues Index' shows that less than 10% of those surveyed considered the EU, Europe, or Brexit as important issues in Britain during the ten years prior to the vote.[6] The unpredicted nature of the result is important for our analysis in that it permits us to compare the pre- and post-referendum periods in a difference-in-difference specification.

Understanding the result is complicated and multidimensional, but sovereignty was a key theme raised by the Vote Leave campaign as captured by the key slogan "take back control". The issue of sovereignty was of particular salience for issues of borders and immigration, UK trade policy, reallocating UK financial contributions to the EU to national concerns such as the NHS, and independence in making UK laws.[7] An alternative explanation is proposed by Fetzer (2019), who provides evidence that the significant post-financial crisis austerity measures enacted by the UK Government predicted increases in support for the UK Independence Party which in turn strongly correlated with Leave support in the referendum.

2.2 Post-referendum uncertainty

The referendum was the start of an extended period of profound uncertainty about the future UK-EU relationship. The post-referendum timeline can be split into three key periods: the negotiation period following the vote but prior to leaving the EU; the transition period after leaving the EU; and the final deal. Our analysis covers the first period, starting after the referendum and ending on the 31st January 2019 with the UK leaving the EU. The primary objective during this period was to negotiate a legally binding 'withdrawal agreement' covering the terms of the transition period, and a non-legally binding 'political declaration' regarding aims for the final deal.

This period consisted of significant ups and downs including three general elections, two changes of Prime Minister, intense brinkmanship regarding leaving the EU without a deal, dramatically different competing visions for the future, and multiple failed votes in parliament. Table 1 presents the key events in the Brexit timeline. For each of the key

[6] https://www.ipsos.com/sites/default/files/ct/news/documents/2019-02/issues_index_january2019_v1_internal_use_only.pdf

[7] http://www.voteleavetakecontrol.org/why$_{v}ote_{l}eave.html$

policy areas affected by Brexit, during the negotiation period it was unclear which of many potential outcomes would be realised, and hence firms had to infer the probability of these outcomes from political signals. In a range of areas, to this day it remains unclear what regulations will be in place after the transition period. Consensus is now building that this has implied delayed economic responses to the referendum as firms and individuals waited for more clarity on specific issues and policies.

2.3 Possible future scenarios for trade policy

UK firms trading with the EU faced three main potential future trade arrangements upon leaving the EU, each with different regulatory barriers and tariff schedules: staying in the single market; leaving the single market and negotiating a comprehensive free trade deal; leaving with no deal.

The 'single market' outcome would ensure continued frictionless and tariff-free trade in goods and access to the European market for services. However, in this scenario the UK would not be able to freely negotiate its own trade agreements and would not have a say in future EU negotiations. Furthermore, the EU's insistence on the indivisibility of the four freedoms of movement meant that free movement of people would remain, and the UK would remain in the jurisdiction of the European Court of Justice. This option was ruled out at an early stage by Prime Minister Theresa May, with the EU then explicitly ruling out sector-specific arrangements that might have maintained existing benefits.[8] Single Market rules allow financial businesses authorised in any Member State to operate freely across the European Economic Area (EEA), a system known as passporting. In November 2017, Michel Barnier, the EU's chief Brexit negotiator stated, "The legal consequence of Brexit is that the UK financial service providers lose their EU passport". This was the point at which it became relatively clear that the UK would not be maintaining passporting rights.

The 'free trade deal' outcome would, in principle, allow the UK to maintain some preferential trade arrangements with the EU while retaining control over immigration, UK tariffs, and UK laws. Regarding goods, this meant no regulatory alignment but with the majority of goods being traded without being subject to tariffs. The challenges of the Irish

[8]See 8th January 2017 speech by Theresa May here: https://www.gov.uk/government/speeches/the-governments-negotiating-objectives-for-exiting-the-eu-pm-speech

Table 1: Brexit Timeline

Date	Event
23rd Jan 2013	David Cameron declares he is in favour of an EU referendum
14th Apr 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 Sep 2015	European Union Referendum Act passed in parliament
20th Feb 2016	Date of referendum confirmed
23rd Jun 2016	EU Referendum
13th Jul 2016	Cameron steps down, Theresa May becomes Prime Minister
29th Mar 2017	Invocation of Article 50
8th June 2017	Snap General Election
15th Nov 2018	The Withdrawal Agreement is agreed and published
25th Nov 2018	EU27 leaders endorse the withdrawal agreement and approve political declaration on future EU-UK relations
15th Jan 2019	First failed vote on withdrawal deal
16th Jan 2019	Government wins vote of no confidence
12th Mar 2019	Second failed vote on withdrawal deal
14th Mar 2019	Vote to request extension of Article 50 (to 12th April if no deal agreed or 22nd May if deal agreed)
29th Mar 2019	Third failed vote on withdrawal deal and originally planned leaving date
10th Apr 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 Jun 2019	Boris Johnson elected Prime Minister by conservative party members
19th Oct 2019	New Brexit deal was lost on amendment in the Commons, Prime Minister wrote to European Council president to request another extension
12th Dec 2019	Boris Johnson won a majority in the UK General Election
23th Jan 2020	European Union (Withdrawal Agreement) Act received Royal Assent
31st Jan 2020	UK left the European Union and entered transition period, due to run until end of 2020

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://commonslibrary.parliament.uk/research-briefings/cbp-7960/.

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 that was designed to maintain peace in the region. 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 pass through parliament, leading Theresa May to give official notice of her resignation on the 24th May 2019.

For the financial services sector, the focus moved from passporting to "equivalence". Equivalence would allow UK and EU financial businesses to carry out specified activities across borders as long as the regulations that underpin these activities are deemed to achieve comparable outcomes. The process of agreeing and maintaining equivalence is neither straightforward nor as all-encompassing as passporting. For example, the approach can take time, depends on wider technical or political concerns, is limited to specified services, assumes continued close regulatory alignment between parties, and can be revoked by either side at any time. In light of this, there is evidence that by 2018 many financial institutions had already started to move their corporate headquarters, branches and staff away from the UK. New Financial, a think tank promoting capital markets, reported in March 2019 that 275 financial institutions had moved or were moving at least part of their operations elsewhere in the EU.

The final possible outcome was a 'no deal' where, for services, the UK's exports would revert to being governed only by the terms set under the General Agreement for Trade in Services (GATS), and for goods, the UK would export to the EU under the EU's World Trade Organisation (WTO) tariff schedule and pay Most-Favoured Nation (MFN) tariffs. Although widely considered as a very negative outcome for businesses, the option was first promoted by Theresa May when she argued that "no deal is better than a bad deal" and later strengthened when Boris Johnson became Prime Minister with statements such as "we are getting ready to come out on October the 31st. Come what may...Do or die. Come what may."[9] This rhetoric meant that, while it had previously been seen as very unlikely that the UK would end up without a deal, from mid 2019 it started to look like a serious

[9] https://www.ft.com/content/366432ce-9741-11e9-8cfb-30c211dcd229

possibility.

In general, the possibility of trade barriers for both good and services became increasingly likely as the negotiation period progressed. For services trade, the decision not to remain in the single market in early 2017 was the first move towards a substantial change in regulation for UK services exporters. For services trade it was possible that even under a preferential trade agreement important barriers of entry for UK firms in EU markets might remain, meaning that the outlook became bleak relatively early on in the process. For financial services particularly, the crunch point came at the end of 2017 when it became clear that passporting rights would not be maintained after leaving. For goods trade, on the other hand, Increased tariffs were a possibility primarily under a no deal scenario, meaning that the risk became sizable later on. The average EU MFN tariff is also relatively low (with a trade weighted average of 3% in 2018), meaning that it was also less clear how much of a threat this posed to businesses in reality, with the exception of firms heavily reliant on global supply chains .[10]

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. These postings are sourced from approximately 40,000 online job boards and company websites, with a total of over 60 million UK job adverts over the period 2012-2019. In Appendix C we provide a detailed discussion of BGT's data coverage relative to other sources of labour market data for the UK. We estimate that BGT's data covers approximately 86% of the total number of vacancies recorded in the UK Vacancy Survey (UKVS) between 2012 and 2019. Online job adverts therefore do not provide a complete picture of the entire labour market, but can provide a useful barometer of labour market demand.

BGT classify the job adverts along a range of dimensions, we make use of the classification by Travel to Work Areas (TTWA) and SOC (Standard Occupational Classification)

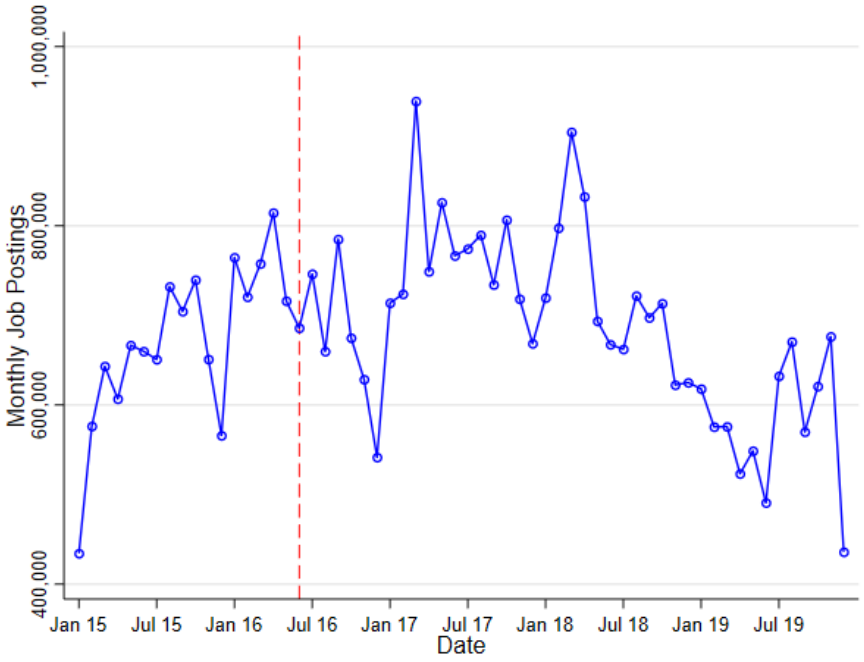
[10] https://www.wto.org/english/res_e/statis_e/daily_update_e/tariff_profiles/E28_E.pdf

Table 2: Summary statistics

Variables	Mean	Median	Min.	Max.	Std Dev.
Job postings:					
Monthly postings	2,442	668	1	206,743	10,225
Monthly postings - unskilled	775	265	1	48,718	2,449
Monthly postings - skilled	1,614	388	1	151,708	7,525
Monthly postings - SOC1	254	56	0	28,761	1,342
Monthly postings - SOC2	793	182	0	74,155	3,828
Monthly postings - SOC3	416	94	0	40,616	1,944
Monthly postings - SOC4	211	57	0	17,181	811
Monthly postings - SOC5	150	54	0	8,505	428
Monthly postings - SOC6	143	58	0	7,742	418
Monthly postings - SOC7	223	66	0	16,004	762
Monthly postings - SOC8	82	32	0	2,788	173
Monthly postings - SOC9	115	45	0	6,916	313
US monthly postings placebo	9,265	8,835	2,176	31,375	3,335
Exposure measures:					
Professional services exposure	0.127	0.0877	0.0323	0.548	0.0902
Financial services exposure	0.0335	0.021	0.00814	0.287	0.0346
Export tariff exposure	0.305	0.208	0.0204	4.2	0.412
Import tariff exposure	0.598	0.408	0.0423	5.52	0.732
Imported inputs tariff exposure	0.23	0.203	0.0671	0.775	0.11
Controls:					
Xrate impact via imports	0.0652	0.0652	0.0644	0.0665	0.000327
Xrate impact via exports	-0.0622	-0.0627	-0.0705	-0.0505	0.00347
EU national worker share	0.0465	0.0444	0.0182	0.144	0.0172
Eastern EU national worker share	0.0297	0.0274	0.0121	0.0624	0.0106
Uncertainty indices:					
Newspaper-based uncertainty index	4.33	4.12	2.16	7.15	1.45
Google-search-based uncertainty index	2.13	1.9	1.13	4.55	0.788
Brexit uncertainty index	44.3	39.2	34.8	58.3	7.79

Notes: This table displays summary statistics for all of the key variables used in the analysis. The dataset includes a total of 213 TTWAs, across 60 months (Jan 2015 - Dec 2019), totalling 12,780 observations. All uncertainty measures run from Sept 2016 - Dec 2019. The newspaper uncertainty index has been scaled by 100 so the mean of 6.61 represents 661 articles per month.

Figure 2: Monthly online job postings in the UK



Notes: Raw unsmoothed total monthly postings data. The vertical red dotted line identifies the point of the Brexit referendum.

codes. They also clean the data and remove duplicate postings.[11] The postings cover 225 TTWAs across the UK, with 76% of total job postings being classified with a TTWA.[12]

Over the period considered in our analysis, January 2015 to December 2019, a total of 31,208,288 postings are present in our dataset, translating into an average of 6,241,658 per year. Figure 2 displays the time series of UK monthly job postings over the period of our analysis. They follow an upwards trend before the referendum before flattening out and starting to decrease form mid-2018. We are interested in understanding to what extent concerns about a future relationship with the EU played into this decrease.

3.2 Local labour market employment data

Our analysis uses UK TTWAs as our statistical unit, which aim to reflect the geographic region where the population would generally commute to a larger town, city or conurba-

[11] Duplicates are recorded as a single posting in the first period in which the posting occurs.

[12] The final dataset includes 213 TTWAs, due primarily to the exclusion of Northern Ireland from the BRES employment data, and secondarily a small number of other, very small TTWAs which are not present in both the BGT data and the BRES data.

tion for the purposes of employment.[13] 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)).

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.[14] 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.

3.3 Professional Services Trade Barrier Exposure

Our aim is to quantify the threat of future trade barriers placed on UK exports of services if the UK were to leave the EU at the end of the transition period without a trade deal. If the

[13] Travel to Work Areas are defined by the ONS 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

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

UK and EU fail to reach an agreement, the UK will leave the EU's Single Market and will become a 'third country' to the EU for the purpose of services trade. Trade with the bloc will then follow the rules of the General Agreement on Trade in Services (GATS) of the World Trade Organisation (WTO). In addition, UK businesses will face rules set by individual EU Member States.

In order to quantify the difference between the current barriers the UK faces on its services exports to the EU and the threat of what these barriers could revert to in a no-deal scenario, we make use of both the OECD Services Trade Restrictiveness Index (STRI) and the OECD Intra-EEA STRI.[15] The OECD STRI contains indices that measure MFN service trade restrictions for each country and sector, and does not take into account any specific concessions or preferential trade agreements. It was assembled by analysing laws and regulations in 34 OECD countries as well as Brazil, China, India, Indonesia, Russia, and South Africa. For each country and sector, five policy areas are considered: restrictions on foreign entry, restrictions on the movement of people, barriers to competition, regulatory transparency, and other discriminatory measures. The policy measures are grouped under the same five policy areas in all sectors, and are turned into an index using a scoring and weighing technique designed by the OECD. The indices take values from 0 to 1, with 1 indicating the highest NTMs (market completely closed to foreign services providers), and 0 meaning a fully liberalised sector.

Some examples of regulations included in the STRI for the Commercial Banking sector under the category 'restrictions on foreign entry' are: limiting foreign equity share in local banks, restricting cross border mergers, and requiring licenses. In the category of 'barriers to competition' some examples are: product level regulations, or having supervisory authorities that are not independent. For the Legal sector under the category 'restrictions on foreign entry' some examples are: whether commercial association is prohibited between locally and not locally licensed lawyers, or whether acquisition and use of land and real estate by foreigners is restricted. For the category 'restrictions on the movement of people' some examples are: whether foreign professionals are required to take local exams, whether there are laws or regulations to establish a process for recognising qualifications

[15]OECD Services Trade Restrictiveness Index (STRI): https://qdd.oecd.org/subject.aspx?Subject=063bee63-475f-427c-8b50-c19bffa7392d. OECD Intra-EEA STRI: https://www.oecd-ilibrary.org/trade/intra-eea-stri-database_2aac6d21-en.

gained abroad, or limitations on the duration of stay for intra-corporate transferees.

The intra-EEA STRI identifies and catalogues policy measures that restrict trade within the EEA for 25 OECD EU member countries. The information in the intra-EEA STRI is comparable with existing information in the STRI database but also covers EU law as well as national legislation. As a consequence, it follows that the resulting indices differ across EEA member countries, reflecting differences in national legislation. The OECD STRI could therefore be seen as a worst case scenario for the UK if it leaves the EU without a trade deal; trade restrictions will revert to MFN terms and barriers will be in line with those quantified in this index. The EEA-STRI, on the other hand, could be seen as the status quo of the current restrictions for the UK while it is in the EEA and covered by these EU laws.

We combine these two indices for the overlapping subset of 24 countries included in both and use them to evaluate the 'gap' between services trade restrictions placed on countries within the EEA and the MFN services trade restrictions they place on third countries.[16] We use the 2014 version of the STRI so that these restrictions were in place prior to discussion about Brexit. Of the 22 sectors, we exclude those relating to transport, logistics, construction and the arts (broadcasting, motion pictures and sound recording) such that we are left with an index that captures primarily professional service exports. The sectors we include are then Accounting, Architecture, Commercial Banking, Computer services, Engineering, Insurance, Legal and Telecoms.

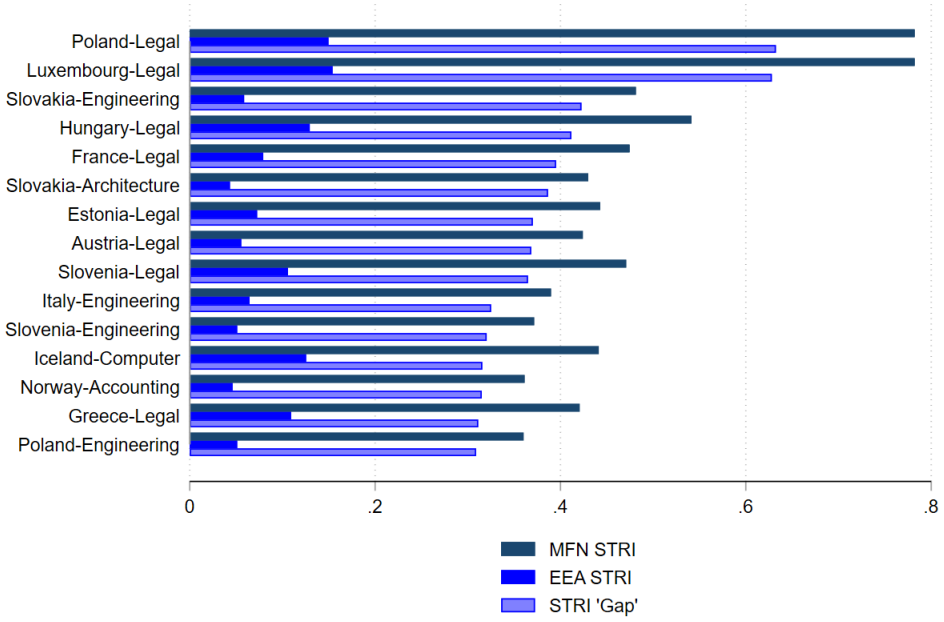
We use data from the Office for National Statistics (ONS) on UK exports of services by service type and country in 2015[17] to develop an EEA trade-weighted STRI 'gap' for each of the sectors we consider. We map the ONS service types to the STRI sectors using the mapping described in Table 13 of Appendix B.[18] These sectors can then be mapped to UK SIC 2007 codes, with this mapping also included in Table 13. We construct the sector level professional service barrier threat as follows:

[16]The 24 countries are: Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden

[17]We use the 2015 trade data because exports of services by detailed service type and country was not available prior to 2015

[18]We construct the trade-weighted sector level STRI gap using the UK-EEA export shares of only the subset of countries that are included in both of the STRIs and in the ONS export data, meaning this weighted-average is over 24 EEA countries

Figure 3: Most exposed sectors to professional services trade barriers



Notes: STRI gaps are country and sector specific, and range from 0 to 1 (where 1 is the highest restrictiveness level). The figure presents the STRI value with respect to other countries in the European Economic Area (EEA), with respect to countries outside the EEA and with no other services trade deal, and the difference between these two measures. *Sources*: Services Trade Restrictiveness Index, OECD.

$$\text{prof services exposure}_j = \frac{\text{Exports}_{j,2015}}{\text{L}_{j,2015}} \times \text{avg STRI gap}_{j,2014} \tag{1}$$

where the avg STRI $\text{gap}_{j,2014}$ is the difference between the 2014 MFN STRI and intra-EEA STRI for industry j in one of the 24 included EEA countries c, weighted by UK exports to the included EEA country c in sector j in 2015. $\text{Exports}_{j,2015}$ are total UK exports from industry j to the EEA in 2015 and $\text{L}_{j,2015}$ is employment in sector j in 2015. Following Autor et al. (2013) and Blanchard et al. (2019) we weight by exports per worker. This captures tradability, i.e. how important are exports for the sector, but also how exposed each worker is to exports within the sector which maps directly to the decision of whether or not a firm decides to increase hiring and hence to post a job advert.

Figure 3 displays the top 15 country-sectors ranked by the difference between the MFN and intra-EEA STRIs. Legal services are the most commonly featured service type in this ranking, with the highest ranked differences being 'Legal services' in Poland, Luxembourg and Slovakia. For the trade-weighted STRI gap, the Legal sector also ranks highest, fol-

lowed by Architecture, Accounting, Computer Services, Information Services, Engineering, Financial Services, Insurance then Telecoms with the lowest STRI gap.

3.3.1 Local labour market exposure

We construct measures of the services barrier threat at the local labour market level by weighting the sectoral measures using baseline employment shares within a local labour market for each industry. The regional measure is then:

$$\text{prof services exposure}_r = \sum_j \text{empl share}_{rj,2015} \times \text{prof services exposure}_j \tag{2}$$

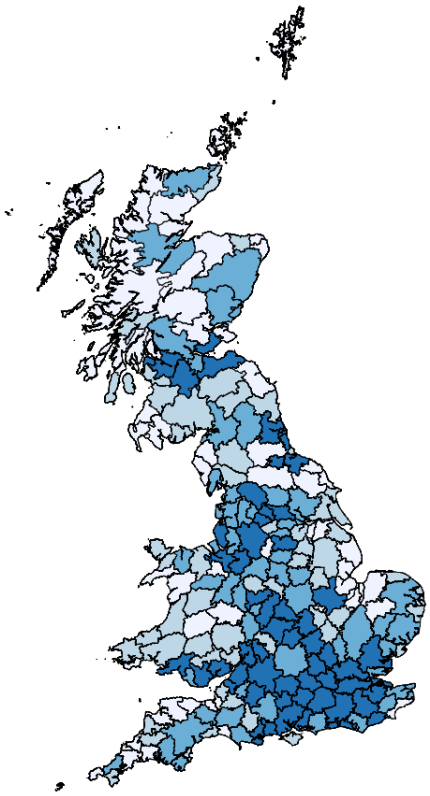
where $\text{empl share}_{rj,2015}$ is industry j's share of TTWA r employment.

Figure 4 presents a map of this measure by TTWA, with darker blue representing a greater professional services trade barrier exposure. There is an unsurprising concentration around the South East and London, combined with a number of very exposed areas in the North of England and Scotland. Figure 5 displays the 15 most exposed TTWAs: London ranks only 5th overall, with Edinburgh, Halifax, Trowbridge, Swindon and Skiption ranked as more exposued.

3.3.2 Financial Services-specific exposure

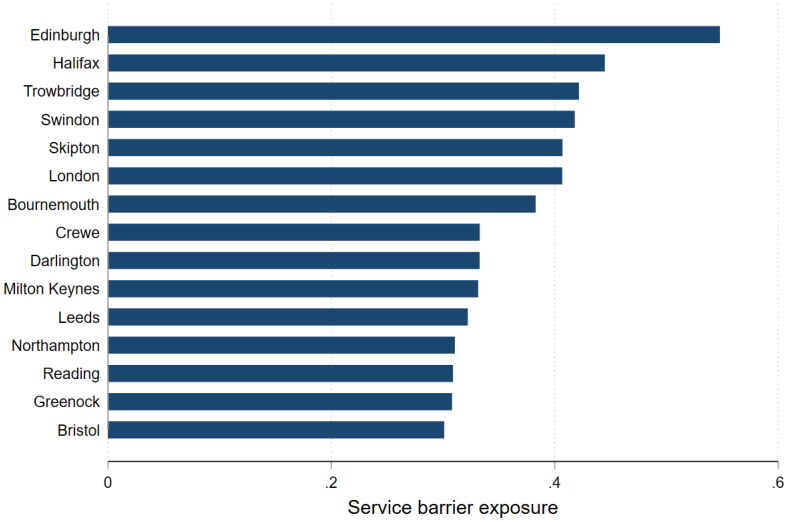
The UK is rare in collecting detailed data on the regional breakdown of service exports. The ONS provides the value of service exports for aggregated service categories, of which Financial Services (henceforth FS) is one, originating from the 11 UK NUTS1 regions. This means that for FS specifically, we can also exploit additional regional variation in the export intensity of the FS sector. This is not possible for the other professional services. Within the group of professional services considered, FS is also of particular importance for the UK economy. FS alone accounted for 42% of the professional services exports to the EEA in the ONS data used in 2015. The FS sector in the UK is also uniquely reliant on 'passporting' arrangements with the EU, which had a distinct and important role in the negotiations, as discussed above. The loss of passporting rights was considered one of the greatest potential consequences of Brexit as these rights were essential to many business functions of financial institutions based in the UK. We therefore also focus solely on the

Figure 4: Exposure by Travel to Work Area: professional services trade barriers



Notes: This map displays the baseline employment-weighted professional services exposure for each TTWA. Darker colours represent more exposed areas.

Figure 5: Most exposed Travel to Work Areas: professional services trade barriers



Notes: This chart presents the employment-weighted professional services exposure for the top 15 most exposed TTWAs. *Sources*: OECD, UN Comtrade.

FS sector and explore its impact separately. We construct a measure of exposure to future barriers on exports of FS as follows:

$$\text{FS exposure reg}_r = \frac{\text{Regional FS Exports to EU}_{2015}}{\text{L}_{FS,reg,2015}} \times \text{avg STRI gap}_{FS,2014} \tag{3}$$

where Regional FS Exports to EU_{2015} are the FS exports of UK NUTS1 region reg to the EEA, Trade-weighted avg STRI $\text{gap}_{FS,2014}$ is defined as above and $\text{L}_{FS,reg,2015}$ is UK regional employment in FS. This can then be brought to the TTWA level using employment share weightings:

$$\text{FS\_exposure}_r = \text{empl share FS}_{r,2015} \times \text{FS exposure reg}_r \tag{4}$$

where empl share $\text{FS}_{r,2015}$ is the Financial Service (FS) share of TTWA r employment in 2015. Figures 13 and 14 in Appendix A display a map of this measure of financial service sector employment share by TTWA as well as the 15 most exposed TTWAs. The list is topped by London, Edinburgh, and Trowbridge. A number of the most exposed regions are home to banks or building societies, for example Skipton (4th most exposed) being home to Skipton Building Society, or Halifax (5th most exposed) being home to Halifax Building Society.

3.4 Tariff Exposure

We begin by constructing the export 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 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 represent the simple average of tariffs across higher levels of disaggregation. We match these tariffs to UK exports to the EU-27 at the HS6 level and then match the combined dataset with 4-digit ISIC codes using crosswalks provided by the UN Statistics Division.[19]

[19]The relevant crosswalks can be fond here: unstats.un.org/unsd/classifications/econ/. We use CPC Ver 2.1 as an intermediate nomenclature between HS 2012 and ISIC Rev. 4. The employment data is provided at the UK SIC 2007 level (equivalent to NACE Rev. 2 up to the 4-digit level) but can be straightforwardly aggregated to the ISIC Rev. 4 level using a concordance from the same UN stats course.

From there we aggregate the tariffs to a per-worker sectoral measure as follows:

$$\text{tariff exposure}_{j,2014} = \frac{\text{Exports}_{j,2014}}{L_{j,2015}} \times \text{avg MFN tariff}_{j,2014} \tag{5}$$

where avg MFN tariff$_{j,2014}$ is the export-weighted average EU MFN ad valorem tariff across all HS6 products mapped to sector j, Exports$_{j,2014}$ are exports from the UK to the EU-27 of a particular HS6 product in 2014, and L_j is the total national employment in sector j in 2015. The tariff data are aggregated up to 419 sectors, of which 188 have positive goods exports to the EU27, and we keep only the manufacturing sectors i.e. those in SIC2007 Division C. We use 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.

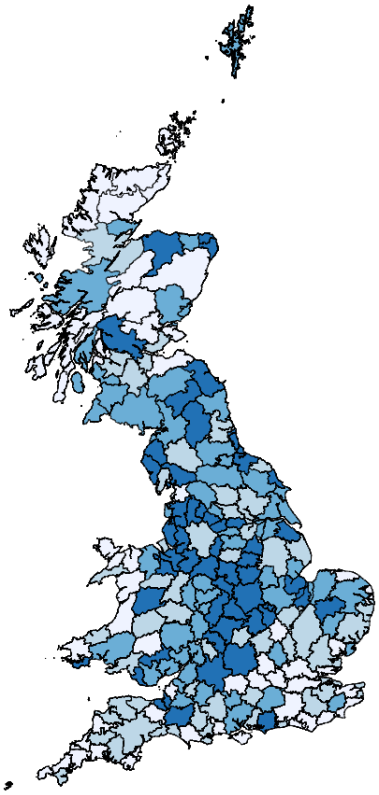
We are focusing primarily on the effect of future MFN tariffs on UK exports, rather than UK import tariffs, for a few reasons. Firstly, while the UK would not be able to control the tariffs placed upon its exports if it left the EU without a trade deal, it would be able to directly control its import 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.[20] 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. This said, measures that take into account potential import tariffs are included in the robustness section. The regional tariff exposure measure is defined as:

$$\text{tariff\_exposure}_r = \sum_{j \in r} \text{empl\_share}_{rj,2015} \times \text{tariff\_exposure}_{j,2014} \tag{6}$$

where empl_share$_{rj,2015}$ is industry j share of TTWA r employment, and tariff_exposure$_{j,2014}$ is the trade-weighted measure of industry j's exposure to future EU MFN tariffs based upon the level of these tariffs in 2014, as defined above. The total employment within each TTWA includes service sectors where each service sector is allocated a value of zero for the tariff threat.

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

Figure 6: Exposure by Travel to Work Area: tariff barriers

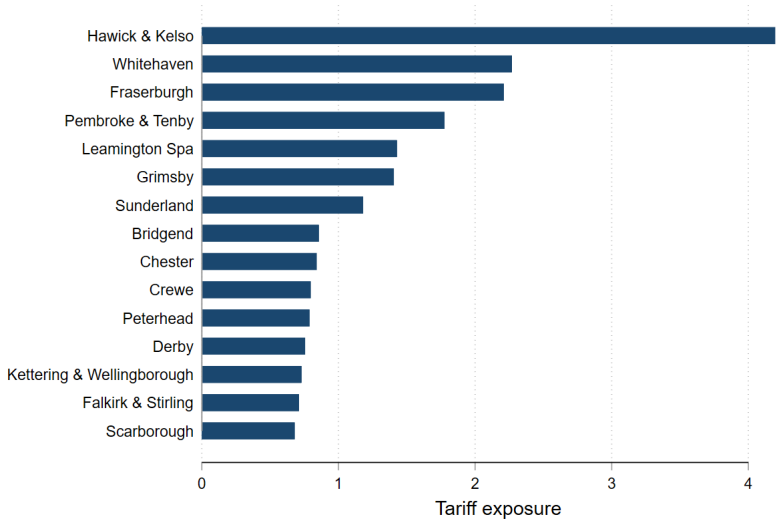


Notes: This map displays the baseline employment-weighted tariff exposure for each TTWA. Darker colours represent more exposed areas.

Figure 7 displays the top 15 TTWAs by exposure level and Figure 6 provides a map of the exposure measures. The most exposed TTWAs include Hawick & Kelso, Whitehaven, and Fraserburgh, all in the North of England or Scotland. The map shows a concentration in the midlands with relatively little exposure in the South East and London, in contrast with the professional services exposure.

Finally, we map the job postings to our tariff exposure measure using the TTWA names 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 60 months, resulting in 12,780 observations.

Figure 7: Most exposed Travel to Work Areas: tariff barriers



Notes: This graph displays the MFN tariff threat for the 15 most exposed TTWAs. *Sources*: World Integrated Trade Solution (WITS), UN Comtrade.

3.5 Classifying job adverts by occupation and skill

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'. These can be aggregated to nine 1-digit groups as presented in Table 3.

The ONS classifies the 2-digit sub-major groups of the SOC 2010 into four skill levels where "skill level is defined with respect to the duration of training and/or work experience recognised in the field of employment concerned as being normally required in order to perform the activities related to a job in a competent and efficient manner".[21]

We define the top two levels (3 and 4) as 'high skill' and the bottom two (1 and 2) 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'. Figure 8 displays the evolution of high skill and low skill job postings over time, we see a clear gap between the

[21] https://www.ons.gov.uk/methodology/classificationsandstandards/standardoccupationalclassificationsoc/soc2010/soc2010volume1structureanddescriptionsofunitgroups

Table 3: Posting occupations and skill levels

SOC Code	Group title	Skill grouping
1	Managers, Directors and Senior Officials	3/4
2	Professional Occupations	4
3	Associate Professional and Technical Occupations	3
4	Administrative and Secretarial Occupations	2
5	Skilled Trades Occupations	3
6	Caring, Leisure and Other Service Occupations	2
7	Sales and Customer Service Occupations	2
8	Process, Plant and Machine Operatives	2
9	Elementary Occupations	1

Notes: Where a skill grouping of 4 is the highest skilled level and 1 is the lowest as defined by the ONS. Our definition of high skill includes levels 3 and 4, and low skill includes 1 and 2. *Source*: ONS Standard Occupational Classification.

progression of the two types with high skill postings overall decreasing, and low skill postings slightly increasing over the period.

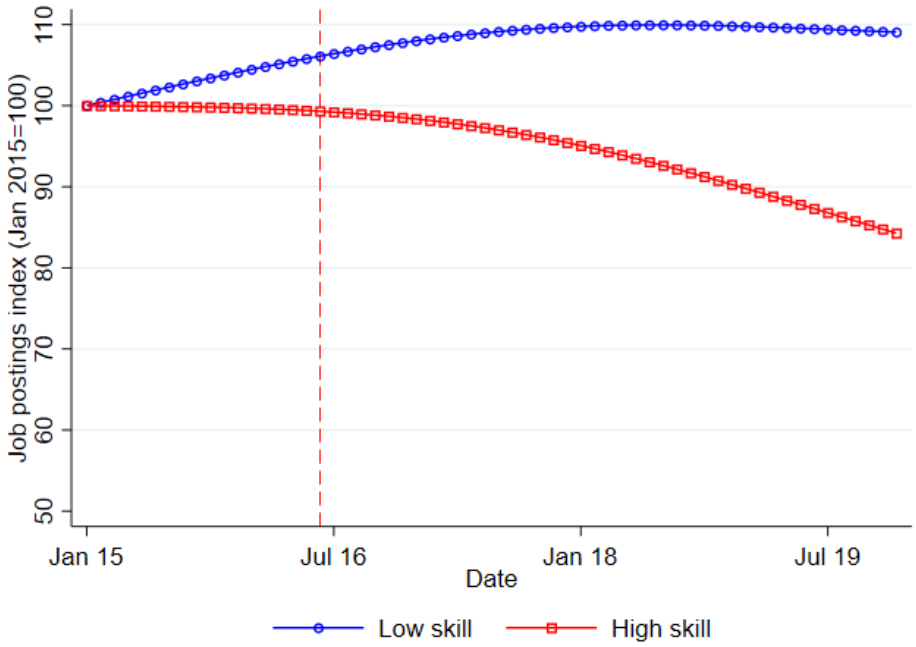
3.6 Measures of Trade Policy Uncertainty

3.6.1 Newspaper coverage

Our objective is to estimate the response to changes in beliefs about the likelihood that UK firms will be subject to services barriers or MFN tariffs when exporting to the EU after Brexit. Since we do not directly observe beliefs about the probability of different trade policy scenarios with the EEA, we develop proxies that reflect uncertainty about the future tariff arrangements with the EU.

Our first approach uses UK newspaper coverage 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 policy 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 6 trade related terms:

Figure 8: Skilled and unskilled job postings over time



Notes: Both trend lines are smoothed using the Hodrick-Prescott time-series filter, removing cyclical components, and normalised to 100 in January 2015 for comparison. The vertical red dotted line identifies the date of the Brexit referendum.

'trade', 'tariffs' 'WTO', 'World Trade Organisation', 'trade policy', 'trade agreement'. Given our additional focus on services trade, we also include two key services-restriction related words: 'passporting' and 'services 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 4 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 2015-2019. This index is displayed in Figure 9 for the negotiation period, which is the focus of our analysis, normalised to 1 for September 2016 so that the three indices

Table 4: Uncertainty measure included terms

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

Notes: This table displays the terms used in the uncertainty measures. We counted any article including a term from Category 1, a term from Category 2 and a term from Category 3.

considered are comparable for the period when the Brexit Uncertainty Index (BUI) is available, discussed below. Newspaper coverage peaked on the referendum date of June 23rd 2016. It subsequently declined, 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 coverage remained high until March 2019, when the government put in a request to extend Article 50.

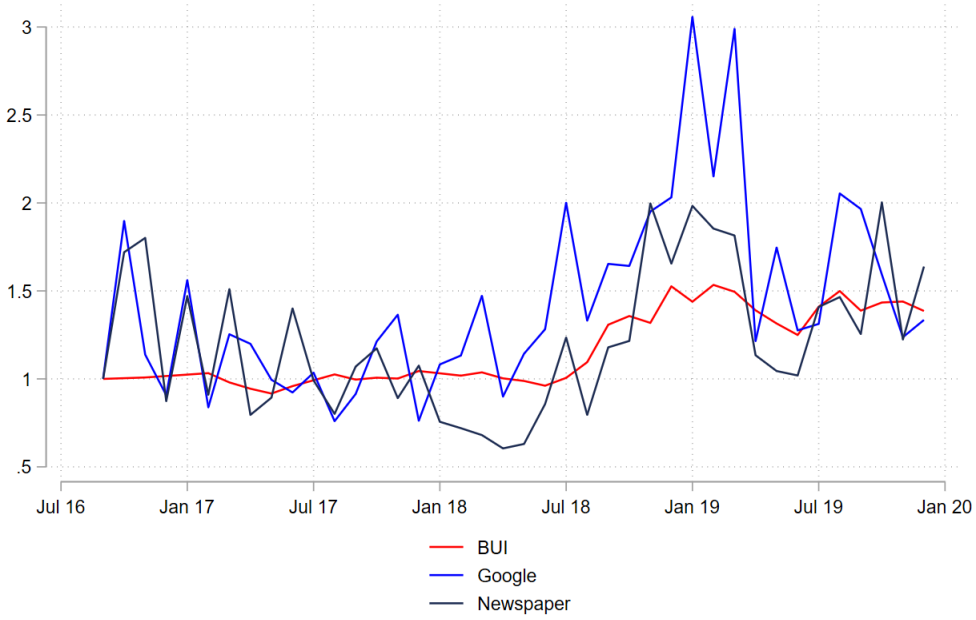
3.6.2 Google searches

Our second approach is to use Google searches.[22] 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 provides public information on the Google searches conducted within a given region over time.[23] We use searches for the same terms as for the newspaper measure, but exclude the uncertainty-related

[22] 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.

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

Figure 9: Brexit trade policy uncertainty measures



Notes: For illustrative purposes the measures are normalised to 1 September 2016, non-normalised versions are used in regressions for simplicity. The BUI originates from the UK Decision Maker Panel Survey. The newspaper index is 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 google index shows the uncertainty measure constructed using google searches for key terms relating to Brexit and trade policy, it reflects search intensity for the relevant search terms in each month.

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 9 displays the normalised google trends measure for the post-vote period alongside the two other measures. Similarly to the newspaper measure, this measure has a marked peak in late 2018 in a similar location to the peak of newspaper coverage, but the latter is much more muted. There is significant month-to-month variation across both measures.

3.6.3 BUI

In addition to the two uncertainty measures discussed above, we also compare our results using the BUI from the Decision Maker Panel (DMP) survey.[24] The DMP is a panel survey of 8,000 firms, with around 3,000 responding in any given month. The BUI is defined as the

[24] https://decisionmakerpanel.co.uk

share of firms which rate Brexit as one of the three highest drivers of uncertainty for their business.[25] Figure 9 compares the BUI with our two uncertainty measures from September 2016, when the BUI starts. All follow similar trends, although the BUI has a lower variance and fluctuates less than our measures.

3.7 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 four key control variables captures changes to the expected supply of EU or EU8 nationals working in the UK, and the sharp depreciation of the pound sterling after the referendum. Below we discuss the construction of the immigration controls, and the exchange rate variables.

3.7.1 Accounting for immigration policy uncertainty

To measure the employment share of EU and EU8 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 EU8 nationals in each UK region and SIC1 industry, where there are 11 regions (for example North West, South West, Scotland), excluding Northern Ireland. We use data on the SIC1 employment composition of each TTWA in a given region to construct the employment share measures. A map of these measures is displayed in Figure 15 of Appendix A.

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 sub-

[25] More information can be found in Bloom et al. (2019)

stantial 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 take the referendum and risk of a no deal as a negative shock to their businesses and hence may reduce hiring until clarity of future arrangements is restored. The measure is defined as:

$$\text{EU national share}_r = \sum_j \text{empl sh}_{jr} \times \frac{\text{EU workers}_{j,reg}}{\text{Total workers}_{j,reg}} \tag{7}$$

where r is the TTWA, reg is the NUTS1 region the TTWA is located in and j the SIC1 sector. Total workers include any individual in employment, and EU workers include any EU National in employment in the UK.

3.7.2 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.[26] 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, 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).[27] Figure 15 in Appendix A provides maps of these measures by TTWA.

Table 2 displays summary statistics for monthly job postings and all other key variables used in the paper.

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 TTWAs as a function of a labour market's exposure to future po-

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

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

tential trade barriers over the period of January 2015-December 2019. We estimate the following model:

$$\log(\text{postings}_{rt}) = \beta_0 + \beta_1 \text{trade barrier threat}_r \times \text{post vote}_t + \text{X}_{rt} + \gamma_t + \gamma_r + \epsilon_{rt} \quad (8)$$

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, $\text{trade barrier threat}_r$ is a measure of the exposure of TTWA r to future trade barriers between the UK and the EU, and X_{rt} are TTWA-time varying controls. The varying measures of exposure are discussed in the data and results sections.

We do not include the post-vote variable on its own as our specification includes month-year dummy variables. We are also interested in the impact of trade policy uncertainty for different skill and occupations groups and so we run the specification in (8) separately for each category of 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 arrangements 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 the negotiations continued, changing the probability of different trade policy scenarios being agreed upon. We therefore also explore how the impact of exposure to professional service export barriers or future MFN tariffs varied during the post-vote period as a function of the proxies for Brexit-induced trade-policy uncertainty. We consider the following specification:

$$\log(\text{postings}_{rt}) = \beta_0 + \beta_1 \text{trade barrier threat}_r \times \text{tariff uncertainty}_t + \gamma_t + \gamma_r + \epsilon_{rt} \quad (9)$$

where $\text{tariff uncertainty}_t$ is a measure of the degree of MFN tariff uncertainty in month-year t. For this specification we focus on the post-referendum negotiation period, such that we evaluate differences in the impact of trade barriers within the period when the Brexit vote result had already been announced.

4.3 Other threats to identification

A primary threat to identification is omitted variable bias. Our specification controls for time-invariant TTWA-specific factors with the inclusion of TTWA fixed effects, and common time trends are controlled for with year-month fixed effects. However, we may still be concerned by TTWA-time varying factors that affect job postings and are correlated with both the post vote variable and our exposure variables.

One such potential concern is the the EU service barriers or MFN tariffs tend to be high in declining industries because EU countries are 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 trade barriers 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.

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, first running a placebo test on the pre-referendum period. We split this period in two, and see whether our exposure measures had significant impacts when comparing the new pre/post periods. If our results capture medium-term trends that are not related to trade barrier exposure then we would expect to see similar results in this placebo test. Insignificant results would support our claim that it is in fact Brexit that matters.

We then run a second form of placebo test using US online job postings. Of course, the US data does not vary at the UK TTWA-time level so to create a meaningful placebo, we take the sector level postings data from the US and weight them by the 2015 BRES employment data as follows:

$$\text{US postings}_{r,t} = \sum_{j} \text{Employment share}_{j,r} \times \text{US postings}_{j,t}$$

In order to ensure the correct sectors, 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.[28] 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.

5. Results

5.1 Baseline post-vote results

We start with our baseline specification laid out in equation 8 before gradually adding controls, the results are presented in Table 5. Column (1) shows the coefficient on the interaction term between the post vote dummy variable and the TTWA trade weighted professional services exposure, and column (2) additionally includes the tariff exposure measure. Columns (3)-(5) subsequently add the controls described earlier in the paper. Across all columns, the professional services measure is negative and significant at the 1% level with the magnitude varying between -0.344 and -0.540. Taking column (4) as our preferred specification, a one standard deviation increase in exposure (0.09) leads to a 3.1% decrease in monthly postings. The tariff measure is close to zero and insignificant across all specifications.

Turning to controls, the import exchange rate measure is negative across all specifications, consistent with an increased cost of imported inputs due to the sterling depreciation reducing firms hiring. However these results just miss significance at the 10% level (p-value=0.11 for column (4)). The export exchange rate measures are positive and significant across all specifications, as would be expected if firms benefiting from the increased competitiveness of UK exports also increase hiring. Here a one standard deviation increase in exchange rate export exposure (0.0034) is associated with an increase in hiring of 3.1%. Both EU shares are insignificant throughout.

5.2 Professional services impact over time

In order to evaluate how the professional services exposure impacted postings throughout the negotiation period we rerun the baseline regression (column (4)) modified to include

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

Table 5: Baseline post-vote results

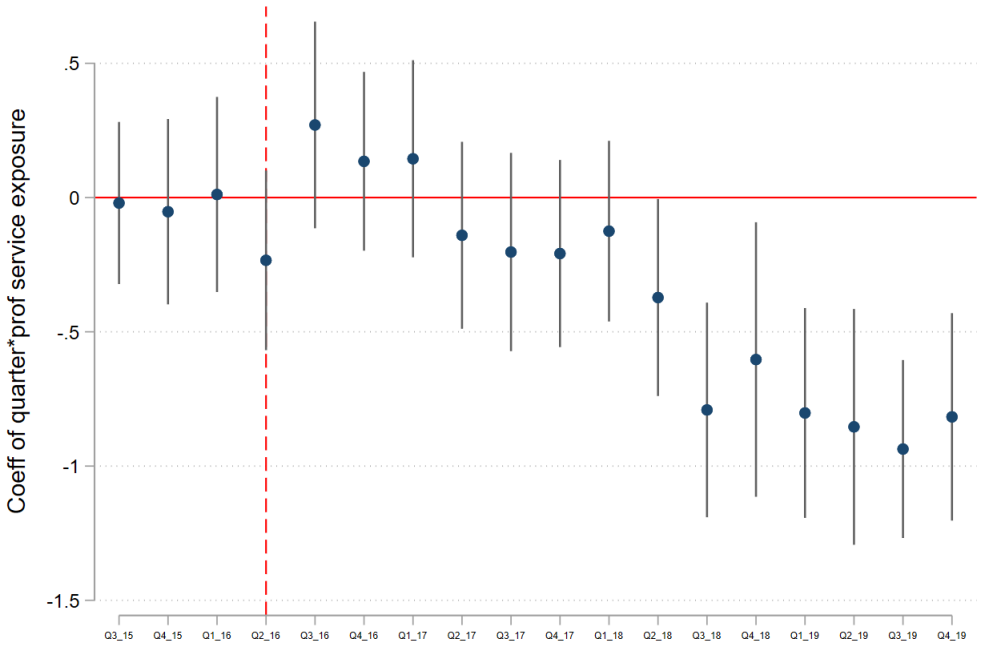
Dep variable: log postings	(1)	(2)	(3)	(4)	(5)
post vote * prof service exposure	-0.538***	-0.540***	-0.351***	-0.346***	-0.344***
	(0.132)	(0.132)	(0.124)	(0.124)	(0.128)
post vote * tariff exposure		-0.008	0.001	0.003	0.001
		(0.033)	(0.035)	(0.035)	(0.035)
post vote * xrate impact via imports			-74.18	-81.09	-76.97
			(52.49)	(50.31)	(50.49)
post vote * xrate impact via exports			7.888*	9.084**	8.587**
			(4.194)	(4.065)	(4.277)
post vote * EU national share				0.639	
				(0.797)	
post vote * EU8 national share					0.556
					(1.341)
Observations	12,780	12,780	12,780	12,780	12,780
Adjusted R-squared	0.984	0.984	0.984	0.984	0.984
TTWA FE	YES	YES	YES	YES	YES
Month-Year FE	YES	YES	YES	YES	YES
Clustering	TTWA-YM	TTWA-YM	TTWA-YM	TTWA-YM	TTWA-YM

Notes: This table displays the results from the regressions of the log of monthly job postings in each TTWA on the average trade barrier exposure measures at the TTWA level interacted with the post vote dummy variable, with and without controls. all specifications include TTWA and month-year fixed effects, and standard errors (in parentheses) are two-way clustered at the TTWA and month-year level. *** p<0.01, ** p<0.05, * p<0.1.

interactions of the exposure measure with dummies for each quarter. Figure 10 presents the coefficients plot. Quarters 1 & 2 from 2015 are excluded so all coefficients are relative to these quarters, and 95% confidence intervals are displayed vertically. We also control for the EU immigrant share and the post referendum exchange rate controls interacted with the post-vote dummy, month-year and TTWA fixed effects.

We can see that pre-referendum the coefficients remain close to zero and insignificant, providing evidence that the professional services exposure was not affecting postings prior to the referendum when a win for the leave campaign was considered unlikely. For several quarters after the referendum, the coefficients remain insignificant although becoming gradually more negative. The first significant coefficient is in Q2 2018 followed by consistently negative and significant coefficients for the rest of the negotiation period. The delayed effect is consistent with an initial period post-referendum where businesses were trying to understand the future consequences for their businesses whilst remaining optimistic about a deep future trading relationship with the EU. Firms only responded by adjusting hiring once it became clear that the likely outcome of negotiations was a significant separation from the Single Market.

Figure 10: Impact of professional services exposure over time



Notes: This graph shows the coefficients from the regressions of the log of monthly job postings on the professional services barrier 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 EU immigrant share and 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 Q1 2015 and Q2 2015. The dots represent the point estimates and the lines the 95% confidence intervals. The red line shows the quarter when the referendum occurred, Q2 2016.

5.3 Negotiation period uncertainty results

Our baseline results use a straightforward interaction of the professional services exposure with a post vote dummy. This approach might be susceptible to the possibility that we are just capturing sectoral trends over time. In addition, 3.5 years passed between the referendum and the UK leaving the EU, a long time period in which a lot of political changes occurred and perceptions about the likely scenarios for Brexit will have changed substantially. In order the address this concern, we interact our exposure measures with the three time varying uncertainty measures (defined in the Data section): the Google Brexit index, the Newspaper Brexit index, and the BUI. We focus on the period after the referendum starting in September of 2016, the first date for which the BUI is available, and ask how regions that were more exposed to future trade barriers changed postings in months of

increased uncertainty about the future outcome of negotiations. The specifications now exclude the exchange rate controls as these pertain specifically to the pre-post referendum devaluation.

Table 6 presents the results for all three uncertainty measures. As before, the tariff exposure remains insignificant across 5 out of 6 specifications, confirming the results that businesses did not appear to be adjusting hiring as a response to a fear of no deal tariffs. For professional services exposure, the coefficients are negative and highly significant for both the Google and BUI measures, whereas the coefficients for the newspaper interaction are negative but weaker in significance. Taking the Google index as an example (column (1)), we see a coefficient of -0.23. For the mean exposure measure (0.127), an increase in uncertainty from the 25th to the 75th percentile (1.57 to 2.53) leads to a 2.8% decrease in monthly postings. The equivalent for the Newspaper measure is a decrease of 1.8%, and the BUI measure sees a decrease of 6.3%.

We also now find negative and significant coefficients across all specifications for the EU and EU8 national shares, with the latter being larger in magnitude. Again taking column (1), for the mean value of the EU national shares (0.047) an increase from 25th to 75th percentile of the Google index decreases monthly postings by 8.5%. The equivalent for the EU8 share is a reduction of 8.3%. This result is consistent with the hypothesis that regions with a greater share of EU (or EU8) nationals in the workforce were negatively affected by the threat of changes to immigration policy limiting freedom of movement within the EU, and so reduced hiring due to the uncertainty around Brexit or saw their profitability decline and so scaled back their workforce.

Table 16 in Appendix B also presents additional specifications, which provide supporting evidence for the specific importance of monthly variation in these uncertainty measures above and beyond sectoral trends. All specifications make use of the full sample period and and instead include a post vote * uncertainty measure * professional services exposure interaction term.[29] The results for the Google and BUI indices remain robust and the newspaper uncertainty index now generates highly significant negative results. We then iteratively control for either the post vote or quarter interaction terms, demon-

[29]As previously mentioned the BUI index starts in September 2016 so we extrapolate backwards using the September value for July and August 2016

Table 6: Uncertainty measure results

Dep variable: log postings	(1)	(2)	(3)	(4)	(5)	(6)
	Google		Newspaper		BUI	
measure*prof service exposure	-0.231***	-0.268***	-0.066*	-0.083*	-0.034***	-0.039***
	(0.058)	(0.060)	(0.039)	(0.042)	(0.007)	(0.007)
measure *tariff exposure	-0.007	-0.001	0.008	0.011**	-0.000	0.000
	(0.011)	(0.011)	(0.005)	(0.005)	(0.002)	(0.001)
measure*EU national share	-1.907***		-0.826***		-0.264***	
	(0.349)		(0.239)		(0.042)	
measure*EU8 national share		-2.900***		-1.249***		-0.413***
		(0.524)		(0.398)		(0.062)
Observations	8,520	8,520	8,520	8,520	8,520	8,520
Adjusted R-squared	0.987	0.987	0.987	0.987	0.987	0.987
TTWA FE	YES	YES	YES	YES	YES	YES
Month-Year FE	YES	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 average trade barrier exposure measures at the TTWA level interacted with varying uncertainty measures. The post vote period from September 2016 to December 2019 is considered. all specifications include TTWA and month-year fixed effects, and standard errors (in parentheses) are two-way clustered at the TTWA and month-year level. *** p<0.01, ** p<0.05, * p<0.1.

strating that the results for Google and BUI remain robust to these specifications.

5.4 US placebo test

To provide further evidence that our results are not capturing global sectoral trends affecting the professional services sectors at the same time as our uncertainty measures peaked, we run a placebo regression using US postings as the dependent variable, mapped to UK TTWAs (see the *Other threats to identification* section). The aim of this exercise is to evaluate how job adverts would have responded, had the UK followed similar sectoral trends in job adverts to those that occurred in the US. If the professional services sectors that are threatened by high export barriers in the EU were globally on a downward trend relative to other sectors, and if our results were being driven by these trends occurring at similar times to when our uncertainty measures were relatively high, then we would expect to find similar results to our baseline in this US placebo regression.

Table 7 repeats the analysis in Table 6 with uncertainty interactions, now replacing UK postings by our US postings placebo. We find that none of our variables are statistically significant, even at the 10% level, hence supporting the claim that the changes we see in

Table 7: US Placebo Test

Dep variable: log US postings	(1)	(2)	(3)	(4)	(5)	(6)
	Google		Newspaper		BUI	
measure*service barrier exposure	0.002	0.002	-0.001	-0.001	-0.000	-0.000
	(0.017)	(0.016)	(0.007)	(0.007)	(0.002)	(0.002)
measure *tariff exposure	-0.001	-0.001	-0.000*	-0.000*	-0.000	-0.000
	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
measure*EU national share	-0.037		0.002		-0.011*	
	(0.052)		(0.033)		(0.007)	
measure*EU8 national share		-0.058		-0.006		-0.019*
		(0.078)		(0.048)		(0.011)
Observations	8,520	8,520	8,520	8,520	8,520	8,520
Adjusted R-squared	0.994	0.994	0.994	0.994	0.994	0.994
TTWA FE	YES	YES	YES	YES	YES	YES
Month-Year FE	YES	YES	YES	YES	YES	YES

Notes: This table displays the results from the regressions of the log of monthly job postings in each TTWA based on US sectoral trends on the average trade barrier exposure measures at the TTWA level interacted with varying uncertainty measures. The period September 2016 to December 2019 is considered. all specifications include TTWA and month-year fixed effects, and standard errors (in parentheses) are two-way clustered at the TTWA and month-year level. *** p<0.01, ** p<0.05, * p<0.1.

the UK are specifically related to uncertainty in the UK surrounding the Brexit and were not patterns also experienced in the US at these times. For completeness, we also include this US postings measure as a control in Table 16, columns (3), (6), and (9), demonstrating that our results once more survive controlling for trends in the US in addition to quarter interactions.

5.5 Impact on different skill groups

Table 8 displays our baseline regressions run separately for high skilled and low skilled job adverts, the classification of which is described in the Data section. Panel (a) shows the effect for high skilled job adverts, while panel (b) shows the effect for low skilled job adverts. Relative to the baseline coefficients, we find that the high skilled professional service exposure coefficients are all strongly statistically significant and larger in magnitude, whereas the low skilled coefficients are mostly not significant. Taking column (4) high skill results, we see that a one standard deviation increase in exposure leads to a 3.9% decrease in postings (compared to 3.1% for aggregate postings). This is intuitive, given professional

services typically involve higher skill jobs, particularly those that are involved in export.

We also find a negative and weakly significant coefficient for the import exchange rate measure for high skilled postings, where a one standard deviation increase leads to a 2.9% decrease in high skill postings. This is consistent with the explanation that firms that were more exposed to increases in the cost of their imported inputs reducing hiring for high skilled positions. The opposite effect is found for increasingly competitive exports, where a one standard deviation increase leads to a 3.1% increase. EU shares are insignificant across both postings measures.

5.6 Breakdown by subsector

Our measure of professional services exposure comprises of variation across 9 subcategories. In order to better understand what is driving the change in job postings, Table 9 shows the results with the professional services exposure broken down into its constituent parts.

The overall professional services results are primarily driven by 3 out of the 9 subcategories: financial services, information services, and engineering services. Given the importance of financial services in these regressions and in the UK economy more broadly, as well as its prevalence in the discussions surrounding a future Brexit deal, in the next section we focus solely on this sector to better understand its specific impact on hiring.

5.7 Aggregate effects

In order to evaluate what the plausible effects of these results for professional services may have implied for the full sample, we carry out a basic counterfactual exercise on our baseline results. For each TTWA, we consider what the predicted values for monthly postings after the vote would have been if they had the exposure score of the 10th percentile TTWA in terms of professional services exposure. This exercise relies on two simplifying assumptions. First, the total effects on postings equal the sum of the direct effects on postings at each firm. Second, TTWAs below the 10th percentile in terms of professional services

Table 8: Impact by skill group

Dep variable: log postings	(1)	(2)	(3)	(4)	(5)
	Panel (a) High skilled				
post vote * prof service exposure	-0.637***	-0.635***	-0.433***	-0.428***	-0.429***
	(0.132)	(0.132)	(0.137)	(0.138)	(0.141)
post vote * tariff exposure		0.009	0.018	0.020	0.018
		(0.032)	(0.034)	(0.034)	(0.034)
post vote * xrate impact via imports			-81.38*	-88.19*	-82.67*
			(47.58)	(46.30)	(46.23)
post vote * xrate impact via exports			7.753*	8.936**	8.077*
			(4.108)	(3.968)	(4.230)
post vote * EU national share				0.632	
				(0.811)	
post vote * EU8 national share					0.258
					(1.379)
Observations	12,773	12,773	12,773	12,773	12,773
Adjusted R-squared	0.982	0.982	0.982	0.982	0.982
	Panel (b) Low skilled				
post vote * prof service exposure	-0.280**	-0.283**	-0.180	-0.173	-0.164
	(0.127)	(0.127)	(0.119)	(0.117)	(0.121)
post vote * tariff exposure		-0.017	-0.008	-0.004	-0.007
		(0.037)	(0.039)	(0.038)	(0.039)
post vote * xrate impact via imports			-32.19	-41.68	-37.99
			(53.76)	(51.41)	(51.55)
post vote * xrate impact via exports			7.478	9.123*	8.933*
			(4.746)	(4.651)	(4.823)
post vote * EU national share				0.875	
				(0.764)	
post vote * EU8 national share					1.152
					(1.321)
Observations	12,766	12,766	12,766	12,766	12,766
Adjusted R-squared	0.976	0.976	0.976	0.976	0.976
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 by skill level in each TTWA on the average trade barrier exposure measures at the TTWA level interacted with the post vote dummy variable, with and without controls. all specifications include TTWA and month-year fixed effects, and standard errors (in parentheses) are two-way clustered at the TTWA and month-year level. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 9: Professional service results breakdown by sub-sector

Dep variable: log postings	(1)	(2)	(3)	(4)	(5)
post vote * finance barrier exposure	**-0.499*** **	**-0.492*** **	**-0.461*** **	**-0.454*** **	**-0.471*** **
	(0.142)	(0.142)	(0.149)	(0.152)	(0.153)
post vote * engineering barrier exposure	**-6.284*** **	**-6.208*** **	**-5.731** **	**-5.501** **	**-6.068** **
	(2.238)	(2.256)	(2.490)	(2.636)	(2.722)
post vote * info services barrier exposure	**-3.815** **	**-3.858** **	**-3.740** **	**-3.804** **	**-3.696** **
	(1.778)	(1.772)	(1.785)	(1.775)	(1.759)
post vote * legal barrier exposure	-3.544	-3.630	**-4.154***	**-4.157***	**-4.221***
	(2.231)	(2.231)	(2.248)	(2.242)	(2.308)
post vote * insurance barrier exposure	1.136*	1.138*	1.040	1.032	1.046
	(0.589)	(0.588)	(0.651)	(0.655)	(0.651)
post vote * telecoms barrier exposure	-0.468	-0.545	-0.589	-0.544	-0.668
	(0.942)	(0.931)	(0.863)	(0.865)	(0.868)
post vote * computer barrier exposure	-0.800	-0.788	-0.065	-0.098	-0.038
	(0.783)	(0.780)	(0.890)	(0.894)	(0.884)
post vote * accounting barrier exposure	-1.904	-1.965	-1.774	-1.825	-1.740
	(2.794)	(2.811)	(2.970)	(2.969)	(2.963)
post vote * architecture barrier exposure	-5.654	-9.794	1.665	2.906	-1.725
	(57.43)	(58.78)	(56.38)	(56.63)	(57.87)
Observations	12,780	12,780	12,780	12,780	12,780
Adjusted R-squared	0.984	0.984	0.984	0.984	0.984
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 average trade barrier exposure measures at the TTWA level interacted with the post vote dummy variable, with and without controls. All specifications include controls for the sterling depreciation's impact on imports and exports, as well as the EU national share, and well as TTWA and month-year fixed effects. Standard errors (in parentheses) are two-way clustered at the TTWA and month-year level. *** p<0.01, ** p<0.05, * p<0.1.

exposure did not change their posting of job ads after the vote in response to the threat of future service export barriers.

We define the counterfactual post-vote monthly postings of TTWA r had they had an exposure score in the τth percentile as:

$$\log \text{postings}^{\tau}_{rt} = \text{E}\Big[\log \text{postings}_{rt} \mid \text{exposure}_r = \text{exposure}^{\tau}_r\Big] \tag{10}$$

$$= \widehat{\log \text{postings}}_{rt} + \hat{\beta}\left[\text{exposure}^{\tau}_r - \text{exposure}_r\right] \tag{11}$$

where $\hat{\beta}$ and $\widehat{postings}_{rt}$ are the fitted values from our baseline regression column (4). Then the total monthly loss of postings due to the threat of trade barriers is:

$$\text{Total monthly loss} = \sum_{\text{exposure}_r > \text{exposure}^{\tau}_r} \Big[\exp(\log \text{postings}^{\tau}_{rt}) - \exp(\widehat{\log \text{postings}}_{rt})\Big] \tag{12}$$

Taking τ as the 10th percentile, this exercise implies that after the vote the mean monthly decline in the number of job postings for a TTWA relative to this counterfactual was 167.

Across all TTWAs each month there were 34,980 less job adverts posted than this counterfactual benchmark. The mean monthly number of job adverts posted prior to the vote across all TTWAs was 535,397, so this full sample effect implies a 6.5% loss in monthly job adverts on average after the vote for the full sample. Summing up over the whole post-vote period, this implies a cumulative loss of approximately 1.5 million job postings.

If we extrapolate the growth rate in total annual job postings in all TTWAs between 2012-2015 to the post-vote period and comparing this to the observed number of job adverts posted implies that there were 4.1 million less job adverts cumulatively in the post-vote period than had the UK continued to follow its pre-vote trajectory. The ratio of the total lost postings implied by our counterfactual exposure exercise to this loss relative to the pre-vote trend is 0.36, implying that the threat of professional services trade barriers can explain around a third of the relative decline in job postings.

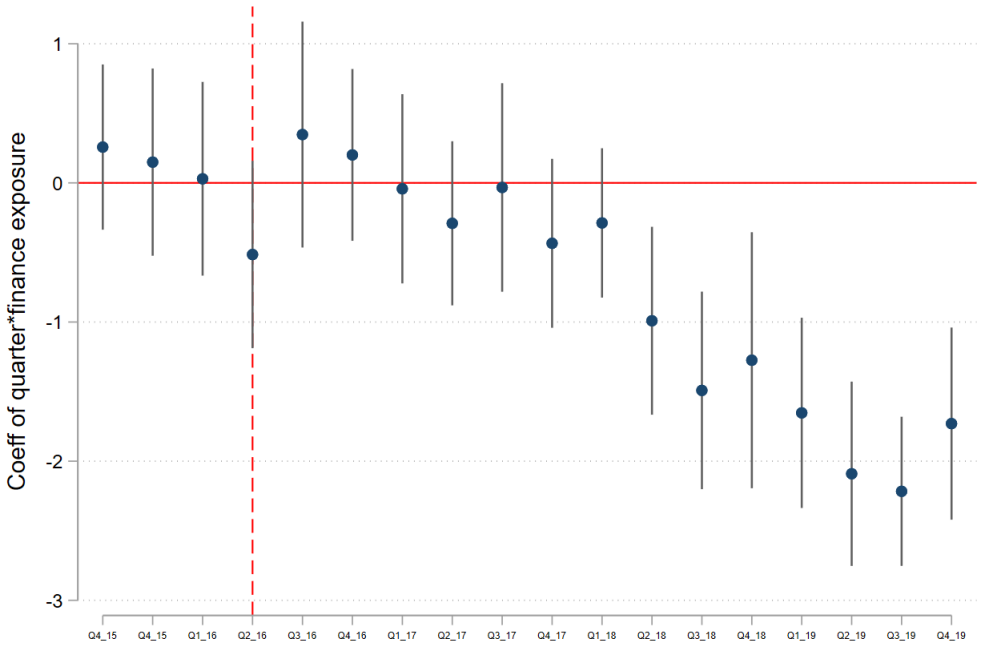
5.8 Financial services results

We now rerun the baseline regressions in Table 5 replacing professional services exposure by regional financial services exposure (defined in the Data section). As before, we find negative and significant results across all specifications with coefficients varying from -1.201 to -0.826. Taking column (4) again, we see that a one standard deviation increase in financial services exposure (0.0345) leads to a 3% decrease in monthly postings. We again see significant coefficients for the exchange rate impacts, where a one standard deviation increase in import exposure leads to a decrease in postings of 3.4% and the same measure for export exposure leads to an increase of 3.4%.

Figure 11 displays the coefficients from the regression of log-postings on the financial services exposure measure interacted with quarter dummies. The results are very similar to the professional services case shown in Figure 10 with the impact being delayed until Q2 2018, and no effect showing prior to the referendum.

Table 11 presents the financial services results broken down by skill level. As for professional services, we find that the results are stronger for high skill postings with a one standard deviation increase in exposure leading to a 3.6% decrease in postings. The exchange rate impacts are significant as for professional services with small changes in magnitudes.

Figure 11: Impact of financial services exposure over time



Notes: This graph shows the coefficients from the regressions of the log of monthly job postings on the professional services exposure measure interacted with a dummy variable for each quarter from Q3 2015 to Q4 2019. Coefficients are relative to the base period of Q1 2015 and Q2 2015. The regressions also controlled for the EU immigrant share and the exchange rate measures interacted with the post vote dummy variables, TTWA fixed effects and month-year fixed effects, and standard errors are two-way clustered at the TTWA and month-year level. The dots represent the point estimates and the lines the 95% confidence intervals. The red line shows the quarter when the referendum occurred, Q2 2016.

Table 10: Financial services post-vote baseline

Dep variable: log postings	(1)	(2)	(3)	(4)	(5)
post vote * financial services exposure	-1.201***	-1.201***	-0.817***	-0.868***	-0.826***
	(0.296)	(0.295)	(0.279)	(0.254)	(0.269)
post vote * tariff exposure		-0.003	0.004	0.007	0.004
		(0.033)	(0.035)	(0.035)	(0.036)
post vote * xrate impact via imports			-98.19*	-105.3**	-100.6**
			(50.48)	(48.40)	(49.15)
post vote * xrate impact via exports			8.203*	9.857**	9.344**
			(4.238)	(4.070)	(4.260)
post vote * EU national share				0.914	
				(0.804)	
post vote * EU8 national share					0.940
					(1.310)
Observations	12,780	12,780	12,780	12,780	12,780
Adjusted R-squared	0.984	0.984	0.984	0.984	0.984
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 average trade barrier exposure measures at the TTWA level interacted with the post vote dummy variable, with and without controls. all specifications include TTWA and month-year fixed effects, and standard errors (in parentheses) are two-way clustered at the TTWA and month-year level. *** p<0.01, ** p<0.05, * p<0.1.

To understand which specific occupation in this less intuitive lower skilled group were affected, we further explore the impact on job adverts by UK SOC group. Table 12 displays the same regressions run separately for job adverts for each of the nine high level occupation categories, the classification of which is described in Table 3 of the Data section. The coefficient on the FS exposure measure is strongly significant and negative for 5 out of the 9 occupations: *Managers, Directors and Senior Officials*; *Professional Occupations*; *Associate Professional and Technical Occupations*; *Skilled Trades Occupations*; and *Sales and Customer Service Occupations*. The coefficients range from -1.105 to -0.630 for *Managers, Directors and Senior Officials* and *Sales and Customer Service Occupations* respectively. A one standard deviation increase in financial services exposure then decreases postings for *Managers, Directors and Senior Officials* by 3.8%, the next highest coefficient is *Professional Occupations* for which the associated decrease is 3.6%.[30]

The *Skilled Trades Occupations* group includes a range of occupations, such as electri-

[30]In Appendix B, we also provide this analysis for the professional services exposure measure, finding that only the first three occupation groups were affected for professional services

Table 11: Financial services impact by skill group

Dep variable: log postings	(1)	(2)	(3)	(4)	(5)
	Panel (a) High skill				
post vote * FS exposure	-1.414***	-1.414***	-0.989***	-1.043***	-0.996***
	(0.322)	(0.323)	(0.317)	(0.286)	(0.308)
post vote * tariff exposure		0.015	0.021	0.025	0.021
		(0.032)	(0.034)	(0.035)	(0.035)
post vote * xrate impact via imports			-111.6**	-119.0***	-113.5**
			(44.88)	(43.29)	(43.78)
post vote * xrate impact via exports			8.154*	9.900**	9.046**
			(4.159)	(3.979)	(4.213)
post vote * EU national share				0.964	
				(0.822)	
post vote * EU8 national share					0.734
					(1.346)
Observations	12,773	12,773	12,773	12,773	12,773
Adjusted R-squared	0.982	0.982	0.982	0.982	0.982
	Panel (b) Low skill				
post vote * FS exposure	-0.662**	-0.662**	-0.455*	-0.512**	-0.468*
	(0.275)	(0.274)	(0.262)	(0.237)	(0.249)
post vote * tariff exposure		-0.014	-0.0063	-0.002	-0.006
		(0.037)	(0.039)	(0.038)	(0.039)
post vote * xrate impact via imports			-43.27	-51.25	-46.79
			(51.63)	(49.68)	(50.31)
post vote * xrate impact via exports			7.613	9.489**	9.251*
			(4.750)	(4.618)	(4.775)
post vote * EU national share				1.032	
				(0.775)	
post vote * EU8 national share					1.345
					(1.300)
Observations	12,766	12,766	12,766	12,766	12,766
Adjusted R-squared	0.976	0.976	0.976	0.976	0.976
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 by skill level in each TTWA on the average trade barrier exposure measures interacted with the post vote dummy variable, with and without controls. all specifications include TTWA and month-year fixed effects, and standard errors (in parentheses) are two-way clustered at the TTWA and month-year level. *** p<0.01, ** p<0.05, * p<0.1.

cians, IT engineers, construction and building trades and even food preparation and hospitality trades. In general, these results suggest that local labour markets that were more exposed to barriers on FS exports reduced the posting of not only high-skilled jobs in the FS industry, but across a range of occupations, suggesting that the impact of FS spilled over to other types of jobs.

6. Robustness checks

6.1 Excluding London

A primary concern around these results could be that this impact was primarily driven by London, widely considered as the UK's professional services hub. First, Figures 4 and 5 show that the professional services exposure is actually not as concentrated in London as is often presumed. Additionally, Table 17 in Appendix B repeats the analysis in Table 5 but excludes the TTWA of London. The resulting coefficients are extremely close to the baseline case with the same levels of significance, allowing us to conclude that London is not driving the results. FS exposure is also spread quite widely across the country, as is shown in Figure 13 of Appendix A. Excluding London also does not have much impact on the significance or magnitude of the baseline results for FS exposure.

6.2 Including shares

A further concern is that our results are driven mainly by the shares in our exposure measure, rather than variation in the STRI or tariff component across sectors (the "shift"). We therefore control for these shares for both the professional services measure and the tariff measure. The shares are constructed by a combination of the TTWA-sector employment weightings, and the sectoral exports to employment ratio i.e excluding the trade weighted STRI or tariff component of the exposure measures.

Table 18 in Appendix B repeats the baseline analysis in Table 5 but includes these shares. The professional services measure remains significant across all specifications, while the associated share is positive and significant at the 10% level in 4 out of the 5 specifications. This suggests that while professional services sectors that exported a lot to the EU were

Table 12: Financial services impact by occupation

Dep var: log SOC postings	1. Managers, Directors and Senior Officials	2. Professional Occupations	3. Associate Professional and Technical Occupations
post vote * FS exposure	-1.105***	-1.030***	-0.878***
	(0.327)	(0.305)	(0.326)
post vote * tariff exposure	-0.018	0.059	0.006
	(0.031)	(0.047)	(0.038)
post vote * EU national share	-90.90*	-180.1***	-105.4**
	(49.14)	(47.15)	(52.70)
post vote * import appreciation	1.741	13.64***	11.22**
	(4.354)	(4.158)	(5.558)
post vote * export depreciation	1.133	0.559	1.309
	(0.880)	(0.833)	(0.957)
	5. Skilled Trades Occupations	7. Sales and Customer Service Occupations	4. Administrative and Secretarial Occupations
post vote * FS exposure	-1.004***	-0.630**	-0.365
	(0.313)	(0.291)	(0.292)
post vote * tariff exposure	0.009	-0.034	0.009
	(0.023)	(0.024)	(0.034)
post vote * EU national share	47.36	-43.75	56.40
	(61.94)	(52.67)	(56.14)
post vote * import appreciation	2.340	2.284	9.635*
	(4.652)	(4.399)	(4.875)
post vote * export depreciation	2.526**	1.176	1.309
	(0.969)	(0.918)	(0.951)
	6. Caring, Leisure and Other Service Occupations	8. Process, Plant and Machine Operatives	9. Elementary Occupations
post vote * FS exposure	-0.056	-0.612*	-0.474
	(0.277)	(0.327)	(0.318)
post vote * tariff exposure	0.035	-0.036	0.035
	(0.034)	(0.036)	(0.058)
post vote * EU national share	-68.27	51.62	23.61
	(51.68)	(61.31)	(59.99)
post vote * import appreciation	18.98***	4.639	5.929
	(4.274)	(6.313)	(5.315)
post vote * export depreciation	0.332	2.395**	1.051
	(0.840)	(0.987)	(0.945)
Observations	12,780	12,780	12,780
TTWA FE	YES	YES	YES
Month-Year FE	YES	YES	YES

Notes: This table displays the results from the regressions of the log of monthly job postings by occupation in each TTWA on the average trade barrier exposure measures at the TTWA level interacted with the post vote dummy variable. All specifications include TTWA and month-year fixed effects, and standard errors (in parentheses) are two-way clustered at the TTWA and month-year level. *** p<0.01, ** p<0.05, * p<0.1.

increasing their job postings, those which were more exposed to higher potential trade barriers experienced a relative decline in postings. To interpret the magnitude of the professional services coefficient in this specification, we fix the professional services share at its mean (0.82) and consider a one standard deviation increase in the sectoral STRI exposure (0.058) which leads to a 16% relative decline in monthly postings. Both the tariff exposure, and the related share, remain insignificant across specifications, although the exposure is now consistently negative across specifications.

6.3 Alternative tariff exposure measures

There are a range of ways in which tariff exposure has been measured in the literature. We additionally consider a number of other formulations of the exposure measure to check robustness. Table 19 in Appendix B presents the results for four different exposure measures. Columns (1) and (2) use the 'output weighted' exposure. Instead of weighting by sectoral exports per worker, this measure weights by the fraction of EU exports in total sectoral output.[31] The exposure used in Columns (3) and (4) removes this weighting altogether, leaving a simple export weighted average tariff normalised by neither total employment nor total output. Columns (5) and (6) first take $ln(1+\tau)$ before applying weightings but otherwise use the same construction as the baseline measure. Finally columns (7) and (8) adapt the baseline by replacing 4-digit national exports by 2-digit regional exports in the weighting.

The results suggest that these different formulations of the exposure measure do not significantly change the conclusions from the baseline and provide confidence in our result that firms did not appear to be adjusting hiring significantly in response to the threat of potential future MFN tariffs.

6.4 Pre-vote placebo

In order to further address the concern that our baseline pre-post results are driven by time varying unobservables that are not absorbed by month-year fixed effects, we conduct

[31] Due to data limitations, this weighting is at the 2-digit ISIC level and is sourced from the UK's Office of National Statistics input-ouput tables for 2014

a further placebo test. Here we limit the data to only 2015 and split the sample into a pre- and post-period with six months in each. We then interact a post-June 2015 dummy with the professional services exposure. Table 22 in Appendix B presents the results to this alternative placebo test using pre-referendum postings. The resulting coefficients are not significant across all specifications, suggesting that this impact was not observed prior to the referendum, but driven primarily by the result of the vote.

6.5 Goods non-tariff barriers

Although tariffs are the most conspicuous trade barrier for goods, it could be argued that after decades of global negotiations they are reduced to a level which is no longer material for firms in most countries. Perhaps more concerning are the non-tariff barriers (NTBs) to trade in goods, which may remain even if the UK were to sign a free trade agreement with the EU. In order to investigate this possibility we create a new measure of regional exposure to NTBs on exports of goods to the EU.

The measure is constructed is an identical way to the baseline tariff exposure measure but with tariffs replaced by a product-level NTB exposure. We use data from the World Integrated Trade Solution which provides a list of MFN non-tariff barriers at the 8-digit HS level. We first count how many barriers each HS8 product would be exposed to under MFN terms and then take a simple average at the HS6 level to match with our Comtrade export data. This measure is then weighted by each product's share of exports to the EU before replacing the avg MFN tariff$_{j,2014}$ in equation 5.

Table 20 presents the results, NTB exposure is not statistically significant in any specification, generally mirroring the results found for the tariff exposure that the threat of barriers on exports of goods does not seem to have had an impact on the posting of job adverts at the local labour market level.

6.6 UK Import Tariffs

Although most of the discussion around tariffs centered around the potential impact of EU tariffs on UK exports, there was also some uncertainty concerning possible UK tariffs on imports from the EU under a no deal scenario. We therefore further evaluate whether

the threat of these tariffs had any impact on the posting of job adverts. We consider two potential channels.

6.6.1 Exposure to reduced competition through import protecting tariffs

One channel through which import tariffs could affect UK businesses is by increasing the price of imports that compete with UK products, hence rendering UK firms more competitive in the domestic market. We can create a similar exposure measure as for exports but with weightings based on UK imports rather than exports. Although it was unclear during the negotiation period what the UK tariff schedule would look like under a no deal scenario, we use the EU MFN tariffs as a plausible default option for the analysis. This is reinforced by the fact that the MFN principal ensures that the UK could not unilaterally lower its tariffs with respect to the EU without doing the same thing for imports from third countries, unless part of a comprehensive free trade agreement (not present under 'no deal' by definition). The potential sectoral future tariff protection exposure is:

$$\text{imp protection}_{j,2014} = \frac{\text{Imports}_{j,2014}}{L_{j,2014}} \times \text{avg MFN tariff}_{j,2014} \tag{13}$$

where avg MFN tariff$_{j,2014}$ is the import-weighted average EU MFN ad valorem tariff across all products mapped to sector j, $L_j, 2014$ is the national employment (4-digit ISIC), and Imports$_{j,2014}$ is UK imports from the EU in 2014. The TTWA level exposure is then:

$$\text{imp protection}_r = \sum_{j \in r} \text{empl share}_{rj,2015} \times \text{imp protection}_{j,2014} \tag{14}$$

where empl share$_{rj,2015}$ is industry j's share of TTWA r employment.

6.6.2 Exposure to increased cost of imported inputs

Alongside potential protection of UK industries, tariffs may have the additional negative impact of increasing the cost of inputs. If industries typically import inputs which are either not produced by UK firms, or are produced at a higher price, then the imposition of tariffs on these products would increase costs and potentially reduce production. We

calculate this exposure by taking the import protection measure from above and, using UK input-output tables, weighting it by the share this 'input' industry makes up in all of the 'output' industry's imported inputs.[32] Specifically, the measure is calculated as follows:

$$\text{intinputs threat}_{k,2014} = \frac{1}{L_k} \sum_j S_{j,k} \sum_{p \in j} \text{Imports}_p \times \text{MFN tariff}_{p,2014} \tag{15}$$

$$\text{intinputs threat}_r = \sum_{k \in r} \text{empl share}_{rk,2015} \times \text{intinputs threat}_{k,2014} \tag{16}$$

where k is the output sector, l is the input sector (both at the 2-digit SIC level), and $S_{l,k}$ is the imported inputs from l as a share of total imported inputs by k. The results for both import tariff measures are presented in Table 21. As was the case for the export exposure measure, we find no effect of potential import tariffs on job adverts throughout the negotiation period. Given that we would expect stronger effects for the export exposure measure, as the default no deal tariff schedule was more clearly defined, it is perhaps not all that surprising that we find no effect for these other measures.

7. Conclusion

This paper uses data on the near universe of UK online job postings from January 2015 to December 2019 to analyse how the threat of future trade barriers on UK exports of both services and goods to the EU affected labour demand throughout the Brexit negotiation period. We exploit *ex ante* variation in EEA country-sector MFN service trade restrictions vis-a-vis services restrictions on other EEA countries and EU MFN tariffs to develop measures of local labour market exposure to the threat of no-deal scenario export barriers for professional services and goods exports.

We find that the threat of trade barriers on professional services exports to the EU had a strong, negative effect on the posting of online job adverts after the vote. A one standard deviation increase in local labour market exposure to future professional service export barriers decreased monthly postings by 3.1% on average in the post-referendum period.

[32] UKinput-outputtables:www.ons.gov.uk/economy/nationalaccounts/supplyandusetables/datasets/ukinputoutputanalyticaltablesdetailed

The equates to an average decline of 74 posting per month per TTWA, relative to the mean of 2,409 postings and a counterfactual calculation suggests that the aggregate impact of this exposure across all TTWAs implies a cumulative 1.5 million postings lost between July 2016 and December 2019. We provide evidence that this negative impact kicked in around Q2 2018 and remained negative for the rest of 2018 and 2019. It is possible that this delayed effect is due to firms taking time to reassess and understand the implications of trade barriers for their operations, or that the likelihood of the UK leaving the Single Market and facing stringent restrictions on service exports looked low straight after the vote but sebsequently increased substantially after the first year of negotiations.

The threat of future MFN tariffs on goods exports to the EU, on the other hand, does not seem to have affected online job adverts during the negotiation period. We find the same also holds for import tariffs and goods NTBs. We provide a few ideas as to why this may have been the case. While MFN tariffs in some cases can be large, at the HS6 level 63% of product lines would have tariffs below 5%. These tariffs would cut away at profitability, but may not be game-changing in a way that some restrictions on services exports, such as revoking passporting rights, or requiring commercial presence to export engineering or legal services to certain EU countries that were previously major trade partners, could be. One possibility is that these tariffs were simply not a large enough threat to have caused firms to stop hiring prior to being levied. Another explanation could be that there was substantial heterogeneity in how different manufacturing industries were affected. When broken down by subsectors, we discovered that some sectors, such as auto manufacturing, did decrease hiring, but others, such as chemicals, increased hiring. Perhaps only industries hit by tariffs multiple times through global value chains faced substantial enough repercussions to pause hiring. Finally, it could just be that manufacturing represents a relatively small share of UK employments and so impacts on the manufacturing sector may not be large enough to show up when studying local labour market outcomes.

Given the Brexit negotiation period lasted 3.5 years, we also explore the role of trade policy uncertainty in affecting job postings during this period. We develop two time-varying measures of Brexit-related trade policy uncertainty during this period based on newspaper coverage and Google searches. Additionally, we make use of the Brexit Uncertainty Index from Bloom et al. (2019). Using these indices we show that uncertainty was

a key driver of the reduction in postings. We interact our trade barrier exposure measures with these uncertainty measures during the negotiation period and find that the impact of the threat of barriers on exports of professional services was greater in months with heightened uncertainty. Taking the Google index, for the mean exposure measure, an increase in uncertainty during the negotiation period from the 25th to the 75th percentile lead to a 2.8% decrease in postings. Using US job postings data to construct a counterfactual for each UK TTWA, we show that such a pattern was not experienced in the US and would not have occurred in the UK, had the UK followed US sectoral trends in online job adverts.

We find that the threat of professional services export barriers only affected the posting of higher-skilled job adverts. When broken down into sectoral components, sectoral components, it was the threat of barriers on financial services, engineering and information service exports that had the biggest impact. We zoom in specifically on financial services due to its particular importance for the UK economy, finding strong negative impacts of exposure to EU-export intensive financial service exports on the posting of job adverts, that affected not only higher-skilled but also lower-skilled job adverts.

We show that these results all hold when additionally controlling for other key channels through which the vote could have affected labour demand, including the sharp exchange rate depreciation in the 24 hours following the vote and immigration policy uncertainty. We find consistent evidence that regions that benefited more from the depreciation of the currency in terms of increasingly competitive exports, increased job postings. A one standard deviation increase in exchange rate export exposure is associated with an increase in hiring of 3.1%. The evidence is weaker for the effect of increased cost of imported inputs, however this seems to matter more for high skill workers than low skill workers. Although not significant in the baseline pre/post regressions, we also find strongly negative and significant effects of the share of EU or EU8 nationals in the labour force on job adverts in the post-period when interacting with our uncertainty measures. The results therefore provide some evidence that firms that have relatively high shares of EU workers held back on hiring due to the uncertainty surrounding future immigration arrangements.

We conclude that the threat of future trade barriers on the export of professional services caused by the Brexit referendum mattered far more for the hiring decisions of UK firms than the threat of tariffs on goods exports, despite the greater focus of the Brexit

discourse on manufacturing and tariffs. This impact on job adverts was substantial and indicates that a retreat from trade integration, and particularly deep integration, can have important negative consequences for labour markets.

References

Ahir, Hites, Nicholas Bloom, and Davide Furceri, "The World Uncertainty Index," *SSRN Electronic Journal*, 2018.

Amiti, M. and S.-J. Wei, "Fear of service outsourcing: is it justified?," *Economic Policy*, April 2005, *20* (42), 308–347.

Amiti, Mary, Stephen Redding, and David Weinstein, "The Impact of the 2018 Trade War on U.S. Prices and Welfare," *NBER WORKING PAPER SERIES*, March 2019, *Working Paper 25672*.

Arnold, Jens M., Beata S. Javorcik, and Aaditya Mattoo, "Does services liberalization benefit manufacturing firms?," *Journal of International Economics*, September 2011, *85* (1), 136–146.

Arnold, Jens Matthias, Beata Javorcik, Molly Lipscomb, and Aaditya Mattoo, "Services Reform and Manufacturing Performance: Evidence from India," *The Economic Journal*, February 2016, *126* (590), 1–39.

Autor, David H, David Dorn, and Gordon H Hanson, "The China Syndrome: Local Labor Market Effects of Import Competition in the United States," *American Economic Review*, October 2013, *103* (6), 2121–2168.

Autor, David H., David Dorn, Gordon H. Hanson, and Jae Song, "Trade Adjustment: Worker-Level Evidence," *Quarterly Journal of Economics*, November 2014, *129* (4), 1799–1860.

Baker, Scott R., Nicholas Bloom, and Steven J. Davis, "Measuring Economic Policy Uncertainty," *The Quarterly Journal of Economics*, November 2016, *131* (4), 1593–1636.

Barone, Guglielmo and Federico Cingano, "Service Regulation and Growth: Evidence from OECD Countries," *The Economic Journal*, September 2011, *121* (555), 931–957.

Bernanke, Ben S., "Irreversibility, Uncertainty, and Cyclical Investment," *The Quarterly Journal of Economics*, February 1983, *Volume 98* (Issue 1), 85–106.

Beverelli, Cosimo, Matteo Fiorini, and Bernard Hoekman, "Services trade policy and manufacturing productivity: The role of institutions," *Journal of International Economics*, January 2017, *104*, 166–182.

Blanchard, Emily J, Chad P Bown, and Davin Chor, "Did Trump's Trade War Impact the 2018 Election?," *NBER Working Paper*, November 2019, *26434*, 35.

Bloom, Nicholas, "The Impact of Uncertainty Shocks," *Econometrica*, 2009, *77* (3), 623–685.

_ , Philip Bunn, Scarlet Chen, Paul Mizen, Pawel Smietanka, Greg Thwaites, and Garry Young, "Brexit and uncertainty: insights from the Decision Maker Panel," *Bank of England, Staff Working Paper No. 780*, February 2019.

Breinlich, Holger, Anson Soderbery, and Greg C. Wright, "From Selling Goods to Selling Services: Firm Responses to Trade Liberalization," *American Economic Journal: Economic Policy*, November 2018, *10* (4), 79–108.

_ , Elsa Leromain, Dennis Novy, and Thomas Sampson, "Voting with Their Money: Brexit and Outward Investment by UK Firms," *CESifo Working Paper no. 7751*, July 2019, p. 30.

Carnevale, Anthony, Nicole Smith, and Jeff Strohl, "Recovery: Job Growth and Education Requirements Through 2020," *Georgetown Public Poliocy Institute, Center of Education and the Workforce*, June 2013.

Cavallo, Alberto, Gita Gopinath, Brent Neiman, and Jenny Tang, "Tariff Passthrough at the Border and at the Store: Evidence from US Trade Policy," *Working Paper*, May 2019, p. 16.

Costa, Rui, Swati Dhingra, and Stephen Machin, "Trade and Worker Deskilling," *CEP Discussion Paper Series*, 2019.

Crinò, Rosário, "Service Offshoring and White-Collar Employment," *The Review of Economic Studies*, 2010, p. 39.

Crowley, Meredith, Ning Meng, and Huasheng Song, "Tariff scares: Trade policy uncertainty and foreign market entry by Chinese firms," *Journal of International Economics*, September 2018, *114*, 96–115.

_ , Oliver Exton, and Lu Han, "Renegotiation of Trade Agreements and Firm Exporting Decisions: Evidence from the Impact of Brexit on UK Exports," 2018, p. 35.

Deming, David and Kadeem Noray, "STEM Careers and the Changing Skill Requirements of Work," *NBER Working Paper Series*, September 2018.

_ and Lisa B Kahn, "Skill Requirements across Firms and Labor Markets: Evidence from Job Postings for Professionals," *NBER Working Paper Series*, 2017, p. 33.

Dixit, Avinash K and Robert S Pindyck, *Investment under uncertainty*, Princeton, N.J.: Princeton University Press, 1994. OCLC: 777593629.

Ebell, Monique, "Assessing the Impact of Trade Agreements on Trade," *National Institute Economic Review*, November 2016, *238*, R31–R42.

Eppinger, Peter S., "Service offshoring and firm employment," *Journal of International Economics*, March 2019, *117*, 209–228.

Fajgelbaum, Pablo, Pinelopi Goldberg, Patrick Kennedy, and Amit Khandelwal, "The Return to Protectionism," *NBER WORKING PAPER SERIES*, October 2019, *Working Paper 25638*.

Fetzer, Thiemo, "Did Austerity Cause Brexit?," *American Economic Review*, November 2019, *109* (11), 3849–3886.

Gervais, Antoine and J. Bradford Jensen, "The tradability of services: Geographic concentration and trade costs," *Journal of International Economics*, May 2019, *118*, 331–350.

Graziano, Alejandro, Kyle Handley, and Nuno Limão, "Brexit Uncertainty and Trade Disintegration," December 2018.

Handley, Kyle and Nuno Limão, "Policy Uncertainty, Trade, and Welfare: Theory and Evidence for China and the United States," *American Economic Review*, September 2017, *107* (9), 2731–2783.

Hassler, John A.A., "Variations in risk and fluctuations in demand: A theoretical model," *Journal of Economic Dynamics and Control*, June 1996, *20* (6-7), 1115–1143.

Hershbein, Brad and Lisa B. Kahn, "Do Recessions Accelerate Routine-Biased Technological Change? Evidence from Vacancy Postings," *American Economic Review*, July 2018, *108* (7), 1737–1772.

Jensen, J Bradford and Lori Kletzer, "Tradable Services: Understanding the Scope and Impact of Services Outsourcing," *Peterson Institute for International Economics*, September 2005, *Working Paper* (05-9).

Liu, Runjuan and Daniel Trefler, "A sorted tale of globalization: White collar jobs and the rise of service offshoring," *Journal of International Economics*, May 2019, *118*, 105–122.

Mayer, Thierry, Vincent Vicard, and Soledad Zignago, "The Cost of Non-Europe, Revisited," *CEPII Working Paper*, 2018, p. 50.

Mulabdic, Alen, Alberto Osnago, and Michele Ruta, "Deep Integration and UK-EU Trade Relations," *World Bank Working Paper*, 2017, p. 24.

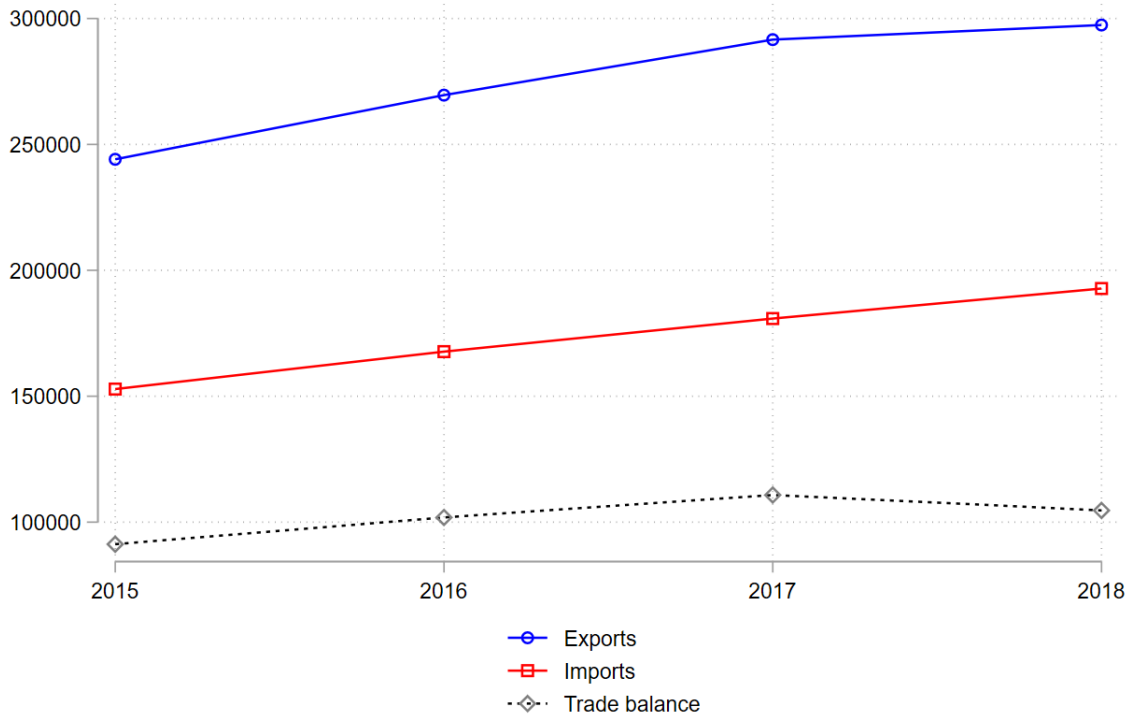
ONS, "International trade in services, UK - Office for National Statistics," 2018.

Pierce, Justin R. and Peter K. Schott, "The Surprisingly Swift Decline of US Manufacturing Employment," *American Economic Review*, July 2016, *106* (7), 1632–1662.

Appendices

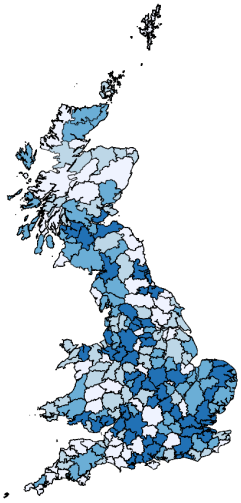
A. Additional Maps and Figures

Figure 12: UK total trade in services in £millions



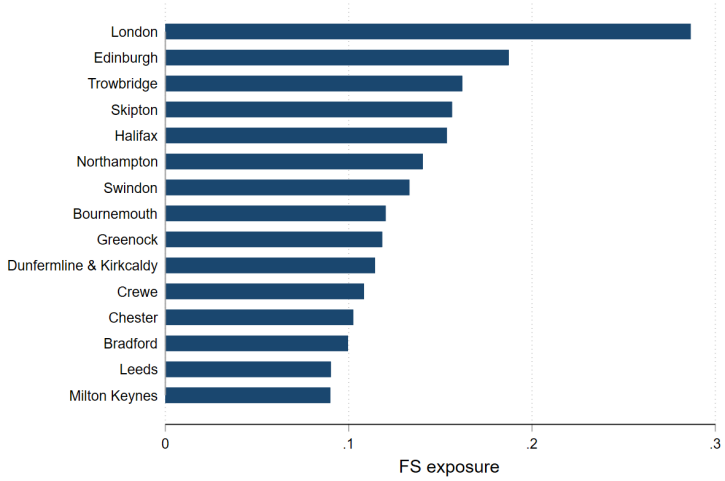
Notes: This figure shows the UK's total exports and imports of services, by year, in millions of pound sterling, taken from the UK's Pink Book 2019.

Figure 13: Financial service exposure map



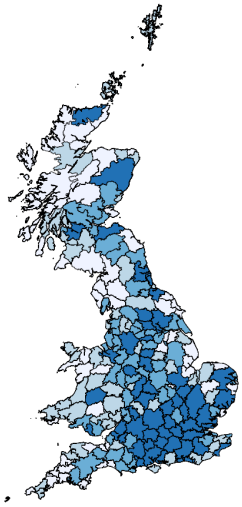
Notes: This map displays the measure of exposure to financial services trade barriers by TTWA. Areas with darker blue had a higher employment share in 2015 in sectors more exposure to potential future trade barriers on financial services exports to the EU.

Figure 14: Most exposed TTWAs: Financial Services

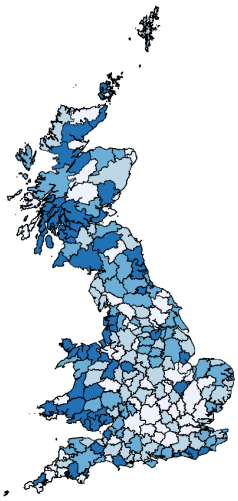


Notes: This chart presents the employment-weighted financial services exposure measures for the top 15 most exposed TTWAs.

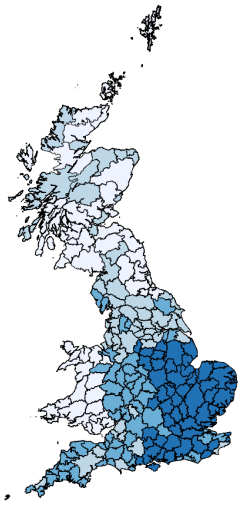
Figure 15: Exposure to the exchange rate depreciation and immigration



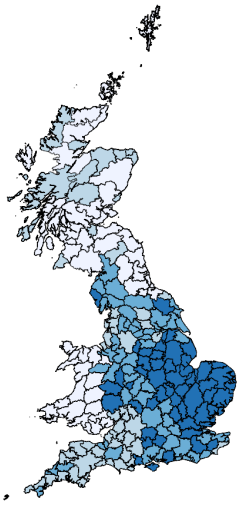
(a) Exposure to more expensive imports



(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, areas with darker blue had a higher share. Panel (d) displays the share of Eastern EU nationals, areas with darker blue had a higher share.

B. Additional tables

Table 13: Mapping between UK SIC, OECD STRI & ONS Service export product types

UK SIC 2007 code	STRI sector	ONS service product type
692	Accounting	Accountancy, auditing, bookkeeping and tax consulting services
691	Legal	Legal services
61	Telecom	Telecommunication services
62	Computer	Computer services
63	Computer	Information services
7111	Architecture	Architectural services
7112	Engineering	Engineering services
65	Commercial banking	Financial services
64	Insurance	Insurance services

Notes: This table displays the UK SIC codes with their mapped OECD STRI sectors and ONS product categories used to construct the professional service barrier threat measures. *** p<0.01, ** p<0.05, * p<0.1.

Table 14: US placebo for Financial Services

Dep variable: log US postings	(1)	(2)	(3)	(4)	(5)	(6)
	Google		Newspaper		BUI	
measure* FS exposure	-0.010	-0.012	-0.011	-0.010	-0.003	-0.004
	(0.036)	(0.034)	(0.016)	(0.015)	(0.004)	(0.004)
measure *tariff exposure	-0.001	-0.001	-0.000*	-0.000**	-0.000	-0.000
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
measure*EU national share	-0.032		0.005		-0.010	
	(0.055)		(0.034)		(0.007)	
measure*EU8 national share		-0.054		-0.003		-0.018
		(0.083)		(0.050)		(0.011)
Observations	8,520	8,520	8,520	8,520	8,520	8,520
Adjusted R-squared	0.994	0.994	0.994	0.994	0.994	0.994
TTWA FE	YES	YES	YES	YES	YES	YES
Month-Year FE	YES	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 average trade barrier exposure measures at the TTWA level interacted with various uncertainty measures. The period September 2016 to December 2019 is covered. all specifications include TTWA and month-year fixed effects, and standard errors (in parentheses) are two-way clustered at the TTWA and month-year level. *** p<0.01, ** p<0.05, * p<0.1.

Table 15: Uncertainty measures with quarterly trend controls

Dep varable: log postings	Google			Newspaper			BUI		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
post vote*measure*	-0.172***	-0.184**	-0.044***	-0.060***	-0.038	-0.026***	-0.013***	-0.041***	-0.007**
prof service exposure	(0.047)	(0.079)	(0.016)	(0.022)	(0.033)	(0.009)	(0.003)	(0.008)	(0.008)
post vote*		0.049			-0.174			1.448***	
prof service exposure		(0.218)			(0.206)			(0.362)	
post vote*measure*	0.009	0.009	0.009	0.006	0.006	0.006	0.001	0.001	0.001
tariff exposure	(0.009)	(0.009)	(0.009)	(0.005)	(0.004)	(0.004)	(0.001)	(0.001)	(0.001)
post vote*	-57.46	-61.02	-61.05	-76.47	-64.74	-64.16	-34.05	-64.42	-64.85
xrate impact via imports	(50.61)	(51.41)	(51.21)	(50.17)	(51.05)	(50.92)	(51.32)	(50.50)	(50.46)
post vote*	6.335	6.409	6.409	7.590*	7.345*	7.333*	6.464	7.162*	7.172*
xrate impact via exports	(4.039)	(4.033)	(4.034)	(3.997)	(3.999)	(3.999)	(4.159)	(4.102)	(4.106)
post vote*measure*	-0.469*	-0.465*	-0.465*	-0.124	-0.131	-0.131	-0.0178	-0.0150	-0.0150
EU national share	(0.253)	(0.252)	(0.253)	(0.124)	(0.124)	(0.124)	(0.019)	(0.019)	(0.019)
Post vote quarters *	No	No	Yes	No	No	Yes	No	No	Yes
prof serv exposure									
Observations	12,780	12,780	12,780	12,780	12,780	12,780	12,780	12,780	12,780
Adjusted R-squared	0.984	0.984	0.985	0.984	0.984	0.985	0.984	0.985	0.985
TTWA FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year-month FE	YES	YES	YES	YES	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 average trade barrier exposure measures at the TTWA level interacted with various uncertainty measures. The quarterly interactions represent the dummies for each specific post-referendum quarter, where Q1 is the third quarter of 2016, interacted with the professional service exposure measure. all specifications include TTWA and month-year fixed effects, and standard errors (in parentheses) are two-way clustered at the TTWA and month-year level. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 16: Professional service exposure impact by occupation

Dep var: log SOC postings	1. Managers, Directors and Senior Officials	2. Professional Occupations	3. Associate Professional and Technical Occupations
post vote * prof services exposure	-0.398***	-0.502***	-0.309*
	(0.148)	(0.140)	(0.162)
post vote * tariff exposure	-0.022	0.054	0.003
	(0.031)	(0.046)	(0.038)
post vote * EU national share	-66.52	-137.8***	-87.23
	(54.16)	(46.64)	(56.03)
post vote * import appreciation	0.883	12.45***	10.56*
	(4.343)	(4.105)	(5.603)
post vote * export depreciation	0.792	0.217	1.039
	(0.863)	(0.805)	(0.963)
	4. Administrative and Secretarial Occupations	5. Skilled Trades Occupations	6. Caring, Leisure and Other Service Occupations
post vote * prof services exposure	-0.042	-0.286*	0.026
	(0.152)	(0.165)	(0.128)
post vote * tariff exposure	0.008	0.005	0.035
	(0.034)	(0.024)	(0.034)
post vote * EU national share	51.05	58.14	-73.94
	(61.15)	(67.99)	(54.85)
post vote * import appreciation	9.613*	1.782	19.07***
	(4.915)	(4.736)	(4.291)
post vote * export depreciation	1.213	2.229**	0.323
	(0.962)	(0.989)	(0.818)
	7. Sales and Customer Service Occupations	8. Process, Plant and Machine Operatives	9. Elementary Occupations
post vote * prof services exposure	-0.144	-0.266	-0.254
	(0.145)	(0.160)	(0.159)
post vote * tariff exposure	-0.036	-0.039	0.033
	(0.024)	(0.037)	(0.058)
post vote * EU national share	-42.19	71.86	46.57
	(54.39)	(65.94)	(62.75)
post vote * import appreciation	2.035	4.032	5.316
	(4.440)	(6.359)	(5.353)
post vote * export depreciation	0.996	2.197**	0.889
	(0.921)	(1.025)	(0.926)
Observations	12,780	12,780	12,780
TTWA FE	YES	YES	YES
Month-Year FE	YES	YES	YES

Notes: This table displays the results from the regressions of the log of monthly job postings by occupation in each TTWA on the average trade barrier exposure measures at the TTWA level interacted with the post vote dummy variable. All specifications include TTWA and month-year fixed effects, and standard errors (in parentheses) are two-way clustered at the TTWA and month-year level. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 17: Baseline Excluding London

Dep variable: log postings	(1)	(2)	(3)	(4)	(5)
post vote * prof service exposure	-0.539***	-0.541***	-0.355***	-0.340**	-0.346**
	(0.135)	(0.135)	(0.125)	(0.130)	(0.132)
post vote * tariff exposure		-0.008	0.001	0.003	0.001
		(0.033)	(0.035)	(0.035)	(0.035)
post vote * xrate impact via imports			-74.38	-81.50	-76.98
			(52.61)	(49.95)	(50.52)
post vote * xrate impact via exports			7.904*	9.181**	8.574*
			(4.191)	(4.114)	(4.296)
post vote * EU national share				0.703	
				(0.953)	
post vote * EU8 national share					0.540
					(1.399)
Observations	12,780	12,780	12,780	12,780	12,780
Adjusted R-squared	0.984	0.984	0.984	0.984	0.984
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 average trade barrier exposure measures at the TTWA level interacted with the post vote dummy variable, with and without controls. all specifications include TTWA and month-year fixed effects, and standard errors (in parentheses) are two-way clustered at the TTWA and month-year level. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 18: Including shares

Dep variable: log postings	(1)	(2)	(3)	(4)	(5)
post vote * prof service exposure	-4.287**	-4.216**	-3.285*	-3.432*	-3.299*
	(1.972)	(1.974)	(1.764)	(1.755)	(1.750)
post vote * prof services emp & export share	0.544*	0.534*	0.419	0.441*	0.422*
	(0.284)	(0.285)	(0.251)	(0.250)	(0.249)
post vote * tariff exposure		-0.032	-0.021	-0.020	-0.021
		(0.060)	(0.060)	(0.060)	(0.061)
post vote * manu emp & exp sh		0.001	0.001	0.001	0.001
		(0.002)	(0.002)	(0.002)	(0.002)
post vote * xrate impact via imports			-50.49	-57.74	-53.42
			(54.59)	(52.82)	(52.97)
post vote * xrate impact via exports			7.284*	8.727**	8.051*
			(4.193)	(4.081)	(4.300)
post vote * EU national share				0.788	
				(0.788)	
post vote * EU8 national share					0.614
					(1.331)
Observations	12,780	12,780	12,780	12,780	12,780
Adjusted R-squared	0.984	0.984	0.984	0.984	0.984
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 average trade barrier exposure measures at the TTWA level interacted with the post vote dummy variable, with and without controls. all specifications include TTWA and month-year fixed effects, and standard errors (in parentheses) are two-way clustered at the TTWA and month-year level. *** p<0.01, ** p<0.05, * p<0.1.

Table 19: Alternative tariff measures

	Output weighted		Export weighted		Logged tariffs		Regional export weighted	
Dep variable: log postings	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
post vote * prof service exposure		-0.338***		-0.345***		-0.337***		-0.325**
		(0.124)		(0.128)		(0.124)		(0.124)
post vote * tariff exposure	9.830	12.66	4.416	0.498	10.34	13.47	0.000	0.000*
	(18.09)	(19.21)	(7.898)	(9.710)	(19.11)	(20.18)	(0.000)	(0.000)
post vote * xrate impact via imports		-81.68		-80.78		-81.75		-82.25
		(49.71)		(53.22)		(49.68)		(49.56)
post vote * xrate impact via exports		9.458**		9.067**		9.462**		10.04**
		(4.024)		(4.232)		(4.024)		(3.893)
post vote * EU national share		0.655		0.630		0.655		0.667
		(0.797)		(0.802)		(0.797)		(0.791)
Observations	12,780	12,780	12,780	12,780	12,780	12,780	12,780	12,780
Adjusted R-squared	0.984	0.984	0.984	0.984	0.984	0.984	0.984	0.984
TTWA FE	YES	YES	YES	YES	YES	YES	YES	YES
Month-Year FE	YES	YES	YES	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 various average trade barrier exposure measures at the TTWA level interacted with the post vote dummy variable, with and without controls. all specifications include TTWA and month-year fixed effects, and standard errors (in parentheses) are two-way clustered at the TTWA and month-year level. *** p<0.01, ** p<0.05, * p<0.1.

Table 20: Goods non-tariff barriers

Dep variable: log postings	(1)	(2)	(3)	(4)	(5)
post vote * prof service exposure	-0.538***	-0.531***	-0.339***	-0.336**	-0.335**
	(0.132)	(0.139)	(0.126)	(0.126)	(0.129)
post vote * tariff exposure		-0.017	-0.013	-0.010	-0.012
		(0.036)	(0.036)	(0.035)	(0.036)
post vote * goods NTBs		0.069	0.117	0.104	0.108
		(0.166)	(0.175)	(0.172)	(0.173)
post vote * xrate impact via imports			-71.45	-77.93	-73.39
			(53.59)	(51.49)	(51.71)
post vote * xrate impact via exports			8.467*	9.477**	8.862**
			(4.269)	(4.178)	(4.324)
post vote * EU national share				0.573	
				(0.770)	
post vote * EU8 national share					0.348
					(1.303)
Observations	12,780	12,780	12,780	12,780	12,780
Adjusted R-squared	0.984	0.984	0.984	0.984	0.984
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 average trade barrier exposure measures at the TTWA level, including non-tariff barriers, interacted with the post vote dummy variable, with and without controls. all specifications include TTWA and month-year fixed effects, and standard errors (in parentheses) are two-way clustered at the TTWA and month-year level. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 21: Import protection and imported inputs

Dep variable: log postings	(1)	(2)	(3)	(4)	(5)
post vote * prof service exposure				-0.337***	-0.333**
				(0.125)	(0.129)
post vote * intermediate import tariff exposure	-0.024		0.082	0.105	0.093
	(0.124)		(0.216)	(0.206)	(0.201)
post vote * import protection tariff exposure		-0.008	-0.054	-0.047	-0.045
		(0.017)	(0.035)	(0.034)	(0.034)
post vote * export tariff exposure			0.072	0.063	0.059
			(0.062)	(0.062)	(0.062)
post vote * xrate impact via imports				-82.73	-78.34
				(49.81)	(50.21)
post vote * xrate impact via exports				9.183**	8.693**
				(4.112)	(4.300)
post vote * EU national share				0.726	
				(0.790)	
post vote * EU8 national share					0.701
					(1.285)
Observations	12,780	12,780	12,780	12,780	12,780
Adjusted R-squared	0.984	0.984	0.984	0.984	0.984
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 various average trade barrier exposure measures at the TTWA level interacted with the post vote dummy variable, with and without controls. all specifications include TTWA and month-year fixed effects, and standard errors (in parentheses) are two-way clustered at the TTWA and month-year level. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 22: Pre-vote placebo for 2015

Dep variable: log postings	(1)	(2)	(3)	(4)	(5)
post June '15 * prof service exposure	-0.037	-0.027	-0.068	-0.081	-0.082
	(0.176)	(0.172)	(0.150)	(0.151)	(0.156)
post June '15 * tariff exposure		0.044	0.065	0.058	0.064
		(0.040)	(0.038)	(0.035)	(0.038)
post June '15 * import appreciation			58.58	76.93	63.54
			(63.95)	(60.74)	(59.90)
post June '15 * export depreciation			14.03**	10.86*	12.79**
			(5.734)	(5.033)	(5.264)
post June '15 * EU national share				-1.696	
				(1.152)	
post June '15 * EU8 national share					-0.988
					(1.999)
Observations	2,556	2,556	2,556	2,556	2,556
Adjusted R-squared	0.985	0.985	0.986	0.986	0.986
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 average trade barrier exposure measures at the TTWA level interacted with the post dummy variable, with and without controls. The period considered is 2015 and the post dummy takes value one for months July-December. all specifications include TTWA and month-year fixed effects, and standard errors (in parentheses) are two-way clustered at the TTWA and month-year level. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

C. Comparison of BGT data with other sources

Online job adverts are one indicator of labour demand. The number of job adverts posted online encompasses only a subset of labour demand because a) not all vacancies will be advertised publicly and b) not all publicly advertised vacancies will be advertised online. We would hence expect the BGT job advert data to vary from the total number of actual vacancies in sectors, regions and job types where employers are less likely to publicly advertise vacancies or to advertise them online. In the UK, it is not a legal requirement to publicly advertise a job vacancy. However, there is an obligation for employers not to discriminate against employees or potential employees and an employer could face legal action if it is believed that a job has not been fairly advertised. Consequently, it is very common for firms to have company policies that require all open positions to be publicly advertised.

We would therefore generally expect that BGT would cover a high proportion of all vacancies, particularly for large firms. However, if one job advert is posted online for a number of openings at once, for example in the case of graduate schemes, then we would expect that BGT would underestimate the true number of vacancies.

In this section, we first evaluate the relationship between BGT online job adverts and another comprehensive measure of labour demand: the estimated number of vacancies from the UK Vacancy Survey.

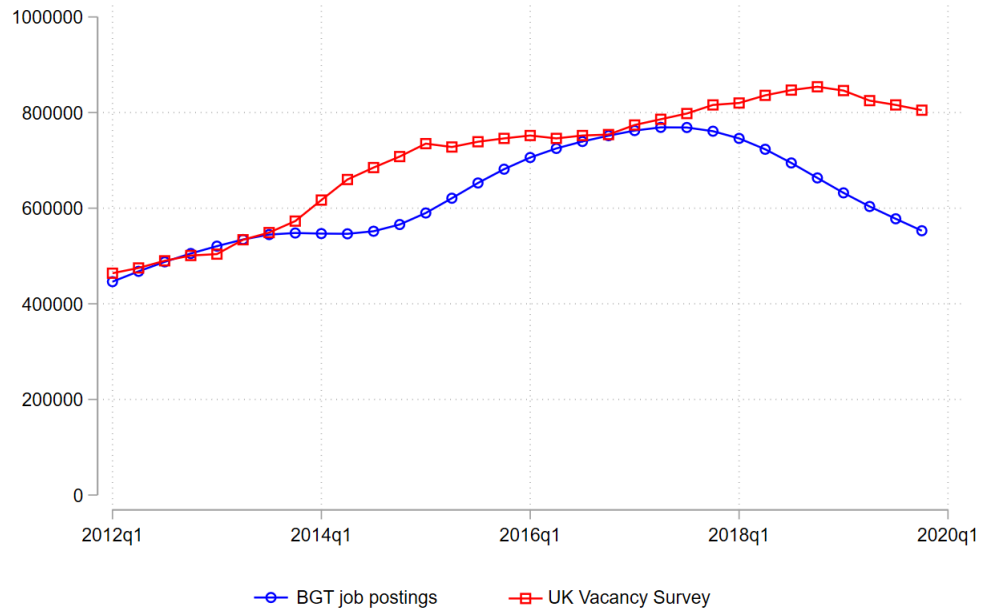
1. UK Vacancy Survey

The UKVS is a statutory, monthly survey of businesses conducted by the ONS.[33] The survey asks a single question: how many job vacancies did a business have in total (on a specified date) for which they were actively seeking recruits from outside their organisation? Results from the survey cover all sectors of the UK economy and all industries, with the exception of employment agencies and agriculture, forestry and fishing.

The total sample is approximately 6,000 businesses per month, with approximately 1,300 large businesses included every month and the remaining 4,700 consisting of smaller enterprises randomly sampled on a quarterly basis. The ONS then constructs total esti-

[33] A summary can be found here: https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/methodologies/vacancysurveyqmi

Figure 16: Average monthly vacancies: BGT and UK Vacancy Survey



Notes: This figure compares the seasonally adjusted average monthly number of job postings from BGT with the UK Vacancy Survey. We deseasonalise the BGT data using the Hodrick–Prescott high-pass filter.

mates for the UK by weighting the data using employment estimates. For non-responding firms a link factor is calculated and applied to previous returns. The original construction for a never-responding business is calculated from a ratio (calculated from other respondent values in the same sampling strata) being applied to the register employment. For subsequent periods, imputed values are then based on movements in similar-sized businesses. They then provide quarterly seasonally adjusted estimates of the monthly average number of vacancies for the UK economy.[34]

To compare figures from the two sources, we deseasonalise the BGT data and take quarterly averages of the total sum of all postings. Figure 16 compares the time series of BGT with the VS over the period of 2012-2019. Over this period, BGT covers on average 86% of the total reported in the VS. The monthly average number of postings in the BGT data is very similar to the monthly average number of vacancies reported in the VS during two period: 2012 & 2013 and 2016, but the two series diverge during 2014, 2015 and after 2016. This divergence could reflect the fact that the VS relies on imputed values, or that firms

[34] Results are seasonally adjusted in X-12 ARIMA using a multiplicative model.

inaccurately report their number of openings in specific time periods, for example due to uncertainty, or that there has been a structural change in the average number of jobs advertised in one online posting during these time periods. Methods of imputation may not be responsive to labour market trends in the way that directly observed, scraped data would be. We hence might expect the VS to over-estimate vacancies in periods of uncertainty on in downturns: this may explain the divergence after the Brexit referendum.

These findings generally reiterate what has been documented for job postings data for the US. Carnevale et al. (2013) have shown that online job vacancy data is strongly correlated with data on total vacancies in the US. Hershbein and Kahn (2018) estimate, for the United States, that approx. 85% of all jobs are posted online - remarkably close to our figure of 86%.

2. ONS Workforce Jobs (WFJ)

We also consider the relationship between labour demand as captured by job adverts and the total number of jobs in the UK economy as measured by the ONS WFJ, which is also affected by labour supply conditions. Vacancies are converted to hires provided the vacancies can be filled. Hires in turn contribute to aggregate job statistics, which additionally depend on the existing number of jobs and firing. The ONS provides a a quarterly measure of the estimated total number of jobs in the UK, measured as the sum of employee jobs measured primarily by employer surveys, self-employment jobs from the Labour Force Survey (LFS) and government-supported trainees and Her Majesty's Forces (HMF) from administrative sources.[35] The definition of an employee is anyone working on a specific date who is aged 16 years and over, that is paid in return for carrying out a full-time or part-time job or being on a training scheme. Private sector employee jobs are obtained from Short-Term Employer Surveys (STES), which are conducted with approximately 32,800 businesses per quarter. The Quarterly Public Sector Employment Survey (QPSES) measures public sector employment and is conducted with 1500 contributors per quarter. The LFS surveys 50,000 households per quarter.

Over the period of 2012-2019 the median number of workforce jobs was 34 million.

[35] https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/methodologies/workforcejobsqmi

Figure 17: BGT average monthly vacancies and ONS average monthly jobs

Notes: This figure compares the seasonally adjusted average monthly number of workforce jobs from the ONS workforce jobs survey. We deseasonalise the BGT data using the Hodrick–Prescott high-pass filter.

The average ratio of monthly vacancies from the VS to the total number of workforce jobs was 2%, while the ratio of job postings from BGT to the total number of workforce jobs was 1.8%. Figure 17 displays the total number of jobs over time, compared to the monthly average number of BGT postings over time for each quarter. The number of workforce jobs has steadily increased from 2012 to 2019 and experienced no dip after the referendum.

There are a number of reasons why the WFJ estimates might not have demonstrated a decline after the referendum. If firms do not hire, but also do not fire, then we would not expect the total number of jobs to decrease. This could have been the case after the referendum: due to the uncertainty about future policy, firms and workers may have been unwilling to hire and fire, or leave and search for new jobs. Another possibility is that these statistics also rely on imputation for non-responsive and non-sampled firms and workers and so could be less responsive in times of downturn or uncertainty.