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# Should We Stay or Should We Go? Firms' Decision on Services Mode of Supply

## Abstract

Services account for one-third of global trade, yet little is known about the impact of trade restrictions on services trade. To make progress in this area, it is crucial to understand through which Modes services are traded (cross-border, movement of people, foreign investment or consumption abroad) and how firms substitute among these Modes. We provide novel micro-level evidence on firms' mode choices, combining detailed data on UK firms' trade and affiliates' sales. We also estimate the substitution between trade Modes using Brexit as an exogenous shock, finding that UK firms increasingly relied on local affiliate sales to serve the EU market after 2016. This shift protected firm-level services exports from expected higher trade barriers after Brexit, but at the cost of lower domestic employment.

JEL-Codes: F130, F140, F160.

Keywords: trade shocks, services trade, modes of supply, Brexit.

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#### 1 Introduction

The last decade provides a unique opportunity to study the economic effects of trade restrictions and disruptions after more than half a century of trade liberalisation post WWII, such as the US-China trade war or Brexit. The current literature tends to focus on the consequences of restricting goods trade, mostly disregarding services.<sup>1</sup> Yet goods and services trade are highly interconnected (see Ariu et al. (2019)), and services account for one-third of global trade and represent the majority of OECD countries' GDP and employment.<sup>2</sup> Thus, omitting services trade might underestimate the overall impact of trade restrictions on countries' welfare.

Estimating the effects of higher barriers to services trade is non-trivial, however. Services can be traded through four different modes as defined by the World Trade Organisation (WTO): cross-border (Mode 1), consumption abroad (Mode 2), commercial presence (Mode 3) and presence of a natural person (Mode 4).<sup>3</sup> As Figure 1 shows, there is a high degree of heterogeneity across services regarding supply modes: for example, intellectual property is exclusively supplied via cross-border while health and educational services are supplied through all modes. Ultimately, the decision on how to supply services is taken at the firm level: a firm supplying software can provide its product abroad by opening a foreign affiliate (Mode 3) or sending the final product to the client (Mode 1). How services are traded has important consequences for the effects of trade barriers. In the above example, if transmitting software becomes more difficult because of new stringent regulations, but firms can simply set up a foreign affiliate in the export destination, overall services trade might not be much affected. But if switching modes is more difficult, restricting trade in one mode will have more severe impacts. At the same time, employment at the exporting firm might be less affected by new trade barriers if switching modes is more difficult since increased foreign local affiliate sales are likely associated with weaker domestic employment growth. Thus, the implication for countries imposing trade restrictions depends on the ease with which firms can switch between supply modes.

Despite the importance of mode choice in evaluating the consequences of trade barriers in services, little to no empirical evidence exists on how firms combine or switch between the different modes of services trade. We fill this gap by presenting new evidence on how firms choose modes of services trade using highly disaggregated data on services traders in the United

<sup>&</sup>lt;sup>1</sup> Amiti et al. (2019); Crowley et al. (2020, 2018a); Fajgelbaum et al. (2020); Fajgelbaum and Khandelwal (2022); Fajgelbaum et al. (2024).

 $<sup>^2</sup>$  See also Richard Baldwin's Vox EU column.

 $<sup>^{3}</sup>$  The WTO provides the official definition of services trade. For a review of the literature on the definition of services trade, supply modes and measurement problems see Francois and Hoekman (2010).

Figure 1: Modes to supply services



**Source:** TISMOS (WTO). Share of the mode of services World export supply by type of services in 2017. The shares are computed using the total services trade flows and modes of supply for the countries included in the TISMOS dataset.

Kingdom, the second largest services trader in the World.

In the first step, we construct a dataset that enables us to observe firms' trade flows and FDI in services by type, sector and partner country from 2009 until 2019. We demonstrate that there is a striking amount of heterogeneity in terms of how UK firms combine the different supply modes, ranging from health services, where 75% of exports take place through commercial presence (Mode 3), to engineering services, where almost all exports happen via cross-border (Mode 1).

Second, we analyse how the mode choices of individual firms correlate with these firms' characteristics. Among other findings, we show that firms exporting or importing goods are more likely to export services through cross-border (Mode 1) rather than through affiliate sales (Mode 3). Likewise, the value of foreign local affiliate sales (commercial presence) is uncorrelated with UK firms' performances such as employment, average wages and turnover. Taken together, these findings allow us for the first time to paint a detailed picture of how service traders choose their mode of supply.

Third, we use the 2016 Brexit referendum (henceforth Brexit<sup>4</sup>) to examine how firms adapt their modes of operation in response to new trade barriers. Brexit was expected to introduce restrictions on the movement of capital, goods, services, and people between the UK and the remaining EU countries. Without alternative arrangements to replace the UK's EU single market membership, Brexit was expected to create new trade barriers for all four modes of services trade. It is important to note that no actual changes to UK-EU trade barriers occurred before January 2021. However, as demonstrated in other studies (e.g., Born et al. (2019); Bloom et al. (2019)) UK firm behaviour already began to shift shortly after the Brexit referendum, due to a mixture of anticipation and uncertainty effects. In our context, this means that firms may have adjusted their supply modes from June 2016 onwards in preparation for potential future barriers (anticipation effects). Additionally, the mere possibility of increased barriers might have prompted firms to change their supply modes (uncertainty effect, see (Graziano et al., 2021) for a detailed discussion of these mechanisms). Therefore, we treat the period after June 2016 as the post-Brexit period in our analysis, interpreting our results as reflecting a combination of anticipation and uncertainty effects.

We estimate the effect of Brexit on mode choice by implementing a double-difference identification strategy, comparing firms' share of affiliates sales in services exports to the EU relative to the same share in exports to other countries, pre- and post-Brexit. The double difference allows us to control for a range of shocks that could potentially bias our results, such as firmand industry-specific shocks or pre-existing service-country characteristics. Our results show that firms' affiliates' share increased in their exports to EU countries relative to other countries after Brexit, that is, firms substituted towards affiliates' exports after Brexit. We further show that the change is driven by extensive margin changes, where firms are more likely to use commercial presence compared to the other modes of services exports after Brexit. By contrast, we do not find a similar mode substitution on the import side. Here, the share of affiliates' imports declines relative to imports via other modes after Brexit. This result seems to be driven by a relatively stronger decrease in the sales of foreign local affiliates in the UK, consistent with previous findings in the Brexit literature showing a strong decline in EU-UK FDI flows (e.g., Breinlich et al. (2020)).

In the final part of the paper, we examine the heterogeneity in our results and explore the implications of UK firms' substitution of supply modes for UK services exports and employment. Our findings show that Germany and Romania experienced the largest increases in affiliate sales shares compared to other EU countries, supporting the hypothesis that firms are relocating

<sup>&</sup>lt;sup>4</sup> In the following, we will use the terms Brexit referendum and Brexit interchangeably.

production rather than merely seeking lower taxes. Additionally, while wholesalers and retailers saw the biggest rise in affiliate sales, likely to maintain access to the EU market, ICT firms also exhibited higher-than-average mode substitution. Not all services exhibit the same degree of mode substitution: computer, advertising, and merchanting services are the most likely to be substituted.

We go on to show that firms exporting services more amenable to mode substitution experienced smaller declines in total exports to the EU following the Brexit referendum, supporting the notion that firms adjust their supply modes to bypass trade barriers. At the same time, however, these firms saw a larger reduction in domestic employment - up to a 0.3% decline consistent with increased reliance on affiliate sales abroad.

Our findings have important implications for the optimal design of services trade policy. Specifically, they suggest that a good understanding of the mode substitution choices of firms is necessary to predict the likely effects of trade barriers on services exports and domestic employment. Regarding services exports, our results imply that policymakers interested in increasing services exports should focus their efforts on reducing trade barriers for services with limited potential for mode substitution. Regarding employment, our findings suggest that policymakers wanting to sustain domestic employment should aim to prevent foreign countries from imposing trade barriers, in particular on services with a high potential for mode substitution. Firms producing these services are likely to respond to new trade barriers by increasing employment at their foreign subsidiaries rather than domestically.

Our work relates to three branches of the international economics literature. First, our study adds to the literature on trade wars and increases in trade barriers (see Fajgelbaum and Khandelwal (2022); Caliendo and Parro (2023)). This literature shows the detrimental effects of the US-China trade war on US consumer prices (Amiti et al., 2019; Fajgelbaum et al., 2020; Flaaen et al., 2020; Cavallo et al., 2021), on trade diversion towards third countries (Alfaro and Chor, 2023; Dang et al., 2023; Fajgelbaum et al., 2024) and on non-targeted sectors along the supply chain (Barattieri and Cacciatore, 2023; Bown et al., 2020; Grossman and Helpman, 2020). We add to this literature by looking at firms' supply mode decisions in response to new trade barriers. Note that while our mode choice analysis focuses on services trade, given the particular relevance of mode choice for this type of trade, in principle similar considerations apply to goods trade as well: firms might substitute local affiliate sales for exports in response to new trade barriers.

Second, we contribute to the growing literature on the impact of Brexit on the UK economy

and trade. Among other findings, this literature has found that Brexit led to a decrease in UK inward FDI (Breinlich et al., 2020; Tamberi and Serwicka, 2018), employment (Costa et al., 2019; Javorcik et al., 2022), trade (Douch and Huw Edwards, 2021; Graziano et al., 2021; Crowley et al., 2018b; Freeman et al., 2022; Gasiorek and Tamberi, 2023) and economic growth (Born et al., 2019), as well as an increase in inflation (Breinlich et al., 2022) and consumer prices (Bakker et al., 2022). Also using firm-level data, Bloom et al. (2019) find negative impacts of Brexit on UK firms across a range of performance indicators such as productivity. In contrast to this literature, we analyse the impact of Brexit on UK trade from a different perspective by looking at changes in the mode choices of British services traders caused by Brexit and the subsequent impact on firm-level trade flows and employment.

Finally, our paper contributes to the literature on services trade, specifically to the one looking at the different modes of trade (Bhattacharya et al., 2012; Christen and Francois, 2017; Cristea, 2011; Kelle et al., 2013; Conteduca and Kazakova, 2021; Muñoz, 2024; Oldenski, 2012; Ottaviano et al., 2018; Rueda-Cantuche et al., 2016). Differently from the previous literature, we can distinguish the supply modes by service types at the firm level. Our data thus allows accounting for the role of firm-level characteristics in mode choice. Furthermore, we exploit an exogenous policy shock (the Brexit referendum) to estimate firm-level reactions to trade barrier changes. By comparing changes in mode choices across EU and non-EU countries, we are able to distinguish the Brexit-induced changes in trade barriers from other effects the referendum might have had on UK services exporters (for example, through the negative impact of Brexit on UK GDP).

The remainder of the paper is organised as follows. The next section presents the data employed. Section 3 presents a stylised model of supply mode choice, which will guide our subsequent empirical analysis. Next, Section 4 presents stylised facts on service traders' supply modes. Section 5 describes the case of Brexit and firms' services trade flows post-referendum. Section 6 provides a formal empirical analysis and the results of the impact of Brexit on firms' service trade mode choices. Section 7 analyses the consequences of those choices for firms' services exports and employment. Finally, Section 8 concludes.

#### 2 Data

We use three sources of data. The first is the Inquiry on Trade in Services  $(ITIS)^5$ , which provides detailed information on the services exports and imports of a sample of UK firms. This

<sup>&</sup>lt;sup>5</sup> Office for National Statistics (2023)

data includes the countries to which services are exported and from which they are imported. Additionally, the ITIS categorizes the types of services each firm trades, distinguishing between 52 different service types, as outlined in the Appendix Tables A.1 and A.2. One of these 52 types is called "trade between affiliated enterprises" and captures intra-firm trade (e.g., the provision of headquarters services to foreign affiliates).<sup>6</sup> Note that the ITIS captures services trade through the WTO Modes 1, 2 and 4. Unfortunately, however, it does not currently allow us to identify trade by mode separately, so we only know the total value of services exported or imported through Modes 1, 2 and 4 combined.<sup>7</sup> In the following, we adopt the shorthand of calling ITIS trade Mode 1 or cross-border trade but note that it also includes Modes 2 and 4.

The second dataset we use is the Annual Inquiry into Foreign Direct Investment (AFDI)<sup>8</sup>, which contains information on the foreign direct investment (FDI) activities of a sample of UK firms. Specifically, for UK companies investing abroad, it provides information on the location of foreign affiliates, their industry, the type of investment, and the profits earned by the foreign affiliate. Similarly, for the affiliates of foreign multinationals in the UK, the AFDI reports the origin country of the foreign multinational, the industry of both the affiliate and its parent, and the profits earned by the affiliate. Our measure of Mode 3 exports and imports is the profits of UK affiliates abroad (Mode 3 exports) and the profits of foreign affiliates in the UK (Mode 3 imports). Ideally, we would like to use local affiliate sales rather than profits as a measure of Mode 3 exports/imports, but this is currently not available in the UK data. Affiliate profits are measured as the difference between the sales and the costs of production; hence, our Mode 3 measure is likely to be an underestimate of firms' Mode 3 trade flows.<sup>9</sup>

The final dataset we use in our analysis is the Annual Business Survey (ABS)<sup>10</sup>, which provides additional information on a sample of UK firms, including employment, foreign ownership status, exports, sales, and value-added. We utilize this data to analyze service supply modes based on firm characteristics and to explore the implications of heterogeneous mode substitution

<sup>&</sup>lt;sup>6</sup> For most of the analysis, we do not use this information, preferring to rely on the AFDI for our measure of Mode 3 trade. In the rest of the paper, we refer to this type of services trade as "intra-firm" trade.

<sup>&</sup>lt;sup>7</sup> Starting in 2018, ONS has surveyed a selection of firms in the ITIS, asking them to specify in the ITIS the mode of services trade. The statistics are available only at the aggregate level, which we report in Figure A.1. The largest share of services surveyed in the ITIS are traded via Mode 1 compared to Modes 2 and 4. The figure is similar when looking at the total exports and imports.

<sup>&</sup>lt;sup>8</sup> Office for National Statistics (2022b)

<sup>&</sup>lt;sup>9</sup> To check the likely accuracy of using profits as a proxy for local affiliate sales, we have used ORBIS data for a selection of countries and found a strong correlation between affiliates' sales and profits with a coefficient of 0.39 and standard error of 0.02 when controlling for firm and year fixed effects. Results are available upon request.

<sup>&</sup>lt;sup>10</sup> Office for National Statistics (2022a)

elasticity on employment and turnover.

	(1)	(2)	(3)	(4)
	ABS	ABS weight	IT-ÁD	AB-IT-AD
	mean (sd)	$\operatorname{mean}(\operatorname{sd})$	mean (sd)	mean (sd)
Employment	255.47	10.52		842.14
	(2,305.6)	(343.25)		(6,006.64)
Turnover (.000£)	55.82	1.68		275.6
	(767.56)	(111.98)		(2,169.23)
$W_{2} = D^{2} D^{2} U (000 ^{\circ})$	0 104 11	079 10		99 461 01
wage Bill $(,000 \pm)$	8,184.11	2(3.10)		33,401.01
	(58,930.42)	(8,766.04)		(138, 448.09)
Foreign Owned (Share)	0.73	0.94		0.7
	(0.44)	(0.24)		(0.46)
Manufacturing (Share)	0.17	0.06		0.32
Manufacturing (Share)	(0.38)	(0.24)		(0.47)
	(0.00)	(012-)		(0.11)
Exports Services $(,000\pounds)$			$3,\!396.3$	$17,\!030.77$
			(43, 246.88)	(105, 520.58)
Imports Services (.000£)			1.585.09	8.963.28
			(26, 123.31)	(58,825.04)
Inwards Affiliates, earnings $(mln \pounds)$			0.81	0.33
			(31.00)	(5.20)
Outwards Affiliates, earnings (mln£)			1.37	0.04
, , ,			(47.32)	(0.91)
Ν	544,754	544,754	413,830	43,354

Table 1: Stylised Facts Sample of Analysis

Source: Own computation using information from the Annual Business Survey (ABS), the Inquire on Trade in Services (ITIS) and the Annual Foreign Direct Investment Survey (AFDI). Column 1 (ABS) shows the descriptive statistics of firms surveyed in the ABS. Column (2) shows the descriptive statistics of firms surveyed in the ABS, applying population weights provided by the ONS. Column 3 (IT-AD) shows the descriptive statistics when merging the ITIS and AFDI datasets. Column 4 (AB-IT-AD) shows descriptive statistics for the merged AFDI, ITIS and ABS; no population weights are applied in Columns 1, 3 and 4.

To construct the final dataset underlying our analysis, we first merge the ITIS and the AFDI through the firm's unique identification numbers.<sup>11</sup> The combined dataset allows us to obtain information on UK firms' services exports and imports through Modes 1, 2 and 4 (from the ITIS) as well as Mode 3 (from the AFDI). In a second step, we combine the AFDI-ITIS data with the ABS, to obtain additional information on the characteristics of the firms trading in services, such as employment, turnover, or R&D expenditure. Appendix A provides a detailed description of

<sup>&</sup>lt;sup>11</sup> Appendix Tables A.1 and A.2 contain the full list of industries covered in the AFDI and the correspondence between these industries and the service types in ITIS.

how we merge these different data sources and further information about the underlying sampling procedures. To summarise, larger firms have a higher probability to be surveyed in the AFDI, while ITIS contains information for firms trading services for more than  $\pounds$ 10,000 per year. For comparison, in Table 1 we show descriptive statistics for the variables of interest for the entire sample of firms in the ABS (Columns 1 and 2), the merged ITIS-AFDI (Column 3) and the ITIS-AFDI-ABS dataset (Column 4). The descriptive statistics in Column 2 use population weights and are thus representative of the population of UK firms. Unfortunately, no population weights are available for the combined ITIS-AFDI-ABS dataset. However, by comparing Column 2 with Column 4, we can see that the ITIS-AFDI-ABS dataset predominantly contains larger firms, which is unsurprising given the underlying sampling procedures (see Appendix A). Thus, our subsequent results should be interpreted as applying to larger UK firms. We do not think this is a significant problem for the external validity of our results, as these larger firms account for the majority of UK services trade and employment (see Breinlich and Criscuolo (2011)).

Our final dataset has several unique features: first, we can observe the industry of profits of affiliates, allowing us to narrowly define Mode 3 of supply. Different from other datasets, we observe the main affiliate's product and can thus distinguish between the industry of the UK firm and its affiliate. As an example, we can observe if a UK manufacturing firm has an affiliate producing business services. Second, we can compare the services trade flows through Mode 1 surveyed in the ITIS with the total services trade by UK firms included in the ABS dataset. Therefore and differently from other datasets, we can check whether the services trade threshold of £10,000 of the ITIS leads to a selection of firms surveyed. This is because there is no reporting threshold in the ABS.<sup>12</sup> Third, we can distinguish between cross-border and affiliate supply and intra-firm trade. To the best of our knowledge, we are the first to be able to distinguish between these three types at the level of individual firms. And fourth, our dataset allows us to distinguish between a wide range of service types and countries of origin/destinations.

#### 3 A simple model of firm's Mode choice

To guide our empirical work, we first develop a simple model of mode choice. Consider a firm j that sources a service S from a firm i based in a foreign country c. The service can be sourced via the four different modes so that firm j effectively consumes a composite service good. Assuming the four modes are aggregated into the service good using a CES aggregator, we get that the

 $<sup>^{12}</sup>$  We will make use of this information in one of the robustness checks below, where we will show that the  $\pounds 10,000$  threshold does not seem to lead to a substantial omission of services trade.

effective consumption of service S by firm j is<sup>13</sup>:

$$S_j = \left[\sum_{m=1,3} x_m^{\frac{\sigma_s - 1}{\sigma_s}}\right]^{\frac{\sigma_s}{\sigma_s - 1}},$$

where  $x_m$  is the quantity of services delivered via Mode m and  $\sigma_s > 1$  is the elasticity of substitution between modes specific to service type S. For example, if it is relatively easy for computer services firms to set up affiliates in foreign countries and thus switch to the provision of computer services via local affiliate sales, the  $\sigma_S$  for computer services would be relatively high. To simplify notation, we drop the S subscript from  $\sigma$  in the following.

Denoting total expenditure on service imports by firm j from firm i by  $E_{ij}$ , we obtain modespecific demand functions of:

$$x_m = p_m^{-\sigma} P^{\sigma-1} E_{ij}$$

where  $p_m$  is the price of sourcing via Mode m and P is the CES price index given by:

$$P = \left(\sum_{m=1,3} p_m^{1-\sigma}\right)^{\frac{1}{1-\sigma}}.$$

Thus, demand for services delivered via Mode m will depend on the delivery price of that mode  $(p_m)$  and the delivery prices of all other modes (via P). Note that it would be straightforward to further model how the importing firm (j) decides its overall level of imports from firm i  $(E_{ij})$ . For example, we could model  $E_{ij}$  as arising from a choice between different inputs (labour, capital, goods and services intermediate inputs), and further model services intermediate inputs to be sourced both domestically or imported from different sources. However, for our analysis below, it is only of secondary interest how  $E_{ij}$  is determined, so we take the shortcut of simply setting it as a model parameter. As we will see,  $E_{ij}$  cancels out of the main equations of interest anyhow, so for the key results below, it is irrelevant how it is determined.

Next, assume that the marginal costs of delivering service component m ( $c_{m,ij}$ ) depend on firm *i*'s marginal costs of production ( $c_{m,i}$ ), as well as mode-specific trade costs ( $\tau_m$ ), which take the usual iceberg form:

$$c_{m,ij} = c_{m,i}\tau_m.$$

We assume that the provision of services via Mode 1 uses domestic labour, paid at a wage rate of  $w_D$ . Provision via Mode 3, however, involves establishing production facilities in the

<sup>&</sup>lt;sup>13</sup> Recall that in our data we have to group modes 1,2 and 4 because they are not separately reported in ITIS. Henceforth and as before we refer to modes 1,2 and 4 as Mode 1. This explains why the summation below has only two elements, 1 and 3.

destination country, so this requires foreign labour, paid at a wage rate of  $w_F$ . As an example, a Romanian software company selling services to the UK via Modes 1 produces at Romanian wage costs. However, when selling to the UK market via Mode 3, it produces at UK wage costs. We are abstracting from the setup costs of the foreign production facility, given that we are not predominantly interested in market entry decisions, as will be clear below.<sup>14</sup> Apart from this cost difference, all modes have the same linear production function, using labour (l) as the only factor of production:

$$x_m = l_m$$

We assume that providers of services compete in a monopolistically competitive fashion so that they set prices at a constant mark-up ( $\mu$ ) over marginal costs:

$$p_{m,i} = \mu \tau_m w_D$$
 if  $m = 1$   
 $p_{m,i} = \mu \tau_m w_F$  if  $m = 3$ 

With these assumptions, mode-specific demand x is:

$$x_m = (\mu w_D \tau_m)^{-\sigma} P^{\sigma-1} E_{ij} \text{ if } m = 1$$
$$x_m = (\mu w_F \tau_m)^{-\sigma} P^{\sigma-1} E_{ij} \text{ if } m = 3$$

and the value of imports z of firm j from firm i via Mode m is:

$$z_m = (\mu w_D \tau_m)^{1-\sigma} P^{\sigma-1} E_{ij}$$
 if  $m = 1$  (1)

$$z_m = (\mu w_F \tau_m)^{1-\sigma} P^{\sigma-1} E_{ij} \text{ if } m = 3$$
 (2)

Of course, imports by firm j from firm i equal exports of firm i to firm j, so the above expressions also represent firm i's exports via Modes 1 and 3. Using equations 1 and 2, we can compute the value share of Mode 3 in the total exports by firm i to firm j:

$$share_{3,ij} = \frac{(w_F \tau_3)^{1-\sigma}}{(w_D \tau_1)^{1-\sigma} + (w_F \tau_3)^{1-\sigma}}$$
(3)

Further, different importers j will be located in different foreign countries, so we can replace subscript j with a country-specific subscript, c:

$$share_{3,ic} = \frac{(w_F \tau_{3,c})^{1-\sigma}}{(w_D \tau_{1,c})^{1-\sigma} + (w_F \tau_{3,c})^{1-\sigma}}$$
(4)

Thus, the share of Mode 3 in the total exports of firm i to country c depends on the costs of

<sup>&</sup>lt;sup>14</sup> Note that we could model the fixed costs of setting up a production facility a *la* Melitz (2003) and express the fixed costs in terms of labour unit.

Mode 3 provision relative to that of provision via the other modes.<sup>15</sup> Note that for additional clarity, we have also added the c subscript to the trade cost variables, as these will vary by destination country. This variation is the main focus of our analysis, as we are interested in how Brexit changes the mode trade costs ( $\tau_m, c$ ). More specifically, Brexit will change the relative trade costs of commercial presence ( $\tau_{3,EU}$ ) compared to the other modes ( $\tau_{1,EU}$ ) with EU countries, as the latter is expected to increase more after Brexit.<sup>16</sup> To see how this relative change affects firm *i*'s Mode 3 share, rewrite equation 4 as:

$$share_{3,ic} = \frac{(w_F)^{1-\sigma}}{\left(w_D \frac{\tau_{1,c}}{\tau_{3,c}}\right)^{1-\sigma} + (w_F)^{1-\sigma}}$$
(5)

It is straightforward to show that an increase in the relative delivery costs of Mode 1  $(\tau_{1,c}/\tau_{3,c})$  will increase the Mode 3 share of UK exporters:

$$\frac{\partial share_{3,ic}}{\partial \left(\frac{\tau_{1,c}}{\tau_{3,c}}\right)} = \frac{\left(\sigma - 1\right) \left(w_F\right)^{1-\sigma} \left(\left(w_D \frac{\tau_{1,c}}{\tau_{3,c}}\right)^{-\sigma} w_D\right)}{\left[\left(w_D \frac{\tau_{1,c}}{\tau_{3,c}}\right)^{1-\sigma} + \left(w_F\right)^{1-\sigma}\right]^2} > 0 \tag{6}$$

In Section 5 we provide descriptive evidence that Brexit was indeed expected to increase  $\tau_{1,c}/\tau_{3,c}$ . Thus, in conjunction with equation 6, our conceptual framework predicts an increase in the share of Mode 3 services exports after Brexit. We formally test this prediction in Section 6. However, before moving on to testing our model prediction, we use our data to provide a number of stylised facts on how UK service exporters choose their supply mode. To the best of our knowledge, this is the first time such stylised facts have been presented at the firm level.

#### 4 Firm Level Mode Choice

A key feature of our data is that we can distinguish services supply mode at the firm level. In this section, we use our dataset to present novel evidence on firms' supply mode choices. Previous literature has shown that UK firms trade multiple services with many countries, predominantly high-income and former colonies (Magli, 2022). Further, firms across all sectors trade in services, with manufacturing accounting for a significant share of total services imports and exports (Breinlich and Criscuolo (2011); Magli (2022)). We extend this literature by studying UK service exporters' supply mode choices.

First, we investigate how supply mode choices depend on firms' characteristics and international activities. For example, serving a market through an affiliate requires additional costs

<sup>&</sup>lt;sup>15</sup>The term  $\mu^{1-\sigma} P^{\sigma-1} E_{ji}$  cancels out.

<sup>&</sup>lt;sup>16</sup> In Section 5 we provide evidence that  $\tau_{1,EU}$  was expected to increase more than  $\tau_{3,EU}$ .

	(1)	(2)	(3)	(4)
	Cross Border	Affiliates	Intra-Firm	Cross Border &
				Affiliates
Foreign Owned	$-0.1436^{***}$ (0.0048)	$-0.0608^{***}$ (0.0027)	$0.0235^{***}$ (0.0033)	$-0.0084^{***}$ (0.0013)
Export Goods	$\begin{array}{c} 0.1152^{***} \\ (0.0089) \end{array}$	$0.0226^{***}$ (0.0034)	$\begin{array}{c} 0.0197^{***} \ (0.0059) \end{array}$	$0.0080^{***}$ (0.0015)
Import Goods	$-0.0319^+$ (0.0163)	-0.0075 (0.0085)	$0.0403^{***}$ (0.0098)	$0.0041 \\ (0.0035)$
Trading Goods	$-0.0420^{*}$ (0.0182)	-0.0109 (0.0091)	$-0.0653^{***}$ (0.0112)	$-0.0098^{**}$ (0.0037)
Investing in R&D	$-0.0167^{***}$ (0.0045)	$0.0053^{**}$ (0.0020)	-0.0034 (0.0032)	0.0015 (0.0010)
N	43,354	43,354	43,354	43,354

Table 2: Services Exports Mode of Supply and Firms' International Activities

Source: Own Computation using information from AFDI, ITIS and ABS. Standard errors in parenthesis are robust. Dependent variables: dummy variable taking value equal to 1 if a firm has positive cross-border export flows (Cross-Border); dummy variable taking value equal to 1 if a firm has positive exports via commercial presence (Affiliates); dummy variable taking value equal to 1 if a firm has positive exports of services between affiliates (Intra-Firms); dummy variable equal to 1 if a firm has at the same time positive services exports via cross-border and commercial presence (Cross-Border & Affiliates). Explanatory variables: Foreign Owned, dummy variable taking value equal to 1 if a firm is foreign-owned; Export Goods, dummy variable taking value equal to 1 if a firm is exporting but not importing goods; Import Goods, dummy variable taking value equal to 1 if a firm is importing but not exporting and importing goods at the same time; Investing in R&D, dummy variable taking value equal to 1 if a firm has positive expenditure in R&D. All regressions include 2-digit sector fixed effects. + p < 0.1, \* p< 0.05, \*\* p< 0.01, \*\*\*

that only the most profitable firms may be able to cover. Similarly, a firm exporting machinery to Germany might provide maintenance services through affiliates located in Germany. Thus, we look at the correlation between the probability of supplying a service through the different modes and dummy variables indicating whether firms are foreign-owned, export or import (or both) goods and whether a firm is investing in R&D. For completeness, we consider intra-firm export as a potential supply mode in addition to cross-border and affiliate sales.

A few stylised facts emerge. First, foreign-owned firms and firms importing goods are less likely to export services via cross-border or affiliate sales (Columns 1 and 2, Table 2). However, they are more likely to export intra-firm services (Column 3). Second, firms exporting goods are more likely to export services via all modes (Columns 1-4).<sup>17</sup> Third, firms investing in R&D

<sup>&</sup>lt;sup>17</sup> Observing a positive correlation between goods exporting and the use of all modes is possible because goods exporters are more likely to export services as in Ariu et al. (2020).

are more likely to export via affiliates sales and less likely via cross-border (Columns 1 and 2).

	(1)	(2)	(3)	(4)	(5)	(6)
	Employment	Turnover	Wage Bill	Capex	GVA	Computer
		$(,000 \pounds)$	$(,000 \pounds)$			Investment
Cross Border	$0.9762^{***}$	$9.5925^{***}$	$113.9133^{***}$	$0.0800^{***}$	$0.0539^{***}$	$1.1463^{**}$
$(,000 \ \text{\pounds})$	(0.1141)	(2.1210)	(12.3289)	(0.0174)	(0.0065)	(0.4394)
	0.0000*	0.0000	0.0001*	0.0000	0.0000	0.0000
Affiliates Sales,	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000
profits $(mln\pounds)$	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
N	43,354	43,354	43,354	43,354	43,354	43,354

Table 3: Services Exports Mode of Supply and Firms' Characteristics

**Source**: Own Computation using information from AFDI, ITIS and ABS. Standard errors in parenthesis are robust. Dependent variables: cross-border exports (in thousands of  $\pounds$ ), affiliate sales profits (in millions of  $\pounds$ ). Explanatory variables: firm's employment, firm's total wage bill (in thousands of  $\pounds$ ), firm's total capital expenditure (in  $\pounds$ ), firm's gross value added at market price (in  $\pounds$ ), firm's total investment in purchased computer services (in  $\pounds$ ). All regressions include 2-digit sector-fixed effects. <sup>+</sup> p < 0.1, <sup>\*</sup> p< 0.05, <sup>\*\*</sup> p< 0.01, <sup>\*\*\*\*</sup> p< 0.001

Next, we look at the correlation between firms' exports via different modes and continuous firm-level variables such as employment, turnover, wage, capital investment, gross value added and computer investment (as a proxy for robotisation). The regressions indicate the correlations between those performance measures and the exports via different supply modes. The results, reported in Table 3, indicate that higher firm performance is correlated with higher services exports via cross-border, but not with higher affiliate sales. The latter result seems to contradict findings in the goods trade literature predicting that larger firms engage more in FDI. However, we caution that Table 3 only looks at correlations with domestic performance measures, and higher exports through commercial presence might be correlated with higher employment, sales or wages in the destination country instead of the country of the parent company.

We also show that the heterogeneity in the choice of export supply modes across services found in the aggregate data (see Figure 1) is also present in our firm-level data (Figure 2). For example, accountancy or business management are almost exclusively traded through crossborder supply, while health services are supplied predominantly through affiliates.

Finally, we categorise mode choices by the industries to which services exporters belong. For this, we aggregate services exports via the different modes by a broad group of industries and compute mode supply choices for these aggregate sectors. As Appendix Figure B.1 shows, most services exports happen via cross-border supply in all the industry groups we consider.<sup>18</sup>

We repeat the descriptive analysis for services imports instead of exports. To ease the readability of the paper, all the additional Figures and Tables are included in Appendix B.

 $<sup>^{18}</sup>$  Please note that disclosure rules prevent us from showing data for some industries



Figure 2: Services Exports by Mode

**Source:** Own Computation using information from ITIS and AFDI. Mode of export supply by type of service. Mode 1 is defined as the exports of services surveyed in the ITIS, while Mode 3 is defined as the profits of the foreign affiliates of UK firms surveyed in the AFDI dataset. Firm-level information are aggregated at the services type and year level and shares are computed for each year. E.g. Share of Mode 1 of Advertising is computed as the total exports in advertising surveyed in the ITIS dataset, divided by the total exports in advertising surveyed in the ITIS dataset, divided by the total exports in advertising surveyed in the AFDI dataset. The Figure refers to the year 2017.

These results are mostly similar to the export results just presented. However, the share of imports via commercial presence is higher for most service types and across most industries (Figures B.2 and B.3). Further, foreign-owned firms are more likely to import services through affiliates and the combination of cross-border and affiliates, differently from exports (Table B.1).

#### 5 Brexit and Services Trade, initial evidence

We now analyse the impact of Brexit on the mode choices of UK exporters. We begin by providing evidence of the uncertainty experienced by UK firms between 2015 and 2021, as well as on the likely extent of future trade barriers on UK-EU trade. We also present descriptive evidence of how uncertainty and anticipation effects have affected UK services trade and supply mode choice since 2016.

As discussed in the introduction, the Brexit vote is likely to have affected firm behaviour

through a mixture of anticipation and uncertainty effects.

By anticipation effects, we mean the forward-looking behaviour of UK service exporters who, expecting higher future barriers to service exports, adjust their mode choices in advance.

By uncertainty effects, we refer to the uncertainty about the height of these future barriers. The Brexit referendum on 23 June 2016 followed months of political discourse on the advantages and drawbacks of EU membership. Furthermore, the subsequent exit negotiations lasted until the end of 2020, and the extent of future barriers on trade between the UK and the EU's single market remained unclear throughout this period, generating uncertainty for exporting and importing firms.



Figure 3: Services Trade Restrictiveness Index (STRI), comparison

**Source:** OECD. Services Trade Restrictiveness Index (STRI) is a unilateral measure of restriction to services trade (imports and exports). EU indicates the STRI for firms outside the EU trading services with EU countries; the measure is an average of the STRI of EU countries excluding the UK. Intra-EU indicates the STRI for EU firms trading services within EU countries. All measures are computed as average over the period 2014-2021.

Assessing the increase in service trade barriers due to Brexit is challenging, but information from the OECD's Services Trade Restrictiveness Index (STRI)<sup>19</sup> provides a good summary measure of the barriers faced by different countries trading with the EU. Figure 3 shows average

STRI values for selected country groups for the period 2014-2021. The STRI is a unilateral index, meaning that the values shown in Figure 3 capture how difficult it is to export services to the country groups displayed, with larger values corresponding to higher barriers. For our current analysis, the relevant comparison is how difficult it is for non-EU firms to export services to the EU (group EU) compared to how difficult it is for EU firms to serve other EU countries (group intra-EU). Brexit implied UK exporters moving from the intra-EU to the EU group, implying a strong increase in trade barriers. Figure 3 also shows mode-specific barriers. In terms of the trade costs variables from our model, the category 'movement of people' is the best available proxy for our  $\tau_1$ , and the category 'foreign entry' is the best available proxy for our  $\tau_3$ . As Figure 3 shows, Brexit is associated with an increase in  $\tau_1$  from 0.0022 to 0.0623, an increase by a factor of approximately 28. By contrast, Brexit is only associated with a five-fold increase in  $\tau_3$  (from 0.0153 to 0.0788). This reflects the fact that the EU, similar to other countries, actively tries to attract foreign direct investment, while being more protectionist towards other market access modes. Crucially for the link between our conceptual framework and the subsequent empirical analysis, Figure 3 provides evidence that Brexit did indeed lead to an increase in the ratio  $\tau_1/\tau_3$ . Put differently, this suggests that UK firms probably expected their EU exports to be subject to substantially higher barriers after the UK had left the EU and the single market, especially for Mode 1 exports. Given that firms are forward-looking economic actors, we would expect them to react to these anticipated increases in trade barriers ahead of the UK's formal single market exit at the beginning of 2021. Our hypothesis, to be tested below, is that this anticipation led firms to switch their mode of service delivery after the Brexit vote, using affiliate sales instead of the modes more affected by trade barrier increases.<sup>20</sup>

In addition, firms' uncertainty due to Brexit increased sharply from the second half of 2016 until the end of 2020. To show this, we use data from the Bank of England's Decision Maker Panel.<sup>21</sup> This survey collects monthly information from a panel of firms on their expectation and uncertainty for the following months based on different institutional and economic factors (e.g. financial constraints). A few questions focus on Brexit, its perception in terms of uncertainty and how it might affect firms' costs and prices. As Figure 4 shows, firms reported a period of heightened uncertainty regarding the future after the Brexit referendum in June 2016. We hypothesize that during this period, firms made decisions about how to trade services with EU countries, taking into account the potentially higher trade costs from January 2021. For example, a UK firm exporting software to the EU between 2016 and 2021 faced the uncertainty

<sup>&</sup>lt;sup>20</sup> See Borchert (2016) for a discussion on barriers to services trade post-Brexit between the EU and the UK.
<sup>21</sup>Decision Maker Panel.

Figure 4: Pattern Brexit Uncertainty Index



**Source:** Bank of England. Monthly Brexit Uncertainty Index for the period May 2015 until May 2023. Data are constructed by the Bank of England using Decision Maker Panel information. Data prior to 2016 are imputed by the Bank of England. The shadow area indicates the period between the Brexit vote and the end of the transition period (June 2016 - December 2020).

of whether it would be able to export its services after 2020 and whether it would face additional costs. As discussed previously, one mitigating measure the UK firm had at its disposal is to open an affiliate in the EU or increase its sales through its existing affiliates in the EU, circumventing future barriers. In summary, we hypothesise that both anticipation and uncertainty effects have led UK firms to change their delivery mode for services exports to the EU towards Mode 3 and away from the other modes after June 2016.

We now turn to some initial descriptive evidence of how the anticipation and uncertainty effects discussed above have affected UK services trade. Figure 5 shows the pattern of the difference in services exports and imports between non-EU and EU countries via cross-border trade (Modes 1, 2 and 4). After the Brexit referendum, the trajectory of the trade flows increased, implying higher exports (imports) to (from) non-EU than to (from) EU countries. By contrast, we find the opposite pattern when looking at trade via commercial presence (Mode 3). Specifically, in Figure 6, we use data from the AFDI to plot the number of UK outward FDI investments over time, distinguishing between EU and non-EU countries and between Manufacturing and Services investments. The number of outward FDI to EU countries grew much more than to non-EU countries after 2016. Notably, investment in the services industry increased more significantly than in manufacturing. These patterns are consistent with the uncertainty



Figure 5: Difference trade flows between Non-EU and EU countries

**Source:** ITIS. Figure shows the difference between UK exports to non-EU and EU countries (solid line) and the difference between imports from non-EU and EU countries (dashed line). Data are for the period 2009-2021. Imports and exports are computed by aggregating firm-level exports and imports. The vertical line refers to 2016, the year of the Brexit referendum.

and anticipation effects discussed above if they led UK firms to switch away from cross-border service delivery.

At the same time, post-referendum services exports between affiliate firms to the EU increased more compared to the non-EU countries, suggesting higher intra-firm activity postreferendum (Figure O.1 in the Online Appendix).<sup>22</sup>

The above results are for aggregate exports. However, the effects of Brexit on services trade seem to vary depending on the type of service and the partner country. In the Online Appendix, we illustrate this by showing the different patterns of imports and exports between 2009 and 2021 for a selection of countries and service types. As those Figures show, the change in service trade after Brexit has considerable variation across different service types: for example, computer services exports increased much more after Brexit than management services. Further

 $<sup>^{22}</sup>$  Trade between affiliates indicates the exchange of a bundle of services, not specified, that multinational firms declare to trade with their affiliates.

heterogeneity is visible in overall exports and exports between affiliates with partner countries. For example, intra-firm exports with Germany increased substantially after the referendum while they remained stable for trade with French affiliates.

Figure 6: Difference outwards investment between EU and Non-EU countries divided by industry



**Source:** AFDI. Figure shows the difference between the number of outwards FDI from the UK to EU and non-EU countries in services industries (solid line) and the difference in manufacturing industries (dashed line). Data are for the period 2009-2021. The number of outwards FDI is computed by aggregating firm-level information, normalised with the volumes of outwards FDI in 2009 for each group of countries (i.e. outwards FDI with EU for the period 2009-2019 are divided by outwards FDI values with EU in 2009). The vertical line refers to 2016, the year of the Brexit referendum.

In summary, the descriptive evidence presented above suggests a slowdown in services trade via cross-border transactions with EU countries post-Brexit, and an increase in services trade with affiliates and commercial presence during the same period. These observations are consistent with UK services exporters increasingly relying on commercial presence for their exports to the EU. In the next section, we undertake a more formal econometric analysis of the mode choice of UK firms after Brexit.

#### 6 Brexit and Services Trade, econometric analysis

We now turn to a formal analysis of how Brexit has impacted the mode choices of UK services traders, both on the export and the import side. We implement a difference-in-differences estimator that compares the share of exports through affiliates (Mode 3) to the EU with the same to non-EU countries before and after the Brexit referendum. We conduct the analysis at the firm-service-country level, estimating the following equation:

$$share_{i(j)sct} = \beta_0 + \beta_1 Brexit_t \times EU_c + \alpha_{jt} + \sigma_{isc} + \delta_{ist} + \varepsilon_{i(j)sct}$$

$$\tag{7}$$

where  $share_{i(j)sct}$  denotes the share of exports through commercial presence in total exports for firm *i* (belonging to industry *j*) exporting service *s* to country *c* at time t.<sup>23</sup>  $Brexit_t$  is a dummy variable taking value 1 if Year > 2016 while  $EU_c$  is a dummy variable indicating if the destination country (*c*) is part of the EU. We also include a wide range of fixed effects to reduce issues with omitted variable bias. Firstly,  $\alpha_{jt}$  indicates 2-digit sector-time fixed effects, which helps to address industry-specific shocks. Additionally, due to the granularity of our dataset, we can also integrate firm-service-country ( $\sigma_{isc}$ ) and firm-service-time ( $\delta_{ist}$ ) fixed effects. These additional fixed effects enable us to account for firm-specific shocks and the comparative advantage of firms at the service level.

	(1)	(2)	(3)	(4)
	Affiliates Sales	Affiliates Sales	Total Exports	Total Cross Border
	(Percentage)	(Millions)	(Millions)	(Millions)
Mean	9.9	274.847	792.657	517.810
St Dev	(29.9)	(14, 582.608)	(17,500.258)	(9,689.735)
Within	1.5	9,454.303	$10,\!590.189$	4,771.729
Between	29.4	8,471.922	$10,\!151.377$	$5,\!599.700$
Years	2.323	2.403	2.403	2.403
Panel (n)	$574,\!514$	856,212	856,212	856,212
Ν	1,334,679	2,057,738	2,057,738	2,057,738

Table 4: Descriptive Statistics Variables of interests

**Source**: Own Computation using information from ITIS and AFDI. Descriptive statistics of exports via affiliates sales (in percentage of total exports and millions of  $\pounds$ ) and cross-border (in millions of  $\pounds$ , the measure includes Modes 1,2 and 4). Total export is the sum of exports through affiliates sales and cross-border (in millions of  $\pounds$ ). The unit of observation is the firm-service-country of destination over time. Within and between indicate the variation of the variable of interest through time and between the units of analysis. Years indicate the average number of consecutive years for which a firm-service-country of destination observation is observed. Panel (n) indicates the number of unit of observation (firm-service-country of destination) in the panel.

 $<sup>^{23}</sup>$  For Mode 3 exports, we use the industry of the foreign affiliate to determine the service types, s. See Tables

A.1 and A.2 for the mapping from industries to services types that we use.

Table 4 reports the descriptive statistics for the variables used in equation 7. On average, affiliate sales account for around 10% of total sales with larger cross-sectional ("Between" in the Table) variation than over time one ("Within"). Service-country trade at the firm level has a high churning rate and on average we observe only two consecutive years (variable Years in the Table); we further discuss this issue in the robustness checks (Section 6.1).

Our coefficient of interest is  $\beta_1$ , measuring the change in the difference in the commercial presence share of exports between EU and non-EU countries before and after Brexit. A positive value for  $\beta_1$  indicates an increase of  $share_{i(j)sct}$  post-Brexit that is larger in EU countries relative to non-EU countries, providing evidence of mode substitution in response to the Brexit vote.

Our analysis relies on the implicit assumption of parallel trends, meaning that the evolution of the control and treatment groups would have been the same in the absence of the shock (Brexit vote). In our context, this implies that i) the mode choice towards non-EU countries was not affected by Brexit within the period of analysis; ii) no shock contemporaneous to Brexit also affected firms' choices to serve EU countries via affiliates; and iii) the share of exports to the EU through affiliates had not been increasing before the referendum for reasons unrelated to the referendum. While these assumptions seem plausible a priori, we provide additional evidence for them in our robustness checks in Section 6.1.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Brexit=1	$0.0345^{***}$ (0.0007)			$0.0002^{*}$ (0.0001)			
EU=1	$\begin{array}{c} 0.0477^{***} \\ (0.0006) \end{array}$	$-0.0002^{*}$ (0.0001)			$-0.0001^{***}$ (0.0000)		
$Brexit \times EU{=}1$	$0.0305^{***}$ (0.0012)	$0.0013^{***}$ (0.0002)	$\begin{array}{c} 0.0017^{***} \\ (0.0002) \end{array}$	$0.0005^{***}$ (0.0001)	$0.0005^{***}$ (0.0001)	$0.0002^{*}$ (0.0001)	$0.0002^{*}$ (0.0001)
Firm	No	No	Yes	No	No	No	No
Firm×Year	No	Yes	No	No	No	No	No
Sector×Year	No	Yes	Yes	No	No	No	Yes
Service×Year	No	Yes	Yes	No	No	No	No
Country	No	No	Yes	No	No	No	No
Year	No	No	No	No	No	No	No
Firm×Service×Country	No	No	No	Yes	No	Yes	Yes
Firm×Service×Year	No	No	No	No	Yes	Yes	Yes
N	1,334,679	$1,\!195,\!965$	1,221,781	1,019,663	1,247,317	$951,\!447$	892,804
AR2	0.017	0.802	0.87	0.996	0.995	0.998	0.975

Table 5: Share of services exports through affiliates on total services exports

**Source**: Own Computation. Standard errors in parenthesis are robust. Dependent variable: share of services export via commercial presence on total services exports. The unit of analysis is firm-service-country of destination through the years. *Brexit* is a dummy variable taking value 1 if the year is post-2016. *EU* is a dummy variable taking value 1 if the year is post-2016. *EU* is a dummy variable taking value 1 if the year is post-2016. *EU* is a dummy variable taking value 1 if the country of destination is part of the EU. + p < 0.1, \* p < 0.05, \*\* p < 0.01, \*\*\* p < 0.001

Table 5 shows the results for the specification from equation 7 using as the dependent variable the export share through affiliates (Mode 3) in total exports. Throughout all the specifications, even those more conservative in terms of fixed effects, we observe an increase in the affiliates' sales share for EU countries relative to non-EU countries, implying that UK firms switched their exports to modes expected to be less affected by Brexit. In terms of magnitudes, the results show that UK firms increased their affiliate export share by up to 3 percentage points, an increase of around a third compared to the sample mean (see Table 4).

	()	(-)	(-)	( )	()	( - )
	(1)	(2)	(3)	(4)	(5)	(6)
	Cross-1	Border	Affi	liate	Total	Trade
$Brexit \times EU = 1$	$-0.0988^{***}$ (0.0073)	$0.0326^{***}$ (0.0066)	$0.0133^{***}$ (0.0009)	$0.0021^{**}$ (0.0008)	$-0.0866^{***}$ (0.0073)	$0.0335^{***}$ (0.0066)
Firm×Year	Yes	No	Yes	No	Yes	No
Sector×Year	Yes	Yes	Yes	Yes	Yes	Yes
Service×Year	Yes	No	Yes	No	Yes	No
Firm×Service× Country	No	Yes	No	Yes	No	Yes
Firm×Services×Year	No	Yes	No	Yes	No	Yes
N	1,729,295	1,250,244	1,729,295	1,250,244	1,221,781	892,804
AR2	0.462	0.851	0.617	0.873	0.665	0.882

 Table 6: Services exports by supply Mode

**Source**: Own Computation. Standard errors in parenthesis are robust. Dependent variable: log exports via cross-border, (Columns 1-2), log exports via commercial presence (Columns 3-4), log total exports (Columns 5-6). The unit of analysis is firm-service-country of destination through the years. *Brexit* is a dummy variable taking value 1 if the year is post-2016. *EU* is a dummy variable taking value 1 if the destination country is part of the EU. The logarithms are computed by adding one to the trade flows (lnx = ln(x + 1)). <sup>+</sup> p < 0.1, <sup>\*</sup> p< 0.05, <sup>\*\*</sup> p< 0.01

Our initial findings are consistent with either an increase in affiliate sales or a decrease in cross-border exports could lead to our results. Thus, we re-estimate specification 7, in turn using each export mode and total exports as the dependent variable. As seen from Table 6, the results are sensitive to the choice of fixed effects. When we use the less conservative set of fixed effects in Columns 1 and 3, we find that cross-border sales to the EU went down after Brexit and affiliates sales went up, explaining why we found an increase in the Mode 3 share in Table 5. However, after incorporating a more conservative set of fixed effects (Columns 2 and 4), we find that both cross-border and affiliate exports increased post-Brexit, with the former increasing more than the latter, which seems inconsistent with our earlier findings from Table 5. These results remain consistent when implementing a Pseudo Maximum Likelihood specification (see Table C.1) or when controlling for sample selection by excluding singletons (see Table C.2).

To understand why the results in Table 6 are sensitive to the combination of fixed effects use, note that it is inclusion of firm-service-country fixed effects that is responsible for producing the counter-intuitive results. This set of fixed effects implicitly restricts the identifying variation to the time dimension (pre- vs. post-Brexit). What seems to be happening is that the findings from Table 5 are driven by changes in the share variable from zero to one pre- and post-Brexit. However, this change is compatible with a parallel increase in cross-border relative to affiliate sales. To see this, we carry out a more explicit analysis of intensive and extensive margin adjustment.

First, to isolate the intensive margin, we re-estimate specification 7 with either cross-border or affiliate exports as the dependent variable, using only firms exporting services continuously between 2015 and 2017. Then, for the extensive margin, we create a dummy variable at the firm-service-country-time level, which takes the value of one if firm i has positive cross-border or affiliates sales of service s to country c at time t. We also include a third dummy variable, both, if a firm exports through affiliates and cross-border at the same time. This aims to capture firms that initially only exported via one mode and added another later.

	Intensive I	Margin	Extensive Margin			
	(1)	(2)	(3)	(4)	(5)	
	Cross-Border	Affiliates	Cross-Border	Affiliates	Both	
$Brexit \times EU = 1$	$0.0369^+$ (0.0204)	$\begin{array}{c} 0.1117\\ (0.2340) \end{array}$	$0.0040^+$ (0.0023)	$0.0002^{*}$ (0.0001)	$0.0004^{**}$ (0.0001)	
Sector×Year	Yes	Yes	Yes	Yes	Yes	
Firm×Service×Country	Yes	Yes	Yes	Yes	Yes	
Firm×Service ×Year	Yes	Yes	Yes	Yes	Yes	
N	536,402	2,627	458,825	1,243,347	1,250,244	
AR2	0.86	0.969	0.134	0.682	0.309	

 Table 7: Intensive and Extensive Margin

**Source**:Own Computation. Standard errors in parenthesis are robust. Dependent variable: log exports via cross-border (Column 1); log export via commercial presence (Column 2); dummy variable taking value 1 if exporting via cross-border (Column 3); dummy variable taking value 1 if exporting via cross-border (Column 3); dummy variable taking value 1 if exporting via both cross-border and commercial presence (Column 5). The unit of analysis is firm-service-country of destination through the years. *Brexit* is a dummy variable taking value 1 if the year is post-2016. *EU* is a dummy variable taking value 1 if the destination country is part of the EU. The logarithms are computed by adding one to the trade flows (lnx = ln(x + 1)). <sup>+</sup> p < 0.1, <sup>\*</sup> p< 0.05, <sup>\*\*</sup> p< 0.01, <sup>\*\*\*</sup> p< 0.001

At the intensive margin, continuous exporters increased their cross-border exports to the EU after Brexit (Table 7 Column 1), consistent with the estimated increase in cross-border sales from Table 6. At the same time, affiliates' exports seem unaffected by Brexit, as seen by the insignificant coefficient on the EU-Brexit interaction term in Column 2. However, at the extensive margin, firms are more likely to export through affiliates (Mode 3) after Brexit, either through Mode 3 on its own (Column 4) or in combination with Mode 1 (Column 5). Thus, we conclude that the increased propensity of UK firms to use affiliates for services exports to the

EU after Brexit is behind the observed increase in the affiliates' sales share reported in Table 5. This is also consistent with research by Crowley et al. (2023) who find evidence of an increase in headquarters relocating to the EU from the UK, particularly among small British firms.

#### 6.1 Robustness Checks

This section reports the results of a number of robustness checks on our baseline results reported in Table 5.

Churning Rates. A first concern with our earlier results is that the churning rate of firms' services export is high, meaning that firms tend to export services to a given destination for only two consecutive years on average (see Table 4). This high churning rate could be problematic for two reasons. First, firms that export a given service to a particular foreign country in only one year are captured by our firm-service-country fixed effects and thus effectively do not contribute to identification, reducing the effective sample size. More problematically, if firms not switching their exports to affiliate sales are more likely to drop out of the export market altogether, this would generate an upward bias on  $\beta_1$  from equation 7. To address these two concerns, we now aggregate across service types, looking at the changes in the trade flows at the firm-country level, which substantially reduces the churning rate.<sup>24</sup> Using these aggregated data, we estimate an empirical specification similar to equation 7:

$$share_{i(j)ct} = \delta_0 + \delta_1 Brexit_t \times EU_c + \gamma_{it} + \rho_{ic} + \alpha_{jt} + \epsilon_{i(j)ct}$$

$$\tag{8}$$

where  $share_{i(j)ct}$  is the affiliate share of exports by firm *i* in sector *j* towards country *c* at time *t*.  $Brexit_t$  is a dummy variable taking value one if Year> 2016 and  $EU_c$  is a dummy variable if the destination country *c* is part of the EU union. The set of fixed effects includes firm-time fixed effect ( $\gamma_{it}$ ), 2-digit sector-time fixed effects ( $\alpha_{jt}$ ), and firm-country-fixed effects ( $\rho_{ic}$ ). We now include intra-firm trade in the export flows, previously excluded. This inclusion is possible because we now aggregate the service dimension, which is not present for trade between affiliated enterprises as reported in the ITIS, i.e., we only know the total trade value between affiliated enterprises, but not broken down by type of service. Aggregating across service types also allows studying changes in firm scope, as measured by the number of services exported per country and whether a firm exports to a given country altogether, rather than just a particular type of service. Appendix Table C.3 shows the results of the estimation of specification 8, confirming our earlier result that firms increase the affiliate exports share after Brexit in their trade with

<sup>&</sup>lt;sup>24</sup> In terms of Table 4, the average duration for which we observe units in the data doubles from two to four (see variable "Years").

EU countries, thus showing that sample selection arising from high churning rates is not driving our main results.

As discussed, we can now look at the changes in firm scope (number of services exported), and the number of destination countries. After Brexit, firms reduced the number of services exported cross-border towards the EU (Table 8, Column 1). Furthermore, after Brexit firms were more likely to serve a country through an affiliate, either exclusively or combined with cross-border supply (Columns 4 and 6). At the same time, the probability of serving a country with intra-firm trade decreases (Column 5).

The finding that UK exporters reduce the number of exported services after Brexit is consistent with the theoretical framework of Mayer et al. (2014) in which exporters shift the composition of their export bundles towards their best-performing products. Thus, the findings in Table 8 could be explained by UK services exporters focussing on their top-performing services and dropping more peripheral services. This is also a potential explanation for our intensive margin increase in cross-border exports in Table 6 if the concentration on their top-service allowed surviving firms to increase exports.

	Number of S	Services	Probability to supply a country			
	(1)	(2)	(3)	(4)	(5)	(6)
	Cross-Border	Affiliate	Cross-Border	Affiliate	Intra-Firm	Cross-Border
						& Affiliate
$Brexit \times EU = 1$	$-0.0163^{***}$ (0.0024)	-0.0051 (0.0149)	$0.0030^{*}$ (0.0012)	$0.0016^{***}$ (0.0002)	$-0.0029^{***}$ (0.0006)	$0.0010^{***}$ (0.0002)
Firm×Year	Yes	Yes	Yes	Yes	Yes	Yes
$\operatorname{Sector} \times \operatorname{Year}$	Yes	Yes	Yes	Yes	Yes	Yes
$\operatorname{Firm} \times \operatorname{Country}$	Yes	Yes	Yes	Yes	Yes	Yes
Ν	728,430	5,206	1,054,252	1,054,252	1,054,252	1,054,252

Table 8: Number of Services and Probability to serve a country

**Source**:Own Computation. Standard errors in parenthesis are robust. Dependent Variables: Number of total services a firm is exporting in each destination country (Columns 1-2); Dummy variable taking value 1 if a firm is exporting service towards a country by supply mode (Columns 3-6). Intra-firms refers to the trade between affiliates. The unit of analysis is firm-country of destination through the years. *Brexit* is a dummy variable taking value 1 if the year is post-2016. *EU* is a dummy variable taking value 1 if the destination country is part of the EU. <sup>+</sup> p < 0.1, <sup>\*</sup> p< 0.05, <sup>\*\*</sup> p< 0.01, <sup>\*\*\*\*</sup> p< 0.001

**Diff-in-Diff assumptions.** In our second robustness check, we assess the validity of the difference-in-differences (diff-in-diff) method used in the previous section. For this approach to be valid, the following conditions must hold: i) Brexit did not influence the mode choice towards non-EU countries during the analysis period; ii) no contemporaneous shock coinciding with Brexit affected firms' decisions to serve EU countries via affiliates; iii) the share of exports to the EU through affiliates was not increasing before the referendum due to reasons unrelated

to the referendum.

To address assumption i), we conduct a placebo check. We replicate the analysis from the baseline section, considering trade with the US as the treated group and non-EU countries as the control group. Intuitively, if our earlier results were driven by the impact of Brexit on non-EU countries, we would expect an increase in the affiliate sales share when using the US instead of the EU. However, we do not observe any statistically significant increase in the affiliate sales share (Columns 1 and 2, Table C.4). This suggests that the effects of Brexit on non-EU countries cannot explain our earlier results.

Regarding assumption ii), we argue that no other trade shock coincided with the Brexit referendum, whose outcome was largely unexpected (Sampson, 2017). Further, existing literature on voters' behaviours in the referendum, shows no evidence of previous trade or immigration policies affecting those who voted to leave the EU (Sampson, 2017). If our results were driven by tax optimization due to changes in tax regulations, we would expect the effects to disappear when excluding countries commonly used for such purposes. To test this, we exclude the Netherlands, Ireland, and Luxembourg—countries known for profit shifting—from our baseline analysis. The results remain robust, indicating that tax optimization is not driving our findings (Columns 3 and 4, Table C.4).

To check for the presence of pre-trends (point iii) above), we conduct an event study to estimate the effect of the share of affiliates' sales in total exports with EU countries over time. We find no evidence of pre-existing trends before the Brexit referendum, while a clear "jump" in the share of exports through affiliates emerges from 2017 onwards (Figure C.1, coefficients are included in Table C.5). One outlier is the significant negative coefficient for 2014, which indicates a relative increase in services exports through cross-border towards the EU compared to affiliates sales. We thus replicate the analysis excluding 2014 (Columns 5 and 6, Table C.4). The baseline results still hold.

Exchange Rate Movement. Another potential concern is whether changes in export flows were influenced by exchange rate fluctuations. Contrary to expectation, the literature suggests that the post-referendum depreciation of the British pound did not boost UK exports (Ayele and Winters, 2020). Nevertheless, we test the robustness of our findings by including exchange rate movements in our baseline model, Equation  $7.^{25}$  The results remain consistent with our baseline findings (Columns 3 and 4, Table C.5). The significant 2014 coefficient in the event study might be due to the strong British pound that year. To account for this, we repeat the

 $<sup>^{25}</sup>$  Exchange rate data is sourced from the Bank of England, using the annual average spot exchange rate (accessible via this link). For countries without available exchange rates available, we use the US dollar as trading currency.

event study, adjusting for exchange rate fluctuations (see Figure O.10 in the Online Appendix). The updated results align with our previous findings, with differences observed only in standard errors (see Table C.5).

Sample selection and error clustering. Our final group of robustness checks concerns sample selection and error clustering. First, we narrow the sample to services that are perfectly matched between the ITIS and AFDI datasets (see Table C.6, Columns 1 and 2).<sup>26</sup> Next, we replicate the analysis clustering the error at the country level (Columns 3 and 4). The main results remain robust.

To complete our robustness checks, we finally compare the services exporters in the ITIS with those in the ABS. The ITIS surveys firms trading services above £10,000 per year, while the ABS records the overall export of services for sampled firms. Table C.7 shows that for firms included in both datasets, the share of Mode 1 exports (cross-border) is similar when comparing the ITIS and ABS data (Columns 1 and 2).

#### 6.2 Imports

So far, our analysis has focused on export flows, highlighting the changes in firms' services export supply mode due to the Brexit shock. To complement our analysis, we now look at the changes in the services imports supply mode due to Brexit. In theory, the changes should be similar: If the expected increase in trade barriers and the associated uncertainty leads UK exporters to switch from cross-border exports to affiliate sales, we would also expect EU exporters serving the UK market to switch their supply mode, using affiliate sales rather than cross-border exports.

In contrast to our export analysis, we do not observe the foreign firm from where UK imports originate, but only the country of origin and the type of service imported. Thus, our preferred specification is at the service-origin country and time level rather than the firm-service-destination country level as in the export analysis.<sup>27</sup> We adjust the regression specification as follows:

$$y_{jsct} = \alpha_0 + \alpha_1 Brexit_t \times EU_c + \delta_{sjt} + \sigma_{sc} + \epsilon_{jsct}$$

$$\tag{9}$$

where j indicates the UK 2-digit SIC07 sector importing service s from country c in year t.

<sup>&</sup>lt;sup>26</sup> Imperfectly matched services refer to service types that do not correspond closely to the SIC07 sector used in the AFDI. For example, legal services are straightforward to match to SIC07 691 "Legal Services"; but there is no unique SIC07 code that corresponds to the services type "Procurements", as this activity spans multiple sectors.

<sup>&</sup>lt;sup>27</sup> We obtain service-country level imports by simply summing over firms' imports by type of service s and country of origin c.

Similarly to before, *Brexit* is a dummy variable taking value 1 if Year > 2016 and EU is a dummy variable if the origin country (c) is part of the EU. As a set of fixed effects, we include service-country ( $\sigma_{sc}$ ) and service-sector-time ( $\delta_{sjt}$ ) fixed effects to account for changes in the sector demand of each service in each year.<sup>28</sup>

Our coefficient of interest is  $\alpha_1$ , measuring the change in the difference in the dependent variable of interest between EU and non-EU countries after Brexit. A positive  $\alpha_1$  indicates EU exporters switching from cross-border to affiliate sales.

	(1)	(2)	(3)	(4)	(5)	(6)
Brexit = 1	$0.0562^{***}$ (0.00124)					
EU = 1	$0.0105^{***}$ (0.000901)	0.000731 (0.000607)			$0.00118^{**}$ (0.000498)	
$Brexit \times EU = 1$	$-0.0189^{***}$ (0.00206)	$-0.0100^{***}$ (0.00139)	$-0.00667^{***}$ (0.00201)	$-0.00423^{***}$ (0.00135)	$-0.00428^{***}$ (0.00111)	-0.00124 (0.0011)
Sector×Year	No	Yes	No	Yes	No	No
Service×Year	No	Yes	No	Yes	No	No
Service×Country	No	No	No	Yes	No	No
Country	No	No	Yes	No	No	Yes
Year	No	No	Yes	No	No	No
$\mathbf{Service}{\times}\mathbf{Sector}~{\times}\mathbf{Year}$	No	No	No	No	Yes	Yes
N	356,441	349,051	$356,\!438$	348,302	344,983	344,980
AR2	0.01	0.448	0.123	0.535	0.663	0.675

Table 9: Share of services imports via commercial presence in total services imports

**Source**: Own Computation. Standard errors in parenthesis are robust. Dependent variable: share of services imports via commercial presence on total services imports. The unit of analysis is industry-service-country of origin through the years. *Brexit* is a dummy variable taking value 1 if the year is post-2016. *EU* is a dummy variable taking value 1 if the country of destination is part of the EU.  $^+$  p < 0.1,  $^*$  p< 0.05,  $^{**}$  p< 0.01,  $^{***}$  p< 0.001

From Table 9, we can conclude that mode substitution patterns on the import side are the opposite of those on the export side. Rather than increasing affiliate import share, Brexit seems to have led to a decrease in the affiliate share, suggesting EU exporters reduced their affiliates' sales in the UK by more than their cross-border sales.

We further decompose the import flows between cross-border, affiliates and total imports to check which channel is driving our results. As seen in Table 10, all import flows decreased after the Brexit vote, but Mode 3 imports declined by more than cross-border imports (Columns 1-4). This finding is consistent with earlier findings in the Brexit literature. For example, Breinlich et

<sup>&</sup>lt;sup>28</sup> There are around 7,000 service-country pairs and 21,000 service-sector-year triplets, which allows us to still have enough degrees of freedom for our identification.

al. (2020) have documented a strongly negative impact of the Brexit referendum on EU-UK FDI flows. A potential explanation for their and our findings is that EU firms simply gave up on the UK market altogether, rather than trying to avoid trade barriers by switching to Mode 3 supply, leading to a decline in Mode 3 exports and explaining our findings from Table 9. Note that the phenomenon of EU exporters dropping the UK market altogether has also been documented in other contexts, such as Portugal-UK goods trade (Fernandes and Winters (2021)). As Breinlich et al. (2020) discuss, the likely explanation for such asymmetric effects is the size difference between the UK and the EU market. While continuing to serve the large EU market is essential for UK exporters, serving the (smaller) UK market is less important for EU exporters and does not justify the setup costs associated with setting up local affiliates.

Our results cannot distinguish between supply or demand-driven results, i.e. whether the UK domestic market reduced the demand for services from Europe or EU firms decided to drop the market. To distinguish the channels, we would need information on domestic trade in UK services. Unfortunately, researchers currently do not have access to this information, making it a topic for future exploration.

	(1)	(2)	(3)	(4)	(5)	(6)
	Cross-1	Border	Affil	Affiliates		mports
EU = 1		$1.110^{***} \\ (0.0553)$		$1.041^{***} \\ (0.1720)$		$\frac{1.106^{***}}{(0.0534)}$
$Brexit \times EU = 1$	-0.00505 $(0.0853)$	-0.0143 (0.100)	$-0.358^{**}$ (0.1660)	$-0.438^{*}$ (0.2480)	-0.0225 (0.0814)	-0.0422 (0.0956)
Sector×Year	Yes	No	Yes	No	Yes	No
Service×Year	Yes	No	Yes	No	Yes	No
Service×Country	Yes	No	Yes	No	Yes	No
$\mathbf{Service} \times \mathbf{Sector} \times \mathbf{Year}$	No	Yes	No	Yes	No	Yes
Ν	526,809	522,410	129,023	120,402	$531,\!635$	$530,\!495$

Table 10: Services imports by supply Mode

**Source**:Own Computation. Standard errors in parenthesis are robust. Dependent variable: imports via cross-border (Columns 1-2), imports via commercial presence (Columns 3-4), total imports (Columns 5-6). The unit of analysis is industry-service-country of origin through the years. *Brexit* is a dummy variable taking value 1 if the year is post-2016. *EU* is a dummy variable taking value 1 if the country of destination is part of the EU. Regression coefficients are estimated with PPML.  $^+$  p < 0.1,  $^*$  p< 0.05,  $^{**}$  p< 0.01

#### 7 Heterogeneity and implications of Mode Choice

Having established that UK firms shifted to service supply mode via affiliates in response to the Brexit vote, we now further explore how these mode switches varied across different countries, industries and service types. Building on these results, we then investigate the consequences of mode substitution for UK trade and employment.

First, we explore whether the magnitude of mode substitution varies by destination country. Note that here and in the following, we also refer to the magnitude of mode substitution as an "elasticity", in analogy to the CES substitution elasticity ( $\sigma$ ) from Section 3.

We expect that when firms switch to affiliate sales, they may choose countries based on factors like human capital endowments, proximity to other markets, or wage differentials ( $\beta_c$  in Section 3).<sup>29</sup> To investigate country-specific effects, we implement our preferred specification 7, including an additional country-specific interaction term:

$$share_{i(j)st}^{c} = \gamma_{0} + \gamma_{1}Brexit_{t} \times Country_{c} + \gamma_{c}Brexit_{t} \times EU_{c} \times Country_{c} + \varphi_{st} + \varphi_{it} + \varphi_{jt} + \epsilon_{i(j)st}^{c}$$
(10)

The dependent variable is still the share of services exports supplied through affiliates sales on total exports ( $share_{i(j)sct}$ ). We implement Equation 10 for each EU country separately and the explanatory variable *Country* is a dummy for each country: for example, when we run the regression for Germany, *Country* = 1 for all the exports with Germany and 0 otherwise. Out coefficient of interest is  $\gamma_c$ , indicating the heterogeneous effects across EU countries as shown in Figure 7.

The countries with elasticities higher than the average coefficient are Germany, Italy, Spain and Romania. A potential explanation for the large estimated coefficient for Germany is the country's strong ties with UK manufacturing producers - for example, in the car industry. For Italy, Spain and Romania, a potential explanation is tax incentives for attracting foreign workers, particularly in the IT sector (see Manelici and Pantea (2021), for an analysis of industrial policy in the Romanian IT sector).

At the other end of the range of estimated substitution elasticities, a handful of countries -Belgium, Austria, Greece and Malta- experience a negative elasticity of substitution, implying an increase in cross-border exports compared to exports through affiliates. Such decreases might be driven by more stringent FDI regulations in the destination country. For example, Austria requires foreign firms to employ at least one Austrian citizen in their affiliates. Alternatively, the country-specific heterogeneity could be explained by the industry in which each firm is operating.

We further investigate this issue by estimating an industry-specific substitution elasticity,

 $<sup>^{29}</sup>$  Recall that in Section 6.1 we already exclude the hypothesis that firms are switching mode solely for tax avoidance purposes.



**Figure 7:** Heterogeneity by EU partner country,  $\gamma_c$ 

**Source:** Own Computation. Dependent variable: share of exports via commercial presence on total exports. The unit of analysis is the firm-service-country of destination through the years. Each point indicates the regression coefficient of the triple interaction term  $Brexit_t \times EU_c \times Country_c$ , where Brexit is a dummy variable taking value 1 if the year is post-2016; EU is a dummy variable taking value 1 if the country of destination is part of the EU and *Country* is a dummy variable taking value 1 for each of the EU countries. The horizontal lines indicate the 95% confidence interval. The vertical line indicates the coefficient of substitution from the main analysis. Each regression also includes 2-digit sector-year, firm-year and service-year fixed effects.

and implementing the regression:

$$share_{isct}^{j} = \gamma_{0} + \gamma_{1}Brexit_{t} \times Industry_{j} + \gamma_{2}EU_{c} \times Industry_{j} + \gamma_{j}Brexit_{t} \times EU_{c} \times Industry_{j} + \delta_{st} + \alpha_{it} + \sigma_{c} + \epsilon_{isct}^{j}$$
(11)

Similarly to before, for each industry j we create a dummy variable and run equation 11 independently for each industry.<sup>30</sup>

- $^{30}$  We distinguish between 11 types of industries:
  - 1. A griculture and Mining (SIC07 code  $01\mathchar`-09).$
  - Manufacturing, Low and Medium Technology (SIC07 code 10-25 and 31-34).
  - Manufacturing, High Technology (SIC07 code 26-30).
  - Commodities and Construction (SIC07 code 35-43).
  - 5. Wholesale and Retails (SIC07 code 45-47).
  - 6. Transportation and Storage (SIC07 code 49-53).

- 7. Hospitality (SIC07 code 55-56).
- 8. ICT (SIC07 code 58-63).
- 9. Finance and Insurance (SIC07 code 64-67). Please note, since the data available to researchers exclude banks and investment banks from the survey, we do not report the coefficients.
- 10. Real Estate (SIC07 code 68).
- Professional and Other Services (SIC07 code 69-98).



**Figure 8:** Heterogeneity by firms' sector,  $\gamma_i$ 

**Source:** Own Computation. Dependent variable: share of exports via commercial presence on total exports. The unit of analysis is the firm-service-country of destination through the years. Each point indicates the regression coefficient of the triple interaction term  $Brexit_t \times EU_c \times Industry_j$ , where Brexit is a dummy variable taking value 1 if the year is post-2016; EU is a dummy variable taking value 1 if the country of destination is part of the EU and Industry is a dummy variable taking value 1 for each industry a firm is registered in. The horizontal lines indicate the 95% confidence interval. The vertical line indicates the coefficient of substitution from the main analysis. Each regression also includes firm-year, service-year and country-fixed effects.

The most notable finding is the significantly higher elasticity of substitution for firms in the Wholesale and Retail industry, nearly double the average effect observed across other sectors (Figure 8). A plausible explanation for this is that, during the EU-UK trade negotiations, wholesalers and retailers shifted their operations to the EU to maintain access to one of the world's largest markets. Additionally, firms in the ICT and professional services sectors also show above-average elasticity. These findings align with the previous hypothesis regarding the relocation of firms to Romania and Germany. Furthermore, our industry-specific analysis allows us to rule out the idea that the shift towards Mode 3 after Brexit we have documented was solely driven by services related to manufacturing. Notably, while firms in high-tech manufacturing display an average elasticity, those in low- and medium-technology manufacturing appear largely unaffected by the Brexit shock.

Next, we explore the heterogeneity of effects based on firms' characteristics, distinguishing them by employment size and productivity. Large and more productive firms may have the financial resources to establish new affiliates in the EU, as in Helpman et al. (2004). We sort firms into small, medium, and large based on their employment size and low, mean, and high based on their labour productivity.<sup>31</sup> Subsequently, for each set of categories, we conduct the following regression:

$$share_{i(j)sct}^{k} = \gamma_{0} + \gamma_{1}Brexit_{t} \times Characteristics_{k} + \gamma_{2}EU_{c} \times Characteristics_{k} + \gamma_{k}Brexit_{t} \times EU_{c} \times Characteristics_{k} + \varphi_{st} + \varphi_{i} + \varphi_{jt} + \varphi_{c} + \epsilon_{i(j)sct}^{k}$$
(12)



**Figure 9:** Heterogeneity by firm's characteristics,  $\gamma_k$ 

**Source:** Own Computation. Dependent variable: share of exports via commercial presence in total exports. The unit of analysis is at the firm-service-country-year level. Each point indicates the regression coefficient of the triple interaction term  $Brexit_t \times EU_c \times Characteristic_k$ , where Brexit is a dummy variable taking value 1 if the year is post-2016; EU is a dummy variable taking value 1 if the country of destination is part of the EU and *Characteristics* is a dummy variable taking value 1 for each of the firm characteristics considered. Firm characteristics: small firms for employment below or equal to the  $25^{th}$  percentile in 2013; medium-sized firms for employment included between the  $25^{th}$  and the  $75^{th}$  percentile in 2013; large firms for employment above or equal to the  $75^{th}$  percentile in 2013; mean productivity firms for labour productivity included between the  $25^{th}$  percentile in 2013; mean productivity firms for labour productivity above or equal to the  $75^{th}$  percentile in 2013. The horizontal lines indicate the 95% confidence interval. The vertical line indicates the coefficient of substitution from the main analysis. Each regression also includes firm, service-year, sector-year and country fixed effects.

#### We run a separate regression for each of the firm categories (small, medium, large firms and

<sup>&</sup>lt;sup>31</sup> At first, we compute the point of the employment distribution of each firm before Brexit. We use as base year 2013 and compute the  $25^{th}$  and  $75^{th}$  percentile of the employment distribution in that year. We then assign each firm to one category depending on their employment in 2013. We assign the categories as follows: small firms for employment below or equal to the  $25^{th}$  percentile; Medium size firms for employment between the  $25^{th}$  and the  $75^{th}$  percentile; and large firms for employment above or equal to the  $75^{th}$  percentile. Similarly for productivity using 2013 as the reference year.

low-, mean- and high- productivity), thus computing a different substitution coefficient for each service category ( $\gamma_k$ , categories are by firm size and labour productivity).

Medium-size and highly productive firms exhibit the highest elasticity of substitution from cross-border to affiliate sales, consistent with theoretical expectations (Figure 9). Conversely, lower productivity and smaller firms experience a decline in the share of affiliate sales.

As a final piece of heterogeneity analysis, we estimate the substitution elasticity for different service types with the following regression:

$$share_{i(j)ct}^{s} = \gamma_{0} + \gamma_{1}Brexit_{t} \times Service_{s} + \gamma_{2}EU_{c} \times Service_{s} + \sigma_{s}Brexit_{t} \times EU \times Service_{s} + \varphi_{jt} + \varphi_{it} + \varphi_{c} + \varphi_{s} + \epsilon_{i(j)ct}^{s},$$
(13)

We conduct a separate regression for each type of service, resulting in one estimate  $\sigma_s$  per service type. As  $\sigma_s$  measures the degree to which firms switch delivery modes, we interpret it as the ease of mode switching for the respective service, akin to the elasticity of substitution between modes ( $\sigma_s$ ) in our conceptual framework.

Our estimates of substitution elasticities across different service types reveal substantial heterogeneity.<sup>32</sup> Specifically, services that were primarily exported cross-border pre-Brexit—such as computing, advertising, business management, and accountancy—exhibit higher elasticity of substitution. This indicates that firms increasingly shifted to exporting these services through affiliates rather than cross-border channels (see Figure 2 for pre-Brexit supply modes and Figure 10 for elasticities of substitution). As noted earlier in the industry-specific analysis for wholesale and retail, certain trade-facilitating services, such as merchanting, were relocated to the EU. We attribute this shift to the uncertainty surrounding the UK-EU trade agreement during the period analyzed. Finally, telecommunications and legal services show the lowest elasticity of substitution among those examined, likely due to the greater challenges of trading these services via affiliates, given country-specific regulations and restrictions to competition.

#### 7.1 Impact of Mode substitution on total trade

We now use the estimated services-specific mode substitution elasticities to evaluate the consequences of mode switches for UK trade and employment.

Intuitively, switching service delivery to modes less affected by Brexit-induced trade barriers might protect UK services exports, but potentially at the expense of UK employment, given that

 $<sup>^{32}</sup>$  Figure 10 shows the results for a selection of services, the complete list is included in the Appendix in Table C.8.



**Figure 10:** Heterogeneity by type of services,  $\sigma_s$ 

**Source:** Own Computation. Dependent variable: share of exports via commercial presence on total exports. The unit of analysis is firm-service-country of destination through the years. Each point indicates the regression coefficient of the triple interaction term  $Brexit_t \times EU_c \times Service_s$ , where Brexit is a dummy variable taking value 1 if the year is post-2016; EU is a dummy variable taking value 1 if the country of destination is part of the EU and Service is a dummy variable taking value 1 for each of the Service listed. The lines indicate the 95% confidence interval. Each regression also includes 2-digit sector-year, firm-year, service and country-fixed effects.

providing services via affiliates necessitates a commercial presence in the destination country.

We begin by studying the implications of mode substitution for UK services exports by estimating the following regression:

$$Export_{i(j)sct} = exp(\beta_0 + \beta_1 Brexit_t + \beta_2 EU_c + \beta_3 Brexit_t \times EU_c + \beta_4 Brexit_t \times EU_c \times \hat{\sigma_s} + \phi_{isc} + \phi_{jt}) \times \epsilon_{i(j)sct}$$
(14)

where  $Export_{isc(j)t}$  indicates the total Exports by firm *i* of service *s* to country *c* at time *t*.  $\hat{\sigma}_s$  is the estimated coefficient from equation 13, indicating the mode supply substitution elasticity by service-type. The coefficient of interest in this specification is  $\beta_4$ , which tells us by how much the change in exports to the EU after Brexit, measured by  $\beta_3$ , varies depending on how easily firms can switch their supply mode of the exported services - with a high  $\hat{\sigma}_s$  indicating a high substitutability across modes. If firms switch modes to circumvent new expected trade barriers after 2016, we expect  $\beta_4$  to be positive. Furthermore, we would expect the direct impact of Brexit on UK services exports to be negative ( $\beta_3 < 0$ ). Because  $Export_{i(j)sct}$  is frequently zero,

we employ the PPML estimator and estimate equation 14 with the dependent variable in levels, rather than in logs.

	(1)	(2)	(3)	(4)
EU=1	$-0.0966^{*}$ (0.0484)		$0.0979^{*}$ (0.0402)	
$Brexit \times EU = 1$	-0.1056 (0.0791)			-0.0084 (0.0323)
$Brexit \times EU = 1 \times \hat{\sigma_s}$	$\frac{46.6534^{***}}{(8.6070)}$	$45.0514^{***} \\ (8.9362)$	$45.8807^{***} \\ (12.0143)$	$26.0645^{**} \\ (9.7653)$
Sector×Year	Yes	Yes	Yes	Yes
Firm×Year	Yes	Yes	Yes	No
Country×Year	No	Yes	Yes	No
Service×Year	No	No	Yes	No
${\rm Firm} \times {\rm Service} \times {\rm Country}$	No	No	No	Yes
N	1,323,687	1,323,645	1,323,645	887,860

Table 11: Impact of elasticity of substitution on total trade

**Source**: Own Computation. Standard errors in parenthesis are robust. Dependent variable: total exports. *Brexit* is a dummy variable taking value 1 if the year is post-2016. *EU* is a dummy variable taking value 1 if the country of destination is part of the EU.  $\hat{\sigma}_s$  is the estimated elasticity of substitution for each service type. All regressions are estimated with PPML. <sup>+</sup> p < 0.1, <sup>\*</sup> p< 0.05, <sup>\*\*\*</sup> p< 0.01, <sup>\*\*\*\*</sup> p< 0.001

As expected, the coefficient on our triple interaction term ( $\beta_4$ ) is positive and statistically significant, indicating that firms with higher mode substitutability had higher exports to EU destinations after Brexit, ceteris paribus (Table 11). At the same time, the direct effect of Brexit was negative, albeit small and not statistically significant. The results on total trade remain statistically significant even when we include the most conservative set of fixed effects as in Columns 2, 3 and 4. As back-of-the-envelope computation, firms exporting Merchanting services have an estimated increase in Merchanting services towards the EU of 0.005% or £3.91 million.<sup>33</sup>

#### 7.2 Impact of Mode substitution on employment and turnover

We now use our estimated service-specific substitution elasticities to evaluate the impact of mode substitution on firms' employment and turnover. We expect the Brexit-induced trade cost increases to reduce UK services exporters' demand for domestic labour, as they switch to services production in the country of the affiliate. In addition, we expect these reductions to be

<sup>&</sup>lt;sup>33</sup> To compute, the elasticity of substitution for Merchanting services  $\hat{\sigma}_S = 0.0115$ . The total effects for firms exporting merchanting is  $\frac{(46.6534 \times 0.0115) - 0.00966 - 0.1056}{100}$ . We then multiply the elasticity by the average Total Export from Table 4.

stronger for firms trading services with a larger mode elasticity of substitution, as switching to services delivery via mode 3 is easier for these firms.

To take these predictions to the data, we proceed in two steps. First, for each firm, we identify the service that accounted for the largest share of exports in 2013. We take 2013 as a reference year, as it is sufficiently distant from the Brexit vote and from the announcement of the referendum. That is, we compute:

$$s_{i,max} = \arg(X_{i2013}^s / \sum_s X_{i2013}^s)$$
(15)

Where  $X_{i(j)2013}^s$  denotes exports by firm *i* of service s in 2013. Thus  $s_{i,max}$  denotes the service which accounted for the largest share of services exports by firm *i* in 2013 (in the following, we refer to this service as the firm's "top export"). Table 12 contains descriptive statistics for the shares and the top service shares in 2013, showing no significant differences between the two.

	Services Share	Top Service Share	
Mean St Dev	$0.4084 \\ (0.4663)$	$0.4188 \\ (0.4933)$	
Ν	$25,\!143$	25,143	

Table 12: Summary statistics services share

**Source**: Own Computation. Average share of exports of services on firm's total exports. Top service share refers to the service with the highest share. Both statistics refer to 2013.

Having identified firms' top exports, we estimate the following regression:

$$lnEmployment_{i(j)t} = \beta_0 + \beta_1 Brexit_t + \beta_2 X_{is,max}^{EU} + \beta_3 Brexit_t \times X_{is,max}^{EU} + \beta_4 Brexit_t \times X_{is,max}^{EU} \times \hat{\sigma}_{s,max} + \phi_i + \phi_{jt} + \epsilon_{i(j)t}$$
(16)

Where  $Employment_{i(j)t}$  is the employment of firm *i* at time *t*,  $X_{is,max}^{EU}$  is a binary indicator of whether firm *i* exported its top export service to the EU in 2013,  $\hat{\sigma}_{s,max}$  is the estimated coefficient from equation 13 for the top export service  $s_{i,max}$  and  $Brexit_t$  is the post-referendum dummy as previously defined. In addition, we include the logarithm of firm *i*'s total exports in 2013 as an additional control variable ( $\varphi_i$  in equation 16 and  $X_{i,2013}^{Total}$  in Table 13). This additional variable is meant to control for the fact that exports tend to be highly auto-correlated over time, so exports in 2013 are likely to be correlated with current exports, which in turn are likely to be correlated with current employment. This would be problematic if exports also happen to be correlated with our triple interaction term. Note that including firm fixed effects is not possible, because both  $\hat{\sigma}_{s,max}$  and  $X_{is,max}^{EU}$  are time-invariant so that almost all sources of variation in our triple interaction would be absorbed by firm fixed effects.

	(1)	(2)	(3)	(4)	(5)
			Firm Cluster	No Outliers	
$X_{si}^{EU} = 1$		$0.6131^{***}$	$0.6131^{***}$	$0.5928^{***}$	$0.1770^{***}$
sı.		(0.0254)	(0.0597)	(0.0247)	(0.0228)
				( )	
$Brexit \times X_{ci}^{EU} = 1$		$0.2997^{***}$	$0.2997^{***}$	$0.3026^{***}$	$0.1572^{**}$
Si		(0.0579)	(0.0621)	(0.0569)	(0.0519)
		× /	· · · ·	· · · ·	× /
$Brexit \times X_{si}^{EU} = 1 \times \hat{\sigma}_{si}$	$-24.0458^{***}$	$-81.2350^{***}$	$-81.2350^{***}$	$-77.2809^{***}$	$-33.8609^{***}$
51 00	(7.60007)	(8.3563)	(13.7286)	(8.3384)	(7.3082)
		· · · · ·		· · · ·	× ,
$X_{i,2013}^{Total}$					$0.4401^{***}$
,_010					(0.0045)
					. ,
$\hat{\beta}_{2} + \hat{\beta}_{2}$		0.9127***	$0.9127^{***}$	$0.8954^{***}$	$0.3342^{***}$
P2 + P3		(0.0520)	(0.0856)	(0.0511)	(0.0471)
		(0.0020)	(0.0000)	(0.0011)	(0.0111)
$\hat{\beta}_2 + \hat{\beta}_3 + \hat{\beta}_4 \mod \hat{\pi}_3$	-0.1089***	$0.6528^{***}$	$0.6528^{***}$	$0.6482^{***}$	$0.2259^{***}$
$r 2 \cdot r 0 \cdot r 4, mean s_i$	(0.0243)	(0.0476)	(0.0785)	(0.0465)	(0.0431)
				( )	· /
$\hat{\beta}_2 + \hat{\beta}_3 + \hat{\beta}_4 \log \hat{\sigma}_{si}$	$-0.251^{***}$	$0.8526^{***}$	$0.8526^{***}$	$0.8382^{***}$	$0.3091^{***}$
, _ , o , _,	(0.0056)	(0.0498)	(0.0820)	(0.0488)	(0.0451)
	× ,		× ,		. ,
$\hat{\beta}_2 + \hat{\beta}_3 + \hat{\beta}_{4,top\hat{\sigma}_{si}}$	$-0.2743^{***}$	$0.2582^{***}$	$0.2582^{**}$	$0.2727^{***}$	0.0613
	(0.0612)	(0.0658)	(0.1085)	(0.0647)	(0.0583)
		. ,	× •	. ,	. ,
Sector $\times$ Year	Yes	Yes	Yes	Yes	Yes
N	36,797	36,797	36,797	35,703	35,703

Table 13: Impact on Employment

**Source**: Own Computation. Dependent variable: log employment. Standard errors in parenthesis are robust (Columns 1, 3, 4) and clustered at the firm level (Column 2). Columns 3 and 4 exclude top and bottom 1% employment and exports in 2013.  $X_{is,max}^{EU}$  is a dummy variable taking value 1 if the firm was exporting the top service towards an EU country in 2013. *Brexit* is a dummy variable taking value 1 if the year is post-2016.  $\hat{\sigma}_s$  is the estimated elasticity of substitution for the top service type.  $X_{i,2013}^{Total}$  is the logarithm of the firm's exports in 2013. The unit of analysis is firm-top service-country of destination through the years. Low  $\hat{\sigma}_s$  corresponds to the elasticity of substitution in the bottom 25<sup>th</sup> percentile. Mean  $\hat{\sigma}_s$  corresponds to the mean elasticity of substitution. High  $\hat{\sigma}_s$  corresponds to the elasticity of substitution in the elasticity of substitution in the top 10<sup>th</sup> percentile. <sup>+</sup> p < 0.1, <sup>\*</sup> p< 0.05, <sup>\*\*</sup> p< 0.01

Our coefficient of interest is  $\beta_4$ , which captures how the employment response varies for firms with different mode substitution elasticities for their primary service export, as measured by  $\hat{\sigma}_s$ . We expect  $\beta_4$  to be negative, as firms that can more easily substitute towards Mode 3 are likely to increase employment at their foreign affiliates rather than domestically. As shown in Table 13, this expectation is confirmed: our estimated  $\beta_4$  is negative and statistically significant.

We test the robustness of our findings by clustering errors at the firm level (Column 3) and excluding firms in the top and bottom 1% of employment, to prevent outliers from disproportionately influencing our results (Column 4). Even with these adjustments, we observe a more negative semi-elasticity of employment for firms with a higher post-Brexit elasticity of substitution between service supply modes.

In the second panel of Table 13, we estimate the overall effects of Brexit on employment for firms whose primary exported service in 2013 had low, average, or high substitution elasticities. We define low elasticity as falling within the bottom 25% of substitution elasticities, and high elasticity as within the top 10%. The panel clearly shows that firms with higher substitution elasticities experience a more significant reduction in UK employment: firms with the highest substitution elasticity see a 0.4% lower growth in employment compared to the mean value.<sup>34</sup>

Finally, we replicate the analysis using turnover as the dependent variable to assess whether mode substitution influences this outcome. We expect that if firms increasingly export through affiliate sales, domestic turnover will decrease. As shown in Table C.9 in the Appendix, our estimates again produce a negative coefficient for the triple interaction term. This provides evidence that mode substitution also significantly impacted turnover in response to Brexit.

#### 8 Conclusions

In this paper, we investigated the determinants and consequences of the mode choices of service exporters using rich firm-level data from the United Kingdom, the world's second-largest service exporter. We started by providing novel descriptive evidence on how firms' mode choices correlate with firm characteristics such as size, R&D activity or whether the firm also trades in goods. We leveraged the Brexit referendum as a natural experiment to study how UK service exporters reacted to expected increases in trade costs, which affected cross-border supply more than affiliate sales. We found that UK service exporters reacted to this relative increase by switching towards affiliate sales when serving EU destination countries, primarily through extensive margin changes - meaning that firms were more likely to export through affiliates over the other modes after Brexit. By contrast, we did not find a similar mode substitution on the import side, where affiliate sales declined more relative to other modes. We also explored the implications of Brexit-induced mode switches for UK services exports and employment. While the move to affiliate sales helped mitigate the decline in UK service exports by bypassing new trade barriers, it also led to reduced domestic employment among UK exporters who relied on foreign affiliates. These impacts were more pronounced in services where mode substitution was relatively easy. Our findings have important policy implications, showing that firms can shift up to one-third of exports from cross-border to affiliate provision when facing higher trade uncertainty and barriers. This insight, valid also for the manufacturing industry, sheds further light on firm responses to protectionist policies and trade restrictions.

<sup>&</sup>lt;sup>34</sup> We reference the results in Column 2,  $(\hat{\beta}_2 + \hat{\beta}_3 + \hat{\beta}_{4,mean\hat{\sigma}_{si}}) - (\hat{\beta}_2 + \hat{\beta}_3 + \hat{\beta}_{4,top\hat{\sigma}_{si}}) = 0.6528 - 0.2582.$ 

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#### A Data Construction

All firms in the UK territory with a VAT number or operating a PAYE scheme are included in the Inter-Departmental Business Register (IDBR), comprising more than 2 million firms per year. A sample of firms from the IDBR is then selected for the ABS and receives a questionnaire on their characteristics (employment, number of plants, assets, trade status, etc.), which aggregate is used for UK national statistics. Large firms (above 250 employees) are always selected for the ABS, while small firms (below 250 employees) are randomly selected based on their region, industry and size (three bands stratification). The ABS contains sample population weights that in principle allow to reproduce of national statistics.<sup>35</sup>

Firms selected into ABS report, among other information, the amount of services traded independently from the value traded. Firms trading more than £10,000 per year are then selected into the ITIS sample, to answer more detailed questions on their services trade. Once a firm is selected into the ITIS, it remains in the sample for the subsequent years, irrespective of the ABS sampling. ITIS contains firms' information on services trade, both on exports and imports, of 52 services by country of origin/ destination of the service traded. Within the 52 services, one category is defined as "Services between related businesses not included elsewhere"; this category includes intra-firm trade that is not specified elsewhere. Hence, the dataset allows us to partly distinguish between affiliate trade and firm-to-firm trade. The services included in the ITIS are supplied either via Modes 1, 2 or 4. Unfortunately, as of today, it is not possible to distinguish between the different Modes. For the rest of the paper, we will refer to the flow from ITIS as Mode 1 of supply.

The AFDI contains information on firms' inward and outward foreign direct investment (FDI). For outward FDI, we observe UK affiliates' earnings abroad, as well as the location and industry of the investment. For inward FDI, we likewise observe earnings of foreign affiliates in the UK, as well as the industry and the country of origin of that affiliate. Firms included in the AFDI sample are selected by combining three sources: an ONS historical inward and outward FDI register of known and proved business (compiled among others by His Majesty Revenue and Customs (HMRC)), the cross-border Mergers and Acquisition Survey carried on a yearly and quarterly basis by the ONS, and from information from the Dun and Bradstreet Worldbase database. AFDI information is used as an official source for national statistics. We define the profits from foreign affiliates contained in the AFDI as Mode 3 of services supply. The most precise measure of Mode 3 flows would be the sales of the affiliate firms, but this is currently

 $<sup>^{35}</sup>$  Note, however, that researchers are currently not allowed to attempt to recompute official statistics.

unavailable for the UK. Affiliate profits are measured as the difference between the sales and the costs of production; hence, our Mode 3 measure is likely to be an underestimate of the trade flows through Mode 3 of the firm.

We first combine the ITIS and AFDI through firms' unique identification numbers, allowing us to provide an overview of firms' supply of services via Modes 1 and 3 separately by type of service, origin/destination and firms' industry from 2009 until 2019. Note that the classification of service types in the ITIS and AFDI differ, with the former following the BMP6 classification and the latter one the UKSIC07 classification. We build a conversion Table to link firms and types of services traded in the ITIS and AFDI datasets (Tables A.1 and A.2). In the second step, we combine the three datasets –ABS, ITIS and AFDI - through firms' unique identification numbers to increase the information available for all firms trading in services through different Modes. However, the three datasets follow different sampling procedures. For example, once a firm is selected in the ITIS, it always receives the questionnaire even if it is not sampled in the ABS or firms in the AFDI are "known businesses". Therefore, it is impossible to link some trade/FDI information with firm-level data (around 370,000 observations). To overcome this problem, we use information from the universe of firms contained in the IDBR secure access environment, which specifies firms' employment, turnover, industry and country of ownership, allowing us to have a better matching score. However, we avoid using any weighting due to the unknown sampling procedure in the AFDI.



Figure A.1: Export supply Mode by UK firms

**Source:** ONS. Share of mode of exporting services by type of service. Average shares for the period 2018-2020. The shares are computed using the total services trade flows and modes of supply included provided by the ONS.

(1)	(2)	(3)		
AFDI (SIC07)	ITIS (BPM6)	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		
	1011	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		

 Table A.1: Conversion Services ITIS and AFDI

**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.

(1)	(2)	(2)
(1)	(2)	(J) Sorvico
AFDI (SICOT)		
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

Table A.2: Conversion Services ITIS and AFDI

**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.

#### **B** Stylised Facts on Services Mode of Supply



Figure B.1: Industry-level Services Exports by Mode

**Source:** Own Computation using information from ITIS and AFDI. Mode of export services by industry of the firms exporting. Mode 1 is defined as the exports of services surveyed in the ITIS, while Mode 3 is defined as the profits of the foreign affiliates of UK firms surveyed in the AFDI dataset. Firm-level information is aggregated at the industry and year level and shares are computed for each year. E.g. Share of Mode 1 in ICT is computed as the total exports of firms in ICT surveyed in the ITIS dataset, divided by the total exports of firms in ICT surveyed in the ITIS dataset, divided by UK firms in ICT surveyed in the AFDI dataset. The Figure refers to the year 2017. Some industries are excluded due to data confidentiality.



Figure B.2: Services Imports by Mode

**Source:** ONS. Mode of importing services by type of service. Mode 1 is defined as the imports of services surveyed in the ITIS, while Mode 3 is defined as the profits of the affiliates in the UK owned by foreign companies surveyed in the AFDI. Firm-level information is aggregated at the services type and year level and shares are computed for each year. E.g. Share of Mode 1 of Advertising is computed as the total imports in advertising surveyed in the ITIS dataset, divided by the total imports in advertising surveyed in the ITIS dataset, divided by the total imports in advertising surveyed in the ITIS dataset. The Figure refers to the year 2017.



Figure B.3: Industry-level Services Imports by Mode

**Source:** ONS. Mode of importing services by industry of the firms importing. Mode 1 is defined as the imports of services surveyed in the ITIS, while Mode 3 is defined as the profits of the affiliates in the UK owned by foreign companies surveyed in the AFDI. Firm-level information is aggregated at the industry and year level and shares are computed for each year. E.g. Share of Mode 1 in ICT is computed as the total imports of firms in ICT surveyed in the ITIS dataset, divided by the total imports of firms in ICT surveyed in the ITIS dataset, divided by foreign firms in ICT surveyed in the AFDI dataset. The Figure refers to the year 2017. Some industries are excluded due to data confidentiality.

	(1)	(2)	(2)	(4)
	(1)	(2)	(3)	(4)
	Cross Border	Affiliates	Intra-Firm	Cross Border &
				Affiliates
Foreign Owned	$-0.1116^{***}$	$0.1553^{***}$	$0.0499^{***}$	$0.0329^{***}$
	(0.0052)	(0.0026)	(0.0035)	(0.0012)
	, , , , , , , , , , , , , , , , , , ,	, , , , , , , , , , , , , , , , , , ,		· · · ·
Export Goods	$0.0216^{\ast}$	$-0.0174^{*}$	$0.0144^{*}$	-0.0006
-	(0.0095)	(0.0073)	(0.0067)	(0.0062)
	× /	· · · ·	× /	
Import Goods	$0.1948^{***}$	$0.0261^*$	$0.0612^{***}$	$0.0211^{***}$
-	(0.0184)	(0.0106)	(0.0105)	(0.0029)
Trading Goods	0 1458***	0.0020	0.0711***	0.0006*
Trading Goods	-0.1450	-0.0020	-0.0711	-0.0030
	(0.0204)	(0.0126)	(0.0122)	(0.0045)
Investing in R&D	-0.0064	$0.1000^{***}$	$-0.0082^{*}$	$0.0090^{***}$
	(0.0048)	(0.0032)	(0.0035)	(0.0015)
	()	()	(	()
N	43,354	43,354	43,354	43,354

Table B.1: Services Imports Mode of Supply and Firms' International Activities

Source: Own Computation using information from AFDI, ITIS and ABS. Standard errors in parenthesis are robust. Dependent variables: dummy variable taking value equal to 1 if a firm has positive cross-border imports (Cross-Border); dummy variable taking value equal to 1 if a firm has positive imports via commercial presence (Affiliates); dummy variable taking value equal to 1 if a firm has positive imports via commercial presence (Affiliates); dummy variable taking value equal to 1 if a firm has positive imports of services between affiliates (Intra-Firms); dummy variable equal to 1 if a firm has at the same time positive services imports via cross-border and commercial presence (Cross-Border & Affiliates). Explanatory variables: Foreign Owned, dummy variable taking value equal to 1 if a firm is foreign-owned; Export Goods, dummy variable taking value equal to 1 if a firm is exporting but not importing goods; Import Goods, dummy variable taking value equal to 1 if a firm is importing but not exporting goods; Trading Goods, dummy variable taking value equal to 1 if a firm is exporting in R&D, dummy variable taking value equal to 1 if a firm has positive expenditure in R&D. All regressions include 2-digit sector fixed effects. + p < 0.1, \* p < 0.05, \* p < 0.01, \*\* p < 0.001

Table B.2: Services Imports Mode of Supply and Firms' Characteristics

	(1)	(2)	(3)	(4)	(5)	(6)
	Employment	Turnover	Wage Bill	Capex	GVA	Computer
		$(,000 \pounds)$	$(.000 \pounds)$			Services
Cross Border	$0.9533^{***}$	$3.1183^{***}$	$108.9117^{***}$	$0.1554^{***}$	$0.0332^{***}$	$2.8973^{***}$
(,000 £)	(0.1487)	(0.6034)	(11.8019)	(0.0186)	(0.0048)	(0.2625)
Affiliates Sales,	0.0000	0.0000	$0.0007^{***}$	0.0000	$0.0000^{***}$	-0.0000
profits $(mln \pounds)$	(0.0000)	(0.0000)	(0.0002)	(0.0000)	(0.0000)	(0.0000)
N	43,354	43,354	43,354	43,354	43,354	43,354
11	10,001	10,001	10,001	10,001	10,001	10,001

**Source**: Own Computation using information from AFDI, ITIS and ABS. Standard errors in parenthesis are robust. Dependent variables: cross-border imports (in thousands of  $\pounds$ ), affiliate sales profits (in millions of  $\pounds$ ). Explanatory variables: firm's employment, firm's total wage bill (in thousands of  $\pounds$ ), firm's total capital expenditure (in  $\pounds$ ), firm's gross value added at market price (in  $\pounds$ ), firm's total investment in purchased computer services (in  $\pounds$ ). All regressions include 2-digit sector-fixed effects. <sup>+</sup> p < 0.1, <sup>\*</sup> p< 0.05, <sup>\*\*</sup> p< 0.01

#### C Additional Results

	(1)	(2)	(3)	(4)	(5)	(6)
	Cross-I	Border	Affil	iates	Tota	l Trade
$Brexit \times EU = 1$	-0.0061	$0.0506^{*}$	-0.1781	0.0971	-0.0142	$0.0509^*$
	(0.0533)	(0.0214)	(0.2813)	(0.2087)	(0.0526)	(0.0213)
Firm×Year	Yes	No	Yes	No	Yes	No
Sector×Year	Yes	Yes	Yes	Yes	Yes	Yes
Service×Year	Yes	No	Yes	No	Yes	No
Firm×Service× Country	No	Yes	No	Yes	No	Yes
Firm×Services×Year	No	Yes	No	Yes	No	Yes
N	1,597,064	965,598	46,972	6,487	1,610,727	971,983,804

Table C.1: Services exports by supply Mode, ppml

**Source**: Own Computation. Standard errors in parenthesis are robust. Dependent variable: exports via cross-border, (Columns 1-2), exports via Commercial Presence (Columns 3-4), total exports (Columns 5-6). The unit of analysis is firm-service-country of destination through the years. *Brexit* is a dummy variable taking value 1 if the year is post-2016. *EU* is a dummy variable taking value 1 if the destination country is part of the EU. All specifications are in PPML. + p < 0.1, \* p < 0.05, \*\* p < 0.01, \*\* p < 0.001

	(1)	(2)	(3)	(4)	(5)	(6)
	Cross-	Border	Affili	ates	Total	Trade
$Brexit \times EU = 1$	$-0.0871^{***}$ (0.0076)	$0.0293^{***}$ (0.0067)	$0.0064^{***}$ (0.0009)	$0.0016^{*}$ (0.0007)	$-0.0824^{***}$ (0.0076)	$0.0297^{***}$ (0.0067)
Firm×Year	Yes	No	Yes	No	Yes	No
Sector×Year	Yes	Yes	Yes	Yes	Yes	Yes
Service×Year	Yes	No	Yes	No	Yes	No
Firm×Service× Country	No	Yes	No	Yes	No	Yes
Firm×Services×Year	No	Yes	No	Yes	No	Yes
Ν	$1,\!195,\!965$	$1,\!195,\!965$	$1,\!195,\!965$	892,804	892,804	892,804

Table C.2: Services exports by supply Mode, excluding singletons

**Source**: Own Computation. Standard errors in parenthesis are robust. Dependent variable: log exports via cross-border, (Columns 1-2), log exports via commercial presence (Columns 3-4), log total exports (Columns 5-6). The unit of analysis is firm-service-country of destination through the years. *Brexit* is a dummy variable taking value 1 if the year is post-2016. *EU* is a dummy variable taking value 1 if the destination country is part of the EU. The logarithms are computed by adding one to the trade flows (lnx = ln(x + 1)).  $^+ p < 0.01$ ,  $^* p < 0.01$ ,  $^{***} p < 0.001$ 

	(1)	(2)
	Affiliate	Affiliate
$Brexit \times EU = 1$	$0.0006^{***}$ (0.0002)	$0.0010^{***}$ (0.0003)
Firm	No	Yes
Firm×Year	Yes	No
$\operatorname{Sector} \times \operatorname{Year}$	Yes	Yes
$\operatorname{Firm} \times \operatorname{Country}$	Yes	Yes
N	829,920	860,737

Table C.3:Share of services exportsthrough affiliates

Source:Own Computation. Standard errors in parenthesis are robust. Dependent variable: share of services export via affiliates in total services exports. The unit of analysis is firm-country of destination through the years. *Brexit* is a dummy variable taking value 1 if the year is post-2016. *EU* is a dummy variable taking value 1 if the destination country is part of the EU. <sup>+</sup> p < 0.1, <sup>\*</sup> p < 0.05, <sup>\*\*</sup> p < 0.01, <sup>\*\*\*</sup> p < 0.001

Table C.4: Robustness Checks, assumptions of the empirical model

	(1)	(2)	(3)	(4)	(5)	(6)
	Place	ebo	No Tax	Havens	No 2014	
US = 1	$\begin{array}{c} 0.0031^{***} \\ (0.0004) \end{array}$					
$Brexit \times US = 1$	-0.0003 (0.0007)	$\begin{array}{c} 0.0000\\ (0.0004) \end{array}$				
EU = 1			$-0.0002^{*}$ (0.0001)		-0.0001 (0.0001)	
$Brexit \times EU = 1$			$\begin{array}{c} 0.0013^{***} \\ (0.0002) \end{array}$	$0.0002^{*}$ (0.0001)	$\begin{array}{c} 0.0012^{***} \\ (0.0002) \end{array}$	$0.0002^{*}$ (0.0001)
$\overline{\text{Firm} \times \text{Year}}$	Yes	No	Yes	No	Yes	No
Sector $\times$ Year	Yes	Yes	Yes	Yes	Yes	Yes
Service $\times$ Year	Yes	No	Yes	No	Yes	No
$Firm \times Service \times Country$	No	Yes	No	Yes	No	Yes
$\mathbf{Firm}{\times}\mathbf{Services}{\times}\mathbf{Year}$	No	Yes	No	Yes	No	Yes
N AR2	$729,629 \\ 0.770$	$523,864 \\ 0.971$	$1,195,965 \\ 0.802$	$892,804 \\ 0.975$	$1,092,172 \\ 0.801$	$780,343 \\ 0.974$

**Source**:Own Computation. Standard errors in parenthesis are robust. Dependent Variables: Share of exports via affiliates on total exports. The unit of analysis is firm-country of destination through the years. *Brexit* is a dummy variable taking value 1 if the year is post-2016. *US* is a dummy variable taking value 1 if the destination country is the U.S. *EU* is a dummy variable taking value 1 if the destination country is part of the EU. <sup>+</sup> p < 0.1, <sup>\*</sup> p< 0.05, <sup>\*\*</sup> p< 0.01, <sup>\*\*\*</sup> p< 0.001



Figure C.1: Event Study

**Source:** Own Computation. Dependent variable: share of services export via commercial presence on total services exports. The unit of analysis is firm-service-country of destination through the years. The regression equation includes an EU dummy variable, taking value 1 if the country of destination is part of the EU, and a year dummy variable. Vertical lines indicate the 95% confidence interval. The regression includes firm-year, service-year and sector-year fixed effects. Standard errors are robust.

	(1)	(2)	(3)	(4)
		Controllin	g for Exchang	ge Rate
ExchangeRate		-0.00009*** (0.00002)	$-0.0001^{***}$ (0.0000)	-0.0002 $(0.0003)$
EU = 1			$-0.0003^{***}$ (0.0001)	
$Brexit \times EU = 1$			$\begin{array}{c} 0.0013^{***} \\ (0.0002) \end{array}$	$0.0002^{*}$ (0.0001)
$2009.Year \times 1.Treatment$	-0.00014 (0.00026)	-0.00007 (0.00027)		
$2010.Year \times 1.Treatment$	-0.00002 (0.00039)	-0.00002 (0.00039)		
$2011. Year \times 1. Treatment$	-0.00025 (0.00033)	-0.00025 (0.00033)		
$2012. Year \times 1. Treatment$	-0.00030 (0.00036)	-0.00031 (0.00036)		
$2013. Year \times 1. Treatment$	-0.00042 (0.00029)	-0.00040 (0.00029)		
$2014. Year \times 1. Treatment$	$-0.00099^{***}$ (0.00037)	$-0.00099^{***}$ (0.00037)		
$2015. Year \times 1. Treatment$	-0.00037 (0.00039)	-0.00037 (0.00039)		
$2017. Year \times 1. Treatment$	$0.00071^{**}$ (0.00036)	$\begin{array}{c} 0.00072^{***} \\ (0.00036) \end{array}$		
$2018. Year \times 1. Treatment$	$\begin{array}{c} 0.00139^{***} \\ (0.00039) \end{array}$	$\begin{array}{c} 0.00138^{***} \\ (0.00039) \end{array}$		
$2019. Year \times 1. Treatment$	$\begin{array}{c} 0.00083^{***} \\ (0.00039) \end{array}$	$\begin{array}{c} 0.00083^{***} \\ (0.00039) \end{array}$		
$Firm \times Year$	Yes	Yes	Yes	No
Sector $\times$ Year	Yes	Yes	Yes	Yes
Service $\times$ Year	Yes	Yes	Yes	No
Firm $\times$ Service $\times$ Country Firm $\times$ Service $\times$ Year	No No	No No	No No	Yes Yes
N	1,195,965	1,195,965	1,195,965	892,804

#### Table C.5: Event Study Coefficients

Source: Own Computation. Dependent variable: share of exports via commercial presence on total exports. Dependent variable: share of services export via commercial presence on total services exports. The unit of analysis is firm-service-country of destination through the years. *ExchangeRate* indicates the exchange rate between British Pound and the currency in the destination country. *Brexit* is a dummy variable taking value 1 if the year is post-2016. *EU* is a dummy variable taking value 1 if the destination country is part of the EU. <sup>+</sup> p < 0.1, <sup>\*</sup> p< 0.05, <sup>\*\*</sup> p< 0.01, <sup>\*\*\*</sup> p< 0.001

	(1)	(2)	(3)	(4)
	Restr	icted	Differe	nt SE
$Brexit \times EU = 1$	$0.0014^{***}$ (0.0002)	$0.0002^{*}$ (0.0001)	$0.0013^{***}$ (0.0003)	$0.0002^+$ (0.0001)
Firm×Year	Yes	No	No	No
Sector×Year	Yes	Yes	Yes	Yes
Service×Year	Yes	No	No	No
Country	Yes	No	No	No
Firm×Service× Country	No	Yes	Yes	Yes
Firm×Services×Year	No	Yes	Yes	Yes
N	995,133	751,451	$1,\!195,\!965$	892,804

Table C.6: Robustness Checks, sample selection and error clustering

Source: Own Computation. Standard errors in parenthesis are robust. Dependent Variables: Share of exports via affiliates on total exports. The unit of analysis is firm-service-country of destination through the years. *Brexit* is a dummy variable taking value 1 if the year is post-2016. *EU* is a dummy variable taking value 1 if the destination country is part of the EU. "Restricted" refers to the sample of analysis using as services trade flows the services categories perfectly matched between the ITIS and the AFDI. <sup>+</sup> p < 0.1, <sup>\*</sup> p< 0.05, <sup>\*\*</sup> p< 0.01

	(1) Cross-Border Share, ITIS	(2) Cross-Border Share, ABS
Mean St Dev	$0.95 \\ (0.22)$	$0.96 \\ (0.18)$
N	30,769	30,769

 Table C.7:
 Comparison ABS and ITIS

**Source**: Own computation. The unit of analysis is firm level through the years. Shares are computed as the share of cross-border exports in total exports. Total exports are computed summing cross-border exports with affiliates sales (from AFDI).

(1) Services	(2) Coefficient (St. Error)	(3) Services	(4) Coefficient (St. Error)	(5) Services	(6) Coefficient (St. Error)
Agricultural and Fishing	0.0001 (0.0002)	Computer	$0.0029^{***}$ (0.0008)	Merchanting	$0.0115^{***}$ (0.0028)
Mining	-0.0008 (0.0016)	Publishing	$0.0052^{**}$ (0.0017)	Audio-Visual	$0.0044^{**}$ (0.0014)
Waste Treatment	$0.0028 \\ (0.0051)$	News Agency	$\begin{array}{c} 0.0002 \\ (0.0002) \end{array}$	Health	0.0018 (0.0027)
Mantainance and Repair	$0.0016^+ \\ (0.0009)$	Information	$0.0021^{*}$ (0.0010)	Education	$0.0008^+$ (0.0005)
Accountancy	$0.0010^+$ (0.0006)	Construction	$-0.0087^{**}$ (0.0033)	Heritage	$0.0015 \\ (0.0021)$
Advertising	$0.0023^{***}$ (0.0005)	Financial	0.0009 (0.0007)	Social	$\begin{array}{c} 0.0034 \\ (0.0036) \end{array}$
Business Management	$0.0021^{***}$ (0.0006)	Life Insurance	0.0924 (0.1527)	Architectural	$0.0069 \\ (0.0061)$
Public Relation	$0.0081^+ \\ (0.0046)$	Auxiliary	-0.0046 (0.0028)	Engineering	$0.0007 \\ (0.0006)$
Recruitment	-0.0021 (0.0018)	Operting Leasing	0.0007 (0.0025)	Other Trade	$\begin{array}{c} 0.0002\\ (0.0010) \end{array}$
Legal	$0.0004^+$ (0.0002)	Property Management	-0.0008 (0.0013)	Business and Professional	0.0010 (0.0007)
R&D	$0.0038 \\ (0.0025)$	Postal and Courier	$0.0064^{***}$ (0.0015)	Telecommunication	$-0.0011^*$ (0.0005)

Table C.8: Sigmas  $\sigma_s$ 

**Source**:Own Computation. Dependent variable: share of exports via commercial presence on total exports. The unit of analysis is firm-service-country of destination through the years. Each cell indicates the regression coefficient of the triple interaction term  $Brexit_t \times EU_c \times Service_s$ , where Brexit is a dummy variable taking value 1 if the year is post-2016; EU is a dummy variable taking value 1 if the EU and Service is a dummy variable taking value 1 for each of the Service listed. Each regression also includes 2-digit sector-year, firm-year, service and country-fixed effects.<sup>+</sup> p < 0.1, \* p< 0.05, \*\* p< 0.01, \*\*\* p< 0.001

	(1)	(2)	(3)	(4)	(5)
$X_{si}^{EU}=1$		$0.7605^{***}$ (0.0340)	$0.7605^{***}$ (0.0778)	$0.7050^{***}$ (0.0326)	$0.1765^{***}$ (0.0301)
$Brexit \times X^{EU}_{si}{=}1$		$0.2997^{***}$ (0.0579)	$0.2997^{***}$ (0.0621)	$0.3026^{***}$ (0.0569)	$0.1572^{**}$ (0.0519)
$Brexit \times X^{EU}_{si} = 1 \times \hat{\sigma}_{si}$	$-47.6629^{***}$ (10.8586)	$-104.3552^{***}$ (11.7716)	$-104.3552^{***}$ (19.1966)	$\begin{array}{c} -97.8857^{***} \\ (11.1382) \end{array}$	$\begin{array}{c} -42.7002^{***} \\ (9.7000) \end{array}$
$X_{i,2013}^{Total}$					$0.5653^{***}$ (0.0056)
$\hat{\beta}_2 + \hat{\beta}_3$		$\frac{1.0966}{(0.0695)}^{***}$	$\frac{1.0966}{(0.1140)}^{***}$	$\frac{1.0830^{***}}{(0.0662)}$	$\begin{array}{c} 0.3531^{***} \\ (0.0604) \end{array}$
$\hat{eta}_2+\hat{eta}_3+\hat{eta}_{4,mean\hat{\sigma}_{si}}$	$-0.1524^{***}$ (0.0347)	$0.7628^{***}$ (0.0656)	$0.7628^{***}$ (0.1079)	$0.7698^{***}$ (0.0614)	$\begin{array}{c} 0.2165^{***} \\ (0.0567) \end{array}$
$\hat{\beta}_2 + \hat{\beta}_3 + \hat{\beta}_{4,low\hat{\sigma}_{si}}$	$-0.0352^{***}$ (0.0080)	$\frac{1.0194^{***}}{(0.0668)}$	$\frac{1.0194^{***}}{(0.1096)}$	$\frac{1.0105^{***}}{(0.0634)}$	$\begin{array}{c} 0.3215^{***} \\ (0.0582) \end{array}$
$\hat{\beta}_2 + \hat{\beta}_3 + \hat{\beta}_{4,top\hat{\sigma}_{si}}$	$-0.3840^{***}$ (0.0874)	$0.2558^{**}$ (0.0946)	$0.2558^+$ (0.1549)	$\begin{array}{c} 0.2943^{***} \\ (0.0877) \end{array}$	$\begin{array}{c} 0.0091 \\ (0.0790) \end{array}$
Sector $\times$ Year	Yes	Yes	Yes	Yes	Yes
N	36,571	36,571	36,571	35,399	35,399

Table C.9: Impact on Turnover

**Source**:Own Computation. Dependent variable: log turnover. Standard errors in parenthesis are robust (Columns 1, 3, 4) and clustered at the firm level (Column 2). Columns 3 and 4 exclude top and bottom 1% turnover and exports in 2013.  $X_{is,max}^{EU}$  is a dummy variable taking value 1 if the firm was exporting the top service towards an EU country in 2013. *Brexit* is a dummy variable taking value 1 if the year is post-2016.  $\hat{\sigma}_s$  is the estimated elasticity of substitution for the top service type.  $X_{i,2013}^{Total}$  is the logarithm of the firm's exports in 2013. The unit of analysis is firm-top service-country of destination through the years. Low  $\hat{\sigma}_s$  corresponds to the elasticity of substitution in the bottom  $25^{th}$  percentile. Mean  $\hat{\sigma}_s$  corresponds to the elasticity of substitution. High  $\hat{\sigma}_s$  corresponds to the elasticity of substitution in the bottom  $25^{th}$  percentile. Mean  $\hat{\sigma}_s$  corresponds to the organize to the elasticity of substitution. High  $\hat{\sigma}_s$  corresponds to the elasticity of substitution. High  $\hat{\sigma}_s$  corresponds to the elasticity of substitution in the bottom  $25^{th}$  percentile. Mean  $\hat{\sigma}_s$  corresponds to the elasticity of substitution. High  $\hat{\sigma}_s$  corresponds to the elasticity of substitution in the top  $10^{th}$  percentile. + p < 0.1, \* p < 0.05, \* p < 0.01

#### Disclaimer

#### **Online Appendix**



Figure 0.1: Difference trade flows in affiliates services between Non-EU and EU countries

**Source:** ITIS. Services exports and imports from/to affiliates firms difference between non-EU and EU countries for the period 2009-2021. Firm-level information is aggregated and distinguished between flows with EU 27 members and the rest of the World for each year. Imports from affiliates are a type of service highlighted in the ITIS dataset. The vertical line refers to 2016, the year of the Brexit referendum.



Figure 0.2: Pattern of Management Services Imports via cross-border

**Source:** ITIS. Log of imports of Management Services divided between EU and non-EU countries for the period 2009-2021. Firm-level information is aggregated and distinguished between flows with EU 27 members and the rest of the World for each year. The vertical line refers to 2016, the year of the Brexit referendum.



Figure O.3: Pattern of Management Services Exports via cross-border

**Source:** ITIS. Log of exports of Management Services divided between EU and non-EU countries for the period 2009-2021. Firm-level information is aggregated and distinguished between flows with EU 27 members and the rest of the World for each year. The vertical line refers to 2016, the year of the Brexit referendum.



Figure 0.4: Pattern of Computer Services Imports via cross-border

**Source:** ITIS. Log of imports of Computer Services divided between EU and non-EU countries for the period 2009-2021. Firm-level information is aggregated and distinguished between flows with EU 27 members and the rest of the World for each year. The vertical line refers to 2016, the year of the Brexit referendum.



Figure 0.5: Pattern of Computer Services Exports via cross-border

**Source:** ITIS. Log of imports of Computer Services divided between EU and non-EU countries for the period 2009-2021. Firm-level information is aggregated and distinguished between flows with EU 27 members and the rest of the World for each year. The vertical line refers to 2016, the year of the Brexit referendum.



Figure 0.6: Pattern of Services Imports from Germany via cross-border

**Source:** ITIS. Log of imports from Germany and imports from affiliates in Germany for the period 2009-2021. Firm-level information is aggregated distinguishing between imports and imports from affiliated firms for each year. The vertical line refers to 2016, the year of the Brexit referendum.



Figure 0.7: Pattern of Services Exports to Germany via cross-border

**Source:** ITIS. Log of exports to Germany and exports to affiliates in Germany for the period 2009-2021. Firmlevel information is aggregated distinguishing between exports and exports from affiliated firms for each year. The vertical line refers to 2016, the year of the Brexit referendum.

![](_page_68_Figure_0.jpeg)

Figure O.8: Pattern of Services Imports from France via cross-border

**Source:** ITIS. Log of imports from France and imports from affiliates in France for the period 2009-2021. Firmlevel information is aggregated distinguishing between imports and imports from affiliated firms for each year. The vertical line refers to 2016, the year of the Brexit referendum.

![](_page_68_Figure_3.jpeg)

Figure 0.9: Pattern of Services Exports to France via cross-border

**Source:** ITIS. Log of exports to France and exports to affiliates in France for the period 2009-2021. Firm-level information is aggregated distinguishing between imports and imports from affiliated firms for each year. The vertical line refers to 2016, the year of the Brexit referendum.

![](_page_69_Figure_0.jpeg)

#### Figure 0.10: Event Study

Source: Own Computation. Dependent variable: share of services export via commercial presence on total services exports. The unit of analysis is firm-service-country of destination through the years. The regression equation includes an EU dummy variable, taking value 1 if the country of destination is part of the EU, a year dummy variable and the exchange rate between British pound and the currency of the country of destination. Vertical lines indicate the 95% confidence interval. The regression includes firm-year, service-year and sector-year fixed effects. Standard errors are robust.