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Mind the break-up: when policy disrupts firms' supply chains

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Abstract

This paper examines how supply-chain disruptions triggered by the UK-EU Trade and Cooperation Agreement (TCA) in 2021 affected UK firms and workers. Using matched UK microdata linking firm-level goods and services trade to firm's outcomes and employer-linked worker records, we document a sharp decline in firms' imports of intermediate goods from the EU after 2021. This contraction is moderated for firms that also trade services, suggesting that joint sourcing of goods and services shapes resilience to trade frictions. In contrast, we find no statistically meaningful response of intermediate services imports to either the Brexit referendum or the TCA. We then show that firms more exposed to EU input sourcing experience declines in employment, sales, and the wage bill, with corresponding effects on workers' hours and pay. These impacts are heterogeneous across occupations, with larger losses concentrated among lower-skilled roles.

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Non-Technical Summary

Over recent decades, global value chains have transformed production by linking firms across borders and improving access to specialised inputs and know-how. These global value chains can improve efficiency and productivity, but they can also leave firms exposed and vulnerable when trade conditions change including trade-policy shocks.

This paper examines the effects on UK firms and workers when Brexit altered trading arrangements between the United Kingdom and the European Union, through the introduction of the Trade and Cooperation Agreement (TCA) in January 2021.

The TCA maintained tariff- and quota-free trade between the UK and the EU, but also introduced a range of new non-tariff barriers in goods and services, including customs procedures, documentation requirements, and regulatory checks. Since many UK firms rely on EU suppliers for important inputs, the TCA provides a useful case study of how policy-driven disruptions to supply chains affect businesses and workers.

We combine several unique UK datasets linking firms' international trade activities to information on business performance and employee outcomes. This allows us to track how firms' imports, sales, employment, wages, and worker earnings evolved before and after Brexit. We find that the TCA lead to a substantial decrease in imports of intermediate goods inputs from the EU by UK firms, but the negative effects were mitigated if a firm was also importing services from the EU at the same time.

Our findings highlight an important difference between goods and services, with services intermediate imports not affected by the TCA. We then examine the consequences for firm performance and find that the Brexit referendum led to a decrease in firm-level employment consistent with the presence of uncertainty, anticipation, and exchange rate effects. This effect first appeared after the Brexit referendum in 2016 and intensified with the TCA.

The negative effects were more pronounced for firms that import both goods and services from the EU. Although these firms reduced their imports less than other firms, they suffered larger declines in employment and sales. This suggests that they faced greater difficulties adjusting their supply chains and were therefore forced to absorb higher costs.

We also investigate how workers were affected. Employees working for firms with greater exposure to EU supply-chain disruptions experienced reductions in working hours and earnings. The effects were again stronger for workers employed at firms exposed to both goods and services disruptions.

The effects were not evenly distributed across the workforce. Younger workers, women, and workers in lower-skilled occupations experienced larger negative impacts than other groups. Regions were also exposed differently. Overall, the most exposed were the South East, and the Midlands (East and West). Average wage declines were concentrated in the North East and the West. However, in both regions, these reductions are largely offset for firms that also trade services.

Overall, our study provides evidence that policy-induced trade barriers can have substantial consequences beyond trade flows themselves. The findings also demonstrate the importance of considering goods and services together when assessing the resilience of modern supply chains. These results suggest that current initiatives such as the planned reset in the EU-UK trade relationship could yield significant benefits, if they manage to offset the negative effects of the TCA.

Mind the Break-Up:

When Policy Disrupts Firms' Supply Chains*

Please do not circulate

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Abstract

This paper examines how supply-chain disruptions triggered by the UK-EU Trade and Cooperation Agreement (TCA) in 2021 affected UK firms and workers. Using matched UK microdata linking firm-level goods and services trade to firm's outcomes and employer-linked worker records, we document a sharp decline in firms' imports of intermediate goods from the EU after 2021. This contraction is moderated for firms that also trade services, suggesting that joint sourcing of goods and services shapes resilience to trade frictions. In contrast, we find no statistically meaningful response of intermediate services imports to either the Brexit referendum or the TCA. We then show that firms more exposed to EU input sourcing experience declines in employment, sales, and the wage bill, with corresponding effects on workers' hours and pay. These impacts are heterogeneous across occupations, with larger losses concentrated among lower-skilled roles.

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Keywords: GVCs; Trade in Goods and Services; Brexit, TCA.

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"But I do think (Brexit) it's not only shooting yourself in the foot, but it's like amputating your leg without a medical reason for doing it."

Alexander Stubb, President of Finland, 17 May 2026

1 Introduction

Over the past decades, global value chains (GVCs) have transformed how goods and services are produced and traded, linking firms across borders and enabling access to specialised inputs and know-how (Baldwin and Freeman, 2022). While GVC participation can raise productivity, it also increases firms' exposure to external shocks, including trade-policy disruptions.

Although these benefits and risks are theoretically well understood, a key empirical challenge is that GVC participation is endogenous: firms choose how and where to source inputs, such that identifying the response of firm outcomes to supply-chain shocks requires exogenous variation orthogonal to firm decisions. Recent work has leveraged disruptions triggered by extraordinary events such as natural disasters (Boehm et al. (2019), Forslid and Sanctuary (2023)) and pandemics (Lafrogne-Joussier et al., 2023; Bonadio et al., 2021). At the same time, trade-policy shocks have become increasingly prevalent (Mao and Görg, 2020; Alfaro and Chor, 2023) and the existing evidence does not yet have much to say about their effects, which might well be different from the effects of disruptions caused by shocks such as natural disasters.

In this paper, we provide evidence on the effects of GVC shocks using a major and recent policy change: the United Kingdom's (UK) exit from the European Union's (EU) single market in 2021 and the entry into force of the UK-EU Trade and Cooperation Agreement (TCA). This change was plausibly exogenous from the perspective of individual UK firms and therefore offers variation that is both exogenous and directly relevant for understanding how policy-induced disruptions to GVCs affect economic outcomes. In particular, the shift from single-market membership to the TCA led to a significant disruption of UK imports from the EU, an important source of intermediate inputs for UK firms (Freeman et al., 2025). This suggests that the implementation of the TCA constituted a substantial GVC shock for UK firms, which we use to estimate the impact of policy-induced GVC disruptions on firm performance and worker outcomes.

We begin by outlining a simple conceptual framework in which the TCA makes importing from the EU more costly by introducing new non-tariff barriers affecting both goods and services. Guided by this framework, we construct two complementary measures of firms' exposure to GVC shocks. The first, based on I/O tables and firm-level trade data, classifies firms as more 'TCA-shock exposed' when their industry relies heavily on imported intermediates and their pre-Brexit

sourcing is concentrated in the EU. The second is a continuous measure defined as the ratio of EU imports to total sales.

We use linked UK microdata to compute these measures and link them to firm performance and worker outcomes. Specifically, we combine HMRC goods transactions data with the ONS ITIS services survey, and then merge these combined trade data with firm-level data from the Annual business survey (ABS) and worker-level data from the annual survey of hours and earnings (ASHE). The resulting panel provides pre- and post-TCA measures of EU import exposure alongside firm outcomes, worker pay and hours, and the regional location of firms, workers, and trade flows.

Using these data, we next document how the UK-EU TCA has affected UK firms' imports of intermediate inputs, establishing three stylised facts. First, EU intermediate goods imports declined after the TCA entered into force in 2021, with no similar break around the 2016 Brexit referendum. Second, the post-2021 decline in EU intermediate goods imports is smaller for firms that also import intermediate services. Third, intermediate services imports from the EU, when not bundled with goods, show no statistically meaningful response to either the referendum or the TCA. Overall, the TCA thus reduced EU intermediate goods imports, confirming that it did indeed trigger a GVC shock.

We next estimate how this shock translated into firm performance and worker outcomes using our pre-Brexit exposure measures. On the firm side, we implement a difference-in-differences design that compares exposed and non-exposed firms before and after two key moments: the 2016 referendum and the 2021 implementation of the TCA, while controlling for time-invariant firm characteristics, sector-specific shocks, and local economic conditions. The results show that exposure to EU-linked goods input dependence is associated with declines in employment and sales, with negative effects already emerging after 2016 and intensifying after 2021. Interestingly, firms importing both goods and services show a more pronounced decrease of employment and sales, suggestive of a more difficult supply chain adjustment for these firms.

We complement our firm-level analysis with a worker-level comparison of outcomes for workers employed at firms exposed to supply chain disruptions versus workers at non-exposed firms. We find that the TCA reduced both hours worked and wages, reinforcing the impression from the firm-level analysis that the TCA's impact on the UK economy was negative. The worker-level analysis further allows us to investigate whether the effects vary across worker groups. The analysis reveals sizeable differences across gender, age, and occupation, with females and younger workers being significantly more affected than other groups.

Our results have important policy implications. We highlight the joint role of goods and

services in shaping firms' resilience to policy-induced GVCs shocks and document the consequences of these shocks for firm performance and workers. These findings can help policymakers design strategies to mitigate the adverse effects of trade-policy disruptions. In the specific case of Brexit, we are among the first to document the implications of the TCA for UK firms performance. This evidence is particularly relevant for the UK government in assessing potential policy responses to counterbalance the economic effects of Brexit.

We contribute to two strands of the literature.

First, we contribute to the literature on the economic effects of supply chain disruptions. As discussed above, much of this literature focuses on disruptions to global value chains caused by natural disasters, such as earthquakes (Carvalho et al., 2021; Boehm et al., 2019; Barrot and Sauvagnat, 2016; Castro-Vincenzi et al., 2025) or pandemics (Lafrogne-Joussier et al., 2023; Bonadio et al., 2021; Breinlich et al., 2025; Khanna et al., 2025). While exploiting such natural experiments strengthens internal validity, it is less clear to what extent these settings can inform our understanding of recent developments in international trade policy, including the renewed rise of protectionism, such as the tariffs imposed during the first and second Trump administrations in the United States. In contrast, we study a policy-induced supply chain shock targeting Non-Tariff Barriers (NTBs), which we argue is particularly relevant for understanding contemporary trade-policy disruptions. From a theoretical perspective, Grossman et al. (2024b, 2023, 2024a) analyse optimal policy responses to policy-induced global value chain shocks. Relative to these contributions, we provide empirical evidence on firms' performance following such shocks. From an empirical perspective, our paper is most closely related to Handley et al. (2020), who study the impact of the Trump tariffs on U.S. firms' export performance. Complementary to their analysis, we examine firms' performance along multiple dimensions (sales, employment, and the wage bill). Most importantly, we introduce a novel dimension to the empirical analysis of global value chain shocks by explicitly accounting for the interaction between goods and services trade. We show that this interconnection plays a key role in shaping firms' resilience to policy-induced disruptions, highlighting the importance of jointly considering goods and services when assessing the overall effects of trade policy shocks.

Second, we contribute to the emerging literature on the impacts of the TCA and the UK's exit from the EU Single Market.[1] From a UK perspective, this literature remains relatively small and has primarily focused on the effects of the TCA on trade flows (see Freeman et al. (2025); Bhalotia et al. (2025); Justo et al. (2026)). In contrast, we study the consequences of the TCA for firm- and worker-level outcomes, which arise from the trade disruptions induced

[1] We cover the existing literature on the effects of the Brexit referendum in the next Section.

by the agreement but have so far received limited attention. One exception is Keiller (2024), who analyses the effects of both the Brexit referendum and the TCA on UK firms' investment decisions. Relative to this work, we consider a broader set of firm- and worker-level outcomes and place particular emphasis on heterogeneity in the impacts of the TCA across firms, workers, and UK regions. As discussed above, we also focus on the joint role of goods and services trade. In this respect, our paper is related to Görg et al. (2026), who study the resilience of German firms exporting both goods and services following Brexit. Similar to their findings, we show that firms trading both goods and services are more resilient to the shock in terms of trade performance. We go one step further, however, by highlighting the implications of this dual exposure for a wide range of firm performance outcomes. From the EU perspective, our analysis is complementary to recent work examining the effects of the TCA in other EU countries (Conconi et al. (2026) for France, Flach et al. (2026) for EU exports and Giglioli and Federico (2026) for Italy). Taken together, these studies provide a more comprehensive picture of the global effects of the TCA.

The remainder of the paper is structured as follows. In the next section, we outline the Brexit timeline and discuss the relevant research associated with each key milestone. Section 3 presents a simple conceptual framework of UK firms' sourcing strategies, which we use to motivate our two measures of exposure to GVC disruptions. Section 4 describes the data sources. In Section 5, we present a set of stylised facts about the impact of Brexit on UK firms' imports of intermediate inputs. Section 6 presents the main empirical results on the firm- and worker-level impacts of TCA-induced GVC disruptions, and Section 7 concludes.

2 The Brexit process

Brexit unfolded in several stages, and it is useful to distinguish between when firms learned that trade arrangements might change and when new rules actually took effect. The process began with the June 2016 referendum, which signalled the UK's intention to leave the EU. While formal trading arrangements remained unchanged at that point, uncertainty about the future terms of UK-EU trade increased. In March 2017, the UK triggered Article 50, formally initiating the withdrawal process and establishing a two-year negotiation period. During this time, the UK remained part of the Single Market and Customs Union, but future trade frictions became more salient for firms operating across borders.

Much of the existing literature on Brexit has pointed out that negative economic effects already appeared at this point. For example, the literature has documented that the Brexit referendum led to an increase in inflation (Breinlich et al., 2022) and food prices (David Bakker et al., 2022), and decreases in UK inward FDI (Breinlich et al., 2020; Tamberi and Serwicka, 2018), employment (Javorcik et al., 2025; Do et al., 2025; Costa et al., 2024), trade (Fernandes and Winters, 2021; Graziano et al., 2021; Crowley et al., 2018; Gasiorek and Tamberi, 2023; Kren and Lawless, 2024), firms' productivity (Bloom et al., 2019) and economic growth (Born et al., 2019).

The UK formally left the EU in January 2020 under the Withdrawal Agreement and entered a transition period during which existing trading arrangements continued. Although trade remained frictionless, this period gave firms and customs authorities time to prepare for the new regime. The future relationship was agreed in December 2020, when the EU and the UK concluded the Trade and Cooperation Agreement (TCA), which entered into force in January 2021 and established the new framework governing UK-EU economic relations. While it maintained zero tariffs and zero quotas on goods, it introduced a range of new non-tariff barriers. On the goods side, cross-border shipments became subject to border formalities such as customs declarations and proofs of origin to claim preferential treatment and, for some products, additional compliance requirements (e.g., for chemicals and medical devices). The TCA also introduced new frictions for services trade, including tighter rules on the temporary movement of workers (visa and work-permit requirements) and additional barriers related to certification and licensing to operate across markets.

In our analysis, the entry into force of the TCA is the key policy change, which created new non-tariff barriers that raised trade costs across products and sectors [2]

[2]We do not model these barriers separately, as separate analyses of specific channels are beyond the scope of this paper. We refer to Conconi et al. (2026) for a study of rules-of-origin implications for France-UK trade, Flach et al. (2026) for an analysis of the trade effects of additional border documentation, and to Justo et al. (2026)

Besides the TCA, we will also investigate whether economic effects linked to expected supply chain disruptions materialised already after the Brexit referendum, in line with the findings from the existing literature discussed above, which has documented such early effects. This literature usually explains early effects through a mixture of anticipation, uncertainty and exchange rate effects. In our context, anticipation effects could materialise if forward-looking firms started the adjustment to future GVC disruptions after 2016, rather than waiting for actual changes in trade barriers. Likewise, increased uncertainty about the future reliability of existing EU-centric GVCs could push firms into making adjustments already after 2016. Finally, exchange rate effects refer to the fact that the outcome of the Brexit referendum led to a sharp devaluation of pound Sterling, which made imports of intermediate inputs more expensive (see (Costa et al., 2024).

and Bhalotia et al. (2025) for the impact of the TCA on UK services exports

3 Conceptual Framework

To illustrate the mechanisms we have in mind, consider a world with N countries. We're interested in firms located in one of these countries (the UK). To see how the TCA could have affected firm- and worker-level outcomes in the UK, consider a typical firm in that country, firm i.

Firm i uses labour and intermediate inputs to produce its output shipped to market n, q_{in}:

$$q_{in} = F(L_i, M_i), \tag{1}$$

where L_i is the labour used by firm i, and M_i is a bundle of intermediate inputs (both goods and services). Intermediate inputs can be sourced either domestically (i.e., from the UK), or imported from any of the other $N-1$ countries. Formally, M is thus a function of domestic and foreign intermediate inputs:

$$M_i = M(D_i, F_i), \tag{2}$$

where D_i denotes domestic intermediate inputs, and F_i denotes foreign intermediate inputs, respectively, with EU member states included among the foreign sourcing options. Given that firms maximize profits by selecting the lowest-cost inputs available, firm i will source from the EU if and only if it offers the most competitive option on the market.

We think of the TCA as leading to an increase in trade barriers that raises input prices or restricts availability, thereby raising the the cost of the intermediate input bundle, increasing the firm's production costs and reducing its overall sales. The impact on employment, however will be more ambiguous. On the one hand, lower output means less labour demand, reducing firm-level employment. On the other hand, an increase in the price of intermediates will lead the firm to substitute towards labour, potentially offsetting the negative impact of decreased sales. The impact on wages will be similarly ambiguous. With a fixed labour supply in the UK, any increase in labour demand will tend to increase wages, and any decrease will lower them.

Two factors determine the extent to which the TCA raises the price of the intermediate input bundle. First, the the ease with which firm i can substitute foreign inputs for domestic ones. As shown by Khanna et al. (2025), the degree of product customization directly dictates this substitutability; highly tailored inputs are often more difficult to replace with domestic alternatives. Product customisation might include ad-hoc services supplied with a good; we will explore the importance of this channel empirically later on by studying outcomes for firms that import both goods and services.

Second, the TCA impact will also depend on the magnitude of the trade shock, which is a function of the share of intermediate inputs imported from the EU by firm i before Brexit.

Taken together, these observations motivate the construction of the following exposure measure:

$$Exposure^{s,g}_{f,2014} = \sum_k \left(\underbrace{\frac{Imported \;\; Inputs^k_j}{Inputs_j}}_{\lambda^k_j} \times \underbrace{\sum_{h \in k} \frac{Imports^{h,EU}_{f(j)}}{Imports^{h}_{f(j)}}}_{\omega^{k,EU}_{f(j)}} \right), \tag{3}$$

where $Exposure^{s,g}_{f,2014}$ indicates the exposure to the TCA of firm f in year 2014, measured separately for goods (g) and services (s). We use 2014 as our reference year, as it predates both the Brexit referendum of 2016 and the TCA of 2021.

In equation 3, index k indicates the good/service imported, and j the sector a firm f belongs to.

This measure is designed to capture the two distinct dimensions of vulnerability identified in our conceptual framework. The first component, import intensity (λ^k_j), represents the structural reliance of firm i's industry (j) on foreign varieties of input k; a high value here implies a lack of viable domestic substitutes, which heightens the firm's sensitivity to international supply disruptions. Information on input use from UK I/O tables is used to construct λ^k_j, as further explained below. This industry-level reliance is then interacted with the firm-level geographic concentration of those imports $\omega^{k,EU}_{f(j)}$. This second term isolates the firm's specific dependence on the EU and is constructed as the share of a firm's imports originating in the EU.

To better understand this measure, consider the example of a firm f in the automotive industry (sector j). The summation in Equation 3 aggregates across all inputs k present in the UK input-output tables for the automotive sector. For example, assume the automotive sector uses steel and leather as inputs. For each input, we calculate the product of our two terms. First, the fraction of the product imported from abroad by industry j as a whole. For example, if the car industry's total use of imported steel is 20%, λ^{steel}_j is 0.20. Second, the fraction of firm f's imports of product k originating from the EU. For this, we map input k to firm-level trade data by aggregating all specific trade codes h that belong to the broader CPA category for input k (e.g., all HS codes for cold-rolled steel).[3] For example, if firm f sources 20% of its

[3]Note that the product classification in the input-output tables (k in Equation 3) is at a higher level of aggregation compared to the ones included in the trade data (h in Equation 3). Specifically, k is defined according to the CPA classification while h is defined according to the HS4 classification for goods and the EBOPS classification for services. We link λ^k_j with $\omega^{k,EU}_{f(j)}$ through firm's sector j and mapping the concordance between goods and services trade codes and input–output sectors allowing consistent aggregation across data sources. For the goods, we construct a correspondence Table available HERE while for services we use the conversion from Magli et al.

total steel imports from the EU, then $\omega_{f(j)}^{steel,EU}$ is 0.20. In this example, the contribution of steel to the firm's total exposure would then be 4% ($0.2 \times 0.2 = 0.04$.)

Note that our exposure measure thus implies that whether a firm is exposed to supply chain disruptions depends on two conditions applying simultaneously: a firm is only considered exposed when it faces a lack of domestic alternatives *and* a high concentration of sourcing from the EU. A firm that imports heavily from the EU but has access to readily available domestic substitutes (low λ_j^k) would not be considered highly exposed, as it can re-orient its supply chain towards domestic inputs with relative ease. Similarly, a firm that is deeply dependent on foreign inputs but sources them primarily from non-EU markets (low $\omega_{f(j)}^{k,EU}$) remains insulated from the GVC shocks caused by the TCA. Consequently, it is only at the intersection of high import intensity and high EU concentration that our measure signals significant exposure to UK-EU supply chain disruptions.

Table 1 reports summary statistics for our exposure measure. While average exposure is relatively low (Column 2), this hides a substantial amount of exposure heterogeneity, with most of the variation resulting from zero versus positive values of the exposure measure (Columns 4 and 5). Going forward, we will thus define a binary exposure measure, taking the value one if $EXP_{f(j),2014}^{s,g} > 0$.

Our primary measure of exposure is subject to certain limitations. Because we rely on Input-Output (I/O) tables to infer firm-level input bundles, the measure may not fully capture heterogeneity in firms' EU sourcing. Specifically, if the I/O tables indicate that a particular input is not imported at the sectoral level, we classify it as non-intermediate, even for firms that record imports of that input in the trade data. This may lead to misclassification, whereby some genuinely exposed firms are not identified as treated. Further, the I/O approach relies on proportionality assumptions, implicitly distributing imported inputs homogeneously across sectors.

We therefore introduce a complementary measure that leverages the full granularity of our firm-level data, defined as the share of EU imports relative to total sales:

$$Exposure\ Share_{f,2014}^{s,g} = \frac{\sum_k Imports_{EU,f,2014}^k}{Sales_{f,2014}}. \tag{4}$$

Similarly to Equation 3, k indexes the product (goods or services) imported by firm f from the EU in 2014. This alternative exposure measure captures firm-specific sourcing patterns that may be missed by the I/O-based measure and does not impose proportionality of inputs across firms and sectors. Normalising EU imports by total sales, $Sales_{f,2014}$, also helps address

(2022).

Table 1: Exposure measure 2014

	(1)	(2)	(3)	(4) No 0s	(5) No 0s
λ_j^k	0.0024				
	(0.0157)				
$\omega_{f(j)}^{k,EU}$ Goods	0.03405				
	(0.1377)				
$\omega_{f(j)}^{k,EU}$ Services	0.0085				
	(0.0766)				
Firm exposure Goods (I/O)		0.0014		0.0102	
		(0.0112)		(0.0286)	
Firm exposure Services (I/O)		0.0002			0.0035
		(0.0031)			(0.0147)
Firm exposure Goods (Share)			0.0175	0.1557	
			(0.0811)	(0.1926)	
Firm exposure Services (Share)			0.0007		0.0397
			(0.0119)		(0.0792)
Firm exposure Goods and Services (Share)			0.0181		
			(0.0828)		

Source: Own Computation. Column 1 shows the summary statistics for λ_j^k, the share of imported inputs k in sector j in total Inputs in sector j and for $\omega_{f(j)}^{k,EU}$, the share of firm f imports of product h from the EU on total imports of product h by f. The statistics are reported separately for goods and services. Column 2 shows the summary statistics for the exposure measure separately for goods and services using the I/O table methodology. Column 3 shows the summary statistics for the exposure measure separately for goods and services using the share imports from the EU methodology. Columns 4 and 5 show the summary statistics of the exposure measure for goods and services when we exclude the zeros. The reference year is 2014.

the concern that some imports may reflect final goods intended for resale: in that case, the associated revenue is reflected in sales, so scaling imports by sales reduces the likelihood that the measure mechanically classifies pure trading activity as input exposure. The intuition of the share measure is therefore the intensity of EU imports relative to the scale of the firm. Relative to the I/O-based exposure measure, the import-share values are larger on average and appear to capture services-import exposure more effectively. Strikingly, when excluding zeros, the share measure is about an order of magnitude larger than the I/O-based exposure: exposed firms have, on average, EU intermediate input shares of 15.5% for goods and 3.9% for services when measured as shares, against 1% for goods and 0.03% for services when measures with I/O tables (Columns 4 and 5 of Table 1). Importantly, the share measure also exhibits substantially more variation across sectors (Table A.4) and across regions (Figure A.1). Throughout the paper, we report results using both exposure measures, but we rely on the share-based measure for our heterogeneity analysis.

4 Data

For our project, we combine four main datasets. We first use the newly created Trade In Goods - IDBR dataset (TiG-IDBR), which merges goods trade data from HMRC (at the CN 8-digit and country of destination/origin level) with firm-level information from the IDBR, including employment, region, industry, sales, enterprise group, and world ultimate owner. [4]

Following Freeman et al. (2025), we address concerns that the move from Intrastat to VAT registration in January 2021 may bias product-level trade reporting. For each firm, we therefore exclude products not traded before the implementation of the TCA and those no longer traded after the TCA, at the HS6-digit level. This also removes the post-TCA extensive margin, as some firms may have genuinely ceased trading with the EU due to new regulations. Consequently, our estimates focus on the intensive margin and should be largely free from measurement error.

The second dataset is the International Trade in Services Survey (ITIS), which provides information on firms' traded services, including type and country of origin/destination. The ITIS is a survey covering the population of large firms and a rotating sample of smaller ones. Because the data are survey-based, reporting methods did not change with the TCA, and no adjustments are required. The ITIS classifies traded services into 52 distinct categories, as detailed in Appendix Tables B.1 and B.2.

We merge TiG and ITIS using firms' unique identification numbers. At the firm–country level, 9% of observations trade continuously with the same country in both goods and services. When aggregated at the firm level, 14% of firms trade both goods and services throughout the period. Firms in the merged trade dataset are predominantly in services sectors (10.02%; Column 1 of Table 2), are of average size (79 employees), and are mainly exposed to the EU through goods imports (which accounts for 14% of their total goods imports on average). This matched dataset forms the basis for estimating the impact of Brexit on firms' goods and services imports and for constructing our firm-level exposure measure defined in Equations 3 and 4. Note that the I/O exposure measure requires data on industries' input usage along with firms' pre-Brexit import patterns. For this, we use data from UK input-output tables and match them to our firm-level data using firms' main industry.

Using firm identifiers, we merge the trade data with the Annual Business Survey (ABS), the official source for UK business statistics. The ABS covers the population of large firms (those with more than 250 employees) and a repeated cross-section of smaller firms, and contains detailed information on employment, sales, wage bill, geographical location, and industry. As shown in Column 2 of Table 2, firms in the ABS tend to be large (280 employees on average)

[4] See Appendix B for details on dataset construction).

and are predominantly in the services sector (43.2%).

Reassuringly, employment and sales information reported in the ABS closely match the same variables reported in the trade data. In the subset of firms that merge perfectly across the ABS, ITIS, and TiG datasets, these statistics are very similar (Column 3 of Table 2). Firms that merge perfectly across the ABS–ITIS–TiG datasets are larger (522 employees on average), more exposed to the EU market (25% of their goods imports and 8.92% of their services imports), and again mostly in the services sector (25%).

The combined dataset includes both trading and non-trading firms. For trading firms, we observe their full trade portfolio together with rich firm characteristics. We assume that firms that are not present in the TiG-ITIS do not trade in neither goods nor services. For the main analysis, we exclude the firms that were in the TiG and ITIS but that are not in the ABS.

Lastly, we combine the information on trade and the firm-level data with information on the workers contained in the Annual Survey on Hours and Earnings (ASHE) dataset. That dataset is a sample of 1% of the labour force matching employer-employee data. For our analysis, we only consider workers working full-time employment and with only one job. We link workers to their employer through the enterprise reference number. In some cases, one enterprise reference number corresponds to multiple reference unit numbers (1% of total cases). As the firm-level information in the ABS is reported at the reference number level, when multiple observations are present, we select the reference unit with the highest employment (this procedure is also consistent with the allocation methodology used by the ONS in other datasets). We observe workers in a panel structure and can track them across the different firms in which they are employed over time. For each worker, we observe age, tenure at the current firm, the sector of the plant in which they are employed, weekly pay, weekly hours worked, sex, and occupation. The dataset contains information on 325,810 workers, with summary statistics reported in Table A.1. Further details on the data construction and merging procedure are provided in Appendix B.

The final dataset includes measures of firms' import exposure to the EU, along with comprehensive information on firm performance (from the ABS), as well as workers' employment outcomes (from ASHE). In addition, we observe the precise regional location of firms, workers, and trade flows, allowing to link labour market outcomes to firm-level Brexit exposure with fine geographical detail.

Table 2: Summary Statistics Dataset Samples

	(1) TiG-ITIS	(2) ABS	(3) ABS-TiG-ITIS
Employment, ABS data		280.75	522.8321
		(2320.628)	(3499.7)
Sales, ABS data		63,909.70	146,308.30
		(740014.9)	(1090967)
Employment, trade data	79.89355		500.0294
	(1,349.829)		(3,638.878)
Sales, trade data	27,358.38		141,468.50
	(718,400.8)		(1,043,044)
Goods Exports ('000)	1,948.20		11,973.65
	(55,982.73)		(166,801.3)
Goods Imports ('000)	2,840.09		16,316.98
	(5,4493.6)		(146,698.5)
Services Imports ('000)	536.88		4,061.21
	(21,529.92)		(65,002)
Services Exports ('000)	998.84		6,545.84
	(27,140.51)		(77,791.74)
Goods Exports from the EU (%)	0.1424		0.3077
	(0.3123)		(0.3891)
Goods Imports from the EU (%)	0.0948		0.2462
	(0.2706)		(0.3792)
Services Imports from the EU (%)	0.0254		0.1005
	(0.1418)		(0.2667)
Services Exports from the EU (%)	0.0274		0.0892
	(0.1441)		(0.2468)
Manufacturing Firms (%)	0.0350	0.0098	0.0192
	(0.0732)	(0.0210)	(0.0261)
Wholesale and Retails Firms (%)	0.0771	0.0049	0.0078
	(0.1248)	(0.0125)	(0.0151)
Services Firms (%)	0.1002	0.4321	0.2532
	(0.1474)	(0.4338)	(0.3948)
Observation	1,267,977	397,143	125,459

Source: TiG, ITIS, ABS (ONS). Column 1 shows the summary statistics of the combined TiG and ITIS datasets. Column 2 shows the summary statistics for the firms contained in the ABS. Column 3 shows the summary statistics for the perfect merging of the firms in the ABS, TiG and ITIS - this excludes the firms in the ABS not trading and firms in the TiG-ITIS not surveyed in the ABS. Sectors are defined as follows: Manufacturing (2-digit Sic2007 between 10 and 33), Wholesale and Retail (2-digit Sic2007 between 45 and 47), Services (2-digit Sic2007 above 49).

5 The impact of the TCA on intermediate imports

The starting point of our analysis is to assess whether the TCA reduced UK imports of intermediate inputs from the EU. The TiG–IDBR data do not allow us to directly distinguish whether an imported product is used as an intermediate input or as a final good. We therefore use information from the UK Input-Output (I/O) tables to classify products as intermediates. Specifically, we define an imported product as an intermediate for a given sector if it is recorded as an intermediate imported input in the sector-year I/O table. This implies that, within a sector and year, we assign the same intermediate status to a given product for all firms. Heterogeneity across firms within a sector then arises from whether the firm actually imports that product from abroad, and from which source country. For example, continuing with our earlier car-producer example, we use the I/O tables to classify inputs such as steel and leather as intermediates for firms in the car manufacturing industry. We then record an intermediate import whenever a firm in that industry imports steel or leather from abroad.

We then estimate the following regression:

$$\ln M_{fct} = \beta_0 + \beta_1 \left(Brexit_t \times EU_c\right) + \beta_2 \left(TCA_t \times EU_c\right) + \gamma_{ft} + \gamma_{fc} + \varepsilon_{fct} \tag{5}$$

where, M_{fct} denotes firm f's imports of intermediate inputs from country c in year t. $Brexit_t$ is an indicator equal to one in the post-referendum period (from 2017 onward), TCA_t is an indicator equal to one from 2021 onward, and EU_c equals one if country c is an EU member. This specification compares firm-level imports from the EU to imports from non-EU countries, which serve as a control group. Firm-time fixed effects γ_{ft} absorb time-varying firm characteristics, while firm-country fixed effects γ_{fc} control for persistent bilateral trading relationships. Equation 5 therefore identifies how the EU-non-EU import differential evolves after the referendum and, in particular, following the implementation of the TCA.

Stylised Fact 1 ***Firms reduced their EU Goods intermediates imports after the TCA came into force.***

After the implementation of the TCA, imports of intermediate goods from the EU decreased by 19.9% relative to imports of intermediate goods from non-EU countries (Column 1 of Table 3). We interpret this relative decline as reflecting the increase in trade frictions, in particular the introduction of new non-tariff barriers under the TCA, which raised the cost of sourcing intermediate inputs from the EU. This magnitude is comparable to estimates in the existing literature. For instance, Freeman et al. (2025) find a decline of around 22–23% in *total* imports

from the EU relative to the rest of the world.[5] Our findings show that a decline of similar magnitude also occurred for imports of intermediate inputs, which is the relevant type of import, given our interest in GVC disruptions.

Table 3: Impact of Brexit on Intermediate Goods Imports

	(1)	(2)	(3)	(4)
$TCA \times EU$	-0.1999***	-0.1992***	-0.1984***	-0.2074***
	(0.0573)	(0.0575)	(0.0576)	(0.0585)
$Brexit \times EU$	0.0110	0.0111	0.0111	0.0110
	(0.0314)	(0.0314)	(0.0314)	(0.0314)
$TCA \times EU \times Service_f$		0.0719*		
		(0.0293)		
$TCA \times EU \times Service_{EU}$			0.0593*	
			(0.0284)	
$TCA \times EU \times Goods_{EU}$				0.1916
				(0.1347)
$Firm \times Year$	Y	Y	Y	Y
$Firm \times Country$	Y	Y	Y	Y
N	2,395,851	2,395,851	2,395,851	2,395,851

Source: Own Computation. Dependent variable: Log import of intermediate goods. Standard errors in parentheses are clustered at the country level. TCA is a dummy variable indicating the period after 2020, $Brexit$ is a dummy variable indicating the period after 2016, EU is a dummy variable indicating if country c is part of the EU. $Service_f$ is a dummy variable indicating if firm f imports services in year t; $Service_Eu$ is a dummy variable indicating if firm f imports services in year t from any EU country; $Goods_EU$ is a dummy variable indicating if firm f imports goods in year t from any other EU country. $^{+}$ $(p < 0.1)$ * $(p < 0.05)$, ** $(p < 0.01)$, *** $(p < 0.001)$

In our data we can also observe whether a firm is importing intermediate services at the same time as intermediate goods, and from which country. Building on Equation 5, we add an interaction term to test whether the effect of the TCA on intermediate goods imports differs for firms that also import intermediate services after the TCA implementation. We consider several alternative definitions of services importing. We distinguish between firms that import intermediate services from the EU in the same year ($Service_{EU}$) and firms that import intermediate services from any country in the same year ($Service_f$).

Stylised Fact 2 ***The decline in EU intermediate imports is less pronounced for firms that also import intermediate services from other EU countries.***

[5] Our regression specification differs slightly in that we include firm–country fixed effects and cluster standard errors at the country level. The corresponding results in Freeman et al. (2025) are reported in their Table 3.

Generally, firms that import intermediate services experience a 7% smaller decline in intermediate goods imports after the implementation of the TCA (Column 2 of Table 3). This effect is driven by firms that import intermediate services from other EU countries in the same year, which face a 5% smaller decline in EU goods inputs relative to firms that do not import intermediate services (Column 3). To assess whether this pattern reflects broader co-dependence in intermediate supply, we replicate the exercise using an interaction based on imports of intermediate goods from another EU country. In this case, however, the interaction term is statistically insignificant (Column 4).

To assess whether these results reflect joint sourcing of goods and services rather than firm size, we repeat the analysis using indicators for whether the firm belongs to the top 1% of the employment distribution (*Large* (*Employment*)), the turnover distribution (*Large* (*Turnover*)), or the total imports distribution (*Large* (*Total imports*)). Table 4 shows that the size measures based on turnover and employment are strongly correlated, whereas importing both goods and services is less tightly linked to these proxies for scale.

Table 4: Correlation Firm Characteristics and Trade

	Goods&Services Importer	*Large Firm* (*Employment*)	*Large Firm* (*Sales*)	*Large Firm* (*Total Imports*)
Goods&Services Importer	1.0			
Large Firm (*Employment*)	0.0055	1.0		
Large Firm (*Sales*)	-0.0091	0.4413	1.0	
Large Firm (*Total Imports*)	0.0782	0.1149	0.1381	1.0

Source: Own Computation. *Goods&Services Importer* is a dummy variable indicting if firm f is importing goods and services in year t. *Large* (*Employment*) is a dummy variable indicating if firm f is in the top 1% of employment; *Large* (*Sales*) is a dummy variable indicating if firm f is in the top 1% of sales; *Large* (*Total Imports*) is a dummy variable indicating if firm f is in the top 1% of total imports.

Firms in the top 1% of the employment distribution (Column 1, Table 5) or sales distribution (Column 2) do not exhibit a significantly smaller decline than other firms. By contrast, firms in the top 1% of the total imports distribution are those that mitigate the negative impact of the TCA the most: they experience a significantly different response relative to the remaining 99% of firms, implying no decline in intermediate goods imports in this group (Column 3).

A plausible interpretation for the smaller effect of the TCA shock on joint goods-services importers is that firms that jointly source intermediate goods and services from Europe face higher switching costs when trade frictions rise. Bundling goods and services inputs may reflect relationship-specific sourcing, tailored specifications, or technical integration across inputs that limits the scope for replacing EU suppliers in the short run. For example, a car manufacturer may

Table 5: Impact of Brexit on Intermediate Goods Imports, Firm Characteristics

	(1)	(2)	(3)
$TCA \times EU$	-0.2019***	-0.1992***	-0.2232***
	(0.0580)	(0.0585)	(0.0585)
$Brexit \times EU$	0.0110	0.0111	0.0104
	(0.0314)	(0.0314)	(0.0314)
$TCA \times EU \times Large\ (Employment)$	0.0656		
	(0.0890)		
$TCA \times EU \times Large\ (Turnover)$		-0.0200	
		(0.0839)	
$TCA \times EU \times Large\ (Total\ imports)$			0.8716***
			(0.0698)
$Firm \times Year$	Y	Y	Y
$Firm \times Country$	Y	Y	Y
N	2,395,851	2,395,851	2,395,851

Source: Own Computation. Dependent variable: Log imports of intermediate goods. Standard errors in parentheses are clustered at the country level. TCA is a dummy variable indicating the period after 2020, $Brexit$ is a dummy variable indicating the period after 2016, EU is a dummy variable indicating if country c is part of the EU. $Large\ (Employment)$ is a dummy variable indicating if firm f is in the top 1% of employment; $Large\ (Sales)$ is a dummy variable indicating if firm f is in the top 1% of sales; $Large\ (Total\ Imports)$ is a dummy variable indicating if firm f is in the top 1% of total imports.$^{+}$ $(p < 0.1)$ * $(p < 0.05)$, ** $(p < 0.01)$, *** $(p < 0.001)$

import physical components such as sensors embedded in seats together with complementary services such as the software, calibration, or monitoring systems required for those components to function within the vehicle. In such cases, substituting away from an EU supplier requires replacing not only the hardware but also the associated service bundle and ensuring compatibility with the rest of the production process. As a result, it will be more difficult for the importer to switch suppliers after an increase in trade barriers, explaining why we see a smaller decline in imports for such firms. At the same time, however, such firms are likely to be more impacted by the GVC disruption, as they cannot easily substitute to alternative sources of inputs and thus have to bear the implied increase in production costs, leading to lower sales and possibly employment (see Section 3). This interpretation is consistent with Khanna et al. (2025), who show that more customised goods are less likely to be substituted following supply shocks, implying stronger propagation when inputs are difficult to replace.

Lastly, we investigate whether Brexit and the TCA also impacted imports on intermediate services, in addition to the imports of goods. We thus estimate Equation 5 using as dependent

variable the imports of intermediate service of firm f from country c in year t.

Stylised Fact 3 ***Services intermediate imports were not affected by the TCA.***

Neither the Brexit referendum nor the implementation of the TCA had a statistically significant effect on services imports from the EU (Column 1, Table A.3). While the absence of a significant effect may seem surprising, it is consistent with the broader evidence in Freeman et al. (2025). Moreover, our analysis focuses on the intensive margin, whereas adjustments along the extensive margin may be more important in services. Indeed, Breinlich and Magli (2024) document a decline in services imports after the Brexit referendum, consistent with firms adjusting the mode of supply and market participation rather than the value of continuing trade relationships.

We also examine whether services imports respond differently for firms that import goods from the same partner country. We find that firms importing larger values of goods tend to experience a smaller decline in intermediate services imports, but this relationship does not differ between EU and non-EU partner countries after the implementation of the TCA (Column 2).

6 The impact of Brexit on firms and workers

Our analysis so far indicates that the TCA had a substantial negative effect on intermediate goods imports from the EU, and that this decline was partly mitigated for firms that also import services. These patterns are consistent with a disruption of existing UK-EU supply chains. We now turn to an investigation of the firm-level consequences of this disruption using the firm-level exposure measures described in Section 3.

6.1 Firm-level analysis

To estimate the causal impact of supply-chain shocks on firm-level outcomes, we estimate difference-in-differences specifications of the form:

$$\ln(Y_{ft}) = \beta_0 + \beta_1 \left(TREAT_{Pf} \times Brexit_t\right) + \beta_2 \left(TREAT_{Pf} \times TCA_t\right) + \gamma_f + \gamma_{jt} + \gamma_{rt} + \varepsilon_{ft}, \quad (6)$$

where Y_{ft} denotes firm performance measures, including employment, average wage, and sales for firm f at time t. The indicator $TREAT_{Pf}$ takes the value 1 when the firm f was exposed to EU imports in 2014 for product P, , where P refers to goods (G) or services (S), that is, when the exposure measure for goods or services is greater than zero. As explained in Section 3, we use two complementary measures of exposure: the first is defined in Equation (3) using I/O tables (denoted I/O exposure measure in the tables), and the second is the ratio of firms' EU imports to total sales as specified in Equation 4 (denoted share exposure measure in the Tables).

We distinguish two potential treatments: the Brexit referendum of 2016 ($Brexit_t$), and the entry into force of the TCA in 2021 (TCA_t). In the previous section, we have established that the imports of intermediate goods only decreased after the TCA (i.e. once the barriers are effectively put in place). But as discussed previously, the Brexit literature has found ample evidence of the negative effects of Brexit already materialising after 2016, due to a mixture of anticipation, uncertainty and exchange rate effects. As discussed, in our context, firms might be anticipating increased difficulties in importing intermediates from the EU, and thus pre-emptively adjusting the size of their operations. Likewise, the uncertainty about future trade barriers to intermediate inputs might induce firms to hold off on expanding production and employment until the uncertainty has been resolved. Finally, the strong depreciation of pound sterling will already have made intermediate inputs more expensive from June 2016, potentially leading to negative firm-level impacts from that date onward (also see Costa et al. (2024)). In the following, we will thus pay close attention to the timing of effects of supply-chain shocks, examining whether effects already emerged in 2016 (as captured by the $TREAT_{Pf} \times Brexit_t$

interaction) or only in 2021 (as captured by the $TREAT_{Pf} \times TCA_t$ interaction).

The specification includes firm fixed effects γ_f, which absorb time-invariant differences across firms, as well as sector-year fixed effects γ_{jt} and region-year fixed effects γ_{rt}, which control for sector- and region-specific shocks. The latter two fixed effects are particularly important to account for the uneven impact of the COVID-19 pandemic, which was concentrated in certain sectors (e.g., hospitality) and regions. In all specifications, we cluster standard errors at the industry level, allowing for correlated shocks within industries.

To further investigate whether firms importing both goods and services from the EU experienced differential performance effects relative to firms importing goods only, we augment the specification by interacting the post-referendum and post-TCA indicators with $TREAT_{both,f}$, an indicator equal to one if firm f was exposed to EU imports in 2014 in both goods and services. This interaction captures the additional effect associated with bundling goods and services sourcing, beyond the effect of goods exposure alone, and is informative about the role of input substitutability in shaping firms' performance responses.

Note that replacing $TREAT_{both,f}$ with the services exposure indicator $TREAT_{Sf}$ yields a conceptually different comparison. The services exposure measure is defined independently of goods exposure, so the corresponding interaction mixes firms that import only goods, only services, and both. By contrast, interacting with $TREAT_{both,f}$ isolates the incremental effect of services exposure *conditional* on goods exposure, allowing us to compare firms exposed through goods only to firms exposed through both goods and services.

As an additional control, we include dummy variables indicating whether a firm exports goods ($Exporter_{EU,G}$) or exports services ($Exporter_{EU,S}$) to EU destinations. This accounts for the fact that EU-oriented exporters may be affected not only by higher non-tariff barriers on imported inputs, but also by new frictions in their exports to the EU, which could confound the estimated effects on firm outcomes.

Table A.5 shows some basic descriptive statistics for treated and untreated groups for both of our exposure measures. As expected, exposed firms perform better in terms of employment, wage bill and sales, independently from the exposure measure used, which is in line with the standard empirical finding that importing firms perform better than other firms. Of course, in our main specification, equ. 6, these ex-ante differences between control and treated firms are absorbed by the firm fixed effects, γ_f.

We next estimate equ. 6 and find that firms exposed to supply-chain disruptions in goods experienced a significant decrease in employment (Table 6, Panel A, Column (1)). Unlike trade effects, this negative impact first emerges following the Brexit referendum and intensifies after

Table 6: Impact of Brexit and the TCA, Combined Results

	Ln Employment		Ln Average Wage		Ln Sales	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: I/O exposure measure						
$Brexit \times tr_G$	-0.0691***	-0.0619***	0.0107	0.0077	-0.0853***	-0.0781***
	(0.0087)	(0.0083)	(0.0097)	(0.0103)	(0.0145)	(0.0141)
$TCA \times tr_G$	-0.0485***	-0.0430***	-0.0262*	-0.0313*	-0.0737***	-0.0647***
	(0.0069)	(0.0066)	(0.0126)	(0.0129)	(0.0138)	(0.0137)
$Brexit \times tr_{both}$		-0.0500**		0.0204		-0.0487
		(0.0182)		(0.0202)		(0.0315)
$TCA \times tr_{both}$		-0.0440**		0.0415+		-0.0726*
		(0.0169)		(0.0241)		(0.0285)
$Firm$	Y	Y	Y	Y	Y	Y
$Region \times Year$	Y	Y	Y	Y	Y	Y
$Sector \times Year$	Y	Y	Y	Y	Y	Y
N	250,382	250,382	245,710	245,710	249,977	249977
Panel B: Share exposure measure						
$Brexit \times sh\_tr_G$	-0.0720***	-0.0649***	0.0071	0.0048	-0.0937***	-0.0873***
	(0.0088)	(0.0085)	(0.0100)	(0.0100)	(0.0135)	(0.0134)
$TCA \times sh\_tr_G$	-0.0508***	-0.0452***	-0.0276*	-0.0319*	-0.0822***	-0.0759***
	(0.0071)	(0.0070)	(0.0127)	(0.0133)	(0.0128)	(0.0129)
$Brexit \times sh\_tr_{both}$		-0.0448**		0.0139		-0.0414
		(0.0167)		(0.0166)		(0.0258)
$TCA \times sh\_tr_{both}$		-0.0394*		0.0304		-0.0438+
		(0.0178)		(0.0226)		(0.0255)
$Firm$	Y	Y	Y	Y	Y	Y
$Region \times Year$	Y	Y	Y	Y	Y	Y
$Sector \times Year$	Y	Y	Y	Y	Y	Y
N	239,666	239,661	235,131	235,126	239,435	239,430

Source: Own Computation. Dependent variable: Log Employment (Columns 1 and 2), Log average wage, measured as the ratio of wage bill and total employment (Columns 3 and 4), Log Sales (Columns 5 and 6). Standard errors are clustered at the industry level. TCA is a dummy variable indicating the period after 2020, $Brexit$ is a dummy variable indicating the period after 2016. tr_g is a dummy variable indicating if firm f is exposed to goods imports of intermediates from the EU in 2014. tr_{both} is a dummy variable indicating if firm f is exposed to goods and services imports of intermediates from the EU in 2014. Exposure measure is computed using I/O Table (Panel A) and share of EU imports in total sales (Panel B). $^{+}$ $(p < 0.1)$ * $(p < 0.05)$, ** $(p < 0.01)$, *** $(p < 0.001)$

the entry into force of the TCA in 2021: firms exposed to goods supply disruption experienced a 6.9% employment decline after the referendum and a further 4.9% decline after the TCA compared to firms not exposed. Using our share-based exposure measure instead of the I/O exposure measure (Panel B of Table 6) leads to the same qualitative conclusion, which is that the Brexit referendum led to a decrease in firm-level employment, which again intensified with

the TCA. Quantitatively, these effects are also broadly similar to the I/O based estimates, with an estimated 7.2 % decline after the referendum and a further 5 % decline after the TCA.

The fact that employment was affected prior to 2021 is consistent with the presence of uncertainty, anticipation, and exchange rate effects documented in the Brexit literature (see Section 2).

Column (2) of Table 6 further shows that the negative effects are more pronounced for firms that import both goods and services from the EU, with an additional 5% employment decline compared to firms who are only exposed to goods GVC disruptions. This suggests that these firms — which adjusted their imports less, as evidenced in the previous section — are bearing the economic costs associated with more difficult supply-chain adjustments.

Columns (3) and (4) of Table 6 (Panel A) examine the impact of GVC disruptions on the average firm-level wage, defined as the total wage bill divided by the number of employees, which serves as an imperfect proxy for worker-level earnings. The results contrast with the results for employment. Specifically, the average wage only appears to be negatively affected following the formal implementation of the TCA (Columns 3); and for firms importing both goods and services, this effect is, if anything, mitigated, as evidenced by the positive (if insignificant) coefficient on the $TCA \times tr_{both}$ interaction (column 4). We caution, however, that this discrepancy may reflect changes in the composition of firms' workforces, rather than actual wage effects. To disentangle this composition effect from the effect on individual wages, we will implement a worker-level analysis in the next section.

The final firm-level measure we analyse is firm sales in Columns (5) and (6) of Table 6 (Panel A). The results here are similar to the earlier results for employment, with negative effects already emerging after 2016, with additional effects in 2021; specifically, Firms exposed to goods supply disruption experienced an 8.5% sales decline after the referendum and a further 7.4% decline after the TCA compared to firms not exposed. As evidenced in Column (6), the effect of the TCA is again stronger for firms that are importing goods and services with an additional 7.3% sales decline compared to firms who are only exposed through goods.

All of these results are robust to controlling for firms' export status (see Tables A.6 - A.11 in the appendix). Frictions on exports to the EU do not seem to be affecting our estimates.

Finally, note that our findings on firms' performance are independent of the specific exposure measure used, as evidenced by the fact that the results in Table 6 (Panel B) are similar both in sign and magnitudes to those in Panel A.

Table 7 presents firm-level impacts for firms exposed to service GVC disruptions, as captured by our services exposure measure from Section 3. These impacts are very similar to the effects

Table 7: Impact of Brexit and the TCA, Combined Results Services Exposure

	I/O Table Exposure			Share Exposure		
	(1) Employment	(2) Average Wage	(3) Sales	(4) Employment	(5) Average Wage	(6) Sales
$Brexit \times tr_S$	-0.0727***	0.0142	-0.0847***			
	(0.0149)	(0.0155)	(0.0214)			
$TCA \times tr_S$	-0.0590***	0.0045	-0.0777***			
	(0.0109)	(0.0202)	(0.0224)			
$Brexit \times sh\_tr_S$				-0.0866***	0.0213	-0.1015***
				(0.0164)	(0.0151)	(0.0232)
$TCA \times sh\_tr_S$				-0.0687***	-0.0145	-0.0883***
				(0.0157)	(0.0221)	(0.0230)
$Firm$	Y	Y	Y	Y	Y	Y
$Region \times Year$	Y	Y	Y	Y	Y	Y
$Sector \times Year$	Y	Y	Y	Y	Y	Y
Controls for exports	Y	Y	Y	Y	Y	Y
N	250,382	245,710	249,977	240,628	236,059	240,386

Source: own computation. Dependent variable: log employment (Columns 1 and 4), Log Average Wage, measure as the ratio of wage bill and total employment (Columns 2 and 5), Log sales (Columns 3 and 6). Standard errors are clustered at the industry level. TCA is a dummy variable indicating the period after 2020, $Brexit$ is a dummy variable indicating the period after 2016. tr_s is a dummy variable indicating if firm f is exposed to services imports of intermediates from the EU in 2014. Exposure measure is computed using I/O Table (Columns 1-3) and share of EU imports in total sales (Columns 4-6). Regressions include the fixed effects indicated in the last four lines, and as well as controls for whether firms export to EU destinations. $^{+}$ $(p < 0.1)$ * $(p < 0.05)$, ** $(p < 0.01)$, *** $(p < 0.001)$

for firms exposed to goods for employment and sales (Table 7): Brexit and the TCA led to a significant decline of both employment and sales for exposed firms. If anything, the decline in sales is stronger in magnitude for firms exposed to services. This finding is surprising in the light of our earlier result that neither the Brexit referendum nor the TCA led to reductions in the UK imports of intermediate services. One interpretation of these findings is that firms were unable to find new services suppliers and hence had to absorb the cost increases brought about by new NTBs to services imports, explaining the negative firm-level outcomes we report in Table 7, as well as the lack of an import reaction documented in stylised fact 3.

Similar to the evidence for goods, we again do not find any significant effect of the TCA on average wages; but as discussed previously, this is an imperfect proxy which might confound composition and actual wage effects.

Overall, these results suggest that exposure to supply chain disruptions matters. Interestingly, the negative effects on employment and sales already emerge after 2016 and get stronger in 2021. This suggests that both effects operating through real increases in trade barriers mat-

ter for the observed deterioration in firm-level outcomes (post 2021), as well as a mixture of anticipation, uncertainty and exchange rates effects (post 2016).

Heterogeneity Analysis. We conclude our firm-level analysis by evaluating how the effects of GVC disruptions after the Brexit referendum and the TCA vary by firms' characteristics.

We do so using our share exposure measure, which leverages the full extent of the heterogeneity in the trade data. Specifically, we further ineract $(TREAT_{Pf} \times TCA_t)$ in Equation 6 with dummy variables indicating either: whether the firm is foreign owned by a EU company, exports goods to the EU or exports services to the EU . Since having a parent company in the EU may allow firms to leverage their multinational structure to source inputs or trade with EU affiliates, there are reasons to think that EU-owned firms may be less affected by the TCA. By contrast, firms exporting goods or services to the EU may be more affected by the TCA as they are likely to face new non-tariff barriers on the export side. The estimates for these triple interactions are presented in Figure 1.

None of the interactions are statistically significant, implying that differential effects exists neither for firms whose ultimate owner is in a EU country, nor for firms that are exposed to exports in goods or services to the EU. The only exception is for the impact on employment for firms exporting services, which have an additional loss of 2.9% in employment compared to the firms not exporting services towards the EU. The results are similar when using the I/O exposure measure instead (Figure A.2).

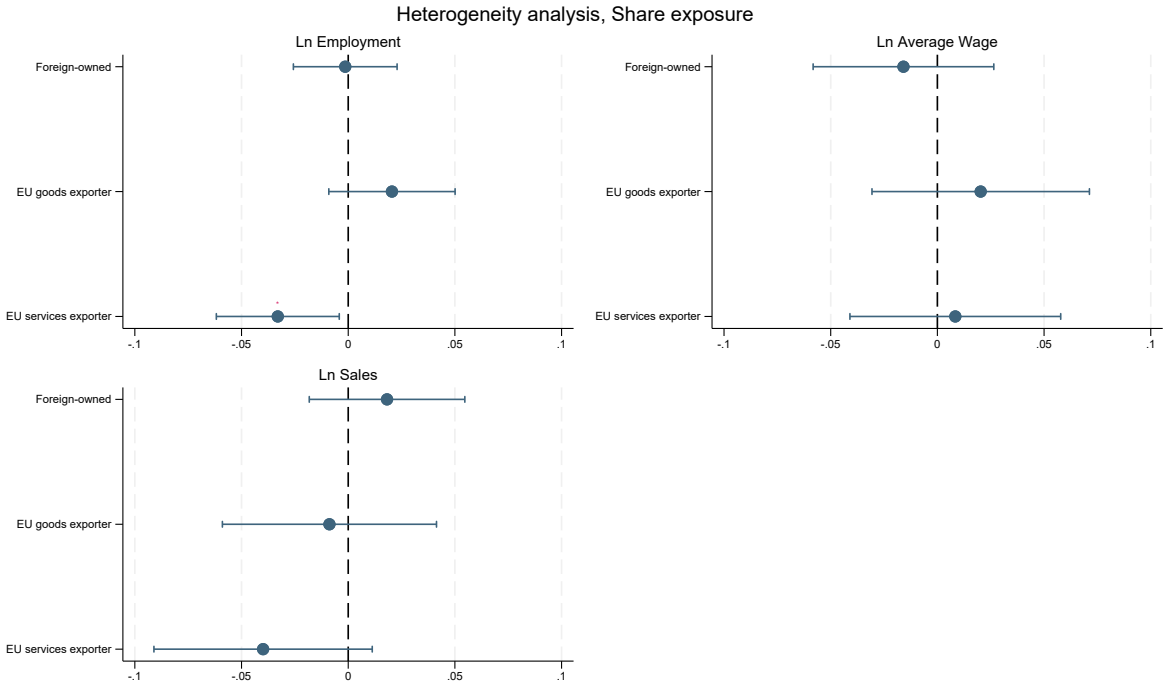
We next analyse heterogeity by firms' locations. Figure A.1 highlights that regions are exposed differently to goods and services intermediate inputs from the EU. The regions that overall are most exposed are the South East, and the Midlands (East and West). We expect that the average effects thus differ across regions. To formally investigate this, we estimate the following regression:

$$\begin{aligned}\ln(Y_{ft}) = \beta_0 + \beta_1 TREAT_{Gf} \times Brexit_t \times Region_f + \beta_2 TREAT_{G\&Sf} \times Brexit_t \times Region_f + \\ + \beta_3 TREAT_{Gf} \times TCA_t \times Region_f + \beta_4 TREAT_{G\&Sf} \times TCA_t \times Region_f + \\ + \gamma_f + \gamma_{jt} + \gamma_{rt} + \varepsilon_{ft}, \quad (7)\end{aligned}$$

Figure 2 reports the regional heterogeneity estimates for the TCA interactions (β_3 in the darker shade and β_4 in the lighter shade). After the TCA, firms exposed to goods imports experience employment declines of around 1-9% compared to non-expose firms. While statistical significance varies across regions, the point estimates are broadly similar.

The interaction with joint goods-and-services exposure indicates additional employment

Figure 1: Heterogeneity Analysis, Share exposure to goods intermediate inputs



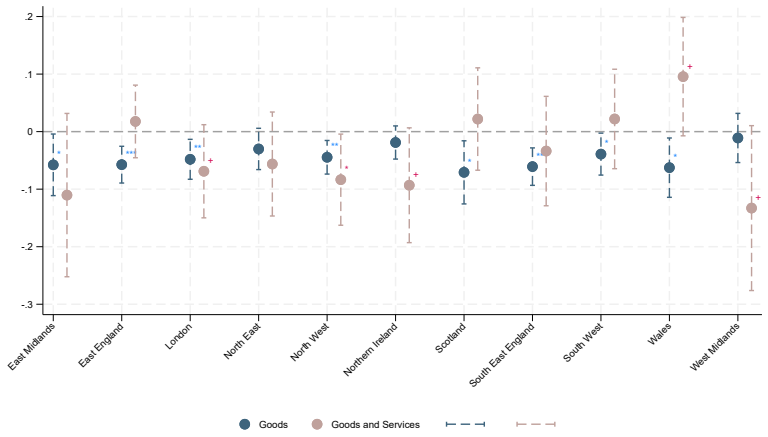
Source: Own Computation. Dependent variables are listed at the top of each graph and include: Log Employment, Log Average Wage and Log Sales. Figure shows the interaction coefficient ($TREAT_{Gf} \times TCA_t \times Characteristic_f$), where the characteristics is a dummy variable indicating if: a firm is an MNE with an EU country as ultimate owner ($foreign\ owned$); is exporting goods to the EU ($EU\ goods\ exporter$); is exporting services to the EU ($EU\ services\ exporter$). All regressions include an interaction term between goods exposure and Brexit ($Treat_{Gf} \times Brexit$), an interaction term between goods exposure and TCA ($Treat_{Gf} \times TCA$), and firm, sector-year, region-year fixed effects. an exposure to imports from the EU in goods and services for each UK region. Exposure measure is computed as the share of imports from the EU in total sales in 2014. $^{+}$ $(p < 0.1)$ * $(p < 0.05)$, ** $(p < 0.01)$, *** $(p < 0.001)$

losses of comparable magnitude in several regions, most notably London, the North West, Northern Ireland, and the West Midlands, suggesting that dual exposure amplifies the employment response. In Wales, by contrast, the services interaction offsets part of the negative effect associated with goods exposure.

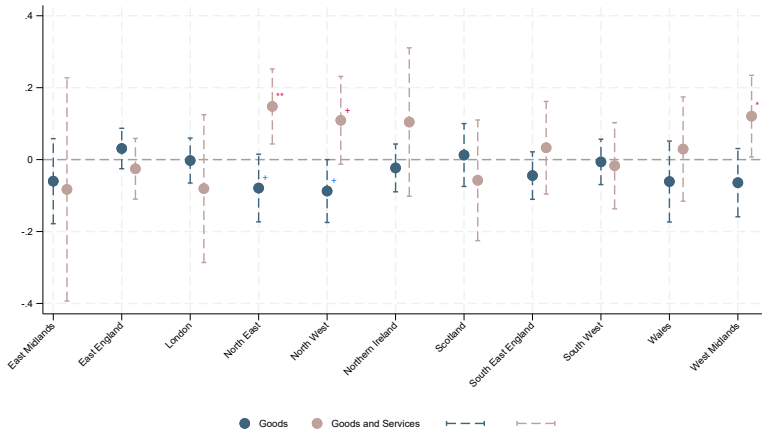
For average wages, declines are concentrated in the North East and the West. In both regions, these reductions are largely offset for firms that also trade services. Finally, sales decline strongly across all regions for goods-exposed firms, with point estimates reaching up to an 18% reduction relative to non-exposed firms.

Results based on the I/O exposure measure lead to similar qualitative conclusions, although the estimates for joint goods-and-services exposure are less precisely estimated (Figure A.3). This difference is consistent with how the measures are constructed: the share-based exposure captures firm-level services sourcing more effectively, whereas the I/O tables report services inputs at a more aggregated level (see Section 3).

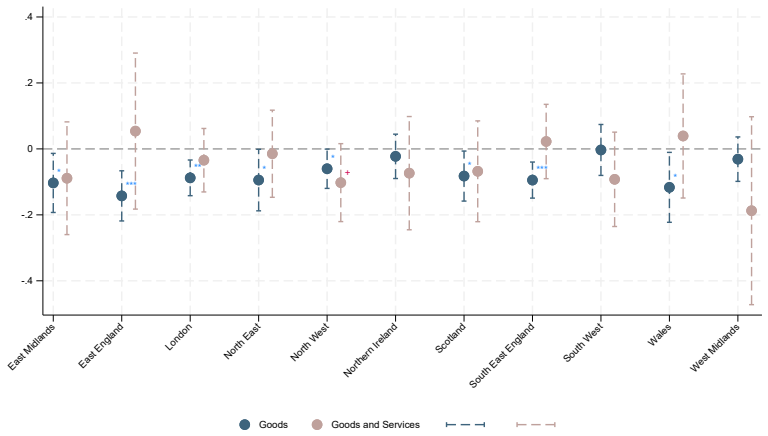
Figure 2: Regional Effects, Share Exposure



((a)) Employment



((b)) Wages



((c)) Sales

Source: Own Computation. Dependent variables are: Log Employment (Figure a), Log Average Wage (Figure b) and log sales (Figure c). Figure shows the interaction coefficient ($TREAT_{Gf} \times TCA_t \times Region_f$), where *Region* indicates the UK region firm f is located in. All regressions include an interaction term between goods exposure-Brexit- Region ($Treat_{Gf} \times Brexit \times Region_f$), interaction term between goods and services exposure-Brexit-Region ($Treat_{both f} \times Brexit \times Region_f$), and firm, sector-year, region-year fixed effects. Exposure measure is computed as the share of imports from the EU in total sales in 2014. $^{+}$ ($p < 0.1$) * ($p < 0.05$), ** ($p < 0.01$), *** ($p < 0.001$)

6.2 Worker-level analysis

Our results so far have relied on firm-level data from the ABS. We now turn to a worker-level analysis using the ASHE data described earlier. Using worker-level data has the advantage of allowing to disentangle worker-level effects from composition effects, which might affect the earlier firm-level results. This is particularly relevant for wages, where so far we have had to rely on a relatively crude proxy, the wage bill divided by the number of employees. This measure risks confusing true wage impacts with effects arising from changes in the composition of a firm's workforce.

To examine how the Brexit referendum and the implementation of the TCA affected workers, we estimate the following specification:

$$y_{it} = \beta_0 + \beta_1 \left(TREAT_{iPf} \times Brexit_t\right) + \beta_2 \left(TREAT_{iPf} \times TCA_t\right) + \Psi\Lambda_{it} + \gamma_f + \gamma_i + \gamma_t + \eta_{it}, \quad (8)$$

where y_{it} denotes either the log of weekly gross pay or total number of weekly hours worked by worker i at time t. The indicator $TREAT_{iPf}$ is defined at the firm level and equals 1 if the firm employing worker i is exposed to EU imports in dimension P (goods or services or both). As in our firm-level analysis, we define exposure as having a positive value for the exposure measure used.

Consistent with Mincer wage equations, the vector Λ_{it} includes time-varying worker characteristics such as age, occupation (used as a proxy for education), tenure in the current firm and its square (used as proxy for experience), as well as indicators for whether the worker remains in the same firm as in 2016 or 2020, to account for potential displacement after the Brexit referendum and the COVID-19 pandemic.

The specification includes firm fixed effects γ_f, worker fixed effects γ_i, and time fixed effects γ_t, which together control for unobserved firm heterogeneity, unobserved individual worker characteristics, and aggregate time shocks. We cluster standard errors at the worker level.

The coefficients of interest, β_1 and β_2, capture respectively the effect of the Brexit referendum and the additional impact of the TCA on workers employed in exposed firms.

Looking at hours worked first, we find that the TCA led to decreases in hours worked, consistent with our earlier findings for firm-level employment (Table 8, column 1). The effects are again stronger for workers employed at firms exposed to both goods and services disruptions (column 2).

Regarding wages, our results suggest that the initial Brexit shock actually led to an increase in wages (Table 8, column 4), although this is offset by a negative effect after the TCA. The overall effects is negative, and is again more pronounced for simultaneous exposure to goods and

Table 8: Worker-Level Results (I/O Exposure)

	(1)	(2)	(3)	(4)	(5)	(6)
	Total hours worked			Weekly gross wage, log		
Brexit x tr_G	-0.0432	-0.2264***		0.0077***	0.0080***	
	(0.0353)	(0.0374)		(0.0019)	(0.0021)	
TCA x tr_G	-0.1241**	-0.0036		-0.0147***	-0.0111***	
	(0.0467)	(0.0495)		(0.0027)	(0.0030)	
Brexit x tr_both		0.7883***			-0.0018	
		(0.1064)			(0.0040)	
TCA x tr_both		-0.5082***			-0.0161**	
		(0.1242)			(0.0058)	
Brexit x tr_S			0.3907***			0.0015
			(0.0685)			(0.0031)
TCA x tr_S			-0.3550***			-0.0254***
			(0.0821)			(0.0045)
Worker age	-0.0083***	-0.0083***	-0.0083***	0.0041***	0.0041***	0.0041***
	(0.0009)	(0.0009)	(0.0009)	(0.0000)	(0.0000)	(0.0000)
Years in the same firm	0.0066*	0.0066*	0.0067*	0.0150***	0.0150***	0.0150***
	(0.0031)	(0.0031)	(0.0031)	(0.0002)	(0.0002)	(0.0002)
Years in the same firm, square	-0.0002**	-0.0002**	-0.0002**	-0.0003***	-0.0003***	-0.0003***
	(0.0001)	(0.0001)	(0.0001)	(0.0000)	(0.0000)	(0.0000)
Same firm as in 2016	0.0960	0.0730	0.0750	0.0722+	0.0727+	0.0729+
	(0.5662)	(0.5663)	(0.5661)	(0.0389)	(0.0389)	(0.0389)
Same firm as in 2021	-0.1576	-0.1674	-0.1729	-0.0040	-0.0046	-0.0058
	(0.6452)	(0.6469)	(0.6466)	(0.0386)	(0.0385)	(0.0384)
Individual FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Enterprise FE	Y	Y	Y	Y	Y	Y
Occupation FE	Y	Y	Y	Y	Y	Y
N	1,012,104	1,012,104	1,012,104	1,011,809	1,011,809	1,011,809

Source: Own Computation. Dependent variables: total hours worked (Columns 1-3) and Log weekly gross wages (Columns 4-6). Standard errors are clustered at worker level. TCA is a dummy variable indicating the period after 2020, $Brexit$ is a dummy variable indicating the period after 2016. tr_G is a dummy variable indicating if firm f is exposed to goods imports of intermediates from the EU in 2014. tr_{both} is a dummy variable indicating if firm f is exposed to goods and services imports of intermediates from the EU in 2014. tr_S is a dummy variable indicating if firm f is exposed to services imports of intermediates from the EU in 2014. Exposure measure is computed using I/O Tables in 2014. All specification control for worker age, tenure in the current firm and its square (used as proxy for experience), and indicators for whether the worker remains in the same firm as in 2016 or 2020. $^{+}$ ($p < 0.1$) * ($p < 0.05$), ** ($p < 0.01$), *** ($p < 0.001$)

services import disruptions, as shown by the negative coefficient on the $TCA \times tr_{both}$ interaction. Overall, our worker-level results thus broadly confirm the conclusion from the firm-level analysis that Brexit and the TCA had negative impacts on UK firms and workers.

Finally, the estimates on the worker controls are broadly in line with standard patterns in the labour literature. Older workers earn higher weekly pay but work fewer hours on average. Tenure in the current firm is positively associated with pay and hours, with diminishing marginal effects once tenure is included with a quadratic term. In addition, the indicator for remaining in the same firm as in 2016 (*Same firm as in* 2016) is positively associated with weekly pay, suggesting that conditional on job retention, more stable workers experienced higher earnings in the post-referendum period.

Using worker-level data also allows us to investigate how the effects of supply chain disruptions vary across worker groups. We do so by interacting the treatment terms in Equation 8 with worker characteristics such as sex, age, occupation, and macro sector of employment. To conserve space, we report and discuss primarily the interaction terms involving the TCA, which capture the effects after the new UK-EU trade agreement came into force.

First, we document sizeable gender differences. Female workers are more affected by the TCA disruption than male workers. Specifically, the TCA shock reduced their hours worked by about one hour, and their wages by about 12 % (Table 9, Column 1)). Male workers only experience a reduction of 0.09 hours and a wage decrease of about 1.5 %. These effects are larger when the employing firm is exposed to both EU goods and services imports (Table 9, Columns 3-4).

Turning to age heterogeneity, younger workers (below 35) experience the largest losses. The TCA shock reduces their hours worked by about 0.3, and their wage by 8.5 %. By contrast, older workers do not observe a significant decrease in hours worked, and their wage only decreases by around 2 %. As before, these negative effects are amplified for workers employed in firms exposed to both EU goods and services imports (Columns 3 and 4).

All of the above estimates are identified net of observed worker characteristics and the fixed effects described above, so the patterns reflect differential changes in outcomes rather than differences in composition across worker groups. The results are similar when using the exposure measure constructed with I/O Tables, although we lose part of the statistical significance of the joint exposure for goods and services (Table A.13).

In the final step, we study heterogeneity in the worker-level effects by occupation and by macro sector of employment, again focussing on TCA effects.

The occupation-level results show meaningful differences across groups. Workers in elementary occupations employed at firms exposed to EU intermediate goods imports work slightly more hours per week (Figure 3). A similar increase is observed for administrative occupations

Table 9: Worker-Level Heterogeneity by Sex and Age, Share Exposure

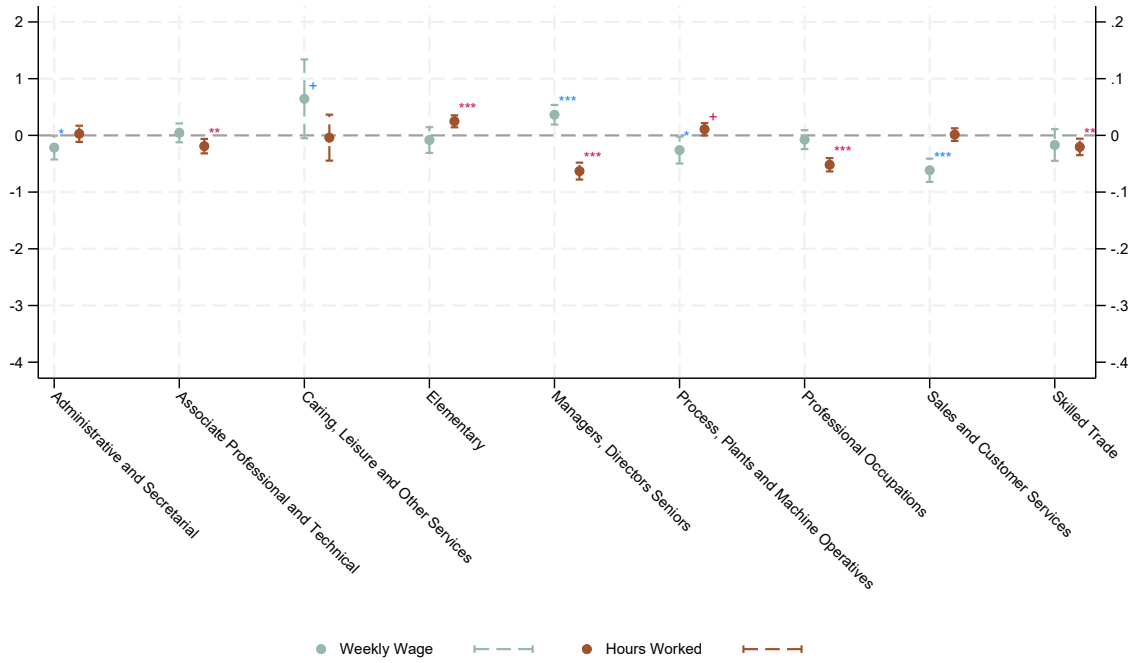
	(1)	(2)	(3)	(4)
	Goods		Goods & Services	
Panel A: Total hours worked				
$TCA \times sh\_treat\#Male$	-0.0897^{+}		-0.5008***	
	(0.0537)		(0.1190)	
$TCA \times sh\_treat\#Female$	-1.0248***		-1.3060***	
	(0.0650)		(0.1340)	
$TCA \times sh\_treat\#Old$		-0.0720		-0.4040***
		(0.0532)		(0.1148)
$TCA \times sh\_treat\#Young$		-0.2920***		-0.7298***
		(0.0706)		(0.1469)
N	962,991	962,991	962,991	962,991
Panel B: Weekly gross wage, log				
$TCA \times sh\_treat\#Male$	-0.0153***		-0.0325***	
	(0.0030)		(0.0055)	
$TCA \times sh\_treat\#Female$	-0.1214***		-0.1286***	
	(0.0042)		(0.0086)	
$TCA \times sh\_treat\#Old$		-0.0224***		-0.0294***
		(0.0031)		(0.0057)
$TCA \times sh\_treat\#Young$		-0.0850***		-0.1134***
		(0.0042)		(0.0078)
N	962,704	962,704	962,704	962,704
Individual FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Enterprise FE	Y	Y	Y	Y
Occupation FE	Y	Y	Y	Y
Worker controls	Y	Y	Y	Y

Source: own computations. Dependent variable: Total hours worked (Panel A) and Log weekly gross wages (Panel B). Standard errors are clustered at worker level. TCA is a dummy variable indicating the period after 2020.sh_{treat} indicate the generic treatment that is either a dummy variable indicating if firm f is exposed to goods imports of intermediates from the EU in 2014 (Columns 1-2) or a dummy variable indicating if firm f is exposed to both goods and services imports of intermediates from the EU in 2014 (Columns 3 and 4). Exposure measure is computed using the share of imports from the EU in total sales in 2014. *Worker controls* include worker age, tenure in the current firm and its square (used as proxy for experience), and indicators for whether the worker remains in the same firm as in 2016 or 2020. $^{+}$ $(p < 0.1)$ * $(p < 0.05)$, ** $(p < 0.01)$, *** $(p < 0.001)$

when firms are exposed to both goods and services (Figure 4). By contrast, several other occupations experience reductions in hours worked, especially when firms are jointly exposed to goods and services.

These patterns are reflected in weekly earnings. With the exception of managers and senior directors, workers across most occupations experience declines in weekly wages when employed in firms exposed to EU intermediate goods imports (Figure 3), and these declines are generally

Figure 3: Heterogeneity Analysis Workers Occupation, Goods exposure

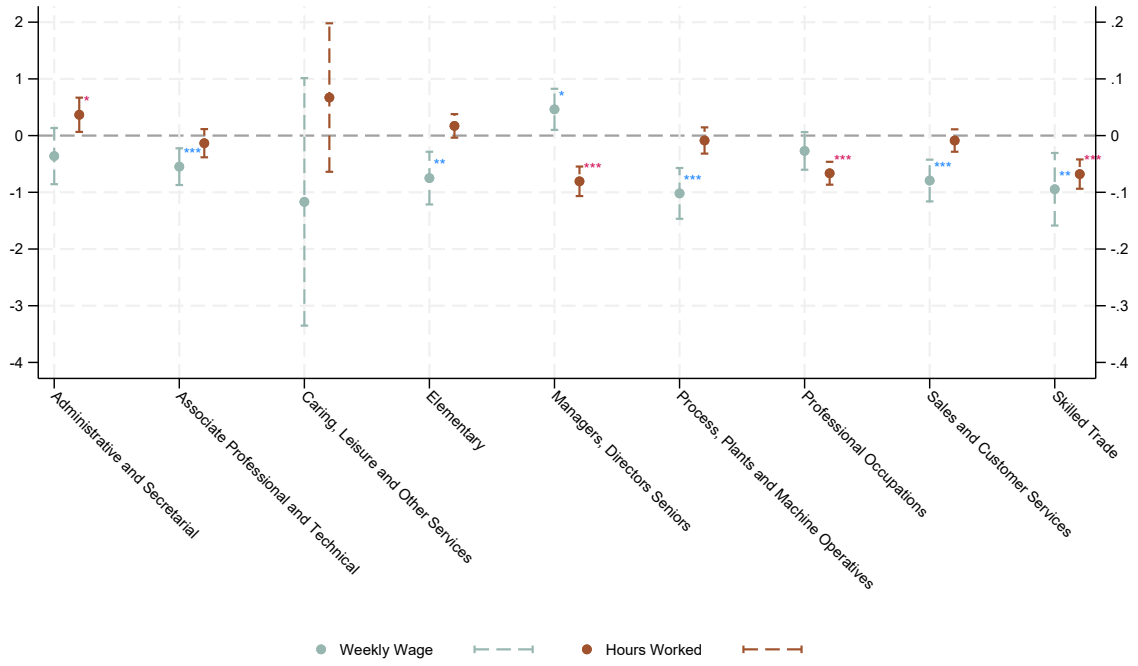


Source: own computation. Dependent variables are: hours worked, log weekly wage. Figure shows the interaction coefficient ($TREAT_{Gf} \times TCA_t \times Occupation_i$), where $Occupation$ indicates the occupation of worker i. Regressions include an interaction term between goods exposure-Brexit- Occupation ($Treat_{Gf} \times Brexit \times Occupation_i$). Exposure measure is computed using share of imports from the EU in total sales in 2014.Regressions include workers controls (worker age, tenure in the current firm and its square (used as proxy for experience), and indicators for whether the worker remains in the same firm as in 2016 or 2020); firm, worker, year fixed effects. $^{+}$ $(p < 0.1)$ * $(p < 0.05)$, ** $(p < 0.01)$, *** $(p < 0.001)$

larger when firms are also exposed to services (Figure 4).

By contrast, we find little evidence of systematic heterogeneity across macro sectors of employment, both when exposure is measured using the import-share measure (Figure A.6) and when using the I/O-based measure (Figure A.5).

Figure 4: Heterogeneity Analysis Workers Occupation, Goods and Services Share exposure



Source: own computation. Dependent variables are: hours worked and log weekly wage. Figure shows the interaction coefficient ($TREAT_{bothf} \times TCA_t \times Occupation_i$), where $Occupation$ indicates the occupation of worker i. Regressions include an interaction term between goods exposure-Brexit- Occupation ($Treat_{bothf} \times Brexit \times Occupation_i$). Exposure measure is computed using share of imports from the EU in total sales in 2014. Regressions include Workers controls (worker age, tenure in the current firm and its square (used as proxy for experience), and indicators for whether the worker remains in the same firm as in 2016 or 2020); firm, worker, year fixed effects. $^{+}$ $(p < 0.1)$ * $(p < 0.05)$, ** $(p < 0.01)$, *** $(p < 0.001)$

7 Conclusion

In this paper, we have analysed the firm-level effects of the Brexit referendum and the EU-UK Trade and Cooperation agreement (TCA) working through supply chain disruptions. We first documented that the TCA did indeed reduce firm-level imports of intermediate goods from the EU, in line with previous findings in the literature. We then constructed a measure of firm-level exposure to both goods and service supply chain disruptions. Using these measures in a simple difference-in-differences regression analysis revealed that both goods and services supply chain disruptions had a significant negative impact on firm-level variables such as employment and turnover, confirming that the TCA did indeed cause a negative supply chain shock. Interestingly, this effects often materialised ahead of the actual entry into force of the TCA in 2021, consistent with other findings in the Brexit literature that uncertainty, anticipation and exchange rate effects affected UK economic activity soon after the Brexit referendum in 2016. However, our results also show that the TCA added to these initial negative effects, worsening the overall economic impact of Brexit.

We complemented our firm-level analysis with an analysis of worker-level outcomes, which broadly confirmed the negative effects found in the firm-level analysis, but also demonstrated that the effects of the TCA-induced supply chain disruptions were highly heterogeneous across different groups of workers.

Overall, our results reinforce the message of existing work in the Brexit literature that the negative economic effects of the Brexit referendum continue to accumulate, with UK economic activity having been hit by both the 2016 referendum itself, as well as by the UK's exit from the EU's single market in 2021.

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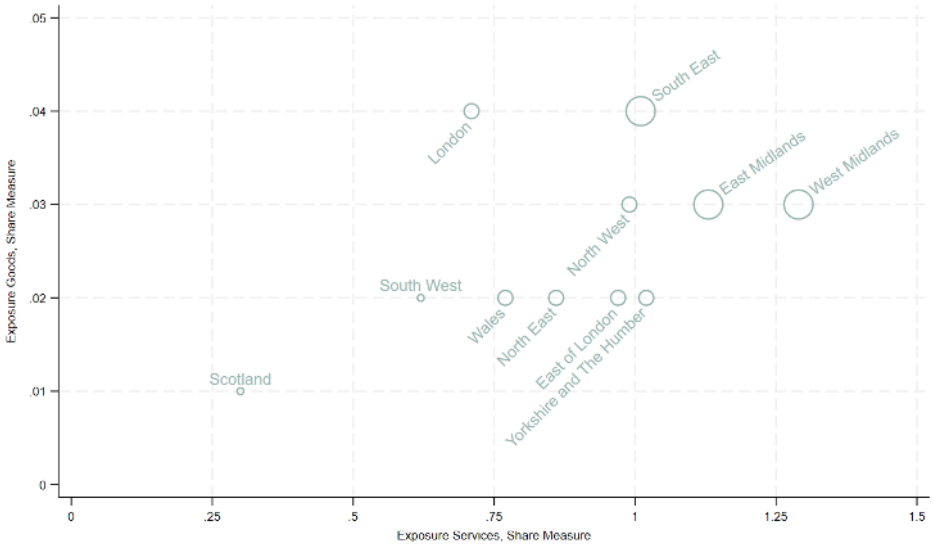
A Additional Figures and Tables

Table A.1: Summary Statistics: Workers (ASHE)

Panel A: Worker and Firm Characteristics		
	Mean	SD
Employment (Enterprise)	12,275.7	(33,649.6)
Gross Weekly Pay (£)	633.335	(536.053)
Total Hours Worked	39.1478	(6.92947)
Worker Age	41.0004	(12.3749)
Female Workers (%)	0.17708	(0.20779)
Workers in Manufacturing (%)	0.01384	(0.03793)
Workers in Wholesale and Retail (%)	0.00535	(0.01908)
Workers in Services (%)	0.44648	(0.31468)
Panel B: Occupational Composition		
Managers, Directors and Seniors (%)	0.01073	(0.03164)
Professional Occupations (%)	0.04048	(0.08103)
Associate Professional and Technical (%)	0.02245	(0.05352)
Administrative and Secretarial (%)	0.01713	(0.04416)
Skilled Trade (%)	0.00664	(0.02230)
Caring, Leisure and Other Services (%)	0.00574	(0.02009)
Sales and Customer Services (%)	0.00481	(0.01765)
Process, Plant and Machine Operatives (%)	0.00621	(0.02124)
Elementary Occupations (%)	0.01215	(0.03466)
Observations	989,196	
Unweighted Number of Workers	325,810	

Source: ASHE (ONS). Table shows means and standard deviation of variables of interest. Sectors are defined as follows: Manufacturing (2-digit Sic2007 between 10 and 33), Wholesale and Retail (2-digit Sic2007 between 45 and 47), Services (2-digit Sic2007 above 49). Occupation classification follows SOC 2010 macro categories.

Figure A.1: Regional Exposure



Source: Own Computation. Figure shows the exposure to imports from the EU in goods and services for each UK region. Exposure measure is computed as the share of imports from the EU on total sales in 2014 using information from the IDBR-TiG (for goods trade) and ITIS (for services trade). The size of each label corresponds to the relative total exposure share (as the sum of exposure in goods and services).

Table A.2: Summary Statistics Goods and Services Traders

	(1) Exporters	(2) Importers
Employment, trade data	728.5579	925.0316
	(7,036.716)	(7,900.362)
Turnover, trade data	241,068.60	265,055.00
	(1,821,106)	(1,671,325)
Goods Exports ('000)	29,585.87	
	(335,600.6)	
Goods Imports ('000)		31,580.71
		(207,597.3)
Services Imports ('000)		17,791.58
		(129,170.7)
Services Exports ('000)	31,374.28	
	(164,486.2)	
Goods Exports from the EU (%)	0.3158	
	(0.3761)	
Goods Imports from the EU (%)		0.3044
		(0.3951)
Services Imports from the EU (%)		0.5171
		(0.3903)
Services Exports from the EU (%)	0.4809	
	(0.3758)	
Manufacturing Firms (%)	0.0528	0.0566
	(0.0845)	(0.0864)
Wholesale and Retails Firms (%)	0.0305	0.0353
	(0.0871)	(0.0927)
Services Firms (%)	0.1606	0.1470
	(0.1583)	(0.1576)
Observation	27,215	28,226

Source: TiG, ITIS, ABS (ONS). Column 1 shows the summary statistics of the combined TiG and ITIS datasets. Column 2 shows the summary statistics for the firms contained in the ABS. Column 3 shows the summary statistics for the perfect merging of the firms in the ABS, TiG and ITIS - this excludes the firms in the ABS not trading and firms in the TiG-ITIS not surveyed in the ABS.

Table A.3: Impact of Brexit and the TCA on Services Imports

	(1)	(2)
$TCA \times EU$	0.0014	
	(0.0249)	
$Brexit \times EU$	0.0156	
	(0.0292)	
$Goods\ Imports, Log$		0.0283**
		(0.0098)
$TCA \times EU = 1 \times Goods\ Imports, Log$		-0.0135
		(0.0110)
$Firm \times Year$	Y	Y
$Firm \times Country$	Y	Y
$Country \times Year$		Y
N	382,160	36,382

Source: Own Computation. Standard errors in parentheses are clustered at the country level. $^{+}$ ($p < 0.1$) * ($p < 0.05$), ** ($p < 0.01$), *** ($p < 0.001$)

Table A.4: Exposure measure by Macro Industry 2014

	(1)	(2)	(3)	(4)
	I/O exposure		Share exposure	
Goods	Services	Goods	Services	
Panel: Manufacturing				
Mean	.0063447	000024	.0411006	.0013837
	(.0241265)	(.0004667)	(.107991)	(.0143385)
No 0s	.0222314	.0003791	.1516112	.0285789
	(.0410665)	(.0018203)	(.162064)	(.0589072)
N	81340	81340	81340	81340
N (No 0s)	23214	5139	23214	5139
Panel: Construction				
Mean	.0000857	.000029	.0005594	.0001073
	(.0006396)	(.0005846)	(.0114477)	(.0053537)
No 0s	.002318	.002905	.018955	.0380911
	(.0024295)	(.0050964)	(.0640327)	(.0944153)
N	16801	16801	16801	16801
N (No 0s)	621	168	621	168
Panel: Wholesale and retail				
Mean	.0008986	.0000327	.054546	.000882
	(.0067711)	(.0004617)	(.1506181)	(.0145085)
No 0s	.003612	.0009727	.2332476	.0412966
	(.0132097)	(.0023313)	(.2352212)	(.0905145)
N	59835	59835	59835	59835
N (No 0s)	14886	2010	14886	2010
Panel: Services				
Mean	.0001567	.0002699	.0017608	.0004974
	(.003033)	(.0043672)	(.02572)	(.009904)
No 0s	.0022439	.0058226	.0554697	.0613586
	(.0112705)	(.0194727)	(.1336529)	(.0914906)
N	222865	222865	222865	222865
N (No 0s)	15567	10330	15567	10330

Source: Own Computation. Column 1 shows the summary statistics for the exposure measure separately for goods and services. Columns 2 and 4 show the summary statistics of the exposure measure for goods and services when we exclude the zeros. The reference year is 2014. All the summary statistics refer to Macro-Industry Manufacturing (Sic 2007 classification between 10000 and 33000), Wholesale and Retail (Sic 2007 classification between 45000 and 47000) and Services (Sic 2007 classification above 49000).

Table A.5: Summary Statistics by Treatment Group

	(1) Exposed (Goods)	(2) Non Exposed (Goods)	(3) Exposed (Services)	(4) Non Exposed (Services)
Panel A: Exposure using I/O table				
Employment	855.034	200.78	1258.222	245.8911
	(5566.118)	(1420.752)	(7796.894)	(1915.583)
Wage Bill	31334.92	6799.228	57996.94	8142.837
	(136411)	(46885.57)	(199148.8)	(54678.8)
Sales	245658.4	39138.44	427134.7	51743.02
	(1351008)	(644138.6)	(2424996)	(645272.6)
N	50,767	393,560	13010	431,317
Panel B: Exposure using share of EU imports on total sales				
Employment	828.6495	187.58	1044.824	240.4199
	(5142.521)	(1401.277)	(6482.046)	(1915.787)
Wage Bill	31999.13	6041.254	48867.64	7810.417
	(129281.3)	(45181.08)	(170475.1)	(54062.63)
Sales	244259.8	33869.86	367997.3	48801.59
	(1588303)	(515208.8)	(2482674)	(566650.7)
N	60,960	383,367	19,395	424,932

Source: Own Computation. Summary statistics of firms' outcome variables by exposure group (treatment group). Firms are considered treated if having a good exposure measure from 2014 ("Exposed (Good)") or a service exposure measure from 2014 ("Exposed (Services)") greater than zero. Panel A computes the exposure measure using I/O tables while Panel B computes the exposure measure as share of EU imports on total sales.

Table A.6: Impact of Brexit and the TCA on Firm Employment, I/O Table Exposure

	(1)	(2)	(3)	(4)	(5)	(6)
$Brexit \times tr_G$	-0.0691***	-0.0679***			-0.0619***	-0.0611***
	(0.0087)	(0.0086)			(0.0083)	(0.0083)
$TCA \times tr_G$	-0.0485***	-0.0518***			-0.0430***	-0.0467***
	(0.0069)	(0.0069)			(0.0066)	(0.0066)
$Brexit \times tr_{both}$			-0.0849***	-0.0816***	-0.0500**	-0.0471**
			(0.0188)	(0.0187)	(0.0182)	(0.0181)
$TCA \times tr_{both}$			-0.0731***	-0.0729***	-0.0440**	-0.0412*
			(0.0173)	(0.0172)	(0.0169)	(0.0168)
$Exporter_{EU,G} = 1$		0.0646***		0.0632***		0.0645***
		(0.0067)		(0.0068)		(0.0068)
$Exporter_{EU,S} = 1$		0.0370***		0.0331***		0.0350***
		(0.0082)		(0.0082)		(0.0081)
$Firm$	Y	Y	Y	Y	Y	Y
$Region \times Year$	Y	Y	Y	Y	Y	Y
$Sector \times Year$	Y	Y	Y	Y	Y	Y
N	250,382	250,382	250,382	250,382	250,382	250,382

Source: Own Computation. Dependent variable: Log Employment. Standard errors are clustered at the industry level. TCA is a dummy variable indicating the period after 2020, $Brexit$ is a dummy variable indicating the period after 2016. tr_G is a dummy variable indicating if firm f is exposed to goods imports of intermediates from the EU in 2014. tr_both is a dummy variable indicating if firm f is exposed to goods and services imports of intermediates from the EU in 2014. Exposure measure is computed using I/O Table. $Exporter_{EU,G}$ is a dummy variable taking value 1 if the firm is exporting goods towards the EU; $Exporter_{EU,S}$ is a dummy variable taking value 1 if the firm is exporting services towards the EU $^{+}$ $(p < 0.1)$ * $(p < 0.05)$, ** $(p < 0.01)$, *** $(p < 0.001)$

Table A.7: Impact of Brexit and the TCA on Firm Average Wage, I/O Table Exposure

	(1)	(2)	(3)	(4)	(5)	(6)
$Brexit \times tr_G$	0.0107	0.0105			0.0077	0.0074
	(0.0097)	(0.0098)			(0.0103)	(0.0103)
$TCA \times tr_G$	-0.0262*	-0.0258*			-0.0313*	-0.0310*
	(0.0126)	(0.0126)			(0.0129)	(0.0129)
$Brexit \times tr_{both}$			0.0256	0.0261	0.0204	0.0210
			(0.0192)	(0.0193)	(0.0202)	(0.0204)
$TCA \times tr_{both}$			0.0205	0.0214	0.0415^{+}	0.0421^{+}
			(0.0239)	(0.0238)	(0.0241)	(0.0240)
$Exporter_{EU,G} = 1$		-0.0064		-0.0074		-0.0063
		(0.0092)		(0.0092)		(0.0091)
$Exporter_{EU,S} = 1$		0.0072		0.0085		0.0086
		(0.0109)		(0.0109)		(0.0109)
$Firm$	Y	Y	Y	Y	Y	Y
$Region \times Year$	Y	Y	Y	Y	Y	Y
$Sector \times Year$	Y	Y	Y	Y	Y	Y
N	245,710	245,710	245,710	245,710	245,710	245,710

Source: Own Computation. Dependent variable: Log Average Wage. Standard errors are clustered at the industry level. TCA is a dummy variable indicating the period after 2020, $Brexit$ is a dummy variable indicating the period after 2016. tr_G is a dummy variable indicating if firm f is exposed to goods imports of intermediates from the EU in 2014. tr_both is a dummy variable indicating if firm f is exposed to goods and services imports of intermediates from the EU in 2014. Exposure measure is computed using I/O Table. $Exporter_{EU,G}$ is a dummy variable taking value 1 if the firm is exporting goods towards the EU; $Exporter_{EU,S}$ is a dummy variable taking value 1 if the firm is exporting services towards the EU $^{+}$ $(p < 0.1)$ * $(p < 0.05)$, ** $(p < 0.01)$, *** $(p < 0.001)$

Table A.8: Impact of Brexit and the TCA on Firm Sales, I/O Table Exposure

	(1)	(2)	(3)	(4)	(5)	(6)
$Brexit \times tr_G$	-0.0853***	-0.0841***			-0.0781***	-0.0774***
	(0.0145)	(0.0144)			(0.0141)	(0.0140)
$TCA \times tr_G$	-0.0737***	-0.0773***			-0.0647***	-0.0687***
	(0.0138)	(0.0138)			(0.0137)	(0.0138)
$Brexit \times tr_{both}$			-0.0927**	-0.0887**	-0.0487	-0.0451
			(0.0321)	(0.0320)	(0.0315)	(0.0315)
$TCA \times tr_{both}$			-0.1164***	-0.1157***	-0.0726*	-0.0691*
			(0.0290)	(0.0289)	(0.0285)	(0.0285)
$Exporter_{EU,G} = 1$		0.0703***		0.0682***		0.0702***
		(0.0112)		(0.0111)		(0.0112)
$Exporter_{EU,S} = 1$		0.0472***		0.0423**		0.0447***
		(0.0129)		(0.0130)		(0.0130)
$Firm$	Y	Y	Y	Y	Y	Y
$Region \times Year$	Y	Y	Y	Y	Y	Y
$Sector \times Year$	Y	Y	Y	Y	Y	Y
N	249,977	249,977	249,977	249,977	249,977	249,977

Source: Own Computation. Dependent variable: Log Sales. Standard errors are clustered at the industry level. TCA is a dummy variable indicating the period after 2020, $Brexit$ is a dummy variable indicating the period after 2016. tr_G is a dummy variable indicating if firm f is exposed to goods imports of intermediates from the EU in 2014. tr_both is a dummy variable indicating if firm f is exposed to goods and services imports of intermediates from the EU in 2014. Exposure measure is computed using I/O Table. $Exporter_{EU,G}$ is a dummy variable taking value 1 if the firm is exporting goods towards the EU; $Exporter_{EU,S}$ is a dummy variable taking value 1 if the firm is exporting services towards the EU $^{+}$ $(p < 0.1)$ * $(p < 0.05)$, ** $(p < 0.01)$, *** $(p < 0.001)$

Table A.9: Impact of Brexit and the TCA on Firm Employment, Share Exposure

	(1)	(2)	(3)	(4)	(5)	(6)
$Brexit \times sh\_tr_G$	-0.0720***	-0.0707***			-0.0649***	-0.0639***
	(0.0088)	(0.0087)			(0.0085)	(0.0084)
$TCA \times sh\_tr_G$	-0.0508***	-0.0539***			-0.0452***	-0.0487***
	(0.0071)	(0.0071)			(0.0070)	(0.0071)
$Brexit \times sh\_tr_{both}$			-0.0807***	-0.0782***	-0.0448**	-0.0429**
			(0.0173)	(0.0171)	(0.0167)	(0.0165)
$TCA \times sh\_tr_{both}$			-0.0697***	-0.0697***	-0.0394*	-0.0369*
			(0.0176)	(0.0175)	(0.0178)	(0.0177)
$Exporter_{EU,G} = 1$		0.0663***		0.0650***		0.0663***
		(0.0072)		(0.0072)		(0.0072)
$Exporter_{EU,S} = 1$		0.0267**		0.0223*		0.0241**
		(0.0087)		(0.0086)		(0.0086)
$Firm$	Y	Y	Y	Y	Y	Y
$Region \times Year$	Y	Y	Y	Y	Y	Y
$Sector \times Year$	Y	Y	Y	Y	Y	Y
N	239,666	239,666	239,661	239,661	239,661	239,661

Source: Own Computation. Dependent variable: Log Employment. Standard errors are clustered at the industry level. TCA is a dummy variable indicating the period after 2020, $Brexit$ is a dummy variable indicating the period after 2016. tr_G is a dummy variable indicating if firm f is exposed to goods imports of intermediates from the EU in 2014. tr_both is a dummy variable indicating if firm f is exposed to goods and services imports of intermediates from the EU in 2014. Exposure measure is computed using Share of imports from the EU on total sales in 2014. $Exporter_{EU,G}$ is a dummy variable taking value 1 if the firm is exporting goods towards the EU; $Exporter_{EU,S}$ is a dummy variable taking value 1 if the firm is exporting services towards the EU $^{+}$ $(p < 0.1)$ * $(p < 0.05)$, ** $(p < 0.01)$, *** $(p < 0.001)$

Table A.10: Impact of Brexit and the TCA on Firm Average Wage, Share Exposure

	(1)	(2)	(3)	(4)	(5)	(6)
$Brexit \times sh\_tr_G$	0.0071	0.0070			0.0048	0.0046
	(0.0100)	(0.0100)			(0.0100)	(0.0101)
$TCA \times sh\_tr_G$	-0.0276*	-0.0272*			-0.0319*	-0.0316*
	(0.0127)	(0.0127)			(0.0133)	(0.0132)
$Brexit \times sh\_tr_{both}$			0.0175	0.0180	0.0139	0.0146
			(0.0166)	(0.0167)	(0.0166)	(0.0167)
$TCA \times sh\_tr_{both}$			0.0093	0.0103	0.0304	0.0312
			(0.0218)	(0.0217)	(0.0226)	(0.0224)
$Exporter_{EU,G} = 1$		-0.0065		-0.0075		-0.0065
		(0.0096)		(0.0096)		(0.0096)
$Exporter_{EU,S} = 1$		0.0072		0.0085		0.0088
		(0.0116)		(0.0116)		(0.0116)
$Firm$	Y	Y	Y	Y	Y	Y
$Region \times Year$	Y	Y	Y	Y	Y	Y
$Sector \times Year$	Y	Y	Y	Y	Y	Y
N	235,131	235,131	235,126	235,126	235,126	235,126

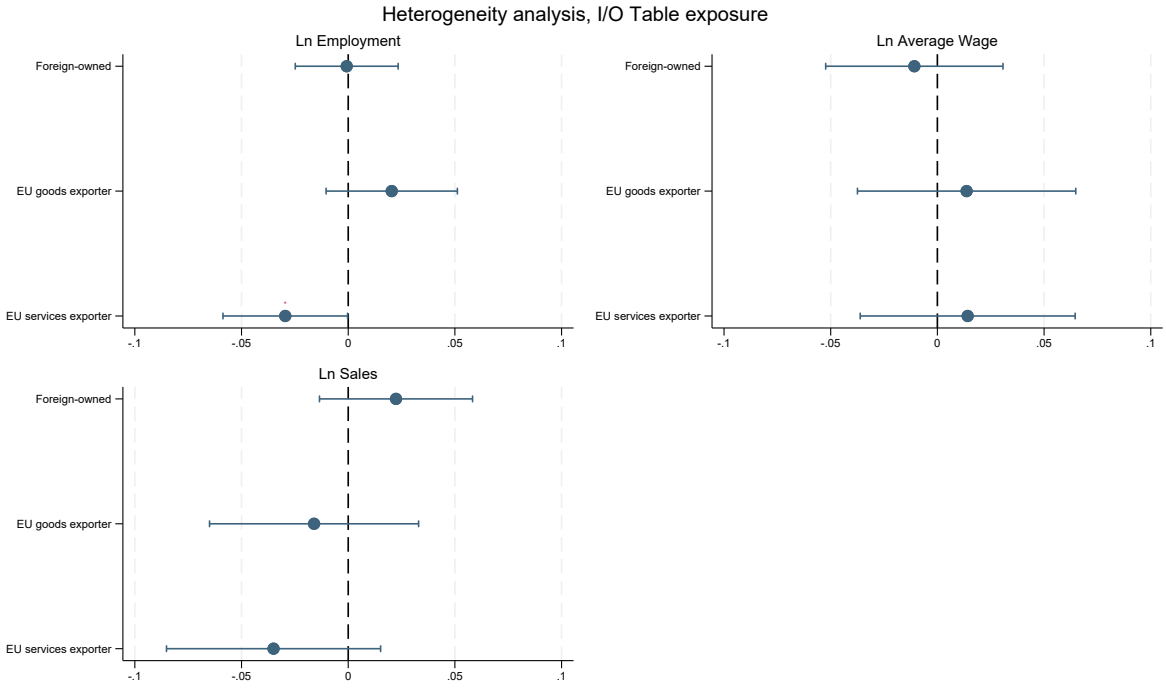
Source: Own Computation. Dependent variable: Log Average Wage. Standard errors are clustered at the industry level. TCA is a dummy variable indicating the period after 2020, $Brexit$ is a dummy variable indicating the period after 2016. tr_G is a dummy variable indicating if firm f is exposed to goods imports of intermediates from the EU in 2014. tr_both is a dummy variable indicating if firm f is exposed to goods and services imports of intermediates from the EU in 2014. Exposure measure is computed using Share of imports from the EU on total sales in 2014. $Exporter_{EU,G}$ is a dummy variable taking value 1 if the firm is exporting goods towards the EU; $Exporter_{EU,S}$ is a dummy variable taking value 1 if the firm is exporting services towards the EU $^{+}$ $(p < 0.1)$ * $(p < 0.05)$, ** $(p < 0.01)$, *** $(p < 0.001)$

Table A.11: Impact of Brexit and the TCA on Firm Sales, Share Exposure

	(1)	(2)	(3)	(4)	(5)	(6)
$Brexit \times sh\_tr_G$	-0.0937***	-0.0922***			-0.0873***	-0.0862***
	(0.0135)	(0.0135)			(0.0134)	(0.0134)
$TCA \times sh\_tr_G$	-0.0822***	-0.0856***			-0.0759***	-0.0798***
	(0.0128)	(0.0128)			(0.0129)	(0.0129)
$Brexit \times sh\_tr_{both}$			-0.0891***	-0.0861**	-0.0414	-0.0388
			(0.0262)	(0.0261)	(0.0258)	(0.0258)
$TCA \times sh\_tr_{both}$			-0.0947***	-0.0942***	-0.0438+	-0.0405
			(0.0255)	(0.0256)	(0.0255)	(0.0256)
$Exporter\_G\_EU = 1$		0.0729***		0.0706***		0.0728***
		(0.0119)		(0.0119)		(0.0119)
$Exporter\_S\_EU = 1$		0.0357**		0.0305*		0.0331*
		(0.0136)		(0.0137)		(0.0137)
$Firm$	Y	Y	Y	Y	Y	Y
$Region \times Year$	Y	Y	Y	Y	Y	Y
$Sector \times Year$	Y	Y	Y	Y	Y	Y
N	239,435	239,435	239,430	239,430	239,430	239,430

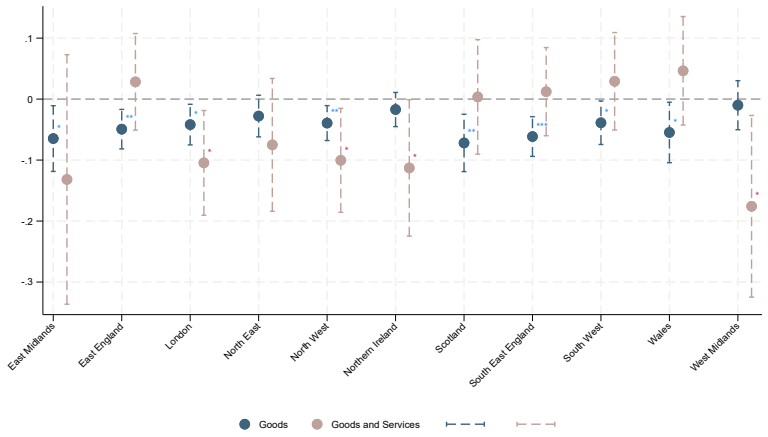
Source: Own Computation. Dependent variable: Log Sales. Standard errors are clustered at the industry level. TCA is a dummy variable indicating the period after 2020, $Brexit$ is a dummy variable indicating the period after 2016. tr_G is a dummy variable indicating if firm f is exposed to goods imports of intermediates from the EU in 2014. tr_both is a dummy variable indicating if firm f is exposed to goods and services imports of intermediates from the EU in 2014. Exposure measure is computed using Share of imports from the EU on total sales in 2014. $Exporter_{EU,G}$ is a dummy variable taking value 1 if the firm is exporting goods towards the EU; $Exporter_{EU,S}$ is a dummy variable taking value 1 if the firm is exporting services towards the EU $^{+}$ $(p < 0.1)$ * $(p < 0.05)$, ** $(p < 0.01)$, *** $(p < 0.001)$

Figure A.2: Heterogeneity Analysis, I/O Table exposure

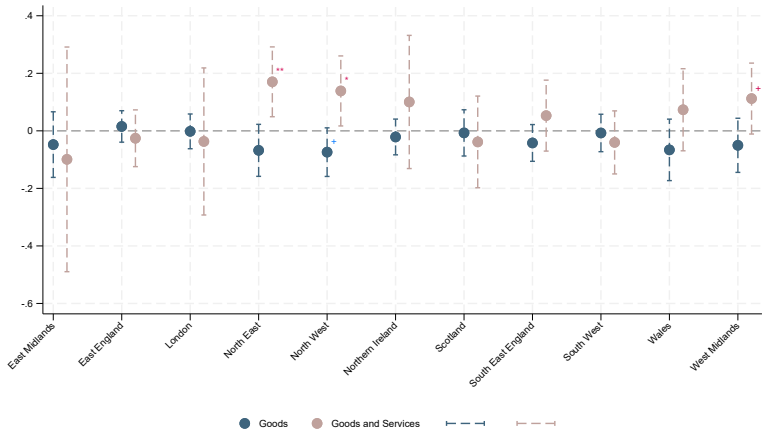


Source: Own Computation.Dependent variable are listed at the top of each graph and include: Log Employment, Log Average Wage and Log Sales. Figure shows the interaction coefficient ($TREAT_{Gf} \times TCA_t \times Characteristic_f$), where the characteristics is a dummy variable indicating if: a firm is a MNE with an EU country as ultimate owner (*Foreing Owned*); is exporting goods to the EU (*EU goods exporter*); is exporting services to the EU (*EU services exporter*). All regressions include an interaction term between goods exposure and Brexit ($Treat_{Gf} \times Brexit$), an interaction term between goods exposure and TCA ($Treat_{Gf} \times TCA$), and firm, sector-year, region-year fixed effects. Exposure measure is computed using I/O Tables in 2014. $^{+}$ ($p < 0.1$) * ($p < 0.05$), ** ($p < 0.01$), *** ($p < 0.001$)

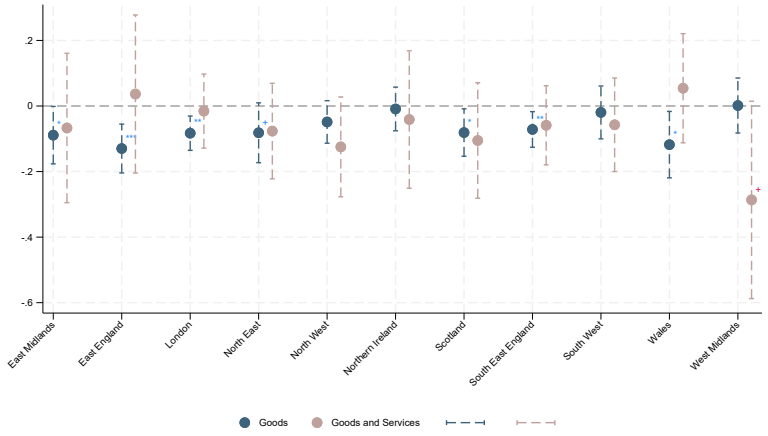
Figure A.3: Regional Effects, I/O Table Exposure



((a)) Employment



((b)) Wages



((c)) Sales

Source: Own Computation. Dependent variable are: Log Employment (Figure a), Log Average Wage (Figure b) and Log Sales (Figure c). Figure shows the interaction coefficient ($TREAT_{Gf} \times TCA_t \times Region_f$), where *Region* indicates the UK region firm f is located. All regressions include an interaction term between goods exposure-Brexit- Region ($Treat_{Gf} \times Brexit \times Region_f$), interaction term between goods and services exposure-Brexit-Region ($Treat_{both f} \times Brexit \times Region_f$), and firm, sector-year, region-year fixed effects. Exposure measure is computed using I/O Tables in 2014. $^{+}$ $(p < 0.1)$ * $(p < 0.05)$, ** $(p < 0.01)$, *** $(p < 0.001)$

Table A.12: Worker-Level Results (Share Exposure)

	(1)	(2)	(3)	(4)	(5)	(6)
	Total hours worked			Weekly gross wage, log		
Brexit x sh_tr_G	-0.0540	-0.2509***		0.0078***	0.0064**	
	(0.0364)	(0.0390)		(0.0020)	(0.0022)	
TCA x sh_tr_G	-0.1180*	0.0147		-0.0148***	-0.0091**	
	(0.0480)	(0.0522)		(0.0028)	(0.0031)	
Brexit x sh_tr_both		0.7747***			0.0052	
		(0.1030)			(0.0040)	
TCA x sh_tr_both		-0.5073***			-0.0219***	
		(0.1192)			(0.0057)	
Brexit x sh_tr_S			0.5269***			0.0070*
			(0.0881)			(0.0035)
TCA x sh_tr_S			-0.4442***			-0.0281***
			(0.1011)			(0.0049)
Worker age	-0.0083***	-0.0083***	-0.0083***	0.0039***	0.0039***	0.0039***
	(0.0009)	(0.0009)	(0.0009)	(0.0000)	(0.0000)	(0.0000)
Years in the same firm	0.0083*	0.0083**	0.0084**	0.0148***	0.0148***	0.0148***
	(0.0032)	(0.0032)	(0.0032)	(0.0002)	(0.0002)	(0.0002)
Years in the same firm, square	-0.0003**	-0.0003**	-0.0003**	-0.0003***	-0.0003***	-0.0003***
	(0.0001)	(0.0001)	(0.0001)	(0.0000)	(0.0000)	(0.0000)
Same firm as in 2016	0.2477	0.2204	0.2668	0.0723+	0.0727+	0.0728+
	(0.5808)	(0.5806)	(0.5781)	(0.0391)	(0.0391)	(0.0390)
Same firm as in 2021	-0.2113	-0.2188	-0.2137	0.0137	0.0127	0.0116
	(0.6889)	(0.6907)	(0.6901)	(0.0392)	(0.0391)	(0.0390)
Individual FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Enterprise FE	Y	Y	Y	Y	Y	Y
Occupation FE	Y	Y	Y	Y	Y	Y
N	962,991	962,991	965,373	962,704	962,704	965,086

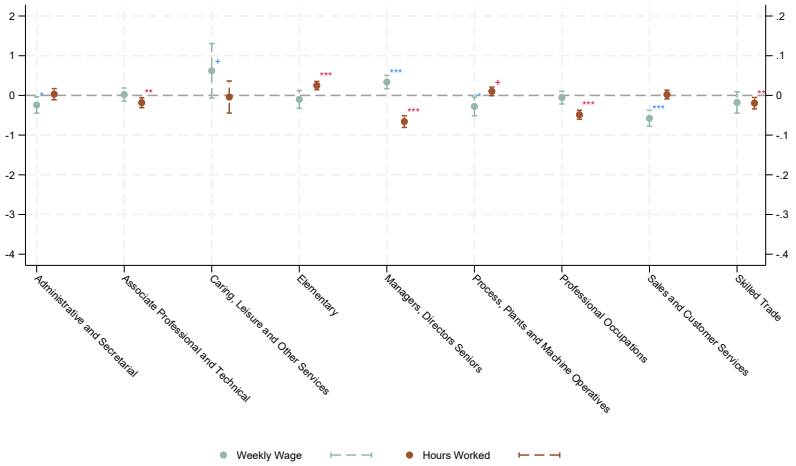
Source: Own Computation. Dependent variable: Total hours worked (Columns 1-3) and Log weekly gross wages (Columns 4-6). Standard errors are clustered at worker level. TCA is a dummy variable indicating the period after 2020, $Brexit$ is a dummy variable indicating the period after 2016. tr_G is a dummy variable indicating if firm f is exposed to goods imports of intermediates from the EU in 2014. tr_both is a dummy variable indicating if firm f is exposed to goods and services imports of intermediates from the EU in 2014. tr_S is a dummy variable indicating if firm f is exposed to services imports of intermediates from the EU in 2014. Exposure measure is computed using the share of imports from the EU on total sales in 2014. All specification control for worker age, tenure in the current firm and its square (used as proxy for experience), indicators for whether the worker remains in the same firm as in 2016 or 2020. $^{+}$ $(p < 0.1)$ * $(p < 0.05)$, ** $(p < 0.01)$, *** $(p < 0.001)$

Table A.13: Worker-Level Heterogeneity by Sex and Age, I/O Table Exposure

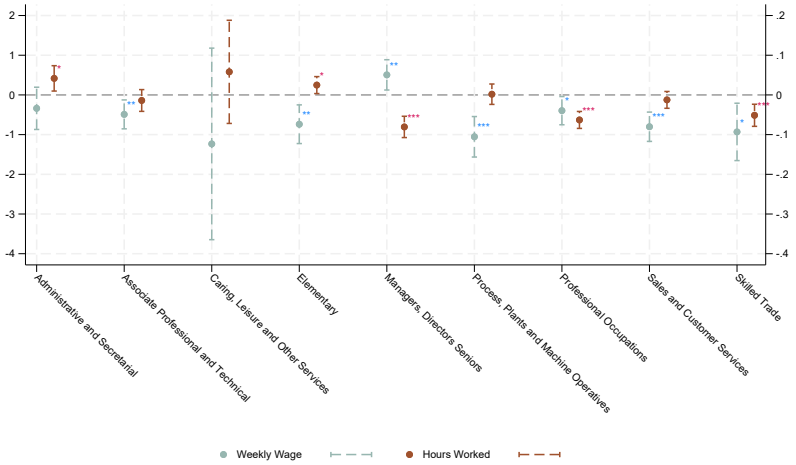
	(1)	(2)	(3)	(4)
	Goods		Goods & Services	
Panel A: Total hours worked				
$TCA \times treat\#Male$	-0.0969^{+}		-0.5068***	
	(0.0523)		(0.1278)	
$TCA \times treat\#Female$	-1.0173***		-1.3288***	
	(0.0635)		(0.1394)	
$TCA \times treat\#Old$		-0.0814		-0.4007**
		(0.0519)		(0.1228)
$TCA \times treat\#Young$		-0.2682***		-0.7528***
		(0.0684)		(0.1555)
N	1,012,104	1,012,104	1,012,104	1,012,104
Panel B: Weekly gross wage, log				
$TCA \times treat\#Male$	-0.0154***		-0.0270***	
	(0.0030)		(0.0057)	
$TCA \times treat\#Female$	-0.1213***		-0.1279***	
	(0.0041)		(0.0093)	
$TCA \times treat\#Old$		-0.0236***		-0.0080
		(0.0031)		(0.0055)
$TCA \times treat\#Young$		-0.0832**		-0.1054***
		(0.0042)		(0.0083)
N	1,011,809	1,011,809	1,011,809	1,011,809
Individual FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Enterprise FE	Y	Y	Y	Y
Occupation FE	Y	Y	Y	Y
Worker controls	Y	Y	Y	Y

Source: Own Computation. Dependent variable: Total hours worked (Panel A) and Log weekly gross wages (Panel B). Standard errors are clustered at worker level. TCA is a dummy variable indicating the period after 2020.sh_treat indicate the generic treatment that is either a dummy variable indicating if firm f is exposed to goods imports of intermediates from the EU in 2014 (Columns 1-2) or a dummy variable indicating if firm f is exposed to goods and services imports of intermediates from the EU in 2014 (Columns 3 and 4). Exposure measure is computed using I/O Tables in 2014. $Workers\ Controls$ include worker age, tenure in the current firm and its square (used as proxy for experience), indicators for whether the worker remains in the same firm as in 2016 or 2020. $^{+}$ ($p < 0.1$) * ($p < 0.05$), ** ($p < 0.01$), *** ($p < 0.001$)

Figure A.4: Heterogeneity Analysis By Worker Occupation, I/O Table Exposure



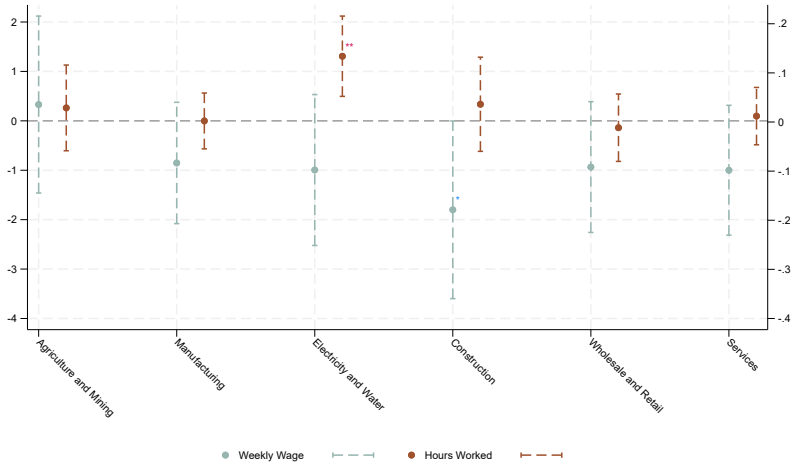
((a)) Goods Only Exposure



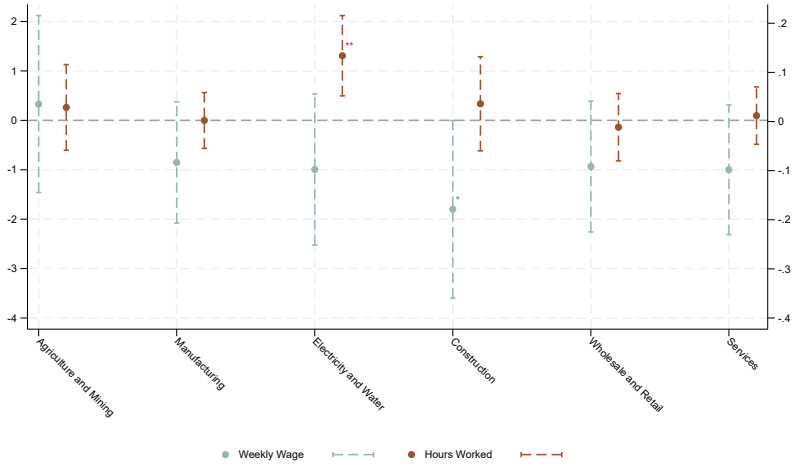
((b)) Goods and Services Exposure

Source: Own Computation. Dependent variable are: Hours Worked, Log Weekly Wage. Figure shows the interaction coefficient ($TREAT_{Gf} \times TCA_t \times Occupation_i$), where $Occupation$ indicates the occupation of worker i (Figure a); and the interaction term ($TREAT_{bothf} \times TCA_t \times Occupation_i$) (Figure b). Regression include an interaction term between goods exposure-Brexit- Occupation ($Treat_{Gf} \times Brexit \times Occupation_i$) and interaction term between goods and services exposure-Brexit- Occupation ($Treat_{bothf} \times Brexit \times Occupation_i$) . Exposure measure is computed using I/O table in 2014. Regression include Workers Controls (worker age, tenure in the current firm and its square (used as proxy for experience), indicators for whether the worker remains in the same firm as in 2016 or 2020); firm, worker, year fixed effects. $^{+}$ $(p < 0.1)$ * $(p < 0.05)$, ** $(p < 0.01)$, *** $(p < 0.001)$

Figure A.5: Heterogeneity Analysis By Worker's Macro Sector of Employment, I/O Table Exposure



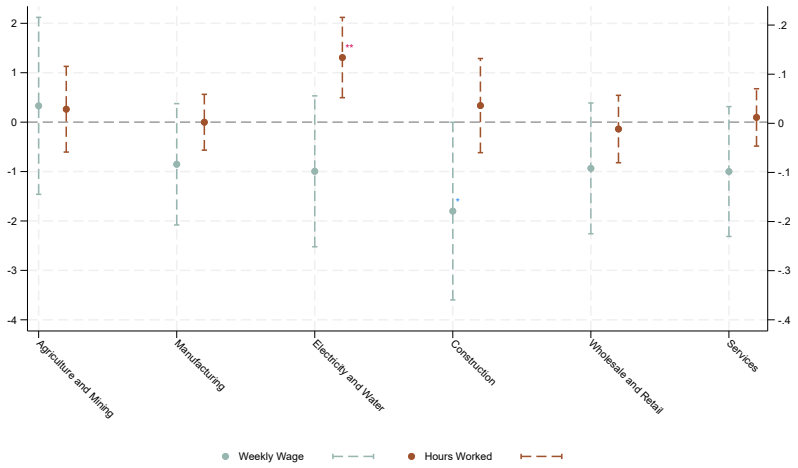
((a)) Goods Only Exposure



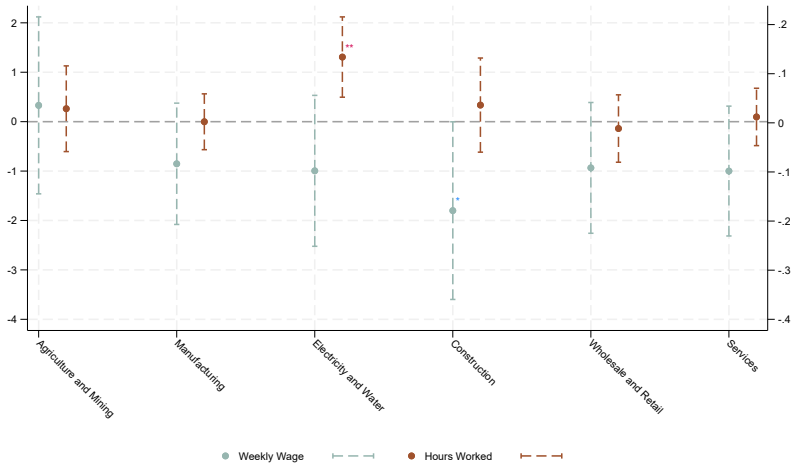
((b)) Goods and Services Exposure

Source: Own Computation. Dependent variable are: Hours Worked, Log Weekly Wage. Figure shows the interaction coefficient ($TREAT_{Gf} \times TCA_t \times Macro_i$), where $Macro$ indicates the macro sector of employment of worker i (Figure a); and the interaction term ($TREAT_{bothf} \times TCA_t \times Macro_i$) (Figure b). Regression include an interaction term between goods exposure-Brexit- Macro ($Treat_{Gf} \times Brexit \times Macro_i$) and interaction term between goods and services exposure-Brexit- Macro ($Treat_{bothf} \times Brexit \times Macro_i$) . Exposure measure is computed using I/O table in 2014. Regression include Workers Controls (worker age, tenure in the current firm and its square (used as proxy for experience), indicators for whether the worker remains in the same firm as in 2016 or 2020); firm, worker, year fixed effects. $^{+}$ $(p < 0.1)$ * $(p < 0.05)$, ** $(p < 0.01)$, *** $(p < 0.001)$

Figure A.6: Heterogeneity Analysis By Worker's Macro Sector of Employment, Share Exposure



((a)) Goods Only Exposure



((b)) Goods and Services Exposure

Source: Own Computation. Dependent variable are: Hours Worked, Log Weekly Wage. Figure shows the interaction coefficient ($TREAT_{Gf} \times TCA_t \times Macro_i$), where $Macro$ indicates the macro sector of employment of worker i (Figure a); and the interaction term ($TREAT_{bothf} \times TCA_t \times Macro_i$) (Figure b). Regression include an interaction term between goods exposure-Brexit- Macro ($Treat_{Gf} \times Brexit \times Macro_i$) and interaction term between goods and services exposure-Brexit- Macro ($Treat_{bothf} \times Brexit \times Macro_i$). Exposure measure is computed using share of imports from the EU on total sales in 2014. Regression include Workers Controls (worker age, tenure in the current firm and its square (used as proxy for experience), indicators for whether the worker remains in the same firm as in 2016 or 2020); firm, worker, year fixed effects. $^{+}$ ($p < 0.1$) * ($p < 0.05$), ** ($p < 0.01$), *** ($p < 0.001$)

B Data Construction

The ONS allocates trade flows to reporting units using several approaches:

- allocating the value of trade flows by employment;
- allocating the value of trade flows by employment weighted by product–industry correspondence matrices;
- allocating the weight of trade flows by employment;
- allocating the weight of trade flows by employment weighted by product–industry correspondence matrices;
- allocating the supplementary unit of trade flows by employment;
- allocating the supplementary unit of trade flows by employment weighted by product–industry correspondence matrices.

Our reference measure is the value of trade flows allocated by employment weighted by product-industry correspondence matrices.

We exclude trade flows referring to HS2 categories 98 and 99 and non-monetary gold.

The ITIS dataset provides information on the value of services traded by firms, without distinguishing the mode through which trade occurs. Throughout the paper, we therefore use the total value of services exports and imports reported in ITIS. Explain how we fix the problem of the spike in the trade flows for 2014 and 2015

Table B.1: Conversion Services ITIS and AFDI

(1) AFDI (SIC07)	(2) ITIS (BPM6)	(3) Service
1(6), 1(7) , 2(4)	1	Agricultural, forestry and fishing
9	2	Mining and oil gas extraction
36, 37, 38, 39	3	Waste treatment and de-pollution
NA	4	Manufacturing services on goods owned by others
33, 95, 45	5	Maintenance and repair
69(2)	6	Accountancy, auditing, bookkeeping and tax consulting
73(0)	7	Advertising, market research and public opinion polling
70(0)	8	Business management and management consulting
70(2)	9	Public relations
78(0)	10	Recruitment
69(1)	11	Legal
77	12	Operating leasing
NA	13	Procurement
68	14	Property management
74, 75	15	Other business and professional
72	16	Provision of R&D
NA	17	Provision of product development and testing activities
NA	18A	Outright sales and purchases of Trademarks,etc transfer of ownership
NA	18B	Charges or payments for the use of Trademarks, etc without transfer of ownership
NA	19A	Outright sales and purchases of Copyrighted transfer of ownership
NA	19B	Charges or payments for the use of Copyrighted without transfer of ownership
NA	20A	Outright sales and purchases of Patents and other IP transfer of ownership
NA	20B	Charges or payments for the use of Patents and IP transfer without transfer of ownership
53	21	Postal and courier

Source: : Own computation. The table shows the industry conversion between AFDI and ITIS dataset used in the analysis. AFDI raw data report affiliates' industry using SIC07 three-digit system, while ITIS raw data classify services using BPM6 system. Table shows the conversion between two digit SIC07 and BPM6, in parenthesis the SIC07 third-digit when necessary for the conversion. E.g. SIC07 two-digit classification for Legal and Accountancy services is 69: in the three-digit system, Legal services correspond to 691 and accountancy services to 692.

Table B.2: Conversion Services ITIS and AFDI

(1) AFDI (SIC07)	(2) ITIS (BPM6)	(3) Service
61	22	Telecommunication
62	23	Computer
58	24	Publishing
63(9)	25	News agency
63(1)	26	Information
41, 43	27	Construction in the UK
NA	28	Construction outside the UK
64	29	Financial
65	30	Life insurance claims
NA	31	Life insurance premiums
NA	32	Freight insurance claims
NA	33	Freight insurance premiums
NA	34	Other direct insurance claims
NA	35	Other direct insurance premiums
81, 82	36	Auxilliary
NA	37	Pension service receipts
NA	38	Pension service charges
NA	39	Standardised guarantee service claims
NA	40	Standardised guarantee service premiums
46	41	Merchanting
NA	42	Other trade-related
59, 60	43	Audio-visual and related
86	44	Health
85	45	Training and educational
90, 91, 92, 93	46	Heritage and recreational
96, 97, 98	47	Social, domestic and other personal
71	48	Architectural
42	49	Engineering
NA	50	Scientific and other technical
NA	51	Trade between affiliated enterprises
84, 80	52	Other trade

Source: : Own computation. The table shows the industry conversation between AFDI and ITIS dataset used in the analysis. AFDI raw data report affiliates' industry using SIC07 three-digit system, while ITIS raw data classify services using BPM6 system. Table shows the conversion between two digit SIC07 and BPM6, in parenthesis the SIC07 third-digit when necessary for the conversion.